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PREFACE

International Conference on Interdisciplinary Applications of Artificial Intelligence 2021 (ICIDAAI'21) was organized online from 21-23 May 2021. This was the first virtual conference which was organized in collaboration with Yalova University, Istanbul University, Kocaeli University, Sakarya University, Bursa Techical University, UET Lahore University, Matej Bel University, University of Tlemcen, Universite 8 Mai 1945 Guelma, International Vision University, Bulgarian Academy of Sciences, Lahore Leads University and IQRA National University.

There were 106 presentations for the virtual conference. A secured platform was used for virtual interactions of the participants. After the virtual conference, there was a call for full papers to be considered for publication in the conference proceedings. Manuscripts were received and they were processed and peer reviewed. These manuscripts cover a range of Artificial Intelligence topics from social sciences to physical sciences.

We hope that these chapters will add to literature, and they will be useful references. To conclude, ICIDAAI'21 was a successful event, and we would like to thank all those who have contributed. We would also like to thank the Organizing and International Advisory committee members, the participants, and the reviewers.

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CONTENT

Artificial Bee Colony Algorithm Based Hyper-Parameter Optimization for Convolutional Neural Networks

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***Abstract*—In recent years, Deep Learning has become a field that researchers are particularly interested in. The Convolutional Neural Network (CNN) is a type of multi-layered artificial neural network mostly used in the analysis, recognition, and classification of images and videos. The performance of CNN models is usually based on custom model architectures, thus several hyper-parameter values in a CNN are manually selected mostly. However, different combinations of hyper-parameters and models need to be used to achieve better performance results. Determination of optimum values of hyper-parameters is also an optimization problem. The meta-heuristic optimization techniques are able to solve such problems. In this paper, we propose to use the Artificial Bee Colony (ABC) algorithm which is a meta-heuristic approach to automatically determine the optimum architecture of a CNN by means of hyper-parameters. The most effective hyper-parameters in the performance of CNN models have been optimized, which are the number of layers, the number and size of filters, activation function, batch size, learning rate, optimizer, and dropout rate. We have evaluated our optimized architecture using the well-known Fashion-MNIST dataset. The results demonstrate that the proposed model using ABC improves the performance of a CNN model.**

Keywords—convolutional neural networks, artificial bee colony, hyper-parameters, optimization, deep learning

I. INTRODUCTION

Artificial Neural Networks (ANNs), one of the common machine learning methods, are computing systems created by imitating the structure of biological neural networks. They are based on the information processing and analysis processes of the human brain. ANNs are widely used in solving real world problems such as speech recognition, visual recognition, and natural language processing [1]. The concept of Deep Neural Network (DNN) has emerged by increasing the number of hidden layers in the structure of ANNs. DNNs, unlike traditional ANNs, consist of more than two hidden layers connected with each other [2]. Its advanced structure produces high performance results in fields such as image recognition and speech recognition compared to traditional ANNs [3], [4].

Convolutional Neural Networks (CNNs), a special type of DNNs, were firstly introduced in 1998 for document recognition tasks [5]. They have been widely used in fields such as handwriting recognition [6] and image classification [7]. In addition, the use of CNNs in robotics has significantly increased in recent years due to the advances in processing technologies [8]. In order to increase the performance of CNNs, studies are generally carried out on the training phase [9]. In addition to the training phase, hyper-parameter optimization also plays an important role in improving the performance of CNNs. The hyper-parameters such as filter size, number of hidden layers, learning rate, and activation function are needed to be optimized. The correct tuning of the hyper-parameters has a direct impact on the performance of a CNN. These parameters are set manually or used by methods such as grid search or random search. In the manual search method, it is necessary to rely on the intuition and experience of the researcher in order to set the hyper-parameters correctly. However, the training process needs to be repeated with each new set of hyper-parameters, and this is quite laborious and time-consuming. The grid search method is one of the traditional methods used in setting hyper-parameters. In a study conducted by Liashchynskyi [10], it has been stated that the grid search method is not effective in high dimensional spaces and its positive effect on network performance is limited. The random search method, which is another hyper-parameter setting method, is based on running all possible combinations. Bergstra and Bengio [11] compared manual search, grid search, and random search methods and they found that the random search method alone gives more successful results than others. However, the random search method is non-adaptive. In other words, the previously tried hyper-parameters are not taken into account when trying new parameters. For this reason, it has been observed in the study that the combination of manual search and random search methods is more successful than the random search method. The use of meta-heuristic approaches in CNNs for hyper-parameter selection is a potential field of study when compared to traditional search methods. Young et al. [12] used genetic algorithms (GA) in the hyper-parameter optimization of CNNs. They used the CIFAR-10 dataset for experiments and stated that the GA approach was more effective than random search.

In this study, the Artificial Bee Colony (ABC) algorithm, one of the nature-inspired meta-heuristics approaches, has been used in the hyper-parameter optimization of CNNs.

II. BACKGROUND

A. Artificial Bee Colony Algorithm

ABC algorithm was introduced by Dervis Karaboga in 2005 for the purpose of optimizing numerical problems [13]. It is a swarm-based meta-heuristic algorithm based on imitating the foraging behaviors of honey bees in nature. ABC algorithm basically consists of three types of bees: employed bees, onlooker bees, and scout bees [14]. Employed bees

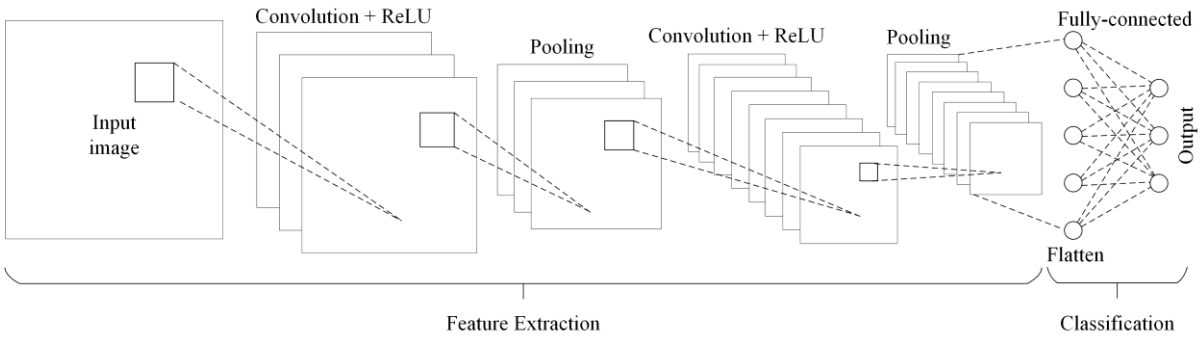

Fig. 1. The basic architecture of CNN

search to find rich food sources. Rich food sources represent the best solutions to the given problem. Then, the employed bee shares information regarding the food source with the onlooker bee. The onlooker bee can choose a source using this information. The scout bees are responsible for finding new food sources instead of abandoned food sources. In the ABC algorithm, all parameters to be optimized of the problem are represented vector and is tried to find the best parameter vector which minimizes an objective function. Each of the parameter vectors is named a food source. The algorithm starts with the initial random values of the parameter. In each iteration, while poor food sources are abandoned, rich food sources are reached by using the neighboring solution mechanism. Thus, food sources that represent the best solution to the given problem are found.

The initial food sources, x_i, are generated randomly in the ABC algorithm using (1).

$$x_{ij} = x_j^{min} + rand(0,1)(x_j^{max} - x_j^{min}) \qquad (1)$$

where i represents ith food source which is a candidate solution and j represents jth parameter to be optimized, x_j^{min} and x_j^{max} are lower and upper bounds of the jth parameter. A random number between 0 and 1 is generated by $rand(0,1)$.

The employed bee searches the neighboring food sources, v_i, according to (2). The information on food sources is kept by employed bees and passed on to onlooker bees.

$$v_{ij} = x_{ij} + rand(-1,1)(x_{ij} - x_{kj}) \qquad (2)$$

where k and j are randomly chosen numbers and they have to be different. $rand(-1,1)$ enables neighboring food sources to be found and represents comparing two different neighboring food sources [14].

An onlooker bee selects a food source according to its probability value, p_i, associated with its quality calculated by (3).

$$p_i = \frac{fit_i}{\sum_{n=1}^{SN} fit_n} \qquad (3)$$

where fit_i is the fitness of the food source i. SN is the number of food sources and it equals number of employed bees.

If the food source cannot be further improved as a certain number of cycles, which is called limit, the food source is abandoned. Instead of that food source, a new food source is generated by the scout bee using (1). When a predetermined maximum number of cycles is reached, the algorithm is terminated. The pseudo-code of the ABC algorithm [13] is shown in Algorithm 1.

Algorithm 1 The pseudo-code of the ABC algorithm

Initialize population with random solutions x_i by (1)
Evaluate the fitness of the population
cycle = 1
Repeat
  Generate new solutions v_i by (2) and evaluate the fitness
  Apply the greedy selection between x_i and v_i
  Select a solution depending on the probability p_i by (3)
  Generate new solution v_i and evaluate the fitness
  Apply the greedy selection between x_i and v_i
  If employed bee becomes scout
    Then replace it with a new produced solution by (1)
  Memorize the best solution obtained so far
  cycle = cycle + 1
Until Maximum number of cycles is reached

B. Convolutional Neural Networks

CNN is a subclass of DNNs widely used in image and video recognition, recommendation systems, image classification, and natural language processing. CNNs, unlike traditional ANNs, show high performance especially in the classification of high dimensional image data [15]. One of the advantages of CNNs is that they can learn directly from data with automatic feature extraction, eliminating manual feature extraction [16]. A CNN consists of several layers:

• Convolutional layer: In this layer, convolution operations are applied using filters in various sizes and types to the input for extracting features.

• Non-linearity layer: This layer takes the feature map produced by the convolutional layer and applies an activation function to bring non-linearity into the output. ReLU (rectified linear unit) is generally used as the activation function in CNNs.

• Pooling layer: This layer provides a reduction of the spatial dimension and the number of parameters.

• Flattening layer: The layer where the data is flattened and prepared for the fully connected layer.

• Fully connected layer: This layer is an ANN in which each unit in layers is connected to every unit in the other layers. The training phase required to classify the features obtained in the previous layers into various classes is performed in this layer.

In Fig. 1, the basic architecture of CNN in which convolution, ReLU activation function, and pooling process are applied twice, respectively, are given.

III. ABC Algorithm Based Hyper-Parameter Optimization

A. Problem statement

Hyper-parameters such as the number of convolution layers and pooling layers, the number and size of filters, the number of fully connected layers, and the number of neurons in each layer directly affect the performance of CNNs. However, the search field consisting of values defined for all hyper-parameters will be very large since each hyper-parameter has different values separately. In this respect, trying all options will be very costly in terms of computation time. The usage of the manual search method decreases over time as it is based on the intuition of the researchers and requires a considerable amount of time. The grid search method, which is one of the alternative methods, does not give effective results in high dimensional spaces, and the computational cost is high. A disadvantage of the random search method, which provides a higher performance compared to the other two methods, is its non-adaptive structure [12]. The transferability of the selected parameters is as essential as the hyper-parameter selection method. Hyper-parameter fine-tuning for simple architectures generally does not have the same effect as for complex architectures. Similarly, success in an image dataset may not be seen in other datasets [17]. The shortcomings of the current hyper-parameter selection methods have increased the use of meta-heuristic algorithms in this area. For this reason, the ABC algorithm has been used in this study for determining the optimum hyper-parameter values.

B. The dataset and hyper-parameters

Fashion-MNIST [18] dataset was used in this study. In the dataset, there are 28×28 grayscale images of 70000 fashion products belonging to 10 classes. Each class has 7000 images. 60000 of the images are selected as training data and 10000 of them as test data. Fashion-MNIST dataset has the same structure and image size as the original MNIST dataset.

A food source in the ABC algorithm consists of hyper-parameters used for a CNN architecture which are in order of the number of convolutional layers, number of filters per convolutional layer, number of fully connected layers, filter size, dropout rate, the type of activation function, optimizer, batch size, and the size of the fully connected layer. Candidate solutions have been generated by using (1), considering the upper and lower limits of each distinct hyper-parameter. Hyper-parameters and their boundaries are shown in Table I. The categorical cross-entropy has been used as a cost function. The pooling size is set to 2×2 fixed and is not included in the optimization. In order to reduce the search space and thus reduce computational costs, the upper bounds of the hyper-parameters were predetermined. In the ABC algorithm, the number of food sources, limit, and maximum number of cycles were set to 100, 100, and 100, respectively. Dimension of the food source is set to 9, which equals hyper-parameters to be optimized. The number of epochs for the training of candidate CNN models was also set to 15.

TABLE I. Hyper-Parameters and Value Ranges to be Optimized

Hyper-parameter	Value ranges
Number of convolutional layers	[1, 6]
Number of filters per conv. layer	[1, 128]
Number of fully connected layers	[1, 3]
Filter size	[1, 8]
Dropout rate	[0, 0.5]
Activation function	ReLU, LReLU, ELU
Optimizer	Adam, Adadelta, SGD
Batch size	32, 64, 128, 256
The size of fully connected layer	[16, 1024]

IV. Experimental Results

The experiments were performed using a computer with an i7 processor and an Nvidia 1050TI GPU. According to the results, it has been observed that the network architecture that reaches the highest accuracy values has three convolution layers and one fully connected layer. The most successful results have been obtained when filter size is $3x3$ and the number of units in the fully connected layer is 51. As an activation function, it has been seen that ReLU gives better performance results than other activation functions. Adam optimizer has better results compared to the other two optimizers. Optimum hyper-parameter values obtained from the experiments are shown in Table II.

TABLE II. Optimum Hyper-Parameter Values Obtained

Hyper-parameter	Value
Number of convolutional layers	3
Filter size for conv. layer 1	3
Number of filters for conv. layer 1	102
Filter size for conv. layer 2	3
Number of filters for conv. layer 2	126
Filter size for conv. layer 3	3
Number of filters for conv. layer 3	29
Dropout rate	0.477
Activation function	ReLU
Optimizer	Adam
Batch size	64
Number of fully connected layers	1
Number of units in the fully connected layer	51

The results have been compared with hyper-parameter optimization studies using the Fashion-MNIST dataset and different methods. Comparisons have been made on accuracy values. The accuracy values of other studies and our study used Fashion-MNIST dataset are shown in Table III.

TABLE III. ACCURACY (%) RESULTS OF THE PERFORMANCE COMPARISON AMONG RELATED WORKS

Study	Method	Accuracy
Dufourq (2017) [19]	GA	90.60
Sun (2017) [20]	GA	92.72
Ma (2018) [21]	GA	94.59
Assunçao (2018) [22]	GA	95.26
Our study	**ABC**	**93.46**

V. CONCLUSION

Hyper-parameter fine-tuning plays an important role in improving the performance of CNNs. Manual search, grid search, and random search methods, which are the traditional methods used, have some deficiencies. For this reason, the use of meta-heuristic approaches in hyper-parameter optimization has increased and these methods have shown higher success than traditional methods. In this study, the ABC algorithm, one of the swarm based algorithms, has been used in hyper-parameter optimization of CNNs. Optimized hyper-parameters are the number of convolutional layers, number of filters per convolutional layer, number of fully connected layers, Filter size, dropout rate, the type of activation function, the type of optimizer, batch size, and the size of fully connected layers. Accuracy values obtained were compared with other studies using the Fashion-MNIST dataset under similar test conditions. The accuracy values of our study give similar results to other studies. As a result, it has been seen that the ABC algorithm achieves high success in hyper-parameter optimization of CNNs.

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The Success Rate Of Turkish Language In An Emotion Analysis

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***Abstract*—This study aims to determine the success rate of Turkish language tweets in machine emotion analysis. The sample of the study consists of 5052 Turkish tweets. In the study, which collected data with C # programming language, Zemberek library, location determination, the language of messages in Turkish and other codes were used for various cases. The data obtained were first categorized under 4 headings according to the emotion-state they expressed and then analyzed with KNIME data mining program using decision tree algorithm. The findings of the research revealed that the changes made in the criteria determined when dividing the data set into test and training departments resulted in minor changes. The possible reasons for this success rate and changes were discussed.**

Keywords—Emotion Analysis, Data mining, Machine learning

I. INTRODUCTION

The rapid development of technology has made the Internet an integral part of our lives over time. The global increase in the use of the Internet has led to a significant increase in the use of various blogs, websites and social media, which we often hear today. In these platforms, people can express their views clearly and easily on a personal or institutional base with respect to diffrent situations. Physical boundaries eventually collapsed in communicstion and people began to act according to the experiences of other people before they took action. The freedom of opinion and its effects on each other, which the Internet provides to its users, have attracted the attention of many companies. The opinions of buyers in trade, production and service sectors gained importance and prepared the basis for companies to take an active role in the internet environment. Following the trends of time, it has become priority of companies to determine the target audience and make changes in their products or advertisements to aim products which people are particularly interested in. Increased interaction with the Internet has led to a growing pool of data. This growth has helped to create various areas for data, and academic studies have accelerated. Studies have contributed to the addition of new definitions in literature. Emotion analysis or idea mining studies are also a few examples. Interpretation of data is one of the popular fields of study today. When implemented correctly, it has a positive effect in most sectors. This study investigated the way to affect the success rate of machine learning when messages which users shared in a certain social media medium have a Turkish language content. Twitter was chosen as a social media tool. The messages to be used for emotion analysis from Twitter were regularly recorded in the database for a week. The messages to be used for emotion analysis were manually labeled under 4 main groups. They were happy, unhappy, confused and angry. Content unsuitable for analysis was removed from the database with various codes. The messages suitable for the project were used in the following stages for data analysis and machine learning.

II. SENTIMENT ANALYSIS

Sentiment Analysis was first reported by Tetsuya and Jeonghee in 2003. The main subject of emotion analysis is to determine how emotions are expressed in the texts and whether the expressions show positive (positive) or negative (negative) views on the subject. For this, emotion analysis; Emotional expressions include the polarity and strength of expressions and their relationship to the subject (Nasukawa and Yi, 2003). The definition of idea mining was first used by Kushal et al. in 2003 (Dave, Lawrence and Pennock, 2003). Although these definitions were expressed in 2003, similar studies have been conducted on this subject before. In 2000 Vasileios and Janyce (Hatzivassiloglou and Wiebe, 2000), in 2001 Tong et al. (Tong et al., 2001), in 2002 Turney (Turney, 2002), in 2002 Pang et al. (Pang et al., 2002) conducted studies similar in this field. (Akçayol, 2018).

A. Methods Used in Emotion Analysis

The basis of the studies in emotion analysis is to determine the polarity of emotion. Document, sentence, and feature-based levels are started based on this feature. One of the methods used to determine polarity is machine-based methods and the second is word-based methods.

1) Method Based on Machine Learning

In this method, the system is provided with a pre-determined training set in the data set. The learning system from the educational data is used for emotion classification. The algorithms used in the classification are Naive Bayes, Maximum Entropy, Support Vector Machine. The most important point to be aware when using these algorithms and choosing this method is the pre-determined or labeled training set. In 2002, Pang, Lee and Vaithyanathan, for the first time, did emotion classification with machine learning (Pang, Lee, and Vaithyanathan, 2002). When dealing with the classification problem, they did not deal with the subject matter, but rather adressed the state of being positive or negative. They used Naive Bayes, Maximum Entropy Classification and support vector machines in their film studies.

Finding and using the features that are important in emotion classification is affected to a great extent by the success rate of the systems working with the machine learning method. These are also called feature vectors. When creating the property vector, the methods such as Word of Bag Model, Term Frequency-Inverse Document Frequency, Part of Speech, and Pointwise Mutual Information are used. It may be necessary to briefly explain the given methods. Word bag; it is a method that is frequently met in text classification and depends on whether or not the words are mentioned in the text.

The number of times a word is used in the text is called Term frequency. The frequency of a selected word in the document, the number of other documents that have that word, and the number of all documents that have that word are term frequency - the definition of the reverse document frequency. Word type, such as nouns, adjectives, adverbs, and verbs in the text types. Emotion analysis is important in studies. Point-based mutual information is a scoring method which was proposed by Church and Hanks in 1990 (Church and Hanks, 1990). The first use of point-based mutual information in emotion analysis has been on automobile and cinema interpretations (Turney, 2002). In Mullen and Collier's work, dot-based mutual knowledge was based on machine learning and feature selection in cinema interpretations (Mullen and Collier, 2004).

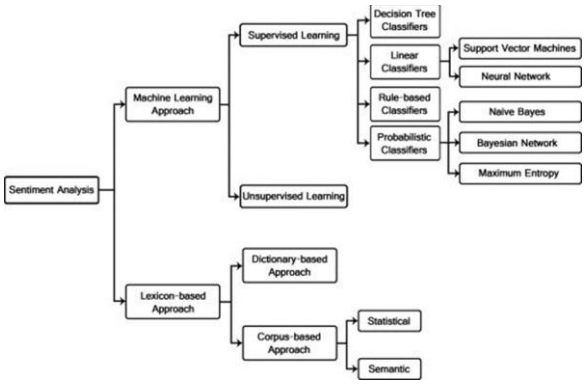

Fig. 1. Emotions Analysis Classifications

References: https://www.kdnuggets.com/2018/03/5-things-sentiment-analysis-classification.html

2) Word-Based Methods

Word-based methods do not require pre-determined (tagged) training data. Natural language processing methods and tools are used. With these methods and tools, the sentences in the text are analyzed where each sentence containing emotive expressions and inferences that form meaningful expressions are obtained. A dictionary of emotion terms can be a preferred choice in order to find expressions that indicate emotion. There are generally three methods used and respectively various applications of these methods are frequently seen. Conditional Random Fields, Dependency Tree, and Rule-Based Approach are the main topics of these methods. In 2001, conditional random fields were proposed by Lafferty, McCallum, and Pereira. Conditional random fields are a statistical method used in areas such as machine learning, artificial intelligence, pattern recognition (Lafferty, McCallum and Pereira, 2001). One of the most used areas is natural language processing. Statistical and probabilistic methods are used. When using natural language processing in conditional random fields, the objective is to determine why certain words are used in sentences in the text. It is tried to find out which words are used before and after a selected word. The determination of those words in the sentence before or after the selected word is of great importance.

Dependency Tree (another title) is a tree structure, as the name implies. The important point in this method is the study of the relationship between the different elements in the sentence (they may be adjectives, pronouns, adverbs, nouns) or which of these elements indicates the other element. In these studies, a feature of the language processing called commitment parser is used and the formation of the tree is provided. To study emotion analysis, the nodes of previously created trees are analyzed.

Finally, in the Rule-Based Approach, the method starts with the important features of natural language processing. These properties are defined as word types or patterns of these types. According to these expressions, the rule of the system is determined and after the analysis of the sentences matching these rules, meaningful expressions or inferences are determined. The rule-based approach often appears to be used with conditional random fields. The first application of this method in emotion analysis was by Turney (Turney, 2002). His work was based on customers' comments. An application based on vocabulary patterns was also made by Maharani et al. (Maharani, Widyantoro and Khodra, 2015). The study includes reviews and discussions by other users on web pages such as forums, blogs, comments, and e-commerce before people buy a product. In this study, conducted by Maharani et al., Turney (Turney, 2002) word types principles already mentioned were used.

III. METHODS AND FINDINGS

In this study, the success rate of emotion analysis of Turkish language was investigated. As of 12.04.2019, tweets were regularly drawn every day for a week. The code required for the withdrawal of tweets written in C # programming language and text content for which it is intended to have the Turkish "new location" Turkey's latitude and longitude code has been entered. This code can be set to the desired country. To avoid density in the database, one of every 500 tweets were recorded in a database. One of the biggest problems on Twitter is the character limitation. Users can refer to various abbreviations to express their feelings. This causes typos and creates confusion for the program to run. It needs to be checked in special expressions like # and @ on Twitter. Zemberek Library was used to correct these and similar spelling mistakes. Zemberek program checks whether the words in the text are Turkish and tries to replace the spelling mistakes with thier correct Turkish ones.

TABLE I. ORGANIZED SAMPLE DATA

Id	OriginalText	EditedText	Mood
1E+18	Eski tadım tuzum yok	Eski tadım tuzum yok	Mutsuz
1E+18	Herkes dengiyle mutlu.	Herkes dengiyle mutlu.	Mutlu
1E+18	yazık	Yazık	Mutsuz
1E+18	Elvedâ Deme Bana	Elveda deme bana	Mutsuz
1E+18	Hoşgeldin Başkan 💙	Hoş geldin başkan	Mutlu

A web page was created during the clearing of data. Even though, data was corrected in Zemberek library,l some spelling errors had to be corrcted manually. In the course of data analysis, texts will be categorized by class for machine learning. Tweets were analyzed under 4 main groups (happy/unhappy/angry/confused). The save-delete button is created in the contents that do not indicate any emotion.

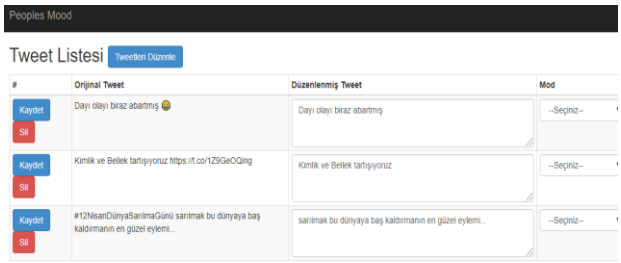

Fig. 2. Web page created to edit tweets

After the emotion labeling of the data, the KNIME program was used for data analysis. Of Approximately 35000 data obtained over a week only 5052 remained to give the most accurate results after various filtration and cleaning operations.

The data stored in the database was first converted to excel .csv format. This file contains the id of a tweet, the date it was created, the content of the tweet, the sense it specifies, and the index columns. After the Excel file was loaded into the program, the file was converted to a document format. The most important point when creating a document is how these tweets will be categorized according to the section. For this, the option to categorize by emotion column should be selected. Otherwise, the program will not work properly in the following stages. Since all information is included in the created document, column filtering is used and only the document file is selected. The node named "Pos Tagger" which is one of the features of the Knime program is making tagging process in a certain part of the speech (as also understandable by the name). In this study, Zemberektokenizer was chosen for examining the Turkish language.

The Knime program is case-sensitive. Since the study mainly focuses on text mining, some features have been applied at this stage. The following were used: Punctuation Erasure to clear the text from the punctuation it has; Number Filter to ensure no numbers other than counting numbers are contained; Case Converter for case sensitivity; N chars because words with less than three letters do not specify any expressions. The filter was used and finally the words and conjunctions that are often expressed in Turkish were removed from the text with the node Stop Word Filter.

The snowball-stemmer feature was used to find the simplest form of the words and the words containing nouns, adjectives and verbs were selected from the list. To prevent the rapid increase of vocabulary, the previously applied spelling rules make it easier to use the word bag feature. The binary method is used if there are no words or phrases in the document. Words are given values of 0 or 1. This is mostly applied in the word bag method. The frequency of a selected word relative to the other words in the text is also expressed as the frequency of the term and how many times a selected word is used in the document is checked. These are important steps to create a document vector. After all the necessary steps were taken, the documents were classified according to 4 predefined moods and color was assigned to each class for visualization.

Machine learning, which forms the basis of this study, is provided by using the decision tree algorithm. The data set was divided into training and test sets at a rate of 66%. In case of the absence of a class in the training or test data, data selections were made randomly. The achieved success rate was 45,809%. The details of the success rate in the error matrix were observed in detail.

IV. Conclusion And Discussion

In this study, the success rate of the texts with Turkish content in the machine learning study was examined. As a result of using the algorithms required for machine learning, a ratio below the expected value was encountered. When the experimental results are examined it can be concluded the first reason for the above result is that a Turkish words express different emotions in different sentences. A similar situation has been observed in texts with same contents which contain emojis. As a result of the study, it was noted that the machine was most successful in the unhappy category.

Another reason is that most of the programs used in the study were invented because their native language was English. Tools such as Visual Basic, SQL Server, Knime, C #, and similar programming language are examples. Unfortunately, Turkish language support added to these applications is not sufficient and cannot meet the actual expectations.

Other research in this area show that the success rate of studies on other European languages, especially English, is higher than that of additive languages.

The Turkish language is still a language which has deficiencies in text classification and emotion analysis studies. It is thought that a program based on Turkish language, which will be developed by experts in this field, will increase the success rate and eliminate the problems in this type of projects in the future.

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Use Of Artificial Intelligence in Logistics Management

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***Abstract*—The aim of this research is to examine the problems in the field of logistics according to problem solving methods. Technology-based problems in the field of logistics, the definition of these problems and the solution of these problems with artificial intelligence techniques are included. The purpose of this paper is to investigate programs and software for using artificial intelligence in logistics and to describe the current problems in logistics.**

The rapid pace of developments in "Artificial Intelligence" (AI) is providing unprecedented opportunities to enhance the performance of different industries and businesses, including the transport sector. The innovations introduced by AI include highly advanced computational methods that mimic the way the human brain works. The application of AI in the transport field is aimed at overcoming the challenges of an increasing travel demand, CO2 emissions, safety concerns, and environmental degradation. In light of the availability of a huge amount of quantitative and qualitative data and AI in this digital age, addressing these concerns in a more efficient and effective fashion has become more plausible.

The successful application of AI requires a good understanding of the relationships between AI and data on one hand, and transportation system characteristics and variables on the other hand. Moreover, it is promising for transport authorities to determine the way to use these technologies to create a rapid improvement in relieving congestion, making travel time more reliable to their customers and improve the economics and productivity of their vital assets. This paper provides an overview of the AI techniques applied worldwide to address transportation problems mainly in traffic management, traffic safety, public transportation, and urban mobility. The overview concludes by addressing the challenges and limitations of AI applications in transport.

Keywords—artificial intelligence, safety, environmental, environment, productivity.

I. ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) implies historically unique opportunities but also threats to humankind. As an emerging global trend, AI becomes relevant at almost all levels of social conduct and thereby raised both – high expectations but also grave concerns. Artificial Intelligence based intelligent optimization techniques are widely used within optimization problems.

Artificial Intelligence is a great research field, which has affected almost all fields of the modern life, with its flexible, effective, and efficient mathematically logically structured solution ways. Day by day, this field gains more popularity and becomes more advanced with the support of developments within also other remarkable fields/technologies like computer, electronics, communication etc. When the field of Artificial Intelligence is examined in detail, it can be seen that it is also divided into some specific sub-research areas like Machine Learning, Swarm Intelligence.

Artificial Intelligence is a complex field that is applied in shipping and logistics companies. In order to eliminate the lack of standardization seen in supply chains and transportation vehicles, web-based, information-based, mobile and so on in transportation and logistics. Solving advanced technologies, analysis of the resource, optimization of traditional mathematical solutions, modeling and simulation techniques, intelligent systems in traffic and transportation, intelligent artificial intelligence are the areas where intelligent Artificial intelligence is used in logistics. The centralization of the scalability of the traffic infrastructure of trucks, trains, airplanes, ships, data processing in limited time, simulation for traffic modeling logistics planning, maritime transport, vehicle shipment, rail transport scheduling, etc. (smart systems traffic and transport systems that can assist in strategic planning and / or management phase (tactical and operational planning) urban, regional and intercity analysis transportation networks for both passenger and freight transport, hybrid-type systems, non-standard databases with a software engineering concept, integration and object-oriented software intelligence, Process Research and Computational Intelligence Genetic Algorithms, Constraint Programming, Agent-Based Modeling and Simulation, taboo Search Meta-Tourism and high performance Optimization and Simulation algorithmic Modal split models transportation network models are used.

II. GLOBAL MARKETS LOGISTICS.

Logistics becomes a more powerful engine for the success of industrial organizations in the global markets. The above-mentioned systems aren't chimaeras even in Slovakia. The company CEIT started to implement the first projects of adaptive robotic logistics systems in factories Volkswagen and ŠKODA. Factory Volkswagen in Bratislava is the first factory which implemented fully automated logistics systems in the hall H4 by the company CEIT. Such systems enable to reduce designing time and design of modifications in real logistics with their interactivity and the offered solution in the virtual environment. The traditional approach to develop and implement innovations in the automotive supply chain is based on productivity improvements of each individual part without considering the mutual interactions and the properties of the whole supply chain.

III. NEW TRENDS AND LOGISTICS STRATEGY

It is necessary to deal with a complex logistics strategy including new trends in this area first, e.g., digitization, robotization, reconfigurable manufacturing systems, a lack of skilled workers, sustainability of production systems, green energy, and others There are several megatrends that are

fundamentally reshaping the entire industry in the next 10 years.

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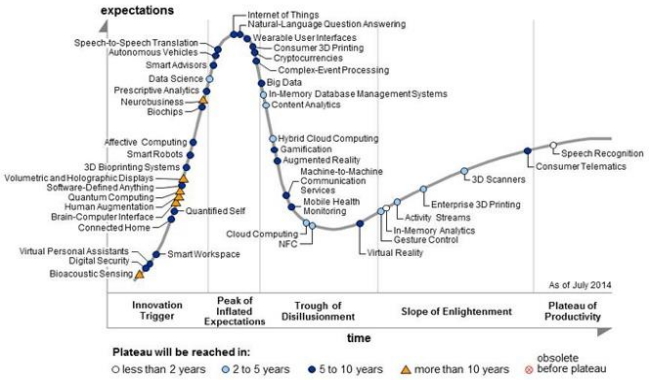


Fig. 1. New Trends And Logistics Strategy

Basically, it is possible to give more emphasis to some essential factors that researchers generally employ in order to achieve intelligent algorithmic structures and so finally intelligent optimization. These are:

Collective particles:Because the optimization is about something like trying to find the best, it is better to benefit from power of a group whose objective is technically using mathematical / logical steps for. interacting each other and trying to find the best (most optimum) for their common problem.

How is described in Figure 1, 3D printing, digital production systems, smart things in factories, logistics visibility (tracked components), intelligence and so on, they will be really real in factories.

Examples of AI methods that are finding their way to the transport field include Artificial Neural Networks (ANN), Genetic algorithms (GA), Simulated Annealing (SA), Artificial Immune system (AIS), Ant Colony Optimiser (ACO) and Bee Colony Optimization (BCO) and Fuzzy Logic Model (FLM) (Abduljabbar, 2020) (Vita Graudina, 2005).

65% of companies such as Forbes Global 2000 are using AI Artificial Intelligence technology in the modernization process in 2023. Artificial intelligence is applied to high-volume data produced in supply chains to maximize AI efforts that can help improve logistics processes.

Automate and accelerate processes reduce errors reduce costs reduce natural language processing (NLP) to import customs documents in a specific format, for example.

DHL prevents proactive delays from companies that apply artificial intelligence to route determination with predictive analytics, estimating air transport delay times in transport modes, network management. With artificial intelligence route optimization that creates value-creating customer participation that reduces cost GPS tracking weather forecast route determination, such as estimating time

You can better plan resources and even tell your customers when their deliveries will occur. It is a great application of artificial intelligence.

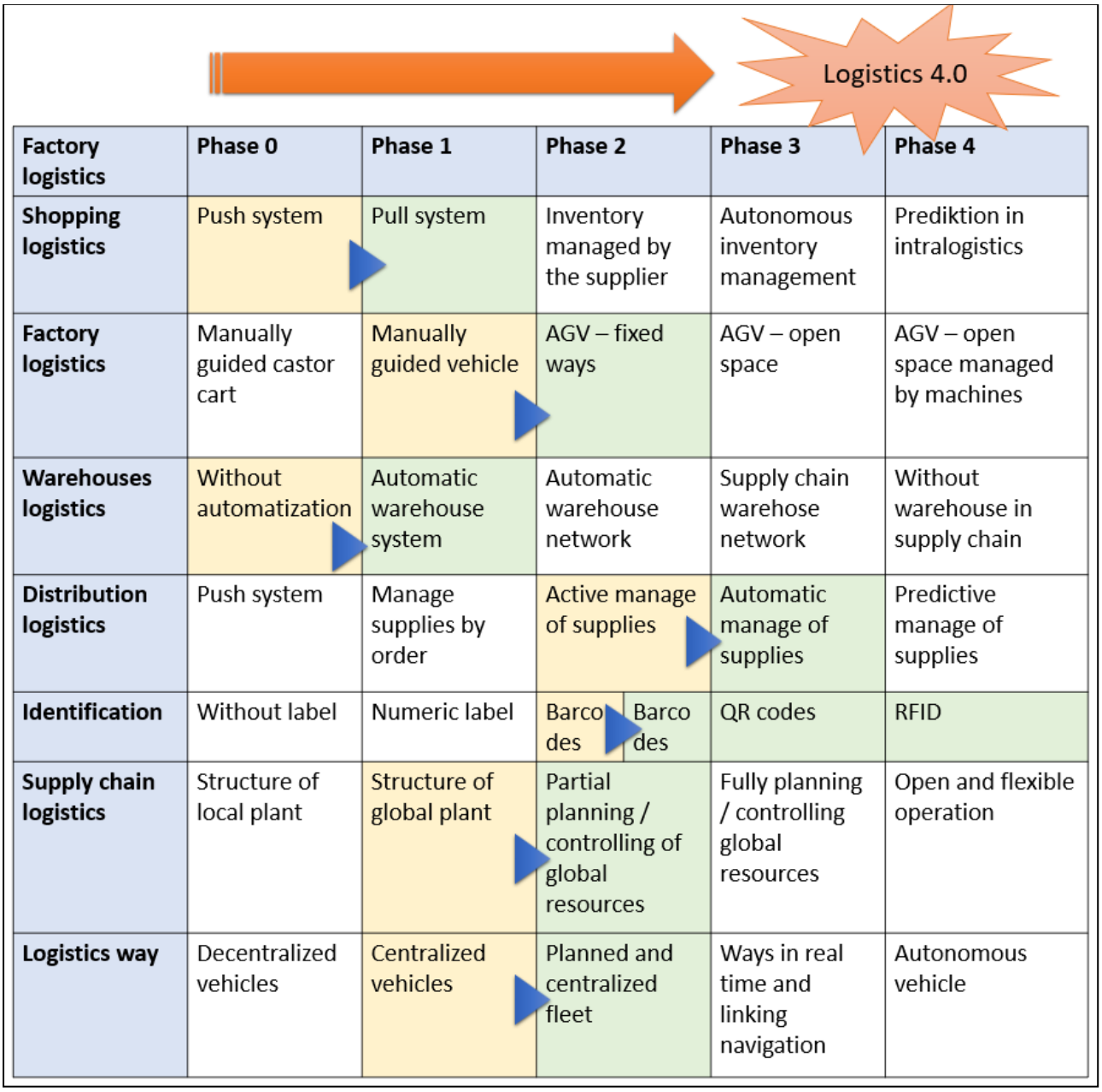
TABLE I. USABILITY OF INDIVIDUAL TECHNOLOGIES FOR SPECIFIC STRATEGIES

Technology/ Strategy	Intelligent systems in pre-production phases	Design to order	Shopping service to order	Production to order	Assembly to order	Make to stock
CAX-Computer-Aided Technologies	4	2	2	2	1	1
Simulation	4	3	2	2	2	2
Virtual Commissioning	4	2	2	2	1	1
Virtual prototyping, Virtual and Augmented Reality	4	1	1	1	1	1
3D Printing	3	4	3	1	1	1
Reconfigurable Production System	0	1	1	4	4	1
Adaptive logistics systems	0	2	4	4	4	4
Advanced Planning and Scheduling Systems	0	4	4	4	4	4
Internet of Things	0	4	4	4	4	4
Real-Time Location System (RTLS)	0	4	4	4	4	4

4 – Full usability 3 – Partially limited usability 2 – Limited usability

1 – Currently difficult to use technology for a strategy 0 – Unusable technology

TABLE II. RELATIONS BETWEEN PRODUCTION AND LOGISTICS STRATEGY AND TECHNOLOGIES



Factory logistics	Phase 0	Phase 1	Phase 2	Phase 3	Phase 4
Shopping logistics	Push system	Pull system	Inventory managed by the supplier	Autonomous inventory management	Prediktion in intralogistics
Factory logistics	Manually guided castor cart	Manually guided vehicle	AGV – fixed ways	AGV – open space	AGV – open space managed by machines
Warehouses logistics	Without automatization	Automatic warehouse system	Automatic warehouse network	Supply chain warehose network	Without warehouse in supply chain
Distribution logistics	Push system	Manage supplies by order	Active manage of supplies	Automatic manage of supplies	Predictive manage of supplies
Identification	Without label	Numeric label	Barco des / Barco des	QR codes	RFID
Supply chain logistics	Structure of local plant	Structure of global plant	Partial planning / controlling of global resources	Fully planning / controlling global resources	Open and flexible operation
Logistics way	Decentralized vehicles	Centralized vehicles	Planned and centralized fleet	Ways in real time and linking navigation	Autonomous vehicle

According to the research named Intelligent Logistics For Intelligent Production Systems By Martin Krajčovič, Patrik Grznár, Miroslav Fusko, Radovan Skokan, one of the strategies used in logistic strategies is Digital Twin. Digital Twin is a system used in logistics systems in factories. From Figure 7, one may observe how the factory will develop in the coming years - green colour. Fixed further phases were defined and established for the factory. The phases should motivate the factory to reach Phase 4 which means Logistics 4.0 ((Krajčovič, 2018).

IV. Artificial Intelligence

Artificial Intelligence has the power to minimize the risks of analyzing infinite possibilities by organizing chaos data that human cant do in supply chain management and applying smart algorithms. A machine can analyze smart algorithms by using computer data sets connected to it, productivity increases with artificial intelligence. It is seen that artificial intelligence, whose foundations are laid today, manages the logistics activities in the supply chain and logistics management of much more complex data in the future:

- Inventory management
- Maintenance of the warehouse
- Optimizing the Shipping Process
- Supplier Relationship Management
- Workforce management
- Shipping Management
- Foreign Language Decoding

A. Warehouse Robots

Warehouse robots that carry pallets, stock shelves and lift items of tons instead of man power-powered vehicles become automated and simplify routine work by limiting manpower. The most reliable way of stocking and transporting the load

on the shelves, counting the load, taking the order, packing, tracking the inventory book of the Fig.2 Proposed Smart Warehouse Logistics

Artificial intelligence robots can transport and even take and pack the orders. Thanks to the internet of objects, it is possible to keep track of the warehouse, enabling communication between machines without touching, minimizing manpower and making life easier by machine power and practice. The warehouse becomes essential for storing the goods that are produced in offseason and the goods that are demanded in offseason.

They play a significant role in the organizations that has a bulk production and supply.

- They ensure the quick and the faster supply of the goods that are in demand and also in the continuous production and the movement of the goods.
- They main reason for the warehouse is price stabilization and bulk breaking.
- They enhance the economic benefit of the business as well as the customer. Several researches' proceeded for the smooth handling of the ware house operations involved the application of the internet of things, cloud computing, The wireless sensor networks, RFID, tag readers, drones, robots and the artificial intelligence etc., to automate the process in the warehouse ensuring the efficient storage and the retrieval of the products and efficient functioning of the warehouse.

The meaning of terms such as the Internet of Things (IoT) and big data, which are frequently used for marketing purposes ((Rakyta, Fusko, Herčko, Závodská and Zrnić, 2016: 43)

The fig.2 below provides the functions incorporated in the ware housing. (Rakyta, Fusko, Herčko, Závodská and Zrnić, 2016:

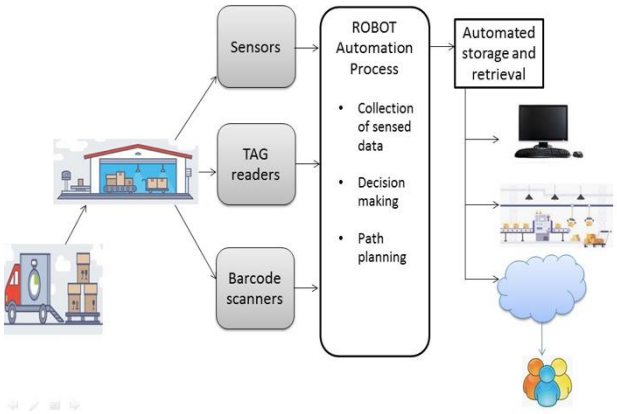


Fig. 2. The AI in Warehouse

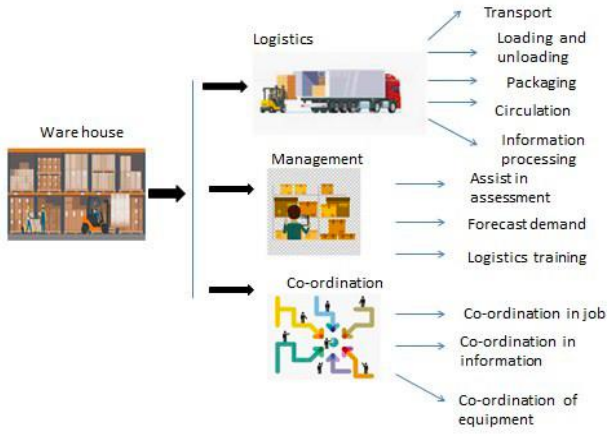


Fig. 3. AI in Warehouse

Source:(Pasump *Pandian*, 2019, 63-72).

The decision algorithm based on the deep learning and the decision tree is and the path planning and the collection of the sensed data are programmed using the python. The control device gathers the data from different monitoring and the executive devices to for training, based on the information gathered the deep learning algorithms are engaged to gain knowledge based on the data and ensure a professional way of decision making in the bots.

B. Blockchain

Blockchain began as the technology used to securely track cryptocurrency transactions in a secure and distributed ledger. The blockchain is a simple yet ingenious way of passing information from A to B in a fully automated and safe manner. One party to a transaction initiates the process by creating a block.

The verified block is added to a chain, which is stored across the net, creating not just a unique record, but a unique record with a unique history. Falsifying a single record would mean falsifying the entire chain in millions of instances. That is virtually impossible.

Bitcoin uses this model for monetary transactions, but it can be deployed in many other ways. A blockchain carries no transaction cost.

Encryption techniques called cryptography are used in blockchain technology. In this way, it is not possible to delete or change the data block subject to the blockchain. Proof of presence and allow asset to be transferred securely. Theoretically, the implementation of a blockchain reduces the replication of data, speeds up transaction times and eliminates data errors, resulting in productivity gains for all parties involved. Blockchain does not need a central authority and by eliminating the intermediaries in the process, it provides faster, safer and more effective communication and transactions between the two units. Today, blockchain has many more applications beyond crypto currency.

With the support of digital products and integration services such as the Blockchain-based open Global Trade Digitalization Platform established in cooperation with Maersk and IBM, we aim to reduce transportation costs, eliminate inefficiencies caused by paper-based processes and increase traceability in container transportation from South America and Africa to Europe. aims. In addition, it is seen that

Blockchain technology is used in the food cold chain. 9 major food manufacturers such as Walmart, Dole, Nestlé, Unilever are collaborating with a private Blockchain Food Safety Association established with retail companies and IBM initiative, through Blockchain technology to provide food safety, waste reduction and food traceability for the logistics of perishable products. Here, producer-origin data from the field or farm, batch numbers, factory and process data, expiration dates, storage temperatures and details about transportation are recorded securely and unchanged on the blockchain. In this way, food is prevented from being wasted due to production, transportation and storage conditions. In addition, the Blockchain eliminates the intermediaries in the food chain, bringing producers and retailers together, providing demand control, significantly eliminating the price differences between the field and the market. Blockchain is very important, especially if you are carrying food products. In order to develop and train Blockchain protocols and standards in the transportation industry, a Blockchain union in transportation, called BITA (Blockchain in transport alliance), was established with more than 500 members consisting of transport management companies, shipping agencies, carriers, logistics service providers and technology providers.

Smart contracts in the transport and logistics industry publish a request for proposal (rfp) via the blockchain network General terms, route and types of transport invite other carriers through the blockchain network. Carriers respond to the request for quotation according to the relevant route, freight volume and preferred tariff. The carrier accepts loads and provides location update.

The shipper verifies the invoice and pays for the completed shipments. Here, all this information is securely and invariably recorded in the distributed database on the Blockchain, and all information is clearly followed by all parties involved in the contract.

In order for this technology to be used in the supply chain and logistics processes, a very robust information technology infrastructure must be allocated. It is also important to integrate this technology into the ERP systems of the parties in the established consortium in order to share information simultaneously. In addition, this technology requires beginning level knowledge, skills and expertise for users and Blockchain training should also be given to users. In agriculture, every stage is recorded from the field until it reaches the end user. anyone on the chain can view that entry. Internet of Things and Blockchain come together.

C. Entrepreneurial Companies

Entrepreneurial companies operating in Europe, Asia and the USA increase their profits by investing millions of dollars with the use of artificial intelligence in logistics. and energy saving has been achieved.

FarEye, which included facilitating logistics in transportation and delivery operations as one of its strategies, invested with Microsoft's corporate venture fund M12, D Series. Eight Roads Ventures, Honeywell Ventures SAIF Partners focuses their entrepreneurial work on the use of artificial intelligence in logistics. Even though automated shelf systems, RFID readers, sensors and logistics software aim to maximize human power, there is always a need for human.

1) *Smart Warehouses*
2) *Autonomous Vehicles*
3) *Smart Paths*
4) *Customer Experience*

Warehouse automation technologies are used in Smart Warehouses.

Robots that perform e-commerce, packaging, handling, conveyor systems, barcoding.

These devices, which transfer information from machine to machine, work with software that imitates human behavior.

Warehouse automation systems will increase your service quality by helping you both save time in operations and use the workforce correctly.

D. Autonomous

It is seen that the digital infrastructure, which will increase the speed of international transportation in the future, such as unmanned metrobus, truck, subway, railway vehicles, is trying to be completed, albeit with a delay.

Used in light vehicles in road transport in the 2030s.One of the important associations suggests that there is not enough digital infrastructure for autonomous vehicles and that autonomous vehicles should be established in terms of usability.

It seems that autonomous vehicles will provide the following opportunities in the logistics industry.

- Reducing delivery traffic
- Minimizing the delivery time
- Increased safety of operations
- Increasing the efficiency of operations
- Fuel saving
- Prooviding transparent traceability

Fig. 4. Market Overview

Source: https://www.marketsandmarkets.com/Market-Reports/autonomous-ships-market-267183224.html

E. Smart Roads

Smart roads infrastructure is being prepared for autonomous vehicles to travel in traffic.

It is planned to reduce the number of traffic accidents by using alternative energy sources and smart vehicles on smart highways.

Along the way, be sure to establish a business metric for each solution (cost reduction, value creation, customer engagement, etc) in creating a significant quantitative impact, so you know what good looks like. Ocado is a supermarket located in the United Kingdom. It has developed an automated warehouse. The system is based on a robot called 'hive-grid-machine.' This robot can execute 65,000 orders per week. 'Hive-grid-machines' main task is to move, sort, and lift items inside the warehouse. Ocado's automated warehouse dramatically cuts labor and the time for orders to be executed

Rolls-Royce is working with Intel to develop self-driving ships. Rolls-Royce released the Intelligence Awareness system in 2018, system that is able to classify all the nearby objects under the water. It can also monitor the engine condition and recommend the best routes. According to a market report, the market of autonomous ships will reach $13.8 billion by 2030.

There is a white paper, which is a document of intention issued by the European Union.

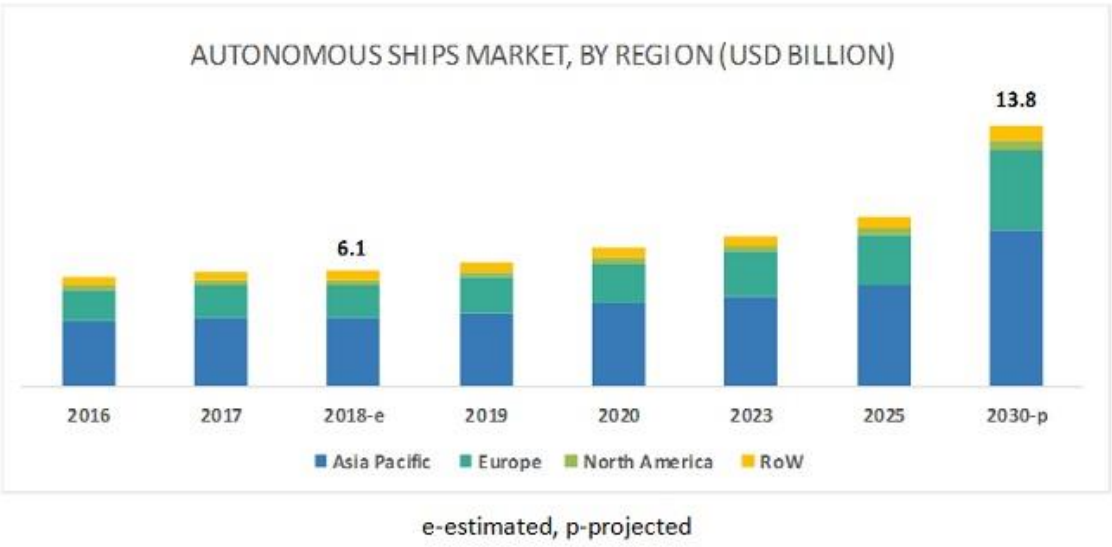


Fig. 5. Autonomous Ships Markets by Region (USD Billion)

Source: www.marketsandmarkets.com/Market-Reports/autonomous-ships-market-267183224.html, 2020)

Asia Pacific has witnessed rapid economic development over the years, resulting in an increase in maritime trade. This rise in sea trade has subsequently led to an increasing demand for ships for the transportation of manufactured goods worldwide. Thus, the rising number of ships has increased the demand for autonomous ships in the Asia Pacific region. According to UNCTAD, South Korea, Japan, and China are the major players in the shipbuilding industry and are expected to account for 80% of the tanker orders during the forecast period. According to IHS Marine, since 2009, 133 LNG tankers have been built in Asia – 100 in South Korea, 20 in China, and 13 in Japan. Shipbuilding companies from Japan, South Korea, and China are also among the largest players in each of the 4 major segments, namely, tankers, bulk carriers, container ships, and offshore vessels (https://www.marketsandmarkets.com/Market-Reports/autonomous-ships-market-267183224.html, 2020).

Korea, 20 in China, and 13 in Japan. Shipbuilding companies from Japan, South Korea, and China are also among the largest players in each of the 4 major segments, namely, tankers, bulk carriers, container ships, and offshore vessels (https://www.marketsandmarkets.com/Market-Reports/autonomous-ships-market-267183224.html, 2020).

V. AI And Managing Anomalies

With the increase in global trade, the importance of the logistics industry comes to the fore. With the increase of sectoral growth, it is of great importance for countries to have information about logistics performance on a global scale (2020 LPI).

Supplies. developed countries in terms of logistics sector behave more competitive and increase their profit margins. For this reason, it is very important for countries to have information about their logistics performance and to ensure their development by knowing their place on a global scale. Six indicators published by the World Bank every two years.

Calculated based on the logistics performance index (LPI), is an important criterion for the location of the countries in terms of the logistics sector. LPI reveals differences between countries in terms of customs procedures, logistics costs, transportation infrastructure of countries.calculated based on the logistics performance index (LPI), is an important criterion for the location of the countries in terms of the logistics sector. LPI reveals differences between countries in terms of customs procedures, logistics costs, transportation infrastructure of countries.

Logistics businesses understands the application of AI to typical industry problems such as route optimisation. Not only is route planning something you instinctively understand, it's also something computers can clearly do in real-time that humans can't.

Artificial neural network: (ANN), are structures consisting of hierarchically connected and parallel artificial neural cells. Neurons to every cell, Your nerves ANN is formed by interconnecting it (Krése, 1996). Logistic regression model, simply can be generated sigmoid information, nerve. It is equivalent to the neural cell model with logistic activation (Kaya, Yeşilova, 2009, 112-116) ANN, inspired by biological – nerves is being created. ANN has many problems today.

It is high enough to produce a solution. Type, such as engineering successful ANN applications in many fields are available. (Diamond, 2003). In health sciences finding a wide use area, ANN, EGG signals classification (Reddy et al. 1992; Subasi and Ergelebi, 2005; Aklan et al., 2005), hypertension in parameter estimation (Tire et al., 2005), In the prediction of atheroscle (Colak et al.2005), PET screening (Kippenhan et al 1992) and cancer (Kékiier, 2005; Bourdes et al., 2007; Navdeep et al., 2008) heavily are using.

Mahroof et al The paper is a "qualitative study are vealing the challenges in the artificial intelligence for the ware housing due to the deficiency in both the skill and the mind-set of the operational management. The paper also provides the opportunities in the IT infrastructure and the prevailing artificial intelligence for the management. Han et al the author presents the "study on the relationship between the production structure and its process. The further provides the analysis and the implementation of the process optimization, production structure to enhance the flexibility and the applicability of the organizational structure based on the strategic mission of the organization". Klumpp et al the article is about the "robotics and the AI application in the transports, logistics and the supply chain management, and plan a sort of mapping for the future research topics to enable the smooth and an efficient changeover with the trends in the digitization"

Artificial Intelligence: Artificial intelligence is defined as the thinking and learning ability of machines.

Simulation: Simulation is defined as the imitation of the operating mode of a real process or system over time. Big Data: It is defined as the transformation of a large amount of information compiled from different sources such as social media publications, blogs, microblogs, GSM operators into a meaningful form.

Vertical and horizontal system integration: All machines and It is defined as communicating with other business segments. Autonomous Robots: It is generally defined as an electro-mechanical device that performs previously programmed tasks either directly under the guidance of an operator through a computer program or independently 2,April2018http://ratingacademy.com.tr/ojs/index.php/arts/indexENDÜSTRİ 4.0'IN),

Rogers and Tibben-Lembke (2001) estimated that reverse logistics is an important part of US logistics costs and that logistics costs are about 9.9% of the US economy. Artificial intelligence and machine learning methods provide faster and more accurate results in complex data sets (Alpaydın, 2014: In addition, machine learning is one of the most efficient research areas in both the application of new techniques and theoretical algorithms, as well as applying them to real life problems.

In the literature, there are studies for demand estimation with successful results by Machine Learning algorithms. Aha et al. (1991) describes a framework and methodology called sample-based learning, which produces classification estimates using only specific examples. Anyanwu and Shiva (2009) conducted an experimental analysis based on sample data records to review the serial applications of decision tree algorithms and evaluate the performance of these algorithms. Erpolat and Öz (2010) tested the success of machine learning methods in the classification of breast cancer data by using artificial neural networks and support vector machines. Deng and Yeh (2011) used the Least Squares method in this study to support the support vector machines (LS-SVM) method which solved the problem of estimating the production cost of body structural projects. Marques et al. (2012) aimed to

determine classifiers according to each community approach in the context of credit score, for this purpose, the estimation performance of C4.5 decision tree, multi-layer sensor, logistic regression, the nearest neighbor and naive Bayes classifiers were evaluated. Lamrini et al. (2016) presented a dynamic model of the process based on artificial neural networks in order to estimate the temperature of the bread dough and the power required for kneading. Internet of Things is a novel paradigm that is based on the pervasive presence of numerous things or objects. These things or objects include sensors, actuators, RFIDs, mobile phones etc., which collaborate with each other through addressing mechanisms with their friends and friend of friends to achieve the desired tasks. The future internet will embody millions of objects. lIoT will provide the opportunities for users, manufacturers and service providers and make all real virtual. At the technology's current level of development, smart contracts can be programmed to perform simple functions. For instance, a derivative could be paid out when a financial Instrument meets a certain benchmark, with the use of blockchain technology and Bitcoin enabling the payout to be automated. With Etherum being the biggest smart contract network, some top cryptocurrency exchanges like OKEx are also deploying their decentralized smart contract networks like OKEx Chain, where users can launch their decentralized applications, create token trading pairs and trade freely with no time and place restricted (Rosic., 2020).

The autonomous ships market has been segmented as follows:

- Systems
  - Communication & Connectivity
  - Intelligent Awareness Systems
    - Alarm Management Systems
    - Safety Systems
    - Navigation Systems
    - AIS
    - Global Positioning System (GPS)
    - Inertial Navigation System (INS),
    - Optical and Infra-red Cameras
    - Radar
    - Lidar
    - High-resolution Sonar
    - Microphones
  - Reliability, health & safety management
    - Ship Information Management Systems
    - Ballast Management Systems
    - Thruster Control Systems
    - Machinery Management Systems
    - Power Management Systems
    - Propulsion Control Systems
    - Health Monitoring System
- Software, by Modules
  - Fleet Management
  - Data Analysis
  - Route Planning
  - Artificial Intelligence
  - Machine Learning
  - Computer Vision
- Structures

VI. CONCLUSİONS

It is stated that autonomous vehicle technologies of automatic transport in transportation, Tesla Semi and autonomous trucks will be seen, and automation in logistics in international transportation will exist with robots and human vehicles. Unmanned autonomous loading of trucks in storage requires the integration of ASRS warehouses. Trucks that know where to move with GPS and other software and applications knowing the destinations they will move .They will be placed knowing the order of the load to be placed on the trailer. Packaging affects the cost in marketing and handling. Is an important product in packaging and marketing in national and international transportation. Packaging is also important in storage. Automatic delivery of the required packages in the new logistics network.

Inventory Management, Demand Forecasts Inventory management, Information Processing and Demand Forecasting, automation and software, artificial an important part of the supply chain of intelligence Logistics systems, internet of things and IoT customer service management is possible. Customer / supplier systems will be created from data sets by providing data entry warehouse management. In strategic partnerships to be provided in the international arena, the product that the customer wants is supplied with software prepared by artificial intelligence. Payments are made with crypto money, paypal payments data entries. International money transfer is provided. Production Planning, Inventory management, Customer service policies development is essential.

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Gender Diversity In Artificial Intelligence

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***Abstract*— Artificial intelligence is increasingly influencing the opinions and behaviour of people in everyday life. However, the over- representation of men in the design of these technologies could quietly undo decades of advances in gender equality. Society's view of gender is at a critical point and the same is true for artificial intelligence. AI appears neutral, but it's made by humans, which means it internalizes the gender bias.**

In accordance with this reality, the types of gender problems that arouses with artificial intelligence can be put in order. First of all, the technology world is still a man's world meaning that the percentage of the jobs in artificial intelligence held by women is very low, with even fewer holding senior roles. Then comes the visual problems including digital assistants and AI celebrities. Virtual assistants are innocent and submissive whereas AI celebrities are femme fatale narratives. Besides virtual assistants also reinforces the role of women as secondary and submissive to men. Third problem called bias, originates from having a poor dataset, which underrepresents or misrepresents a certain group; woman. Like a game of word-association, these systems can often associate 'man' with 'doctor' and 'woman' with 'nurse'. These don't reflect modern society, or at least how we want modern society to progress.

This paper will evaluate these problems and then will review the steps towards overcoming these. After all, some suggestions will be discussed to bridge the gender gap and reshape the future of a bias-free AI world, creating new challenges and opportunities for women.

Keywords— Artificial Intelligence, Gender Diversity, Technology, Digital Assistant

I. INTRODUCTION

There have been many revolutions in production and industry. These revolutions are respectively Industry 1.0, Industry 2.0 and Industry 3.0. Then, Artificial intelligence has brought about a change in the pattern of the operation of industry, driven by a new form of interaction between man and machine. Industry 4.0 can be considered the 21st century's industrial revolution and will soon be the new form of manufacturing delight. The definitive customer would experience manufacturing requests determined by artificial intelligence, machine learning, and automated technologies linked with data science support for gauging customer necessities (Umachandran et al., 2019: 138).

In the first industrial revolution, the factory achieved production primarily through machines powered by water and steam and heavy manpower. In the second, operations became slightly more complexed through machines powered by electricity supported by mass production and division of labour. The third industrial revolution ushered in the use of electronics and information technology, adding more complexity to the production process in making it more automated (Brettel et al.,2014) Industry 4.0 is being presented as an overall change by digitalization and automation of every part of the company, as well as the manufacturing process (Marcos et al., 2017). People are obligated to learn new, everyday tasks but now are also compelled to use hi-tech gadgets which are fast becoming the most important factor in their working life (Tay, S.I. et al., 2018: 1379). Broadly, it refers to the collapsing of boundaries between the physical, digital and biological spheres. More specifically, it's about the digitalisation of all kinds of systems and processes. Artificial Intelligence (AI) is at the forefront of this reality (https://theconversation.com/).

Artificial intelligence is also shaping gender relations. Like all technologies before it, artificial intelligence also reflects the values of its creators" (Crawford, 2016). Developers of artificial intelligence are overwhelmingly male. So, the AI world is almost entirely dominated by men. There have been attempts to address gender bias in machine learning through the review of learned gender-based associations and modification of the algorithms to exclude stereotypes (Bolukbasi, 2016: 4350). For their personal development and professional growth to be fully integrated, more women need to participate in the design, implementation, evaluation and debate on ethics and norms of the next generation of machine learning and AI-powered technologies (http://webfoundation.org/). It is generally believed that increasing the diversity of the workforce developing AI systems will reduce the risk that they generate discriminatory and unfair outcomes (Stathoulopoulos, 2019: 5).

It is important to look more closely at how AI is, and will affect gender equality, in particular women, who represent over half of the world's population.

II. GENDER DIVERSITY IN ARTIFICAL INTELLIGENCE

Gender refers to the historically inherited, socially constructed, and normalised behaviours, characteristics and appearances which operate to define people as female or male, or which act as a framework to be resisted. Gender is understood to have an inextricable relationship with unequal power dynamics, and to function intersectionally with other protected characteristics such as race, ethnicity, and sexuality (Collett and Dillon, 2019: 7).

Diversity refers to the existence of human differences on the grounds of colour, race, ethnicity, gender, identity, age, physical attributes, ethical values, nationality, education, personality, experiences and knowledge base. Wentling & Palma-Rivas (2000) asserted that diversity in an organization refers to the co-existence of employees with a wide variety of sociocultural, socio-economic and demographic attributes.

Gender diversity is an umbrella term that is used to describe gender identities that demonstrate a diversity of expression beyond the binary framework. It is a question of equality and also a priority for progress.

It is important to realise that many cultures throughout history have recognised gender diversity beyond masculine

and feminine. Today the internet has provided a platform where people can explore common experiences with gender diversity and a lot of the language used to describe these experiences is still evolving (https://genderrights.org.au/). Feminist scholars of science and technology have been looking at the mutual shaping of gender and technology for several decades (Wajcman, 2007).

Nowadays, lack of gender diversity in the Artificial Intelligence (AI) workforce is raising growing concerns. Algorithms and devices have the potential of spreading and reinforcing harmful gender stereotypes. These gender biases risk further stigmatizing and marginalizing women on a global scale (https://en.unesco.org/). The World Economic Forum has revealed in its latest global gender gap report that only 22% of Artificial Intelligence (AI) professionals globally are female compared to the 78% who are male and they are more likely to occupy jobs associated with less status (https://reports.weforum.org/). Due to the rapid rate of technology, organisations need to pay more attention to how diverse their teams are when developing AI solutions (https://www.diversityintech.co.uk/). There is a huge lack of recognition and support; pay gaps are a minimum of 19% and only 21% of executives in the tech industry are women. According to studies, 56% of women in technology leave their employers midcareer, this being at least partially related to a lack of supportive mentors and role models and other workplace related barriers (https://www.cell.com/patterns/).

While on the other hand, there are significant tangible results delivered by women; women are the lead adopters of technology and startups with women executives succeed more often (Abouzahr et al.,2018). In addition to this, studies show that gender diversity in senior positions in the tech industry have a positive impact on the overall companies' performance and profit (Triana et al., 2019).

Furthermore while AI poses significant threats to gender equality, it is important to recognize that AI also has the potential to make positive changes in our societies by challenging oppressive gender norms. For example, while an AI-powered recruitment software was found to discriminate against women, AI-powered gender decoders help employers use gender-sensitive language to write job postings that are more inclusive in order to increase the diversity of their workforce. AI therefore has the potential of being part of the solution for advancing gender equality in our societies (https://en.unesco.org/).

III. Artificial Intellingence and Gender Problems

The term artificial intelligence was put forward in 1956 and described by the English Oxford Living Dictionary as "the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between language." (https://www.lexico.com/).

Artificial Intelligence (AI) is a cognitive science with rich research activities in the areas of image processing, natural language processing, robotics, machine learning etc (Lee, J., 2018:20).

Artificial intelligence (AI) involves using computers to classify, analyze, and draw predictions from data sets, using a set of rules called algorithms. AI algorithms are trained using large datasets so that they can identify patterns, make predictions, recommend actions, and figure out what to do in unfamiliar situations, learning from new data and thus improving over time (https://en.unesco.org/).

Artificial intelligence (AI) is a general purpose technology that increasingly mediates our social, cultural, economic and political interactions. AI has the potential to transform our digital, physical and social environments in unprecedented ways and at an unprecedented speed (Makridakis, 2017).

Artificial intelligence is playing a significant role in transforming our daily lives. It's being used to design smarter cities, optimise transport and meet new consumer expectations by enabling the provision of automated solutions. Even in sensitive sectors such as education, health and safety, where justice and fairness are essential, algorithms are increasingly employed to aid decision- making. However, while AI makes it possible to solve complex problems in an innovative, personalised and efficient way, there is also the risk of proposing biased solutions, particularly in terms of gender (https://www.orange.com/).

Even though it sounds like these machines have a mind of their own, AI is just the reflection of our decisions and our behavior, because the data we use to train AI is the representation of our experiences, behaviors, and decisions as humans. If I want to train an AI application to review, say, credit card applications, I have to show it previous applications that were approved or rejected by humans. So, you're really just taking human behavior and codifying it. (https://www.oliverwyman.com/).

Many of the debates in artificial intelligence on the topic of gender bias mirror those related to gender equality in society since the 1960s. However, the over-representation of men in the design of these technologies could quietly undo decades of advances in gender equality. machine intelligence learns primarily from observing data that it is presented with. While a machine's ability to process large volumes of data may address this in part, if that data is laden with stereotypical concepts of gender, the resulting application of the technology will perpetuate this bias (Leavy, 2018: 14). It is important that computer scientists look to such debates so that negative consequences for women due to gender bias are not repeated. The gender ideologies are still embedded in text sources and result in machine learning algorithms learning stereotypical concepts of gender (Bolukbasi, 2016).

The challenges of artificial intelligence related to gender are multi-layered. The first layer is its design. Women need to have an active role in shaping the next generation of technologies, so stereotypes are not reproduced and diversity is considered. The second layer is related to the deployment of such technologies and the direct social economic and political impact AI will have to reduce or exacerbate gender equality. The third layer relates to collateral effects of the digitisation strategies on the future of work and advancement opportunities for women (http://webfoundation.org/).

If AI and automation are not developed and applied in a gender-responsive way, they are likely to reproduce and reinforce existing gender stereotypes and discriminatory social norms. We can classify these problems into 6 sections (https://towardsdatascience.com/).

A. Gendered Issues In The Workplace

Over the past few decades, workforce diversity and inclusive work practices have acquired the core position in

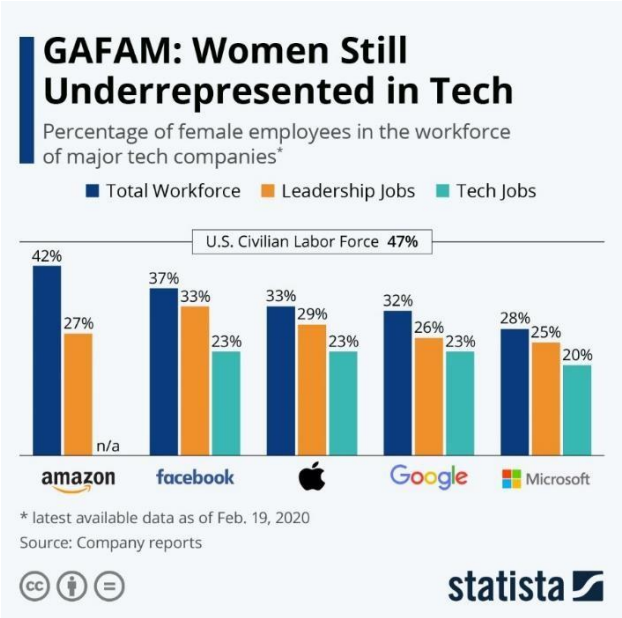
several small, medium and large sized organizations whether national or international (Kaur and Arora, 2020: 125). Currently, there is significant gender disparity in the AI workforce. Those designing, coding, engineering and programming AI technologies do not exhibit a diverse demographic (Collett and Dillon, 2019: 5).

Digital transformation is being used to unlock human potential with new technologies like Blockchain and Artificial Intelligence. They play a critical role in the transformation of today's technology to help build trust and increase the inclusion of women in the workforce (https://www.diversityintech.co.uk/). With the rapid development of the fields of data science and artificial intelligence, a dichotomy presents itself; more professionals are needed to fulfill the growing workfoce demand, and women continue to be underrepresented in all computer science-related jobs (https://www.cell.com/patterns/pdf/).

One of the most widely studied areas that examines the barriers to women's career advancement are the consequences of discrimination in the workplace. The most well-known illustrations of discrimination in the workplace are captured by the concept of the glass ceiling, which defines the invisible barrier that prevents many women from advancing into senior and executive management positions within organizations (Morrison et al., 1987). In addition, studies show that women experience barriers at all levels not only at the top and these barriers significantly retard a woman's career advancement and detract from her performance in the profession. The concept of occupational gender segregation describes the disproportionate overrepresentation of women and minorities in low-paying, low-status occupations compared to men and nonminorities (Jacobs, 1989).

Today, over-representation of men in the design and developments of AI technologies, risks undoing the advances gained over the years in ensuring gender equality in various levels of the society including workplace (https://news.itu.int/). If we look at the numbers, AI workplaces are clearly extremely male-dominated. Men are likely to apply to a job where they meet 50% of the requirements or more, while women usually only apply if they meet 90% of the requirements or more (https://business.linkedin.com/talent-solutions/).

While the percentage of women in labor force has gradually climbed over the past decades, it is still significantly lower in the tech sector. As to the chart below, based on self-reported company figures, indicates, female employees make up between 28 percent (Microsoft) and 42 percent (Amazon) of the total workforce at America's largest tech companies, the so-called GAFAM group. In terms of leadership positions, the status of women in the technology sector, as represented by its most prominent (and valuable) companies in our chart, is roughly on par with the rest of the economy. According to the lastest available data, women hold 26.5 percent of executive, senior-level and management positions in S&P 500 companies – a percentage many tech companies match or exceed, but one that is still far from parity (https://www.statista.com/chart/).



AI also risks having a negative impact on women's economic empowerment and labour market opportunities by leading to job automation (https://en.unesco.org/).

B. AI is Overwhelmingly Female

A virtual assistant is a voice- or text-enabled computer software package capable of performing basic, information-based tasks for its users (Burton&Gaskin, 2019:1). Virtual assistants are essentially a representation of virtual humans, but without the human body (Piper, 2016: 4). They were once only dreamed of in science fiction but now these virtual assistants is to create a personal relationship between users and virtual assistants—and perhaps their devices. Developers are humanizing these virtual assistants by giving them a sense of humor, the ability to learn about users' likes and dislikes, their method of transportation, their favorite sports teams, where they live, where they work, and where they like to eat in order for consumers to become emotionally attached. These AIs have the potential to know us better than some of our closest friends, and that is the point (Piper, 2016: 62).

Technically, a virtual assistant has no gender. However, the drastic rise of digital across the world demanded more remote personal assistant which reportedly are mostly female. A virtual assistant is typically the counterpart of an office-based secretary who does all the intricate work for you. The only difference is that they are working from home or remotely from anywhere in the world (https://hopla.online/blog/).

Virtual assistants and secretaries keep track of important dates in our calendars for birthday or appointments; there are also similarities in filing systems because virtual assistants can find specific documents; some can even order us items from Amazon after a simple verbal command. Virtual assistants on phones and other devices are essentially secretaries for everyday people . They are helpful virtual assistants fulfilling a western, subordinate feminine typecast. Using these virtual assistants enables consumers to live a nostalgic lifestyle in which virtual assistants are simply secretaries (Piper, 2016: 11).

With their female names, voices and programmed flirtatiousness, the design of virtual personal assistants reproduces discriminatory stereotypes of female secretaries

who, according to the gender stereotype, is often more than than just a secretary to her male boss. It also reinforces the role of women as secondary and submissive to men. These AI assistants operate on the command of their user. They have no right to refuse these commands. They are programmed only to obey. Arguably, they also raise expectations for how real women ought to behave (https://theconversation.com/).

Siri is a Nordic name meaning "the beautiful woman that leads you to victory". Cortana takes its name (as well as visuals and voice) from the game series Halo. In Halo, Cortana was created from a clone of the brain of a successful female scientist married with a transparent and highly- sexualised female body. She functions as a fictional aide for gamers with her unassuming intelligence and mesmeric shape (https://www.iol.co.za/).

In the US, 94.6% of secretaries and administrative assistants are women. Unsurprisingly, so is Siri. There are almost no major AI assistance projects that avoid this pitfall, and there isn't much push for improvement. Alexa, Cortana, even the automated announcements on public transport – they all have one thing in common: a female voice or female avatar. These teams are turning to the development of "genderless" voices to avoid criticism (https://medium.com/swlh/).

Since the first generation of projects from the early 1990s and also by the end of that decade, many American call centres were answered by robot "assistants" who would cheerfully greet customers with "How may I help you?" and handle their various requests for flight booking, movie ticketing and so on (https://qrius.com/).

Female voices are favoured because they are viewed as being helpful, polite and cordial — just like an assistant. In developing Alexa, Amazon conducted research which showed that a woman's voice is more 'sympathetic' and 'pleasing', a conclusion that has been confirmed by numerous studies since. Businesses say it's a simple case of catering to customer preferences, but these preferences are based in problematic gender biases which we should be ushering out the door. In the virtual world, women are once again filling the role of 'helper' or 'assistant' while someone else is the boss. It's ironic that many of the companies investing in Virtual Assistants are the same ones that have expansive policies aimed at stamping out gender discrimination and improving outcomes for women in the workplace (https://idealog.co.nz/tech/).

With their female names, voices and programmed flirtatiousness, the design of virtual personal assistants reproduces discriminatory stereotypes of female secretaries who, according to the gender stereotype, is often more than than just a secretary to her male boss. It also reinforces the role of women as secondary and submissive to men. These AI assistants operate on the command of their user. They have no right to refuse these commands. They are programmed only to obey. Arguably, they also raise expectations for how real women ought to behave (https://theconversation.com/).

The objective of these assistants is to also free their user from menial work such as making appointments and purchasing items online. This is problematic on at least two fronts: it suggests the user has more time for supposedly more important work. Secondly, it makes a critical statement about the value of the kind of secretarial work performed, first by real women and now by digitalised women, in the digital future (http://www.hsrc.ac.za/).

C. Bias

AI applications are generally trained using data that are generated by humans, and humans are inherently biased. And many organizations are also biased in their historical behavior. The models and systems we create and train are a reflection of ourselves. So it's no surprise to find that AI is learning gender bias from humans (https://www.oliverwyman.com/).

Man is to King as woman is to Queen. Father is to Doctor as Mother is to nurse for AI This issue is caused by something known as bias. The problem originates from having a poor dataset, which underrepresents or misrepresents a certain group. When we train our models on this data, the model becomes biased as well (https://towardsdatascience.com/).

Historically, "managers were almost always men; the lower level white-collar workers were always women" (Acker, 2006: 444). Today, "office wives" don't exist in the same capacity. Office environments have changed dramatically in the last 60 years, but administrative positions are still categorized as "pink collar;" pink collar positions are workspaces that are primarily held "by women doing work seen as 'feminine' and often devalued" (DeVoss, 2009: 349).

The secretaries answered phones, scheduled appointments and meetings, and filed paperwork as is required of administrative positions; but they also had the task of getting their executives coffee or alcohol for their office liquor cabinets, remembering birthdays and purchasing gifts for the executive's children, and keeping wives occupied so executives didn't get caught in embarrassing situations. These secretaries are essentially the executive's "office wife," a term used in many publications to label the role of a female administrator who goes above and beyond to provide for and care for her boss (Martin, 2014: 17).

In order to produce technology that is more fair, there must be a concerted effort from researchers and machine learning teams across the industry to correct this imbalance. Few studies have assessed the effects of gender bias in speech with respect to emotion and emotion AI is starting to play a more prominent role in the future of work, marketing, and almost every industry you can think of. In humans, bias occurs when a person misinterprets the emotions of one demographic category more often than another, for instance, mistakenly thinking that one gender category is angry more often than another. Some types of bias are (https://hbr.org/).

- An incomplete or skewed training dataset: This happens when demographic categories are missing from the training data. Models developed with this data can then fail to scale properly when applied to new data containing those missing categories. For instance, if female speakers make up just 10% of your training data, then when you apply a trained machine learning model to females, it is likely to produce a higher degree of errors.
- Labels used for training: The vast majority of commercial AI systems use supervised machine learning, meaning that the training data is labeled in order to teach the model how to behave. Given that the machine-learning models are trained to estimate these labels, this misclassification and unfairness towards the particular gender category will be encoded into the model, leading to bias.

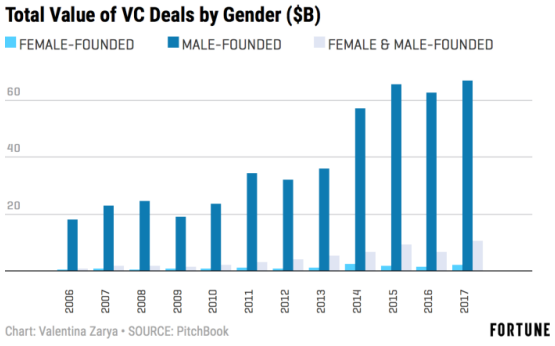
- Features and modeling techniques: The measurements used as inputs for machine-learning models, or the actual model training itself, can also introduce bias. This is attributed to the fact that the way speech was analyzed and modeled was more accurate for taller speakers with longer vocal cords and lower-pitched voices. As a result, speech technology was most accurate for speakers with these characteristics which are typically males and far less accurate for those with higher pitched voices which are typically female.

D. Venture Capitalism

A venture capitalist (VC) is defined by the large investments they make in a promising startup or young business. A venture capitalist can work on their own, but it's more common for them to work for a venture capital firm that pools money from members. Venture capitalists are willing to risk investing in such companies because they can earn a massive return on their investments if these companies are a success (https://www.thebalancesmb.com/).

One of the important indicators of gender roles in tech in the last 30 years, and in computing and AI in particular, is the image of the "boy genius" who worked in a garage and changed the world. From Bill Gates, to Steve Jobs, Jeff Bezos, to Jack Ma of Alibaba and Pony Ma of Tencent, the "kings" of the digital era and the AI era are male. Venture capital (VC) investment fuelled the growth of these companies. To make it big, all tech entrepreneurs need investment from venture capitalists and all the founders mentioned above took investment from these "king-makers" at a critical stage of growth.

However, as seen in the below table only 1-2% of the startups that receive VC funding are led by female founders, even though female-led companies make 200% returns on investment. This is the most gender-biased segment in the tech industry (https://www.weforum.org/). Only 21% of executives in the tech industry are women, only 7% of venture capital (VC) funding goes to women-owned businesses, and only 4.2% of investing VCs are women (Gilpin, 2014).



Source: Gilpin, 2014

In addition, research has shown that men are promoted for their potential, while women are promoted for their achievements. VC investment is all about betting on the potential of the founder. Unfortunately, as more male-led companies are funded, there are more success stories among them, and the more VCs choose to fund male-led companies. The gender roles are reinforced and the representation of women continues to decrease (https://www.weforum.org/).

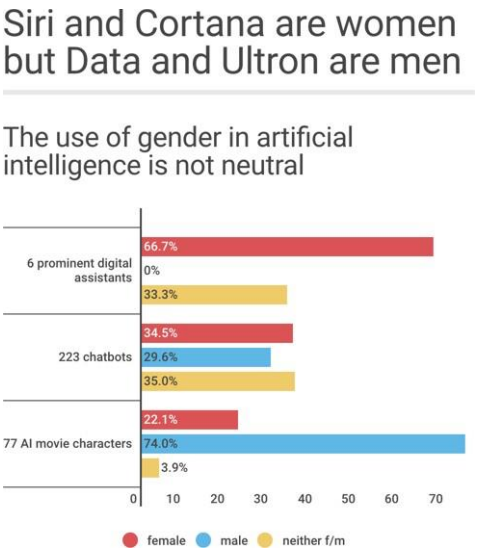
E. Cinematic AI

Robots and other artificially intelligent (AI) mechanisms are now a common plot device or even main character in movies The relationship between humans and AI in the movies is often complicated, much like it is in reality.

AI has been the center of attraction for filmmakers since the era of the silent-motion picture started. The portrayal of AI on film has been constantly evolving from 1927 to the present day. What began as a fantastic imagining of something practically unthinkable for its audience has slowly become an everyday reality for many of us, and as AI weaves itself into our lives more and more, it will continue to expand its presence onscreen as well (https://interestingengineering.com/).

There is a significant under-representation of female directors in all levels of the industry. This is in spite of evidence that there is an almost equal share of women graduating from film schools, women's films perform well in festivals and awards and, in some instances, enjoy a higher average share of admissions per film than those directed by men (https://www.ewawomen.com/). According to Mulvey (1975), Feminine characters are often given a secondary role to the masculine protagonist. Most romantic movies present the typical storyline of the male protagonist wooing a feminine character over the course of the movie, ending in him achieving his goal and possessing her love and affections, thus her. Feminine characters serve as an object or prize to be won by the end of the movie, lacking their own agency for choosing an intimate partner. (Mulvey, 1975: 13).

The popular media further reinforces this image of the "boy genius" or "wunderkind". TV shows from "Silicon Valley" to "Big Bang Theory" and movies from "The Matrix" to "Iron Man" are rife with portrayals of male tech titans. In addition to this, from the first sci-fi film "Metropolis" to the more recent "Ex-Machina", to popular TV series such as Humans and Westworld, we see female androids created by men in a sexualized form, starting in submissive servitude or becoming rebellious femme fatales (https://qrius.com/).



Source: https://medium.com

It seems that the superstars of the internet and AI era are all male in the popular imagination. The fictional male techie characters are often portrayed as "adorable dorks", socially awkward nerds who are smart and eventually get the girl (https://www.weforum.org/).

The gender problem underlying AI is exacerbated by deep- seated stereotypes. Science fiction is laden with these stereotypes. Too often, female AI beings are personified as submissive sexual beings created by men. Examples abound, including "Her" and "Ex-Machina". In contrast, male AI beings are habitually personified as powerful beings—the likes of Iron Man and Terminator, for example (https://www.forbes.com/).

F. Education

One of the fundamental originating issues is the underrepresentation of female students in education. Though more than 60% of the students in higher education are female, less than 20% are enrolled in engineering and computer science subjects (Sassler et al., 2017:195). Adding to this, the lack of role models and mentors within this industry and the unconscious biases, discrimination, pay gaps, and unwelcoming climates are identified, among others, as reasons for low female representation within the tech workforce. Digital supporting communities and private companies are aiming to dramatically increase the number of women in AI by inspiring and promoting female role models in this sector through education and employing of women in AI-related technologies. Organizations such as Girls Who Code (https:// girlswhocode.com/), Women in Technology (https://www.womenintechnology. org/), the AnitaB.org (https://anitab.org/), and Women In Technology International (https://witi.com/) have as a main goal increasing the number of women in tech related jobs with their programs and services worldwide (Cerit et al.,2020: 1).

Uptake of STEM subjects (science, technology, engineering, maths) at school and university still exhibit a considerable lack of diversity in most countries (Sanders, 2005). Last year, PwC surveyed 2000 A-level students in the UK, looking at their perceptions of technology. From the sample, 78% could not name a woman working in technology. Regarding future careers, 27% of female students said that they would consider a career in technology and only 3% said this would be their first choice. This is no surprise considering that only 6% had had it suggested to them as a career option. In comparison, 61% of male students said they would consider a career in technology. It is clear that careers in technology have not been normalised for women. They are not commonly suggested to young women, and even though there are inspiring women working in tech, it is not well- known which roles models to look up to. If these pipeline issues cannot be addressed, things will only get worse (Collett and Dillon, 2019: 26-27).

CONCLUSION

In this digital era, the competition should not be between male and female. AI companies need to attract more women in tech jobs, to diversify the pipeline and the workforce creating these new technologies. Diversification of the AI workforce will be vital in order to design and implement technology which is equitable. More women must work in tech, or else they risk being left behind in every industry. They should be active participants rather than mere passive beneficiaries in creating AI and automation. Women and their experiences should be adequately integrated in all steps related to design, development and application of AI and automation.

Only the meaningful inclusion of women at all stages will result in policies and technologies that make digital equality a reality. By doing so, it will help to prevent gender bias and maximise AI's efforts to change the workplace and technology overall. Gender-biased AI not only has immense impacts on individuals but also can contribute to setbacks in gender equality and women's empowerment. Gender balance in machine learning is therefore crucial to prevent algorithms from perpetuating gender ideologies that disadvantage women (Leavy, 2018: 14).

A new working culture of digital technology to enable women to build successful digital technical careers in AI must be built.. The aim is to address two critical dimensions: an ever-increasing need for women-working empowerment in the tech industry and the workforce need for digital technologies experts , These two dimensions happen to also be two of the ''gender gap accelerators'' identified in the Global Gender Gap Report 2020 (Cerit et al.,2020: 2).

AI and automation should be designed to overcome gender discrimination and patriarchal social norms. In other words, these technologies should be employed to address challenges faced by women such as unpaid care work, gender pay gap, cyber bullying, gender-based violence and sexual harassment, trafficking, breach of sexual and reproductive rights, and under-representation in leadership positions. Special steps should be taken to make women aware of their human rights and the impact of AI and automation on their rights (https://www.openglobalrights.org/).

Finally, all standards related to AI and automation should integrate a gender perspective in a holistic manner, rather than treating gender as merely a bias issue to be managed.

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Space Design Optimization through Generative Adversarial Networks

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***Abstract*—As a result of the development in information technology, programming has become an inevitable attribute for its function and discipline. Its inclusion in the coding design process, which is the first step of programming and program development, has been achieved with the growth of computer-aided design. Mass data-indexed progression of design has led the developments to bring new approaches to the process. These approaches help to shorten the analysis and processing time of the design and bring designers closer to data science-supported machine learning in the formation of architectural design. By working on Generative Adversarial Networks (GAN), which is an exemplary framework in machine learning, to learn and produce to feed alike. With GAN, similar and different new designs are created according to data inputs in architecture. The presence of an AI technology that can support this process is a big step forward for designers to have powerful techniques that can make better design decisions in space experience optimization. In this study, the potential of GAN technology and its better understanding and application in the field of architectural design is researched.**

Keywords—artificial intelligence, architecture, space design, optimization, generative adversarial networks.

I. INTRODUCTION

Changing facts on the design process and the concept of space in the discipline of architecture take place with the formal development of technology. One of the most realistic ways of designing the interior space that contains variability and movement, is by the help of the drawings created by computer-aided systems. Design makes use of technological tools and methods in the process from draft to productization. These technical components are redounded to computer systems by programming and program development. Modeling, which increases the visual quality and design quality with a three-dimensional interface, and automation that provides the sharing between the user and the machine, are methodical processes that determine the steps of technology in the architectural discipline. All these computer-aided operations performed during the design process affect the speed of the work depending on the user factor. Computer-aided design systems that support the progress of the process are continueing to be developed in order to provide the diversity, variability and flexibility of architectural design with the help of the algorithms that they contain. The learning of algorithms, which takea large place within the application field of artificial intelligence, can be provided with various approaches. Neural networks operating on the principle of automation and algorithms are also factors in the use of these approaches. Generative Adversarial Networks (GAN) is a neural network architecture whose main purpose is to generate realistic and previously unproduced data over the defined dataset. It facilitates the analysis of mass data and provides production and variability support to the optimization process. GAN, which can offer operations from many different perspectives within the title of architectural design, promises intuitive production and spatial solutions as well as making the process practical. With the development of methods and diversification of approaches, it is anticipated that the design tools and technical support to be offered to the users will carry architectural design to different points.

In this article, the process of the evolution of architectural design on the technology axis, includes spatial research and studies on GAN which is a product of a developing artificial intelligence technology are analyzed. Functional algorithms and applied studies that assist the optimization process will be examined in terms of scope, method, and principles.

II. ARCHITECTURAL INTELLIGENCE

A. Computer Aided Design

The need for tools and process-specific methods in spatial design are the basis for the advancement of technology in architecture [1,2]. Architectural design technology, which is thought as a representative tool, has been driven by coding and program development [3,4]. When the physicality of the design is transferred to the computer environment, the performance of the architecture in technology has changed with simulations. Supporting the drawings in three dimensions with models provided more realistic results in design [5].

The parametric design approach, which aims at working simultaneously with varying quantities, is an important algorithmic development in the architectural discipline. It is included in the computer-aided architectural design process as a design method that has the flexibility to be directed in the light of the determined parameters and provides its control through neural networks and algorithms [5, 6].

It has been observed that the design ideas transformed in the process and the tool feature of architectural programs, which is used as a necessity, has now become the starting medium of design. Content based on calculation and automation was created with common user language and visual scripting techniques over automated systems [7]. Computer aided design, which is developed in this logic, gained an innovative place where new forms emerged and extended to the building construction process [2].

B. Artificial Intelligence in the Design Process

Accelaretaiton and facilitation of the process with artificial intelligence in technology and demanding tools that provide flexibility, freedom, and control comfort are driving the developments [8]. Various approaches that will accelerate the architectural studies in this field are developed in the process. The time savings to be provided to the designer through the

development of spatial solutions and methods with artificial intelligence is the factor in the acceleration of the architectural design process.

The approaches in the process are diverse and have features that offer new ways to create architectural forms. Optimization, which defines the operational and analytical process in artificial intelligence, can be developed by training algorithms and neural networks that help to create adaptable new design options [9].

Computation and automation, which is the basis of the computer-aided architectural design, play a role that supports the emergence of all design softwares. Artificial intelligence works as a system that allows softwares to create their own algorithms using common use techniques [7]. It offers the maximum level of productivity, variability and control comfort that designers can produce their own design tools according to their needs and habits [7, 10]. According to the requested special design system content; with the potential to produce free and variable systems, a high level of efficiency can be obtained [10]. In general, artificial intelligence offers a radical change in the design process by affecting analysis and system operation.

III. GENERATIVE MODELS

A. Learning

New contexts are taught to autonomous systems with productive and analytical approaches over machines [11]. Deep learning methods and algorithms are adapted to provide machine learning, and quick learning of the complex data is being planned[12]. Deep learning, which simulates changing brain functions such as observation, analysis, experience, and decision, plays a supportive role in the development of artificial intelligence. The imitation of these active brain functions that form the basis of the design by productive systems with deep learning, reveals new features of artificial intelligence [12, 13].

Working with numerous documents due to the originality and complexity of the design processes emphasizes the necessity of the systems based on large data sets in learning. In order to obtain the optimization results on the best level, architectural design should be considered as data processing [7]. Multilayered artificial neural networks and deep learning algorithms that perform learning from large data sets accompany the design process [14, 15].

Conditions such as appropriate design conditions and ensuring optimum levels in calculations should be taught to the system through artificial intelligence optimization algorithms. Optimization algorithms use algorithms as analysis, research and problem solution techniques within the design process [16].

The relevant data set is defined and analyzed for deep learning algorithms, which vary according to the complexity in the architectural design process. The algorithm selected for the defined data set is thus trained and its performance evaluated for new data [15, 17].

B. Generative Adversarial Networks

Generative Adversarial Networks (GAN), which is defined as data science-aided machine learning, is a technique that can produce new outputs by training on the data set that creates its content [18, 19]. It processes mass data with the principle of induction in order to create factual examples and contributes to the development of the design to be created [18, 20]. While ensuring productivity, a system that distinguishes between real data and output data is included in the model. In addition to the generative model, which generates new data by random selections from the data set, the distinctive model plays a perceptual role with its multi-layered structure [19]. With the training of the optimization algorithm, the process is concluded when the output data becomes real data. The working principle of GAN is a neural network architecture that can provide algorithm training for many models [18, 19].

As a product of artificial intelligence technology, GAN continues its development over a wide range. The design diversity and productive quality that it offers within the discipline of architecture make it possible to create high quality outputs. Until this time, GAN models that support the design process from various scales and different perspectives have been created. By presenting these different dynamics together in a holistic approach, model contents and methods are included in the related studies.

IV. RELATED WORKS

Existing studies that explain their approaches and models include innovative, productive, and flexible ideas on architectural design and design process at various scales.

CityGAN has been trained as a model in order to learn architectural features of the region and to create images of non-existent buildings on architectural design at an urban scale [18]. While the system is trained to distinguish between real and output data, it learns to create more realistic data in proportion to the width of the data set and increases the product quality.

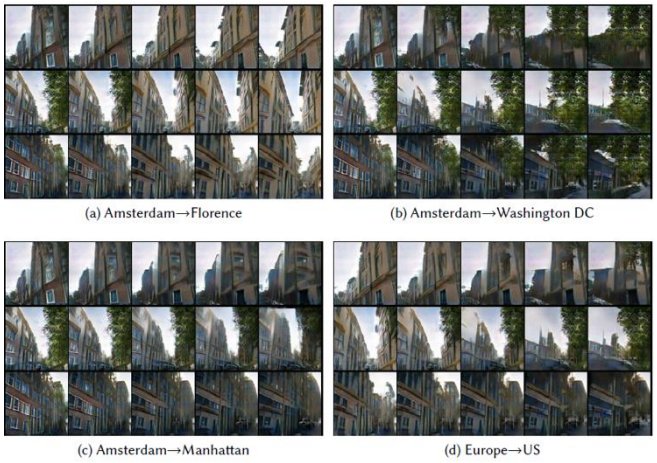

Fig. 1. Transitions between cities that make up the data set, CityGAN model [18]

A system study named SchGAN, which creates a settlement plan according to roads and borders on the scale of the land, has been carried out [21]. The most appropriate layout is aimed with the optimization of many parameters such as the flow plan of the primary school campus, functional layout, event planning, and clearance calculations. It involves the user in the process with a multivariate interface that uses existing primary school placements in the data set.

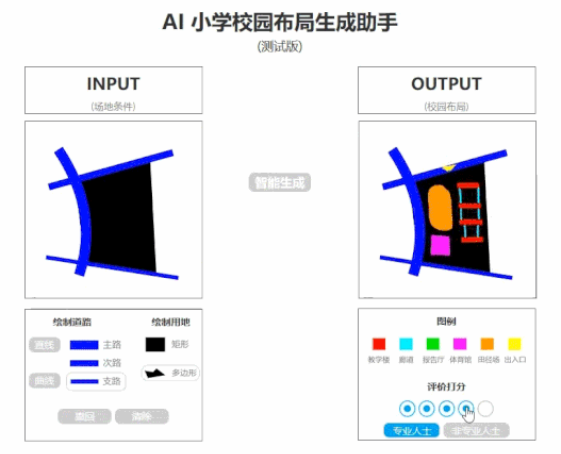

Fig. 2. Designing the selected area according to the available data, the SchGAN model [21]

A residential community model based on GAN's principle of diversity is being studied on creation of general settlement arrangements in the regions [22]. The training process of the model is similar to that of existing residential communities formed as a result of long-term trial and error. In this context, the trained model also by the effect of the optimization algorithms added to itself, has the aim of making existing mechanism problem analysis and reaching special design factors.

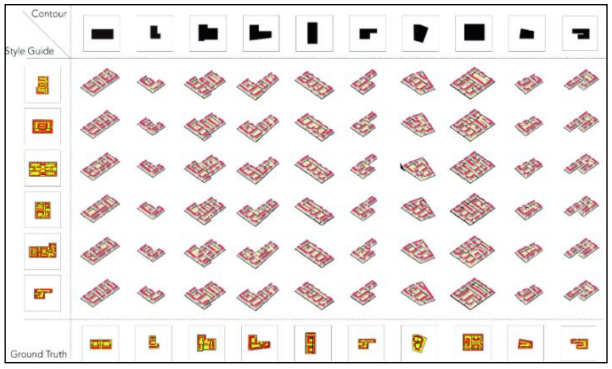

Fig. 3. Creating a multi-stage regional housing plan, GauGAN model [22]

Pix2pix algorithms in systems which are developed for creating interior space plans have been trained to recognize architectural drawings, diagrams of spatial functions, and to create a house plan [23, 24]. The width of the data set and the training of the GAN increase the quality of the outputs. ArchiGAN, which is one of the trained systems in the process of creating the interior plan, can provide diversity and variability in design through the different architectural styles it contains. Thus, in architectural design, it is observed that the user's involvement in the algorithmic production process and ensuring the control yield better results.

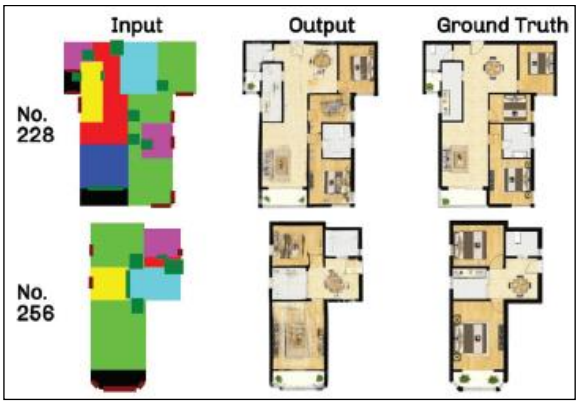

Fig. 4. Space optimization produced with GAN [23]

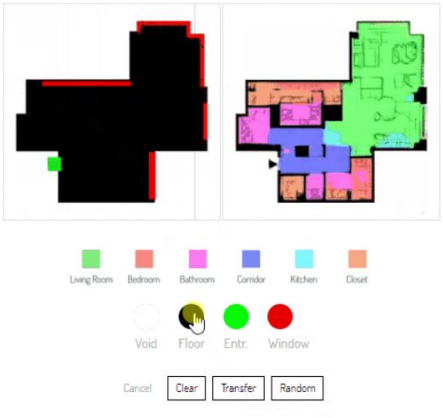

Fig. 5. Space optimization in the ArchiGAN interface [24]

V. CONCLUSION

Developing systems using artificial intelligence technology in order to ensure design diversity and productivity is important in terms of the architectural discipline. While a more practical design process is achieved with automations, the designer can take an active role in the process with controllable interfaces. User capability combined with artificial intelligence can be the harbinger of an innovative and efficient process in this sense.

The processing of analysis and technical information performed before the creation of design is a very comprehensive and time consuming process. By including artificial intelligence technologies in this process can be realized such as scanning the existing spaces in question for the design, selecting relevant technical information, and teaching them to algorithms. Thus, the burden of the designer is relieved and he/she is encouraged to make the right design decisions. The designer monitors the model interfaces and guides the algorithm in line with his/her own design decisions. The producer model of GAN provides these transactions and offers a way to realize design ideas that are not possible with human power.

GAN, which has a structure that can connect the past and present in architecture, can improve its existing features with a more detailed understanding of space optimization. With the increase in the funcktionality of GAN, new environments that meet the design needs on the best level can be created

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A Model for The Success of Companies in the Industry 4.0 Transition process: Example of Bilecik Organized Industrial Zone

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***Abstract*— We set model to determine whether companies have managed for transition period of industrial 4.0 and find out critical success factors. Our study focus on production companies around Bilecik province. A survey composed of 30 questions has been created to measure knowledge of them and data were gathered by face to face interview method. It has been formed from two section. Second part is used to set model while first part has been operated to cluster. Analyzes were performed by utilizing statistical methods and artificial neural networks.**

Keywords— Industrial 4.0, Logistic Regression, Neural Network System

I. INTRODUCTION

The 1980s and 1990s brought very different approaches to production processes. The market has expanded, but competition has risen significantly. Globalization has displaced the term "economy of scales" in favor of "economy of scope." The primary goal of all businesses is to open themselves to the world, and the ultimate goal of those who have done so has been branding. In response to these changes, companies have shifted toward specialization and therefore toward greater output productivity, toward higher-quality yet less expensive production. Following these technological trends, manufacturing practices changed and supply chains increasingly expanded. With the development of computer programs, design activities have also differentiated and diversified. Computer-aided design, modern manufacturing techniques, and the expansion and extensive use of automation in manufacturing have entered a new age. In easily and rapidly performed with computer design, it has increased the level of consumer satisfaction. Undoubtedly, developments in other sciences have been added to this process, interdisciplinary studies have increased; mechanical devices have been enriched with electronic elements and have become "smart". Finally, a new era has begun with advancements in information and networking technology and their direct application to business. This accelerated growth shows that it has reached the fourth stage of industrialization with a strong coalition and that the manufacturing process has begun to adopt "Industry 4.0."

Industry 4.0 is collective concept that refers to a variety of contemporary automation networks, data transfers, and manufacturing innovations. Industry 4.0's most notable identifying characteristics can be classified into three categories (Schwab, K. ,2016).

- Speed: Industrial growth in the modern century is accelerating. Every day, a new technological advancement occurs, and each new technological development provides an opportunity for future ones.
- Width and Depth: The developments in the new era are based on the digital revolution. However, this rapid development causes profound changes not only in the production structure but also in the business world, society and the living conditions of the individual.
- System Effect: The digital era affects the configuration (systems) of businesses, industries, and nations, as well as the development of whole systems.

Industry 4.0 is a collective set of technologies and concepts of value chain organizations. This structure contributes greatly to the vision of smart factories (Selek, A.,2016). Despite the growing complexities of the Industry 4.0 method, it also has the following advantages (Prinz. C., et al. 2016).

- Increasing competition and flexibility arising from the dynamic nature of business processes (quality, time, risk, durability, price and environmental friendliness),
- Eliminating demand chain failures
- Optimizing decision making with real-time visibility
- Ensuring increased resource productivity (providing the highest output from a given volume of resources) and efficiency (using the least amount of resources possible to achieve a given output)
- Creating value opportunities (innovative services, new forms of employment, opportunities for SMEs and new enterprises to develop)
- Reducing energy and personal costs

In order to talk about Industry 4.0 and digitalization, it may be useful to give brief information about the main components. Some of these paradigms are briefly summarized below.

1) Cyber-Physical Systems: Cyber Physical Systems (CPS) refer to the whole network that provides connectivity and synchronization between the physical and virtual worlds. CPS's primary function is to satisfy the dynamic and competitive needs of manufacturing while still increasing the industry's reliability and competitiveness. (Andreas, S. et al. 2016)

2) Internet of Things: The Internet of Things (IOT) provides a network that enables objects to communicate with one another (Sinan A.,2016). The Internet of Things is expected to provide multiple economic possibilities and is regarded as one of the most promising developments with a high potential for damage (Hofmann E. and M. Rüsch,2017). Not only artifacts, but also processes and data are considered as variables in this method, which results in the creation of a structure composed of all (Witkowski. K.,2017). IoT is a technical term that refers to a set of physical instruments that involve embedded structures of electrical, mechanical, electronic, and communication mechanisms that allow internet-based communication and data sharing.

3) Cloud Based Manufacturing (CBM): CBM is a temporary solution that can be reconfigured to react to the variable demand produced by the user, thus increasing performance, lowering product life cycle costs, and enabling optimal resource allocation. It can be described as a networked generation model that enables the creation of cyber-physical production lines via on-demand access to a shared network of different and shared production resources (Stock T. and G. Seliger., 2016).

4) Vertical and Horizontal Integration: In Industry 4.0 implementations, vertical and horizontal integration refers to the system's integration in all steps of the manufacturing phase. What should support Industry 4.0 is that all integrated devices interact constantly and are capable of monitoring and controlling one another when appropriate (Kagerman et al. 2013). Kagerman et al (2013) describes the Industry 4.0 paradigm in three dimensions

- Horizontal software integration between networks of value production,
- Engineering from start to finish during the product's lifecycle
- Introduction of connectivity and vertical software in production

Vertical software integration is the process of connecting and digitizing manufacturing lines, warehouses, and production networks. Horizontal integration includes internal departments and inter-business connections and digitalisations. The term "end-to-end engineering" refers to the process of connecting and digitizing all phases of the life cycle of smart devices (Alçın, S., 2016).

Horizontal and vertical software integration enables real-time data sharing, increases productivity with resource diversity, ensures consistent business plans and accurate planning (Salkın C.,2018)

5) Cyber Security Industry: Cyber security is a critical aspect of Industry 4.0. Computer and communication device integration has resulted in a significant weakness in CSI. This cyber security issue has the potential to have a significant effect on physical infrastructure, the economy, and community. There are various attack scenarios in standard IT settings where unauthorized users want to access and manipulate confidential data inside a secure network region.

6) Big Data and Data Analytics: Through the advancement of technology, the number of devices connecting with one another increases daily, and the amount of data generated increases proportionately. For the last decade, the word "big data" has gained popularity. Big data is a term that refers to the analysis of very broad or complicated data sets using conventional approaches.

Big data analytics can be classified under the 6C title in the sources, Industry 4.0 and Cyber-Physical System peripherals. This classification is as follows (Lee,J. et al.,2014)

- Connection; sensors and networks
- Cloud (Cloud); informatics and desired data
- Cyber (Cyber); model and memory
- Content; meaning and context
- Community; sharing and collaboration
- Customization; personification and valuation

7) Smart Factories and Smart Products: Industry 4.0 (Fourth Industrial Revolution) is defined as the integration of new production technologies, the establishment of smart autonomous systems and the combination of smart 36 factories with integrated product services as a new trend in production (Santos, C.,2017).In many Industry 4.0 definitions similar to this definition, smart factories are frequently mentioned. Smart factories are among the important components of Industry 4.0. As a result of the rapid digitalization of production facilities, the transition to smart factories has begun. Thus, smart products have started to be produced in smart factories.

8) Sensors: Industry 4.0 applications allow simultaneous production connections, rapid processing of necessary production details from information technology, significant reduction of error and waste by the use of sensors and electronic control systems, and shortening of production times (Alçın S.,2016)

Sensors are one of the most important tools for connecting objects in production. Sensors, which are easy to apply in production systems, can be easily applied to products, machines and production systems. Full-time data flow in the production area is also provided with the help of sensors.

9) 3-D Printers: Industry 4.0 may be thought of as the next stage of industrial digitalization. At this time, four topics should be considered or companies should adapt: stored data, data collection and measurement, rapid growth in internet connectivity for data; improved market intelligence and analytical capabilities; and emerging frameworks for human-machine contact (new interfaces and virtual reality systems). It is the increased use of 3-D printers and sophisticated robotic systems to convert computer data into real structures.

10) Smart Robots: The general approach of Industry 4.0 is to expand automation in production systems. Robots, which are frequently used in automation systems, take part in frequently repeated, sensitive and productive jobs in production, and their usage rates continue to increase as they adopt new technologies. Smart robots and robotic systems are very useful in the design, production and assembly stages of production systems (Salkın C., et al.2018). The use of robots instead of humans in some heavy jobs enables people to stay away from work situations that may pose a danger such as

high temperatures, heavy loads, and toxic gases, and the risk of occupational safety is reduced (Aksoy, S. 2017)

11) Virtual Reality: Although virtual reality mapping technology is currently used mostly in industries such as video games and tourism, with the advent of the smart factory model, it has been increasingly used in quality control systems, production line preparation, logistics operations, and supply chain behavior (Salkın C., et al.2018).) In the manufacturing sector, the value of simulation studies continues to grow. Industry 4.0 strives to link the physical and virtual worlds by transferring real-time output details (Santos M.Y, et al.,2017).

Thus, it is hoped to avoid the difficulty of manufacturing processes, improve efficiency, and lower long-term costs. Augmented reality technology allow the transition of real-time data to the virtual environment.The idea of smart enterprise evolves as a consequence of companies implementing Industry 4.0 technology. Businesses became smart as a result of their technology, systems, and goods being smart (Lu.Y.,2017).

Industry 4.0 enables companies to become smarter by implementing real-time knowledge and network infrastructure and equipping them with CPS technologies that combines the virtual and physical worlds (Kocsi B., et al.,2017).Equipping smart companies with CPS technologies enables them to react quickly to consumer orders while generating fewer waste (Wang L.,2016). Smart companies should incorporate green energy sources into their self-procurement strategy and thereby function as both a seller and a buyer of energy (Stock.,T & G. Seliger, 2016).

With Industry 4.0, it would be able to quickly verify facts regarding the product's sources, the equipment that processes it, or the raw material used to make the product without leaving the current location or even from a foreign office. These tasks are now completed, but in a small capacity. However, the details must be checked by either the machine's programmer or a member of the operating team. With Industry 4.0, it would be feasible to collect details without the assistance of a control or computer operator, and the data required by ERP software will be realized by the sensors or measurement instruments on the equipment, not through an operator. With Industry 4.0, also known as the unmanned factory revolution, a manager will be able to control geographically dispersed factories via data carried horizontally or vertically, and will be able to provide the knowledge required by customers by self-generation of data on ERP in these factories. Managers can make faster choices as a result of being told at all levels on the fields about which they choose to make decisions, because of business 4.0. By incorporating (integrating) the grain warehouse silo control method, which is a supplier to a food manufacturing business, into the food manufacturing company's ERP system, the food manufacturing company's manager would be able to see the moisture content of the production raw material in the grain bin and make production decisions. The employee in the same grain warehouse would be able to monitor stock levels in the silos using sensors and measurement devices installed in the silos, regulate the humidity level, and notify the truck bringing the grain to which silo to discharge the grain from the grain producer without entering the silo region. Such decisions regarding buying, distribution, and stock are made possible by the technology knowledge and processes that carry the details generated by Industry 4.0.

Turkey's Industrial Revolution 4.0 is aimed at capturing and establishing a foothold in the world's leading countries; it is important to encourage access to new technology for all industrial firms, to develop digital business hubs, to provide suitable solutions for widespread usage of smart industry, and to concentrate all stakeholders on a shared country strategy and goal. Our study aims to develop a model for estimating the status of enterprises in the transition to Industry 4.0 by using the cluster analysis. Model is created by using logistic regression and artificial neural network methods. SPSS 22.0 is used to do both analyses.

II. METHOD

A. Purpose of the research

The aim of this research is to develop a model for estimating the status of enterprises in the transition to Industry 4.0 by using the cluster analysis published in our publication " Evaluation of Enterprises in Bilecik Organized Industrial Zone in terms of Industry 4.0" (Hatipoğlu C. and Tunacan T., 2021).

B. Research Sample

The 71 enterprises out of a total of 110 large, medium, and small businesses in Bilecik Province's Organized Industrial Zones were reached. The survey was used as a data collection instrument. Our survey was created by Eylem Çetinkaya based on the industry 4.0 situation assessment of the enterprises in the Thrace Organized Industrial Zone (The study is still ongoing). The questions in survey contain the main components of Industry 4.0 and Digitalization which attained in the result of literature research. Our data was collected through face-to-face interviews.

Our questionnaire was divided into six parts; The first section: details regarding the businesses that participated in the survey; The second part: Companies' usage of cyber-physical technology; The third section: The degree to which industry 4.0 systems were utilized in production-manufacturing departments during the last two years and the extent to which they will be used in the future, as well as the methods used to analyze the system's process input-outputs; The fourth section: Knowledge and applicability of industry 4.0; The fifth section: The use of industry 4.0 sub-components, and The sixth section: the factors for implementing industry 4.0. We previously performed cluster research on the data collected from the first three sections' questions. The aim of this study was to develop a prediction model in order to the fourth, fifth, and sixth parts by using the cluster analysis results.

In our research, we created a model using logistic regression and artificial neural network methods. Additionally, since the questionnaire was analyzed, standard distribution and reliability analyses were conducted to determine the data's suitability. SPSS 22.0 was used to do both analyses.

C. Research Sample

1) Logistic Regression

Logistic regression analysis is a technique for estimating variables that are independent and have two or more

meanings. Logistic regression aims to create a model that is commonly acceptable and capable of defining the relationship between the dependent variable and the collection of independent variables with the least number of variables (Aktaş & Erkuş, 2009). When the dependent variable contains categorical data such as "successful-unsuccessful", "less-medium-more", or "positive-negative", logistic regression is preferred. (Gök, Özdemir, 2011). The aim is to introduce a model that represents the relationship between one or more independent variables and the dependent variable. Other regression analyses use continuous dependent variables, while categorical dependent variables are used. Independent variables may be categorical, constant, or a hybrid of both. If there is only one independent variable, logistic regression is used; if there are multiple independent variables, multiple logistic regression is used (Cangül, 2006). Probability and chances ratio are used in logistic regression analysis. Probability is described as the ratio of the number of possibilities of a specific type to the total number of possible outcomes. The probability ratio is characterized in logistic regression as the ratio of the probability of an occurrence occurring to the probability of it not occurring (Ural et.al., 2015).

Logistic regression analysis can be used in 3 different ways depending on the type of dependent variable (Özdamar, 2004):

- Binary Logistic Regression: The binary logistic regression method produces two results for the classifying term. This variable can be numeric or a short alphanumeric. The classifier variable is used as the reference variable in the analysis, and its relationship to the independent variables is analyzed, as well as the predictive regression equation to be used for classification. The defined equation is used to predict classes.
- Ordinal Logistic Regression: Where the dependent variable has three or more answers, ordinal logistic regression is used. Additionally, the responses may have an ordinal relationship.
- Nominal and Multinomial Logistic Regression: Nominal logistic regression is equivalent to organized logistic regression, except that the dependent variable's answers are not expected to be sequential.

2) Artificial Neural Networks

Artificial Neural Networks are systems developed with the aim of automating the human brain's capacities such as producing new knowledge, developing and exploring new information by learning through integrating the neuron, synapse, and axon features (Ooi et al., 2018). Neural networks have the capacity to learn how to specify nonlinearity and how to create an input-output relationship (Sim etal., 2014). Additionally, it quantifies the linear and nonlinear interactions between equations and the accepted decision (Chan and Chong, 2012). Applications of Artificial Neural Networks include prediction, grouping, data correlation, data analysis, and data filtering (Anonymous).

- Estimation: Artificial neural networks are used to estimate the values of inputs for an output.
- Classification: Artificial neural networks are used to classify input values. A classification of machine-generated errors may be used as an example.
- Data association: Artificial neural networks are used to complement missing data with learned data.
- Data Interpretation: This is accomplished by the application of artificial neural networks. It allows the analysis of new activities by using the data gathered during the training and produced as a consequence of the event.
- Data Filtering: Networks trained for this role are capable of identifying relevant information from a large amount of data.

III. FINDINGS

This section contains the findings of all data analyses. First of all, we will provide the usual distribution and reliability analyses that we conducted to determine the data's characteristics. Then, the findings of logistic regression and artificial neural networks would be discussed. The logistic regression approach was used to determine the impact of the questions asked in the last questionnaire's 3 categories on the clustering results and to eliminate questions. Using the questions obtained by logistic regression, artificial neural networks were used to construct a prediction model.

A. Normal Distribution and Reliability Analysis Results

If the data being analyzed is a batch or a 5-point Likert scale survey, the Skewness and Kurtosis values are used to determine the data's suitability for normal distribution. Skewness and Kurtosis values are used to determine the data's conformity to the normal distribution. If the sample data has a Skewness value in the range of ± 1.0 (Hair et al., 2013) and a measured Kurtosis value of ± 2.0 (George & Mallery, 2010), the sample conforms to the normal distribution. Many with distributions that differ from these values are said to have a skewed distribution. Table 1 summarizes the skewness and kurtosis values for the classes used in our analysis.

In Table 1, Due to the fact that all factors measured are inside the evaluation set, they are all ideal for regular distribution. Additionally, based on the averages of the variables, it can be concluded that the majority of them see Industry 4.0 investment as critical ($\mu > 3$) and are committed to make the required investments for transformation.

TABLE I. SKEWNESS AND KURTOSIS VALUES

	Mean	*Std Deviation*	*Skewness*	*Kurtosis*
Q1	3,0423	1,12677	-0,147	-0,521
Q2	2,9859	0,83654	0,027	-0,05
Q3	3,2817	0,86492	-0,723	0,441
Q4	3,3239	0,93770	-0,913	0,729
Q5	3,3099	1,19034	-0,369	-0,585
Q6	3,2817	1,19742	-0,312	-0,659
Q7	3,3099	1,12874	-0,337	-0,363
Q8	3,2676	1,10786	-0,231	-0,482
Q9	3,1831	1,21078	-0,114	-0,798
Q10	3,2394	1,18881	-0,429	-0,642
Q11	3,2958	1,13885	-0,432	-0,541
Q12	3,3239	0,98234	-0,420	0,189
Q13	3,3239	,93770	-0,378	0,188
Q14	3,3099	1,14132	-0,345	-0,454
Q15	3,2676	1,23007	-0,106	-0,880
Q16	3,4085	1,10295	-0,221	-0,664
Q17	3,3380	1,12051	-0,521	-0,109
Q18	3,3662	1,11149	-0,198	-0,765
Q19	3,1831	0,99009	-0,108	0,015
Q20	3,2817	0,94390	-0,180	-0,281
Q21	3,2254	0,95912	0,028	-0,729
Q22	3,0704	1,00462	-0,144	-0,570
Q23	3,3099	1,15377	-0,237	-0,671
Q24	3,4648	0,96852	-0,286	-0,135
Q25	3,4507	1,13123	-0,666	0,081
Q26	3,4507	1,13123	-0,423	-0,558
Q27	3,3380	1,14572	-0,234	-0,564
Q28	3,4366	1,10496	-0,293	-0,402
Q29	3,4930	1,13230	-0,286	-0,713
Q30	3,4507	1,05273	0,058	-0,570

TABLE II. ITEM-TOTAL STATISTICS

	Scale Mean If Item Deleted	*Scale Variance If Item Deleted*	*Correced Item-Total Correlation*	*Cronbach's Alpha If Item Deleted*
Q1	95,9718	277,771	0,618	0,91
Q2	96,0282	286,542	0,530	0,912
Q3	95,7324	284,37	0,587	0,911
Q4	95,6901	284,303	0,54	0,911
Q5	95,7042	279,44	0,537	0,911
Q6	95,324	277,027	0,597	0,91
Q7	95,7042	276,726	0,646	0,909
Q8	95,7465	77,563	0,635	0,91
Q9	95,83	279,171	0,534	0,911
Q10	95,7746	279,491	,537	0,911
Q11	95,7183	279,234	0,57	0,911
Q12	95,6901	286,017	0,459	0,912
Q13	95,6901	282,245	0,607	0,91
Q14	95,7042	278,754	0,582	0,91
Q15	95,7565	274,735	0,637	0,909
Q16	95,6056	281,328	0,532	0,911
Q17	95,6761	281,328	0,532	0,911
Q18	95,6479	281,46	0,524	0,911
Q19	95,9310	281,857	0,584	0,911
Q20	95,7324	289,313	0,375	0,913
Q21	95,7887	286,712	0,45	0,912
Q22	95,9437	283,682	0,519	0,911
Q23	95,7042	285183	0,404	0,913
Q24	95,5493	291,051	0,31	0,914
Q25	95,5634	286,564	0,376	0,914
Q26	95,5634	289,164	0,307	0,915
Q27	95,6761	286,565	0,37	0,914
Q28	95,5775	289,476	0,307	0,915
Q29	95,5211	288,139	0,334	0,914
Q30	95,5634	293,849	0,202	0,916

In Table 2, reliability analysis is presented in terms of the answers given to our 30 questions, and the Cronbach's Alpha reliability value for the whole questionnaire was calculated as 0.915. According to this value, it can be said that the reliability of the questions in the last part of our questionnaire is high. The reliability status of each question is presented in Table 2. When the table is examined, it is seen that the reliability value will increase to 0.916 when only the 30th question, where all the questions are important, is deleted. However, it can be said that this change does not make a significant difference because it is at the rate of 0.001.

B. Logistic Regression Analysis Results

The results of the model obtained as a consequence of the logistic regression study are summarized in the tables below in this section. The original model is one in which no variables are used to forecast the clustering of companies for Industry 4.0, but instead a fixed value is used. The model's "-2 LogLikelihood (-2LL)" meaning was determined to be 96,033. This is a very large value, given that the -2LL value, which correlates to ideal match, is 0. If the variables for the prediction model are applied, the value of -2LL can decrease as the fit of the intended model improves.

TABLE III. INITIAL ESTIMATION CONDITION OBTAINED AS A RESULT OF LOGISTIC REGRESSION ANALYSIS

	Predicted		
Observed	***Cluster 1***	***Cluster 2***	***Percentage Correct***
Cluster 1	42	0	100
Cluster 2	29	0	0
	Overall Percentage		59,2

In Table 3, it can be found that the study' right classification percentage is 59.2 percent, since all of the firms in the group with high and low probability of being competitive in Industry 4.0 are in the successful firm (cluster 1) band, which corresponds to the first classification performance.

TABLE IV. VARIABLES IN THE INITIAL MODEL / EQUATION

	B	***S.E.***	***Wald***	**df**	**Sig.**	**Exp(B)**
Constant	-0,37	0,241	2,353	1	0,125	0,69

Table 4 shows the constant term (-0.37), the constant term's standard error (0.241), the Wald (2.353) measure of the variable's importance, the degree of freedom (1), the significance amount (0.125), and Exp (0.69) gives the importance of the exponential logistic regression coefficient. Odds ratio is described by the exponential logistic regression coefficient. The likelihood value is smaller than 0.5 if the Odds value is less than 1.0, and greater than 1.0 if the probability value is greater than 0.5. The likelihood is less than 0.5, as the estimated value for phase 0 is less than 0.69 and 1.0.

TABLE V. OMNIBUS TESTS OF MODEL COEFFIIENTS FOR STEP 1

	Chi-Square	*df*	*Sig*
Step	44,726	30	0,041
Block	44,726	30	0,041
Model	44,726	30	0,041

The importance of the estimated p value for the chi-square value of the model ($p < 0.05$) indicates that there is an association between the clustered firms and the variables used to measure it, as seen in Table 5. The hypothesis that there is no difference between the variables used for estimation and the one obtained with the phase 0 initial model, which suggests that the questions asked in the fourth, fifth, and sixth

parts of the questionnaire are relevant in the estimation of grouped businesses, is supported by the chi-square value of the model.

TABLE VI. MODEL SUMMARY

Step	*-2LogLikelihood*	*Cox & Snell R Square*	*Nagelkerke R Square*
1	51,307	0,467	0,630

The fact that the -2LL value in Table 6 is as low as possible, if not near to zero, demonstrates the model's strength. The prediction model established as part of the study has a -2LL value of 51,307. When the questions posed for prediction are entered into the study, it illustrates 46.7 percent of the uncertainty in forecasting performance in Industry 4.0, according to the Cox & Snell R Square value. The R square of Nagelkerke is 63 percent. This demonstrates that our model is medium compatible.

TABLE VII. THE RESULT OF HOSMER VE LEMESHOW TEST

Step	*Chi-Square*	*Df*	*Sig*
1	3,683	8	0,885

In Table 7, when all of the questions included in the assessment are used in the study, the outcome of the Hosmer and Lemeshow tests is higher than p> 0.05, indicating that the results are not relevant. This value's insignificance means that the model has a good fit, i.e., the model data fit is adequate. Table 8 provides a summary of the model's characteristics.

TABLE VIII. THE ESTIMATION RESULTS FOR STEP 1

	Predicted		
Observerd	*Cluster 1*	*Cluster 2*	*Rescentage. Correct*
Cluster 1	35	7	83,3
Cluster 2	7	22	75,9
	Overall Percentage		80,3

Table 8 shows that the industry correctly identified 35 of the 42 companies in the cluster category that were more competitive during the 4.0 transformation phase, with an accuracy rate of 83.3 percent. The effective predictive rate was estimated at 75.9% for the 29 companies that were less likely to succeed during the transformation process, with 22 accurately predicted and 7 mistakenly expected. The intended model's overall right classification rate is determined to be 80.3 percent.

TABLE IX. THE RESULT OF HOSMER VE LEMESHOW TEST

	B	*S.E.*	*Wald*	*df*	Sig.	Exp(B)
Q1	1,872	,946	3,919	1	0,048	6,5
Q2	-1,964	1,130	3,018	1	0,082	0,14
Q3	0,621	1,036	0,359	1	0,549	1,861
Q4	-4,139	1,712	5,848	1	0,016	0,016
Q5	1,050	1,050	1,000	1	0,317	2,857
Q6	1,582	1,150	1,894	1	0,169	4,866
Q7	-1,126	0,894	1,586	1	0,208	0,324
Q8	-1,564	1,133	1,905	1	0,168	0,209
Q9	1,318	0,990	1,772	1	0,183	3,735
Q10	1,222	1,171	1,090	1	0,296	3,395
Q11	-1,162	1,006	1,335	1	0,248	0,313
Q12	-1,500	0,915	2,686	1	0,101	0,223
Q13	0,206	1,207	0,029	1	0,864	1,229
Q14	2,771	1,251	4,903	1	0,027	15,976
Q15	-3,237	1,328	5,941	1	0,015	0,039
Q16	1,481	0,995	2,216	1	0,137	4,399
Q17	2,975	1,404	4,492	1	0,034	19,585
Q18	-0,329	0,797	0,170	1	0,680	0,72
Q19	-1,932	1,037	3,473	1	0,062	0,145
Q20	2,549	1,025	6,183	1	0,013	12,795
Q21	-2,468	1,136	4,722	1	0,030	0,085
Q22	1,182	0,900	1,725	1	0,189	3,26
Q23	1,934	1,058	3,339	1	0,068	6,918
Q24	0,450	0,820	0,301	1	0,583	1,568
Q25	-0,257	1,162	0,049	1	0,825	0,774
Q26	0,597	1,017	0,344	1	0,558	1,816
Q27	-1,344	1,071	1,574	1	0,210	0,261
Q28	0,055	0,923	0,004	1	0,952	1,057
Q29	-1,050	0,996	1,111	1	0,292	0,35
Q30	-1,159	0,772	2,251	1	0,134	0,314
Constant	3,244	3,002	1,168	1	0,280	25,637

The original coefficients of the variables used for estimation are shown in Table 9 Beta (B) column. The orientation of the interaction is determined by the sign of the initial coefficients, which is either positive or negative. Table 9 shows exponential coefficients for Beta (B) values as Exp (B). The logarithms of the initial coefficients are these numbers. A positive relationship is indicated by an exponential coefficient greater than 1.00, and a negative relationship is indicated by a coefficient smaller than 1.00. In other terms, if the estimate is greater than 1.00, the odds ratio for the outcome or chance of the incident rises as the forecast component is increased. If it is less than 1.00, the occurring likelihood of the incident decreases in relation to the rise. Question 1, Question 4, Question 14, Question 15, Question 17, Question 20, and Question 21 are also meaningful in forecasting (p0.05) as we analyze the importance of the variables in our model. We will clarify the questions' explanatory detail as follows:

- Question 1: "Our company conducts Industry 4.0 research" (Chapter 4 Question): An gain of one unit in this vector increases the enterprise's chances of performance in business 4.0 by 550 percent (6,5 -1).
- Question 4 (Chapter 4): "Is existing information technology architecture compliant with Industry 4.0?" A one-unit improvement in this vector reduces the likelihood of performance by 98.4%. (0.016 - 1).
- Question 14 (Chapter 5): "The computers we use in manufacturing processes will identify errors independently and immediately and halt processing when an error occurs." The Success Odds rise by 1497.6 percent as a result.

- Question 15 (Chapter 5): "The good / service we create may be designed digitally before production": It reduces the chances of success by 96.1 percent.
- Question 17: "In our business, data is gathered and processed with the aid of sensors / actuators": This reduces the Success Odds by 1858,5 percent.
- Question 20 (Chapter 6): "Our company has corporate priorities for digital transformation": The Success Odds rise by 1179.5 percent as a result of it.
- Question 21: "If Industry 4.0 is introduced in our business, we will be able to enforce a job mitigation program" (Chapter 6): It reduces the chances of success by 91.5 percent.Equations

C. Artificial Neural Networks Results

The network model was developed in the study of artificial neural networks by using the response values of the questions that were considered to be important in the prediction model as a consequence of logistic regression. The defined model is shown in Figure 1. The dark arrows show that the statistical variables in each layer are extremely important. The training set contained 70.4 percent (n: 50) of the results, while the testing set contained 29.6 percent (21). The following are some of the other variables that were used to build the network model:

- Rescaling Method for Covariates: Normalized
- Hidden Layer Activation Function: Hyperbolic Tangent
- Hidden Layer: 2
- Output Activation Function: Softmax
- Error Function: Cross-Entropy
- Criteria Training: MiniBatch

Table 10 shows the effects of the artificial neural network model that we developed using our seven separate questionnaires. When we look at the graph, we can see that the training set has an overall performance rate of 68 percent. When we look at the classification figures, we will see that 25 of the clustered companies that are more competitive (C1) in 30 industry 4.0 are correctly categorized, whereas 5 are incorrectly classified, with an 83.3 percent performance rate. 9 out of 20 companies projected to move through the Industry 4.0 transformation phase more progressively (C2) have been rated accurately, with a 45 percent progress rate. The average performance rate for the test set is 71.4 percent, the estimation rate for C1 is 91.7 percent, and the right classification rate for C2 is 44.4 percent, according to the values measured for the test set. Table 11 and figure 2 show the intensity rating of the criteria used for classification.

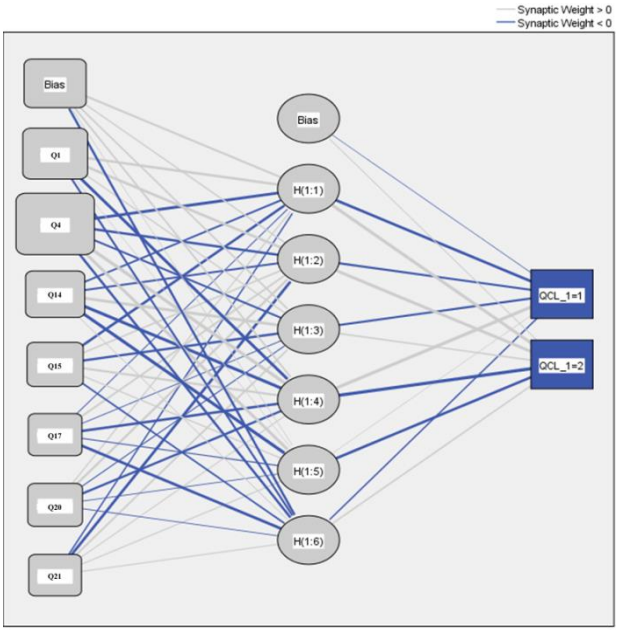


Fig. 1. Neural Network Model

TABLE X. CLASSIFICATION OBTAINED AS A RESULT OF ARTIFICIAL NEURAL NETWORK MODEL

	Observed	*Predicted*		*Percent Correct*
		C1	**C2**	
Training	**C1**	25	5	%83,3
	C2	11	9	%45
Overall Percent		%72	%28	%68
Testing	**C1**	11	1	%91,7
	C2	5	4	%44,4
Overall Percent		%76,2	%23,8	%71,4

TABLE XI. INDEPENDENT VARIABLE IMPORTANCE

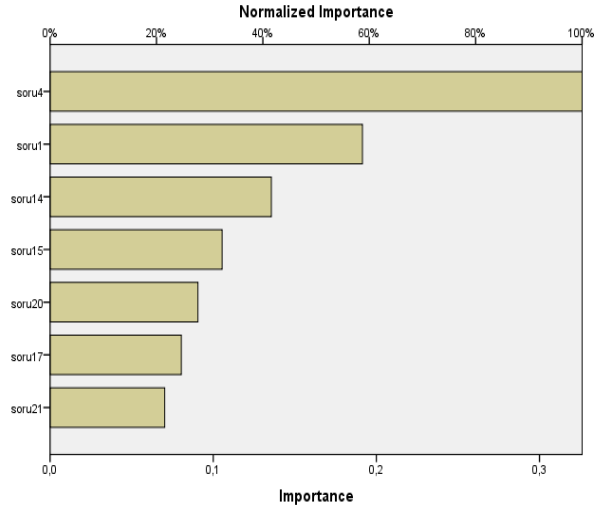
	Importance	*Normalized Importance*
Q1	0,191	% 58,7
Q4	0,326	% 100
Q14	0,136	% 41,6
Q15	0,105	% 32,3
Q17	0,08	% 24,7
Q20	0,091	% 27,8
Q21	0,07	% 21,5

In Table 11, the order of the most important input variables in our artificial neural network model is as follows with the explanation of the questions.

- Question 4 (Chapter 4): "Is the current information system architecture compliant with Industry 4.0?" 100 percent importance standard
- Question 1: "Our corporation conducts Industry 4.0 research" (Section 4 Question): The importance amount is 58.7%.

- Question 14 (Part 5): "The computers we use in manufacturing processes will identify errors individually and immediately, stopping output when an error occurs." 41.6 percent importance floor
- Question 15 (Section 5): Importance 32.3 percent: "The good / service we create can be modeled digitally until manufacturing takes place"
- Question 20 (Section 6): Importance Level 27.8%: "Our company has strategic priorities on digital transformation"
- Question 17: "In our business, data is gathered and processed using sensors/actuators": significance 24.7 percent
- Question 21: "If Industry 4.0 is introduced in our business, we will be able to enforce an employment decrease policy" (Chapter 6): Importance 21.5 percentage points

Fig. 2. Significance Of The Input (Independent) Variables



The compatibility of the enterprise's architecture for industry 4.0 has been defined to be the most significant determinant when looking at these values. The other determinants have an average meaning rating, and the employment reduction strategy is the factor with the least value in comparison to the others.

D. Conclusion

The aim of our research is to develop a estimation model for analyzing industry performance in the industry 4.0 transition. We used the clustering findings from our previous publication "The Situation Assessment of Enterprises in Bilecik Organized Industrial Zone in Terms of Industry 4.0" (Hatipoğlu C. and Tunacan T., 2021) for estimation model in our research. The answers provided for the current situation infrastructure details and potential plans that we received from the clustering companies were helpful in the related analysis. This study attempted to forecast clustering outcomes using perception questions based on a 5-point Likert scale to assess awareness of industry 4.0, the usage of subcomponents, and the motives for implementing or not applying Industry 4.0. The logistic regression approach was used in the first model of the prediction model, which has two phases. All questions were included in the development of the model in this process, and those that were minor or statistically irrelevant were removed. Seven of the thirty questions included in the model for prediction were shown to be statistically important. Artificial neural network research was used in the second phase of our process, and an artificial neural network model was developed using the responses to these seven queries. The SPSS 22.0 software was used to do both analyses. The logistic regression model has an 80.3 percent success rate, while the artificial neural network model has a 71.4 percent classification success rate. In this scenario, we can conclude that the model established in our analysis has a correct estimate rate of 71%. We believe this is attributed to the assumption that, on average, those in the company group who would be more competitive in terms of pace in the industry 4.0 transformation phase, as well as those with a slower transition value, offer similar answers to the queries. Despite this, the success rate of predictions is still very strong. The relevant circumstances in the model for forecasting are market infrastructure enforcement, like industry 4.0 tests, automated error detection, computer modelling, sensor / actuator usage, business strategy, and work, according to the findings obtained using the logistic regression process. In comparison, when we looked at which of the questionnaire's query parts were included in the model, we discovered that many of the comment sections that were used for interpretation were included. When we examine the effects of the artificial neural network model, we will see that the most significant thing that can influence industry 4.0 performance is whether or not the enterprise's architecture is compliant with industry 4.0. The employment policy is the element of the least importance in terms of results.

In future research, both problems may be compared using an artificial neural network, a logistic regression model, and a separate classification model. Through contrasting the logistic-artificial neural network results with a system such as the decision tree with logistic regression in a two-layer assessment, it can be determined which two-layer method is more accurate.

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Detection of Lane Changing Vehicles with Wavelet Transform and K-Nearest Neighbor Algorithm

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***Abstract*— Traffic management is getting more complicated due to the increasing urbanization rate day by day. Therefore, many models have been developed using smart transportation systems to overcome this problem. Lane changing, which is one of the important issues of smart transportation, is one of the basic driving behaviors that has a major impact on traffic efficiency, safety, and flow. Many various approaches have been presented in the literature for lane changing detection. In this study, a novel method for lane changing detection with a wavelet transform approach is presented. In the study, the pNEUMA dataset was used to evaluate the performance of the proposed method. In detecting lane changing, the azimuth angles of the vehicles were calculated using the WGS-84 coordinates in the dataset. Multi-level discrete wavelet transform, and lateral deviation were applied to the azimuth series of vehicles on a sample street in the dataset, and the data obtained were then classified with K-Nearest Neighbor Algorithm to determine whether there was a lane changing. In addition, the direction and time of the lane changing were determined by using the maximum amplitude obtained with wavelet transform methods. The proposed approach in the study achieved an average accuracy rate of 98%. Compared to other approaches, the proposed method has less computation complexity and therefore can find results more quickly.**

Keywords*— *intelligent transportation systems, classification, lane changing, traffic

I. INTRODUCTION

Lane changing (LC) is one of the most important driving tasks observed in the traffic flow. Compared to other daily routine driving behaviors, the LC maneuver is more complex and requires drivers to be aware of surrounding traffic conditions (for example, the speed and distance of the vehicle ahead and gaps in the current driving lane). LC has attracted great interest especially in highway systems. Due to the lack of data covering urban roads, lane changing maneuver has not been studied sufficiently on urban roads. For this reason, in this study, lane changing detection was carried out using a dataset with data on urban roads.

LC detection has been performed by many researchers using machine learning methods such as Hidden Markov Model (HMM), support vector machine (SVM), and artificial neural network (ANN). The spectral time-frequency analysis partitioning approach has been used by Zheng and Hansen [1] to generalize potential LC and Lane Keeping (LK) candidates. The classification was performed with dynamic time warping (DTW) and HMM approaches, and these approaches were compared with each other. Dou et. al. [2] developed a model about the prediction of drivers' LC maneuver on highways. Vehicle and road surface condition information were used for the detection of LC. The ANN and SVM models were combined and then was compared with other classifiers in the literature. A neural network is one of the popular approaches used in LC estimation because of its ability to generalize, learn and resolve uncertainties. Ding et. al. [4] applied a backpropagation artificial neural network model and performed LC detection on past vehicle data. Then, the training time and accuracy results of the applied model were compared with the results obtained using the Elman network model. According to the study performed by using a driving simulator and NGSIM data, the applied model has reached high accuracy in traffic flow on urban roads.

Recently, deep learning methods have been used frequently to detect LC maneuvers. The convolutional neural network (CNN) is one of these methods. Back and He [3] used the information of extracted edge from the region of interest in the original image. They employed SVM based framework to detect the LC behavior. Before that, the principal component analysis (PCA) has been applied to reduce the dimension of the images. The authors stated that the accuracy reached 68.5% when tested on actual driving data. Besides, they have implemented a CNN-based LC classifier using extracted edge information as input and reached 79.7%. LC was predicted using the group-based CNN model and three different types of physiological signals of the driver's. Gao et. al. [5] performed raw data labeling using SVM with density-based clustering. They tested the proposed model on highD dataset, which created using camera-equipped drones. Wei et. al. [6] developed a deep learning-based computer vision system using deep CNN to predict LC. This approach was considered the inadequacy of GPS data in lane-level decision-making and the cost of using LIDAR in order to achieve high accuracy. The authors stated that detection performed in 0.028 seconds per image with 86.95% accuracy.

As a result of inadequate traffic penetration rates, privacy issues, GPS errors, etc. various problems may arise. Therefore, it can be difficult to take account of traffic situations in arteries and busy city centers. In order to solve such problems, data has been collected from the traffic flow in the areas where traffic congestion was faced by using the swarm of drones [7]. Barmpounakis et. al. [8] detected the LC using the vehicle coordinate information contained in these data. The azimuth angle of the instantaneous latitude and longitude of the vehicles has been determined comparing with the true north. They used the peak detection tool to determine the peaks that mean LC in the azimuth graphic. The authors stated that LC maneuvers of the vehicles were detected with 96% accuracy.

In this study, the data of the vehicles in the region determined as the study area was extracted from the pNEUMA dataset [9]. The azimuth angle of the vehicle was calculated using the latitude and longitude information in these data. These angle series were filtered using the Finite Impulse Response (FIR) filter. The lateral deviation was calculated by using filtered series, level and maximum amplitude properties were obtained by applying multi-level discrete wavelet transform. LC in urban roads was detected with the K-Nearest Neighbor (K-NN) classifier applied to the lateral deviation and maximum amplitude features.

II. METHODOLOGY

A. Dataset

The current trajectory data can be insufficient in terms of spatial and temporal coverage. More comprehensive trajectory data is required for complete vehicle tracking and processing the traffic flow dynamics of the relevant vehicle accurately. The pNEUMA dataset was employed in this study. This dataset is provided by The Laboratory of Urban Transport Systems (LUTS) of the Ecole Polytechnique Federale de Lausanne(EPFL) deploying a swarm of drones over the city of Athens, Greece, in October 2018. It contains 10 different zones recorded in the morning peak hours for weekdays. The recording area is 1.3^2 km that covers roads of different densities and different numbers of lanes. The dataset includes the speed, acceleration, traveled distance, and vehicle type (car, taxi, bus, motorcycle, medium vehicle, and heavy vehicle), as well as allowing for a large number of new features that can be generated using location information.

B. Lane Changing

LC maneuver is defined as a vehicle crossing the lane line between two adjacent lanes. LC process usually takes a few seconds. It basically begins with the emergence of motivations that cause LC and is completed when the vehicle is laterally stable in the target lane. In the study, LC detection was performed using azimuth, lateral deviation, and wavelet transform. As indicated in Fig. 1 where LC steps are shown, the WGS-84 coordinates of a vehicle were for the azimuth, that is, the angle series was obtained by taking 2 points in the study.

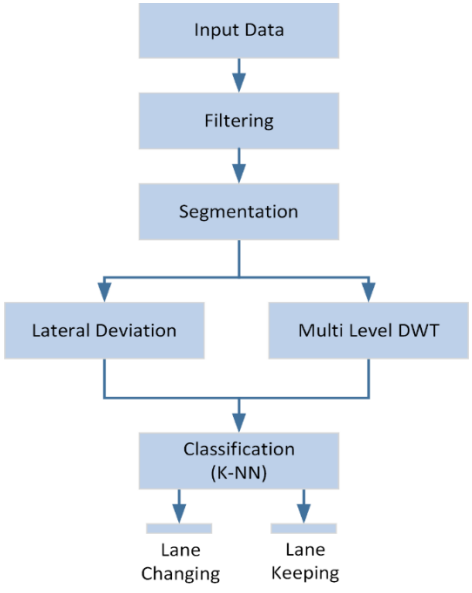

Fig. 1. Flowchart of developed LC detection model

Due to a high level of noise in the dataset, the moments when the vehicle in the angle series stopped were removed, and then the noise was removed with the FIR filter. Lateral deviation and multilayer wavelet transform are applied to the noiseless series. Compared with freeways, many more lane changes occur in urban roads. In Fig. 2, the lane changes in urban roads are shown the thin lines between the dense lines.

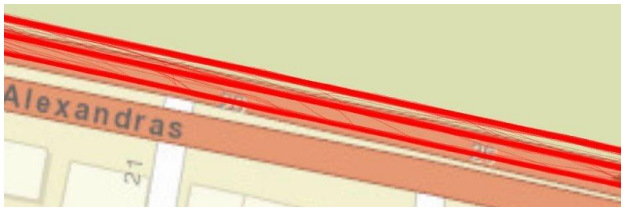

Fig. 2. Thin lines between dense lines represent LC of vehicles

1)Azimuth: The term of azimuth describes the angle formed by two lines; one that connects the current position to the North Pole, the other is the current position and the next position. In this study, the azimuth that is the angle between the direction of movement of the vehicles with the North Pole was calculated using the WGS-84 coordinate of the vehicles in the pNEUMA dataset.

When the azimuth of the road and the azimuth of the vehicle are compared, it has been observed that the two angles show similarities in a straight road. When the vehicle starts to change lane, the azimuth of the vehicle starts to increase or decrease depending on the vehicle's movement way. After the azimuth reaches the local maximum or minimum, that is, when the vehicle completes the lane changing, because the azimuth of the road remains constant on straight roads, it will gradually return to its original value.

To calculate the azimuth of the vehicle with the specified equation given in (1) was used.

$$az_x = \alpha tan2[(\sin \Delta\lambda * \cos \varphi 2), (\cos \varphi 1 * \sin \varphi 2 - \sin \varphi 1 * \cos \varphi 2 * \cos \Delta\lambda)] \quad (1)$$

where $\varphi 1$ and $\varphi 2$ are the initial and final latitude of the vehicle, $\lambda 1$, and $\lambda 2$ are the initial and final longitude of the vehicle, respectively. The difference between two longitudes is called $\Delta\lambda$.

To smooth noisy azimuth series, a window-based finite FIR was utilized. Multi-level DWT was applied to the smoothed trajectories data with the objectives of optimizing the lane-changing algorithm and identifying the peak.

2)Lateral Deviation: Using the latitude and longitude data in the form of WGS-84 coordinates, the distance traveled by the vehicle between two consecutive coordinates is calculated using (2). The lateral deviation is calculated as in (3) with the azimuth of the road, the instantaneous azimuth of the vehicle, and the calculated distance information in (2).

$$dist = 6371 * 2 * \arcsin((sin^2 \Delta\varphi/2 + cos\varphi_1 * cos\varphi_2 * sin^2 \Delta\lambda/2)^{\frac{1}{2}})] \quad (2)$$

$$dy = dy + \sin(az_x - az_{road}) * dist \quad (3)$$

In the classification to determine whether vehicles have changed lanes or not, the cumulative sum of lateral deviation over the distance traveled by a particular vehicle is used as a second feature. Due to the use of the distance traveled by the vehicle, noisy data are not visible in the cumulative sum of lateral deviation when the vehicle stopped because of traffic signals or congestion.

3) Wavelet Transform: Multi-level decomposition of the signal can be performed with multi-level DWT. Approximation and detail coefficients are obtained by applying multi-level DWT. Multi-level DWT was applied to the denoised azimuth series obtained by calculating the azimuths of each vehicle. Approximation or scaling coefficients represent the signal as low pass. The detail coefficients are wavelet coefficients. At each subsequent level, the approximation coefficients are divided into a rough low pass and high pass coefficients, which are approximation and detail coefficients respectively. The scale and shift variables of LC vehicles were determined using Haar, Daubechies, and Symlet wavelets. The maximum amplitude levels of each vehicle are determined according to the detail coefficients separately. The coefficients of detail obtained by applying Haar, Symlet, and Daubechies wavelets to azimuth-time series of different lengths as 12 levels were investigated. The level of maximum amplitude was determined as the level at which the LC takes place. Fig. 5 shows the detail coefficients for a vehicle selected randomly from the dataset. As seen in the figure, the maximum amplitude of the vehicle that changes lanes is in the 8th level. The scale and shift variables were determined according to the detail coefficients of the level where the LC occurred. While the scale variable corresponds to the level at which the LC occurs, the shift variable corresponds to the order of the coefficient at the level where the maximum amplitude is reached. Child wavelets are generated from the mother wavelet $\psi(t)$ using (4)

$$\psi_{j,k}(t) = \sqrt{1/2^j} * \psi((t - k * 2^j)/ 2^j) \qquad (4)$$

where *j* is the scale parameter and *k* is the shift parameter both which are nonnegative integers.

III. Exprerimental Results

Leoforos Alexandras avenue in the dataset was chosen for the evaluation of the LC model. The avenue is a 400 m three-lane artery. The test dataset includes 388 vehicles in the study area shown in Fig. 3 between 10:00 - 10:30 on October 24, 2018. These vehicles do not include motorcycles and turning vehicles that need a different approach in which detection of LC maneuver.

As shown in Fig. 5, level 8 has the maximum amplitude that is proper wavelet length for lane-changing detection of a selected vehicle. The time of lane changing was determined in seconds using the scale and shift variables. The sampling period is *Ts = 0.4* seconds, depending on the data used. After the child wavelets are generated using (4), their lengths and start and endpoints are determined. The starting point of this wavelet was specified as t_0 and its end point as t_e. The time when the vehicle changes lane whose detail coefficients are shown in Fig. 5, was calculated as 179.2 in seconds type using the expression $(t_0 + t_e) / 2 * Ts$. This calculated value corresponds to the time after the first data of the vehicle is recorded. In other words, the vehicle changed lane 179.2 seconds after the first recording time. Besides, the lane where the vehicle passes to was determined by the sign of the maximum amplitude. If its sign is positive, the vehicle passes to the right lane and the negative to the left lane. It is understood that the vehicle given as an example in Fig. 5 passes from its current lane to the lane on its right because of a positive sign.

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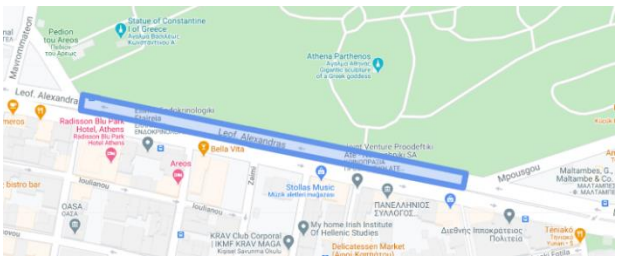

Fig. 3. Study area to evaluate the performance of the model

The classification of LC and LK was successfully performed with K-NN on Haar, Daubechies, and Symlet wavelets. The performance results of the proposed model are shown in Table I. The best result was achieved using the Haar wavelet with 98% accuracy. Although not as good as Haar, the classification was carried out with remarkable accuracy on Daubechies and Symlet wavelets, too. 60% of the dataset was used as training, and the rest is used as a test. Only a few vehicles are incorrectly classified for each class. In Fig. 4, it is seen how many incorrect classifications have been made in which classes for each mother wavelet.

TABLE I. Performance Results of the Proposed Model

Type of Wavelet	Precision	Recall	F1-Score	Accuracy
Haar	0.97	0.98	0.97	0.98
Daubechies	0.95	0.95	0.95	0.96
Symlet	0.94	0.92	0.93	0.94

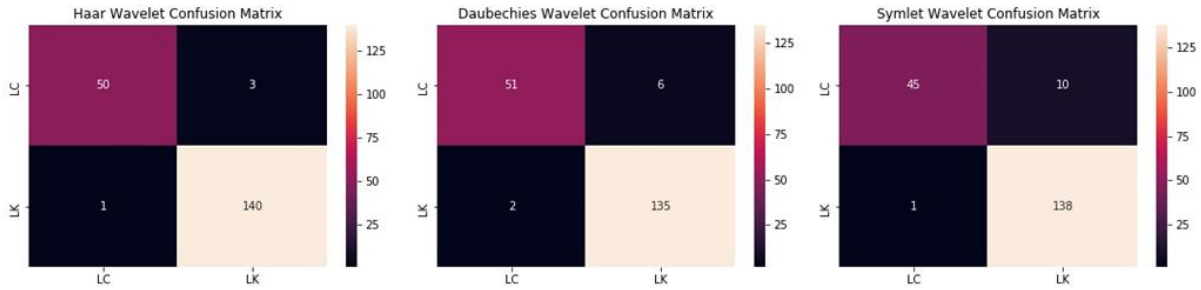

Fig. 4. The confusion matrices of Haar, Daubechies, Symlet wavelets

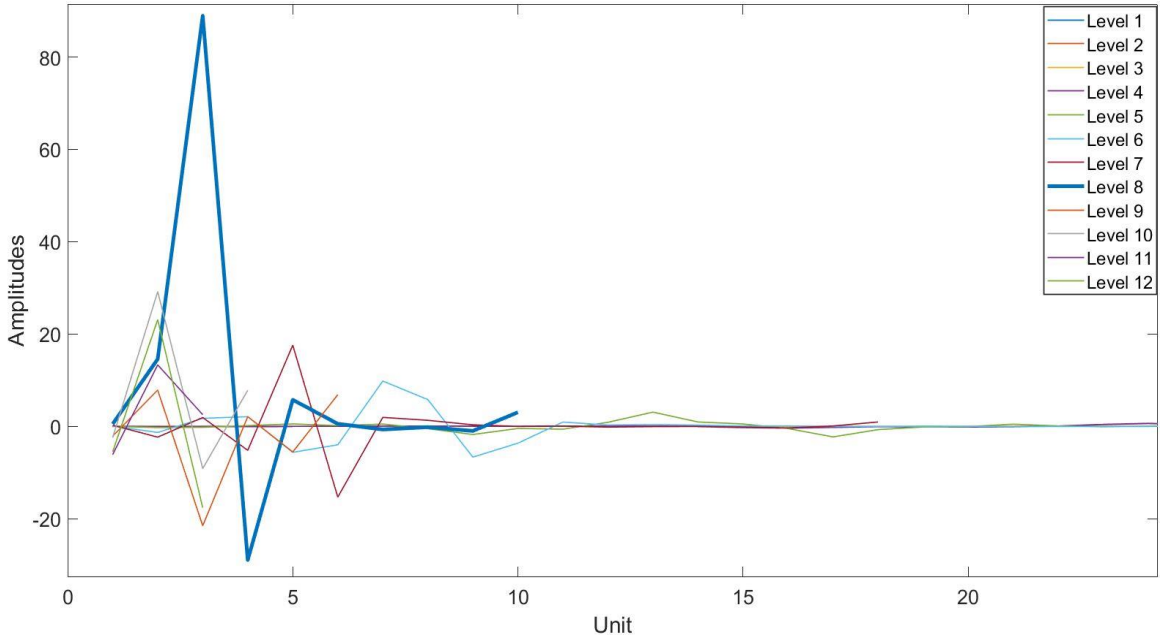

Fig. 5. Detail coefficients of the LC vehicle

IV. CONCLUSION

LC maneuver is the basic type of vehicle movement modeled by signal processing and machine learning methods earlier, and mostly deep learning techniques recently. In this study, multi-level DWT used to predict the LC maneuver with only the position data that has WGS-84 format of vehicles. The Leoforos Alexandras in the pNEUMA dataset consisting of 388 vehicles was used to train and test the proposed model. Three mother wavelets, which are Haar, Daubechies, and Symlet, were used in multi-level DWT. Amplitudes and lateral deviation features for each mother wavelets were obtained and then used in a K-NN classifier. We confirmed that the proposed method has been successful in detecting the LC maneuver. Experimental results show that the proposed method is successful in detecting the LC maneuver. In future studies, the success of the proposed method can be increased by applying different filtering methods due to very noisy vehicle data.

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Traffic Sign Recognition based on Correlation-based Feature Selection Method

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***Abstract*—Detection and recognition of road traffic signs have an important role in intelligent transportation systems. Reliable traffic sign recognition system with high accuracy provides safety and comfort in driver assistance systems. On the other hand, traffic sign recognition is a challenging example where algorithms must cope with natural and complex dynamic environments, high accuracy demands, and real-time constraints. For this reason, many approaches have been proposed for traffic sign detection and recognition. In this study, feature extraction and correlation-based feature selection methods are performed on the features that are extracted by applying pattern recognition methods in two different models. Naive Bayes, k-Nearest Neighbor, random forest, support vector machine, and artificial neural network have been tested on developed models. The proposed models have been tested on both the German Traffic Sign Recognition Benchmark and the KUL Belgium Traffic Sign data sets. According to the experimental results, the recognition of traffic signs with the proposed models show that a successful recognition rate is achieved**

Keywords—intelligent transportation systems, road sign recognition, correlation-based feature selection, feature extraction, classification

I. INTRODUCTION

Road traffic sign detection and recognition plays an important role in intelligent transportation systems. The road signs warn the driver and manage the actions of the driver in traffic. A real-time and reliable traffic sign recognition system supports the driver and significantly increases driving safety and comfort [1]. The traffic sign recognition problem is a challenging example where algorithms have to deal with natural and complex dynamic environments, high accuracy demands, and real-time constraints. Therefore, many approaches have been proposed for traffic sign detection and recognition. Useful information can be obtained using large amounts of data with pattern recognition processes, but at the same time, the efficient use of large amounts of data can be difficult. A large amount of data means a lot of storage space and a long computation time due to the fact that many feature inputs makes the training process time-consuming. The high number of attributes prevents the convergence of study and affects the recognition sensitivity. With feature extraction and feature selection, which are the most important steps of pattern recognition, the most effective feature group in the classification problem is determined, the high dimensional feature space can be compressed into a low dimensional space [2]. Many studies have been carried out in the literature on the recognition of road signs. Bahlman et al. [1] used classical classification algorithms as the classifier model while developing a model of recognizing traffic signs by classifying traffic signs according to their different shapes. Support vector machines (SVM) [3] [4] are the most used model for the recognition of traffic signs. In a color-based study using the neural network as a classifier [5], it is stated that successful classification is carried out according to the experimental results. In another study using pattern recognition methods and SVM [6], traffic sign detection and recognition is performed with color-based segmentation techniques according to the color information obtained from the image sequence. The most suitable classifier is determined in the model developed using many classifier methods. Santos et al [7] performed efficient segmentation by applying Hough transformation in Color, Saturation, Value (HSV) color space, and the classifier that gives the highest accuracy in detecting traffic signs with machine learning classifiers are determined. Gudigar et al [8] perform size reduction with graphical linear discriminant analysis after extracting the GIST descriptors of the traffic sign images in the developed model. They conduct experiments with support vector machine, extreme learning machine, and K-Nearest Neighbor (K-NN) classifiers on German Traffic Sign Recognition Benchmark (GTSRB) and BelgiumTS datasets. According to the authors, the highest recognition accuracy is achieved with K-NN. In another study, Long et al [9] also propose extracting the GIST features. The traffic sign classification method based on SVM classifier parameters optimized by feature fusion and particle swarm optimization (PSO) is developed to classify traffic signs with high accuracy by authors. First, after extracting the HOG and GIST properties, they are combined in parallel, and then SVM parameters are optimized with the PSO algorithm to increase the classification performance. According to the authors, performance enhancement with the use of fusion and PSO has been successfully achieved thanks to the developed model.

In this study, a traffic sign recognition model is developed by using traffic sign images in GTSRB and BelgiumTS datasets. After the color images of different sizes are reduced to a uniform size, they are converted to grayscale images, and then the normalization process is carried out. The analysis is carried out by using two different classifying approaches. While the features obtained from the feature extraction methods are classified separately in the first approach, which is the classical model, the components vector is created with the features obtained from the feature extraction methods in the second approach called the combined model. The classification is carried out by obtaining the best features from the component vector with correlation-based feature selection

in the second approach. In both approaches, the classification process is carried out using machine learning methods.

II. METHODOLOGY & METHODS

A. Dataset

Two different data sets, which are GTSRB [12] and BelgiumTS [13], are used in this study. These datasets are presented as open source. The datasets consist of 43 and 62 different classes with 43 and 62 different road signs, respectively. Although the number of images in the classes varies, they have an uneven distribution. The pixel values of the images stored in PPM format as RGB based vary between 15x15 and 250x250. Training and test data are randomly generated from the data sets used for each class. In this direction, a total of 8600 images are taken from 51839 images in 43 classes found in the GTSRB data set. These images are split into 6880 training data and 1720 test data. Experiments are carried out by taking a total of 4591 training and 2534 test images in 62 classes from the BelgiumTS data set.

B. Preprocessing

Preprocessing has an important role in the recognition and detection of traffic signs. First of all, due to the different pixel values of the images, all images are reduced to the same dimensions determined as 16x16. Then, 3D RGB images are converted to grayscale images. With this process, normalization is applied to the grayscale images. Each image is turned into a line vector, and these vectors are combined to create a single input vector.

C. Feature Extraction

Within the scope of the study, three different feature extraction methods are used. The features obtained from these methods are classified with two different approaches. Principal component analysis (PCA) [10] is a technique whose main purpose is to keep the data set with the highest variance in high dimensional data. While doing this PCA performs dimension reduction. It enables the reduction of the number of dimensions and the compression of the data by finding the general features in the multi-dimensional data. The size is reduced by determining the minimum number of principal components to maintain 95% of the variance by using PCA. When PCA is applied to 6880 training data, the number of components are obtained as 61 in GTSRB dataset. The number of components obtained by applying PCA is 107 in BelgiumTS dataset.

Linear Discriminant Analysis (LDA) [10] aims to reduce the size while preserving the information that will distinguish the classes as much as possible. The distance between classes is tried to be maximized in LDA. While classifying with LDA, the number of components coming to the classifiers is determined as 26, which gives the most appropriate value in both datasets.

Kernel PCA (KPCA) [10] is the generalization of the linear PCA method to the nonlinear case using the kernel method. With KPCA, the original input vectors are first mapped to the higher dimensional feature space, then linear PCA is applied in this space. The classification is made by choosing the kernel method as linear and the number of components as 34 in feature extraction with KPCA in both datasets.

D. Feature Selection

Feature Selection is one of the core concepts in machine learning which hugely impacts the performance of the model. The data features that trained in machine learning models have a huge influence on the performance can be achieved. The goal of feature selection in machine learning is to find the best set of features that allows one to build useful models of the studied area. In this study, Pearson correlation coefficient based feature selection [11] is applied to combined features.

$$\rho_{x,y} = \frac{\mathbb{E}[(X-\mu_X)(Y-\mu_Y)]}{\sigma_x \sigma_y} \quad (1)$$

The correlations of all features in the feature vector created in the combined model are calculated by using Eq. 1 wherein *X*, *Y* are the features, μ_X and μ_Y are mean of features, σ_x and σ_y are the standard deviation of features, $\rho_{x,y}$ is the correlation between two features. The next step, the classification process, is performed by selecting the optimum number of features with the highest correlation among the correlations of all the features in the vector.

E. Classification

Classification is a learning approach in which the classes of unknown records are assigned by classifying machine learning methods to one of the previously defined categories. In this study, Naive Bayes, K-NN, Random Forest, SVM, and developed back propagation artificial neural network (BPANN) methods are used. K-NN is a controlled, non-parametric machine learning algorithm that can solve both classification and regression problems. It is a lazy learning algorithm because it does not have a specialized training stage and uses all the data for training while classifying. The K-NN algorithm uses feature similarity to predict the values of the new data points, and a value is assigned to the new data point based on its proximity to the points in training. The random forest algorithm generates decision trees by picking random samples from the data set and takes predictions from each decision tree and finally selects the most voted solution by voting. Random forest is a community method that is better than a single decision tree because it reduces over-compliance by averaging the result. In the developed approaches, the depth is selected as 16 for the random forest classifier and the optimum values are obtained. SVM is a supervised algorithm used in classification and regression problems. The purpose of SVM is to maximize the distance between support vectors belonging to different classes and to obtain the hyperplane, that is, decision boundaries that will separate the classes. In this study, optimum classification is carried out using Linear SVM. Naive Bayes is a lazy learning algorithm that is based on the Bayes theorem and can also work on unstable data sets. The algorithm calculates the probability of each situation and classifies it according to the one with the highest probability value. The classification is carried out using the Bernoulli model approach, where more than one feature can exist, but each is a binary variable. The Back-propagation algorithm looks for the minimum value of the error function in the weight domain using the delta rule or gradient descent. While performing this purpose, it processes the net value coming to the cell and uses the neuron's output corresponding to this input in activation functions. Linear, sigmoid, tanh, and softmax functions, which are among the

activation functions, are used in forward propagation and backpropagation stages in the algorithm.

F. Proposed Model

Two different approaches are presented in the model developed for the recognition of traffic signs. The first is the classical model, which is carried out using classical pattern recognition methods and machine learning methods, and the other is the combined model. The classification is performed on features selected with correlation-based feature selection from the combined vector created with the components obtained by the feature extraction methods.

Fig. 1 Flowchart of the classical traffic sign recognition model

1) Classical Model: The classical model is an approach to recognizing traffic signs using machine learning and pattern recognition methods. In this approach, datasets are first preprocessed to obtain standardized dataset. Afterwards, the feature extraction process is performed by using the extraction methods PCA, LDA and KPCA separately.

Classification is made with five different classifiers in this study; K-NN, SVM, Naive Bayes, Random Forest and BPANN. The flowchart of the classical model is as shown in Fig 1. Each classifier is separately applied to features obtained with feature extraction methods.

2) Combined Model: In this study, a combined model has been developed for the recognition of traffic signs. Standard data is obtained by preprocessing the datasets as in the classical model. In addition to the classification of traffic signs by applying the feature extraction methods separately, correlation-based feature selection is applied to the combined vector obtained by combining the components obtained from PCA, LDA, and KPCA feature extraction methods.

At the end of this process, the feature vector is created by combining all the obtained features. Correlation-based feature selection is carried out in order to increase the success and performance of the model with the optimum number of features selection. The optimum number of features with the highest correlation are selected among the features whose correlations are calculated, and are classified with the classifiers as used in the classical model.

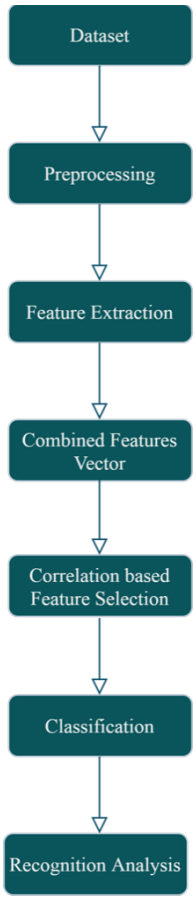

Fig. 2 Flowchart of the correlation based traffic sign recognition model

III. EXPERIMENTS

Experiments are carried out using two different datasets. In the classification step, both datasets are divided into 70% training data and 30% test data. Performance analysis of the proposed models is carried out using performance metrics. Accuracy, precision, and recall are the metrics used in the model. Accuracy in classification problems is the number of correct predictions made by the model over all kinds of predictions made. Precision is a metric that shows how many of the values classified as correct are actually correct, while recall is a metric that shows how many of the operations that need to be classified correctly are really correctly classified.

A. Experimental Results

We first show how accuracy changes based on different classification methods in the classical model using various feature extraction methods for both datasets. Then, accuracies of classifiers are shown for the combined model. According to the results given in Fig. 3, SVM classifier gives the best result in the use of PCA feature extraction method and the accuracy is 91% , while the K-NN classifier gives the best result in the use of LDA feature extraction method and its accuracy is 91%. In the KPCA method, the best results are obtained with K-NN and SVM and accuracies of them are 90% and 88%, respectively. As can be seen from Fig. 3, the Naive Bayes algorithm is the classifier that gives the worst results in the GTSRB dataset for all three feature extraction.

According to the results obtained at the end of the classifications performed in the BelgiumTS dataset, the most successful classifier in the PCA method is BPANN with

TABLE I
PRESICION AND RECALL RESULTS IN THE CLASSICAL MODEL

		K-NN		SVM		Naive Bayes		Random Forest		BPANN	
		Recall	Presicion	Recall	Precision	Recall	Presicion	Recall	Presicion	Recall	Presicion
GTSRB	PCA	0.89	0.90	0.91	0.92	0.58	0.59	0.75	0.75	0.89	0.89
	LDA	0.91	0.91	0.86	0.86	0.67	0.69	0.79	0.80	0.82	0.82
	KPCA	0.90	0.90	0.90	0.89	0.51	0.52	0.78	0.78	0.85	0.85
BelgiumTS	PCA	0.66	0.76	0.86	0.90	0.79	0.86	0.62	0.68	0.87	0.90
	LDA	0.88	0.91	0.87	0.90	0.80	0.86	0.79	0.83	0.84	0.89
	KPCA	0.65	0.75	0.86	0.89	0.77	0.84	0.66	0.71	0.87	0.89

TABLE II
PRESICION AND RECALL RESULTS IN THE COMBINED MODEL

	K-NN		SVM		Naive Bayes		Random Forest		BPANN	
	Recall	Presicion	Recall	Precision	Recall	Presicion	Recall	Presicion	Recall	Presicion
GTSRB	0.93	0.94	0.89	0.89	0.69	0.70	0.81	0.82	0.81	0.81
BelgiumTS	0.79	0.80	0.87	0.90	0.84	0.89	0.79	0.81	0.89	0.91

accuracy of 89% as can be seen in Fig. 4. K-NN and BPANN are the classifiers with the highest accuracy in the LDA and KPCA methods with accuracy of 87%, respectively. The Random Forest algorithm is the classifier that gives the worst results in the BelgiumTS dataset for all three feature extraction.

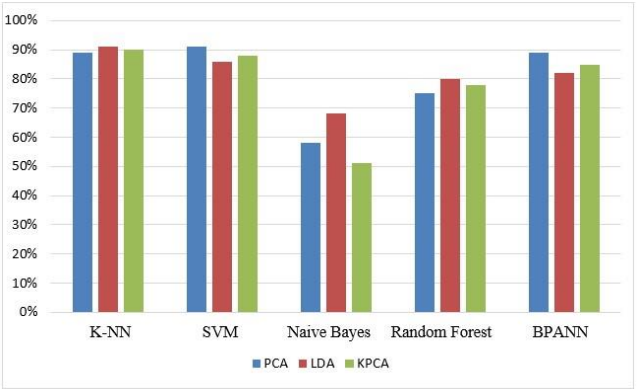

Fig. 3 Classification of traffic sign of GTSRB

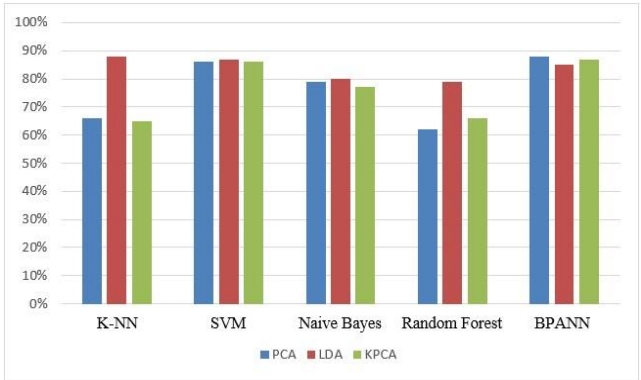

Fig. 4 Classification of traffic sign of BelgiumTS

We conduct a new experiment to measure performance of the combined model. Recall that after applying feature extraction methods separately, Pearson correlation based feature selection method is applied to select best features among all. The 61 components from PCA, 26 from LDA and 34 from KPCA are combined in the combined model for GTSRB dataset.

The number of components combined in the experiments performed for the BelgiumTS dataset is 107, 26, and 34 respectively. Then, the best features are selected by applying correlation-based feature selection and classification is made with five different classifiers. The best feature number is determined according to the experiments with different values. For the GTSRB dataset, the best feature number value is 50 for all classifiers, for the BelgiumTS dataset it is 50 for KNN, Naive Bayes and, Random Forest classifiers, 70 for BPANN and SVM. Accuracy rates of the combined model for each classifiers are shown in Fig. 5.

As can be seen in Fig. 5, the results of the model in which the correlation-based feature selection method is applied by combining the components obtained from all feature extraction methods, KNN has been the most successful classifier. K-NN is also the most accurate classifier of this model and this study, with 93% accuracy in the GTSRB dataset. The BPANN is the most successful classifier in BelgiumTS dataset with 89% accuracy for combined model.

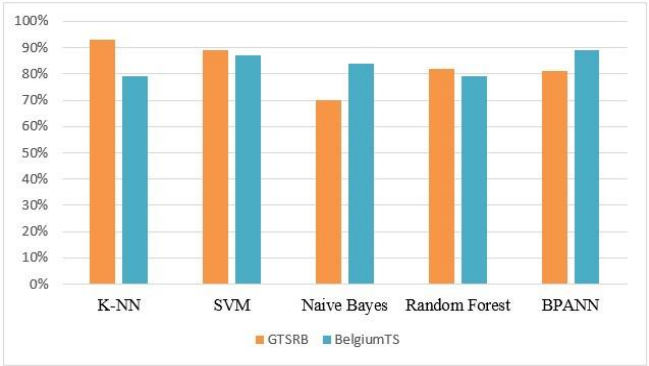

Fig. 5 Classification of traffic sign for correlation-based combined model

Naive Bayes, which is the worst classifier for the GTSRB dataset in the classical model, is also the worst classifier in the combined model with 70% accuracy in the GTSRB dataset as seen in Fig. 5. We also measure how the recall and presicion values change for each classifier in both models.

According to the results given in Table I, which shows the classical model values, Random Forest and Naive Bayes have the best values with the LDA method in BelgiumTS dataset while K-NN, SVM, and BPANN classifiers have the best values with the PCA method in the GTSRB dataset. According to Table II, which includes the recall and presicion values of the combined model, Naive Bayes and BPANN gave better results in the BelgiumTS dataset while K-NN has better results in the GTSRB dataset. The other classifiers have approximately the same recall and presicion values in both datasets.

IV. CONCLUSION

In this study, it is aimed to classify the road signs that have an important place in smart transportation systems by using the GTSRB data set with images of 43 different road signs and the BelgiumTS data set with 62 different road signs. The components obtained by applying PCA, LDA, KPCA are used separately in the classical model and together in the combined model and classified with K-NN, SVM, Naive Bayes, Random Forest and Back propagation BPANN classifiers in both models. We confirm that the combined model has been successful in the recognition of traffic signs. Experimental results show that the K-NN classifier is the classifier with the highest accuracy rate for the GTSRB dataset in the combined model, and in this study with a rate of 93% whereas BPANN is the most successful classifier with a rate of 89% in the experiments performed on the BelgiumTS dataset for the combined model. Since the recognition of traffic signs is actually an image classification, the accuracy rate can be increased by using deep learning models in future studies.

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A Portable System for Customer Interest Analysis in Shops

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***Abstract*—The analysis of customer interest in stores can provide insights about how shelves can be organised to attract more customers. However, this analysis requires long time monitoring of customers engaging with products in a store, with potentially a camera, by resulting in large size of data to be stored. This study presents a system to collect and analyse the customer interest data in real time with a low-cost portable system. As the first step of customer interest analysis, customers are detected with a pretrained Mobile SSD Net network running on Raspbery Pi 4 and Intel Movidius Neural compute stick 2, with an attached high resolution camera. Our method obtained a detection performance above 95%, with a FPS rate of over 10. We also report customer engagement time, by revealing hot spots in a store.**

Keywords—Deep learning, embedded system, image processing

I. INTRODUCTION

Nowadays, the use of cameras in public spaces increases day by day, particularly for security purposes. Similarly, stores in big shopping centers keep records of costumer activities around shelves with the same purpose. For many strores, this provides an opportunity for them to improve their design according to customer interest in a large range from detecting blind and hot spots in the stores to organisation of shelves according to engagement of customers. This may reveal important information about in which locations and in which situations costumer interest increases, which may not be obtained by analysing sells per se.

Stores can record costumer videos to analyse their behaviour. However, it may raise concerns about the use of personal information without the acknowledgement of costumers. Moreover, stores usually need to record the videos for long time to extract meaningful information. This requires large storage to save this data.

To address the aforementioned problems, this study presents a deep learning-based image processing method to analyse customer behaviours on camera images in real time with a portable system. Because the proposed method saves only customer statistics after processing real time images, it protects personal information. Moreover, because it only saves the statics, it reduces total cost of such as system, by requiring much smaller storage capacity.

II. LITERATURE REVIEW

Deep learning methods have been extensively used for many image processing problems in a wide range of areas, from image classification to instance segmentation [5-7]. Object detection is one of popular areas deep learning methods found application. One reason is the availability of large labelled image datasets such as ImageNet [8], which allows to train many large deep networks without overfitting [2-4].

In the image processing literature, there are mainly three approaches for human detection in images [9]:

1- Detecting each person with a bounding box.

2- Using regression to approximate the number of people in an image, without detecting them with bounding boxes individually

3- Predicting the number of people in an image from density maps.

In the first approach, people are detected by framing them with bounding boxes by using deep networks such as R-CNN [10], YOLO [11] and SSD [12], similar to object detection. To determine the number of people with this approach, one needs simply to count the number of boxes. In this approach, pretrained networks with larger datasets can be used for human detection in custom datasets, with transfer learning or even without any further training [13].

In the second approach, a regression method, such as random forest, is trained to estimate people count directly from input images. The third approach is generally used for crowd estimation by approximating the number of people from density maps. This group of studies can be put into three sub-groups further: studies using simple convolutional networks [14], those using multiple column networks [16-21] and those using single column networks [21-27].

III. THE DESIGNED SYSTEM

Our system mainly consists of a Raspberry Pi 4, an Intel Movidius neural compute stick 2, a camera and an SD card, as demonstrated in Figure 1. We will explain the function of each component as follows.

Raspberry Pi acts as a main processing unit. Because we aim for real time image processing based on deep networks, we use a neural compute stick to accelerate computation speed. The neural compute stick acts as a mobile graphical processing unit (GPU) connected to USB interface of the Raspberry Pi. To collect costumer images in stores, we use a camera with a resolution of 5MP, attached to the Raspberry Pi. Our system also includes an SD card to store necessary software and our analysis results. Apart from these components, our system also requires a mouse, keyboard and display during the setup of the system and to access costumer statistics after its collection. It should be noted that these peripheral components are not necessary when our system is put into a store.

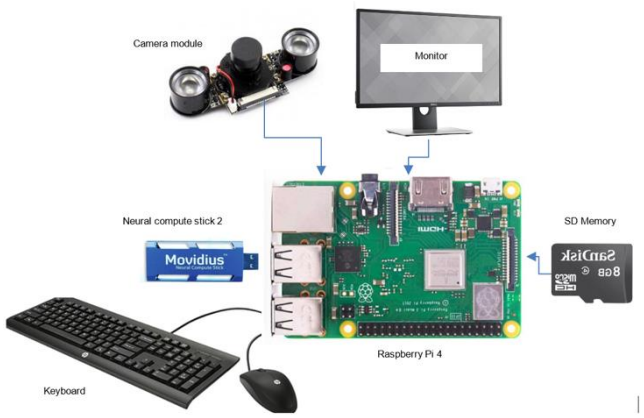

Fig. 1. Components of our system

Given the difficulty of collecting data in the pandemic, we use a pretrained model for human detection in stores. We used Single Shot Detector (SSD) architecture, with MobileNet backend, which was designed for mobile visual applications, with its depth-wise separable convolutions. The network was pretrained with MS-COCO dataset. This network is a single-stage object detection model has 300x300 pixels input layer that goes straight from image pixels to bounding box coordinates over 21 convolution layers and class probabilities. Figure 2 illustrates this architecture.

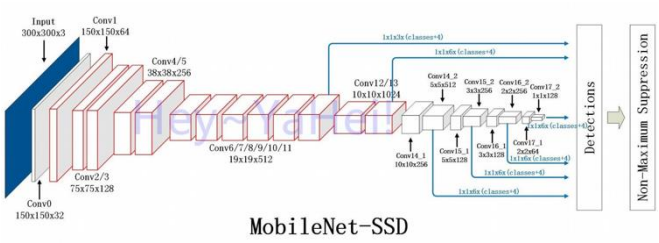

Fig. 2. MobileNet-SSD model

With this network, we calculate the number of costumers in videos showing some aisles of a store.

IV. RESULTS

Real-time images are used to test the performance of the system. People with a distance of 1-1.5 meters from the camera is used in the videos. Real time performance of the system is observed. In good light condition, the recognition performance of the system was over 95% when 85% coincidence value is used.

Figure 3 shows the output of the system during the test phase. Where, detected number of people, number of interested people and total number of interested people are given as output.

After the initial test phase, the system is tested on various store videos available on the internet to simulate real situations. In these videos, customers are seen waiting in front of the aisle, taking something or passing by the aisle. Figure 4 shows the some frames of test videos. Table 1 show analysis results for the test videos.

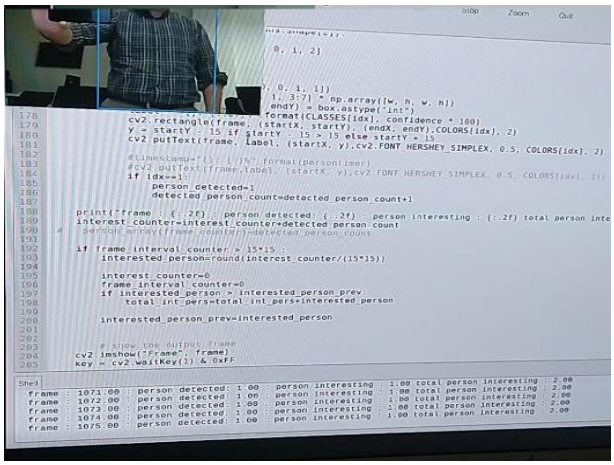

Fig. 3. Output of the system

TABLE I. RESULT FOR TEST VIDEOS

Aisle #	***Output of System***	
Aisle 1	Detected # of customer	2
	# of interested customer	2
	Total # of interested customer	2
Aisle 2-a	Detected # of customer	2
	# of interested customer	0
	Total # of interested customer	0
Aisle 2-b	Detected # of customer	1
	# of interested customer	1
	Total # of interested customer	1
Aisle 2-c	Detected # of customer	1
	# of interested customer	1
	Total # of interested customer	2
Aisle 3	Detected # of customer	1
	# of interested customer	1
	Total # of interested customer	1

V. CONCLUSION

The system described in this study, which works in real time, has been developed as a application for the smart store/shopping system. The developed application analyzes which aisles the customers find more interesting and statistically reports them. The information on whether there is a customer in front of the aisle / showcase, whether the customer is interested and total number of interested customers can be reported instantly. In addition, it is also possible to monitor the time plot of the number of customers visiting the aisles. Thus, it can be determined which aisle attracts the most attention in which time interval. Time plot for the test videos is shown in Figure 5.

Although the study is presented as a shopping application, it has a scope and potential for improvement that can be applied to all kinds of markets, shop and exhibitions etc. In fact, the system has an infrastructure that can be easily adapted software in order to ensure the security of the store and to prevent theft.

Fig. 4. Sample frames from test videos

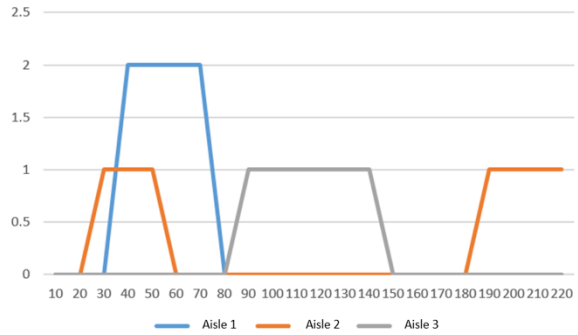

Fig. 5. The time plot of the number of customers visiting the aisles (Time axis is in terms of FPS * axis value)

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Estimations of Neutron Induced Reaction Cross-Sections on Uranium by Neural Networks

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***Abstract*—Neutron-induced reaction cross-sections on uranium isotopes are important for nuclear reaction studies including power plants. In this study, we have estimated these reaction cross-sections for the energies up to 200 MeV by using artificial neural network (ANN) methods. For the training of the ANN, available data in the literature databases have been used. The main purpose of this study is to find neural network structures that give the best estimations on the cross-sections and to compare them with each other and available literature data. By this aim, different activation functions and various ANN structures have been used. The results indicate that the method can be a powerful tool for the estimation of neutron-induced reaction cross-section data for uranium isotopes.**

Keywords—Neutron-induced reaction, cross-section, Uranium, neural network

I. INTRODUCTION

Uranium is a chemical element with the symbol U and atomic number 92. It is a silvery-grey metal in the actinide series of the periodic table. Uranium is radioactive since all isotopes of uranium are unstable. The half-lives of its naturally occurring isotopes range between 159.200 years and 4.5 billion years. It occurs naturally in low concentrations of a few parts per million in soil, rock, and water, and is commercially extracted from uranium-bearing minerals such as uraninite. Since it is naturally radioactive, uranium, usually in the form of uranium dioxide (UO2), is most commonly used in the nuclear power industry to generate electricity. Naturally occurring uranium consists of three isotopes: uranium-234, uranium-235, and uranium-238. With the abundances of 0.0054%, 0.71% and 99.28%, respectively. Although all three isotopes are radioactive, only uranium-235 is a fissionable material that can be used for nuclear power [1].

When a fissionable material is bombarded by a neutron, its nucleus can release energy by splitting into smaller fragments. If some of the fragments are other neutrons, they can strike other atoms and cause them to split as well. A fissionable material, such as uranium-235 with a half-life of 704 million years, is a material capable of producing enough free neutrons to sustain a nuclear chain reaction. Only 0.71% of naturally occurring uranium is uranium-235. This is too low a concentration to sustain a nuclear chain reaction without the help of a material known as a moderator. A moderator is a material that can slow down a neutron without absorbing it. Slow neutrons are more likely to react with uranium-235 and reactors using natural uranium can be made using graphite or heavy water as a moderator. Methods also exist for concentrating uranium-235. Once the levels of uranium-235 have been increased to about 3%, normal water can be used as a moderator.

Since the neutron-induced reaction is used in the fission process, it should be known the cross-sections of the reactions. The cross-sections can be determined experimentally or theoretically. Some computer codes are available in the literature based on the theories. TALYS [2] is one of the commonly used computer code systems for the analysis and prediction of nuclear reactions. The basic objective behind its construction is the simulation of nuclear reactions that involve neutrons, photons, protons, deuterons, tritons, ^{3}He- and alpha-particles, in the 1 keV-200 MeV energy range and for target nuclides of mass 12 and heavier.

In this study, the artificial neural network (ANN) method [3] has been used for the estimation of the (n, n), (n, 2n) and (n, f) reaction cross-sections in different energies on natural uranium-235 target. The data for the ANN estimations are taken from TENDL-2015 library [4] which are generated using TALYS code. ANN is composed of neurons that are processing units in different layers. It generates its own output which is the analytical functions of the input value. ANN does not need any relationship between inputs and outputs. Therefore, it is called a nonlinear function approximator. Recently, ANN has been used in many fields in nuclear physics. Among them, the studies performed by our group are developing nuclear mass systematic [5], obtaining fission barrier heights [6], obtaining nuclear charge radii [7], estimation of beta decay energies [8], an approximation to the cross-sections of Z boson [9], determination of gamma-ray angular distributions [10], estimations of radiation yields for electrons in absorbers [11] and estimations of fusion reaction cross-sections [12] and determinations of the (n, p) reaction cross-sections [13].

II. MATERIALS OF METHOD

An artificial neural network (ANN) is a mathematical model that mimics brain functionality. It consists of several processing units called neurons in mainly three different layers [3]. Because it has layers, it is named as layered ANN. In one of the most common type of ANN, the data flow forward direction from input layer to output layer. Therefore this type of ANN, which is also used in this study, is named as layered feed-forward ANN. The neurons are connected to the next layer neurons via weighted connections. The neurons in the input layer receive the data and the output layer neurons give the result. According to the problem variables, the numbers of the neurons in input and output layers are determined. Between these two layers there are hidden layers. Besides, the number of the hidden layer is from one to more leading deep-learning. There is no rule for the determination of the numbers of hidden layer and their neurons. After many trials for the problem, the numbers of hidden layer and the

neurons can be taken into account that gives the results as close as to the desired values.

ANN consists of two main stages, one of which is the training and the other is the test stage. The whole data for the problem is usually divided into two parts in the calculations. Generally, 80% is used for training of ANN and 20% for the test of ANN. The main goal in training is to determine the weight values of the connections between neurons. In the training stage of this work, Levenberg–Marquardt [14, 15] back-propagation algorithm was used. For hidden layer neurons, calculations have been made by many activation functions and it has been seen that the best results are obtained with the tanh function. However, sigmoid activation results are also considered as an alternative, as they do not yield results that are far from these results. The results of the sigmoid activation function for the (n, n) reaction are also given for comparison.

The error between the desired and ANN outputs produced by the network is determined by MSE. It is not enough to see that the network gives successful results on the training data. It should also be determined whether the network can generalize on this type of data. This is done on the 20% data set previously allocated. The constructed network is applied to the test data and the outputs of the network are compared with the desired outputs. If the MSE values are below the desired level in the test stage also, it can be said that the network is successful in solving the given problem. In our study, we consider the reaction in which neutrons are sent on the uranium-235 isotope to induce a reaction. For different neutron energies, we tried to obtain the cross-section of this reaction with ANN. We took the neutron energies as inputs of ANN and reaction cross-section as output. We used the values of 1 to 3 as the number of hidden layers with the different number of neurons in each. In Fig.1 we have shown one of the ANN structures that is used in the estimations.

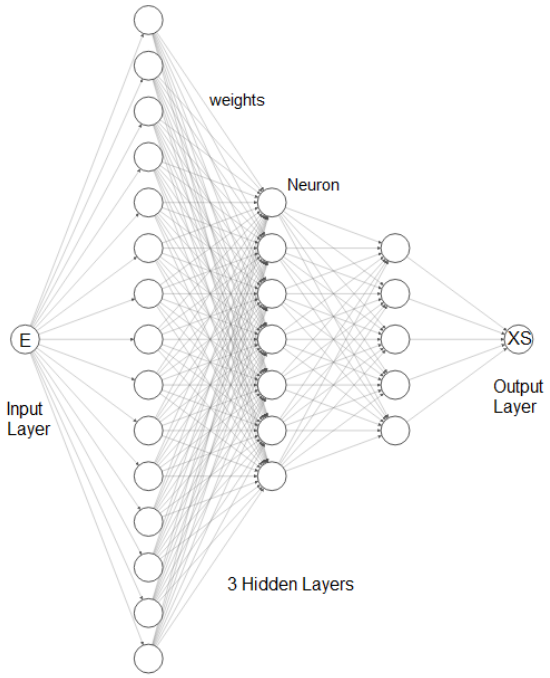

Fig. 1. One of the used ANN structure for the estimations of the neutron-induced reaction cross-section on uranium-235

III. Results and Discussion

In the reactions where the scattering of neutrons sent on the uranium-235 isotope was examined, we made predictions with ANN structures consisting of 1, 2 and 3 hidden layers. The best neuron numbers for these structures are 11, 11-5, and 11-5-4, respectively. As can be seen from the Fig.2, in the predictions on the training data, the single hidden layer ANN structure gave worse results compared to the others. It is seen that the deviations of the ANN results from the data obtained from the TENDL-2015 database are approximately -100 to +100 mb. This means a deviation of about 10%. However, the deviations of the results obtained from 2 and 3 hidden layer structures are in the range of approximately -20 to +20 mb. These deviations are approximately 2% deviations, which are within the acceptable limits of deviation in the calculation of the reaction cross-sections. Fig. 3 shows the application of the constructed ANN on the test data. As can be seen here, the single hidden layer ANN structure gave worse results than the 2 and 3 hidden layer structures. For (n, n) reaction the MSE values are 39, 9 and 6 mb for h=11, h=11-5 and h=11-5-4 on the training data, respectively. The corresponding correlation coefficients are 0.99, 0.99 and 0.99 for h=11, h=11-5 and h=11-5-4. For the sigmoid activation function in hidden layer neurons, the MSE and correlation coefficient values are 359 mb and 0.91 on the training data. The MSE values are 39, 9 and 6 mb for h=11, h=11-5 and h=11-5-4 on the test data, respectively. The corresponding correlation coefficients are 0.99, 0.99 and 0.99 for h=11, h=11-5 and h=11-5-4.

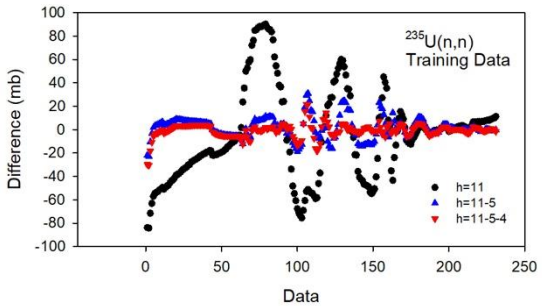

Fig. 2. Difference between TENDL-2015 and ANN estimations for (n, n) reaction cross-sections on the training data (Data is plotted according to increasing energy)

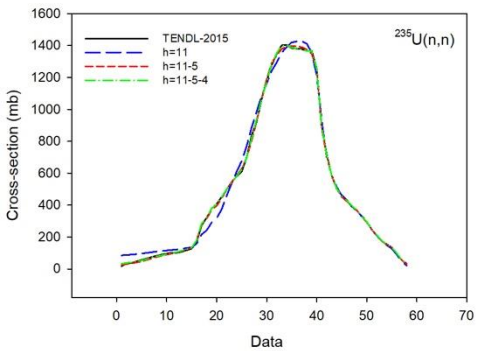

Fig. 3. Comparison of estimations obtained from different ANN structures with TENDL-2015 data for (n, n) reaction (Data is plotted according to increasing energy)

We used three different ANN structures to estimate the (n, 2n) cross-section of the reactions on the uranium-235 target (Fig. 4). It is seen that the results obtained from the structure with a single hidden layer (h=4) have deviations from the

literature data to be approximately -60 to +60 mb for the training data. In our predictions using two (h=4-4) and three (h=4-4-4) hidden layers, it is seen that these deviations are concentrated around the zero line. Considering that the graphs are drawn according to the increasing energy, it is seen that the deviations are more for low energy reactions. The estimates we made on the test data are presented in Fig. 5. It is clear that the ANN results are very consistent with the literature data. For (n, 2n) reaction the MSE values are 21, 4 and 1.5 mb for h=4, h=4-4 and h=4-4-4 on the training data, respectively. The corresponding correlation coefficients are 0.99, 0.99 and 0.99 for h=4, h=4-4 and h=4-4-4. The MSE values for the test data are 22, 4 and 1.5 mb for h=4, h=4-4 and h=4-4-4, respectively. The corresponding correlation coefficients are 0.99, 0.99 and 0.99 for h=4, h=4-4 and h=4-4-4.

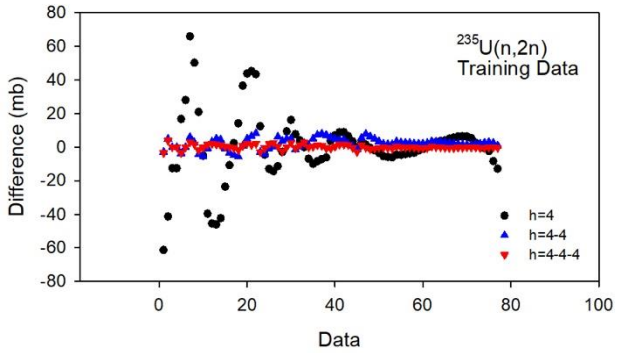

Fig. 4. Difference between TENDL-2015 and ANN estimations for (n, 2n) reaction cross-sections on the training data (Data is plotted according to increasing energy)

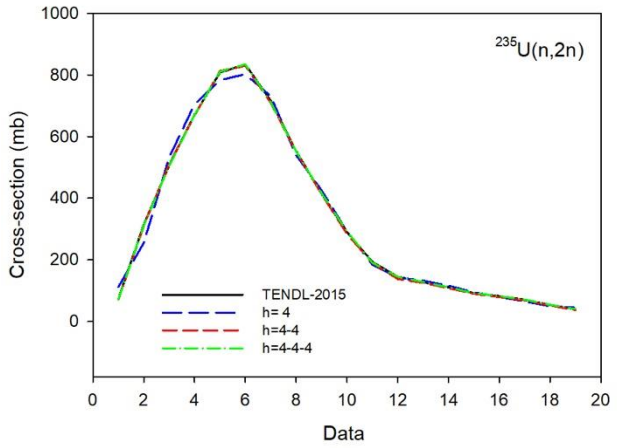

Fig. 5. Comparison of estimations obtained from different ANN structures with TENDL-2015 data for (n, 2n) reaction (Data is plotted according to increasing energy)

We used 3 different ANN structures in the estimations for the cross-section of (n, f) reactions that take place with neutrons sent on uranium-235. Since the fluctuation in the cross-section of these reactions is greater than the other reactions previously presented, it is seen that the deviations in the estimation results are slightly higher. Fig. 6 gives estimations on the traiing data. As can be seen, the results obtained from one and two hidden layer ANN structures have higher deviations, especially in the low energy region.

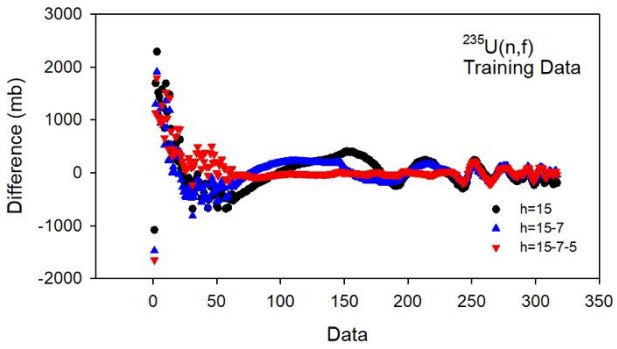

Fig.6 Difference between TENDL-2015 and ANN estimations for (n, f) reaction cross-sections on the training data (Data is plotted according to increasing energy)

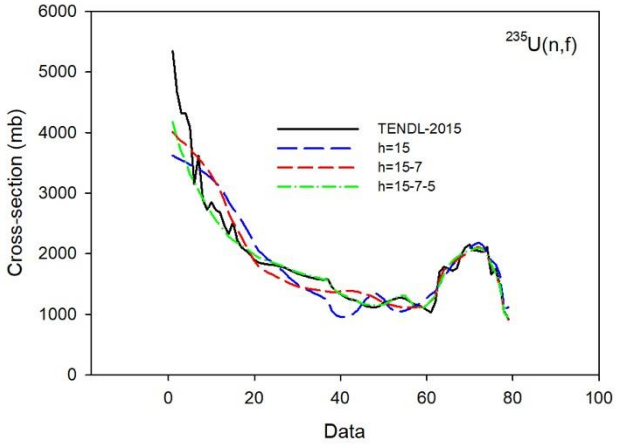

Fig. 6. Comparison of estimations obtained from different ANN structures with TENDL-2015 data for (n, f) reaction (Data is plotted according to increasing energy)

A comparison of different activation functions is given as an example for these reactions in Fig. 8. When we look at the sigmoid function which gives the most acceptable results to the tanh function, it is seen that these functions are suitable for this problem. For the sigmoid activation function, the MSE and correlation coefficient values are 333 mb and 0.92 on the test data from one hidden layer ANN structure (h=15).

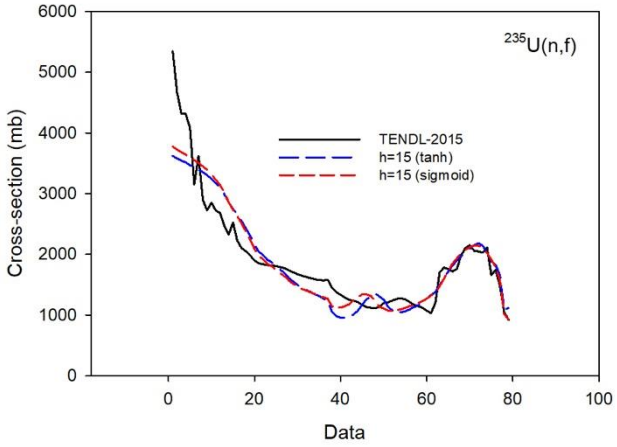

Fig. 7. Comparison of different hidden neuron activastion functions with TENDL-2015 data for (n, f) reaction (Data is plotted according to increasing energy)

IV. CONCLUSIONS

In this study, we obtained the cross-section values of neutron-induced reactions on uranium-235 isotope by using the artificial neural networks (ANN) method. According to the results we have obtained, this method is a suitable method for this purpose. Apart from fluctuations in the low energy region, we have seen that the deviations are in acceptable levels. As a result, the cross-section information required for any nuclear reactions can be easily obtained by using ANN. Thus, it has been seen that approximate values of cross-sections corresponding to energies that do not have values in the literature can also be obtained easily and quickly by ANN.

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Binary Whale Optimization Algorithm for Resource Allocation in Cloud Computing

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***Abstract*—Cloud computing is a widely preferred technology and is getting prevalent among users gradually. The optimization of requirements of hardware and software cloud resources especially for multimedia applications become an attractive research topic for providing services at both lower cost and higher quality. Cloud resources allocation for video streaming services is formulated as a mixed integer quadratic problem. The problem is an NP hard problem. During this study, since the problem is challenging, binary and has many constraints, a new, modified discrete whale optimization algorithm (WOA) is proposed due to the shortcomings of the classical WOA to solve this optimization problem. The proposed approach is exemplified on randomly generated multimedia data by using the YouTube statistics. Virtual machines, storages and content delivery networks are used for cloud computing resources. From the point of quality attributes, latency, security (encryption and streaming over https) and video resolution as a quality are considered. It is compared with benchmarking binary PSO algorithms in the literature to compare the performance of the proposed WOA algorithm. The results are analyzed under three error indicators; mean squared error, mean squared log error and mean absolute error.**

Keywords—Whale optimization algorithm, Binary whale optimization algorithm, optimization, resource allocation

I. INTRODUCTION

With the Industry 4.0 revolution and significant growth in usage of social medias, huge amount of big data especially in the type of videos are streamed over the Internet in recent years. Storing the big data or streaming them on physical infrastructures puts a lot of burden on organizations while keeping, managing, or preserving them. Several studies have tried to guarantee to increase the productivity while reducing production cost by making use of new cloud computing technologies [1].

Emerging cloud computing techniques that offer low cost, advanced storage architecture, distributed computing and high performance for processing becomes an excellent option for video streaming applications [2]. There exist several huge cloud service providers such as Amazon, Microsoft Azure or Google Cloud in industry offering wide range of services. These services are also provided in many different locations within high range of cost. Allocating video into appropriate cloud services in a way to maximize the performance while reducing the cost is an extremely challenging situation analyzed both in industry and academia. In the literature, there are many different studies for cloud resource allocation which take into consideration of only Virtual Machines. However, in real life applications, since different cloud services must be made use of, cloud storages are included in this study.

This study theoretically aims to find an optimal solution for the NP-hard problem of resource allocation for distributed cloud systems while considering QoS defined in Service Level Agreements. To solve this problem, different algorithms are proposed in the literature.

From the past decade, there are several bio-inspired heuristic algorithms, and their variants are proposed in the literature, mainly particle swarm optimization (PSO), ant colony optimization, genetic algorithm. Besides, Whale Optimization Algorithm (WOA), bio inspired metaheuristic algorithm, is proposed and its several variants are used by the researchers in the literature at a short notice. When we investigate the literature deeply, we come up many different applications of WOA, briefly feature selection, optimization solutions, clustering algorithms and unit commitment. Having few parameters to be tuned, balancing between exploitation and exploration, not trapped in local optima, and having simple frameworks are the main reasons behind it [3].

The original version of WOA is proposed for continuous search space. However, in real life, there are several problems that has solution in binary search space. To solve such problems, several binary versions of WOA are introduced. In the study of Srikanth et al., three different transformation functions are applied to transform real valued position to binary values [4]. Moreover, Hussien et al. propose novel binary WOA for dimensionality reduction [5]. In this study, the common S-shaped function is used to transform real valued position to binary value. Additionally, Hussien et al, also propose hyperbolic tangent transformation function for binary WOA [6]. Kumar et al. also propose a novel binary PSO, which provides the C'_{step} and C''_{step} transformation functions, transforming the shrinking and spiral updating position, respectively. Tawhid et al, also introduce two different transformation function for shrinking and spiral updating [7]. For the spiral updating position in exploratory phase, another transformation function is offered. The striking situation in this study is not only the proposed transformation functions are quite different, but also while evaluating the new position of the whale, previous positions of best agent or own location is assigned for updated position. Similarly, Pham et al. also propose binary WOA by defining new transformation function for resource allocation problem in wireless networks [8]. Lastly, Sayed et al. suggest another transformation function to convert the real valued search space to binary search space [9].

The mathematical model is created by the perspective of video streaming providers that use cloud resources for hosting applications at an Infrastructure as a Service (IaaS) level. Virtual Machines (VM) and Storages are used as IaaS resources. Cost is incurred with VM usage per minute, storage usage per GB and bandwidth usage per GB.

This study presents the binary whale optimization algorithm, metaheuristic approach, to solve the NP hard cloud computing resource allocation problem. The problem is non-

convex, constrained binary nature optimization problem that minimizes the total cost spent on cloud resources for video streaming applications.

The main contribution of this study is to propose a novel binary WOA for finding the optimal solutions of the problems having binary search space nature. The proposed approach is applied to minimize the cost for the efficient allocation of VM and storage cloud resources for videos requested. The results are compared with Linear Programming (LP) and PSO solutions.

The rest of this study is organized as follow. Mathematical models constructed for the cloud resource allocation problem is defined in Section 2. In Section 3, the theory background of the WOA is explained. Section 4 represents the binary constrained version of WOA introduced during this study. The results are given in Section 5 and the effectiveness of the algorithm is discussed and compared with the result of well-known optimization algorithm, PSO. Finally, the study is concluded with significant findings and future work in Section 6.

II. Problem Formulation

A. Objective Function

The aim of this study is to minimize the cost spent on cloud resources for applications. During this study, the type of the applications considered are video streaming. For these kinds of applications, mainly cloud resources of storages and virtual machines are used. The mathematical model represented in the study of [10] is used. The variables, objective function and constraints are given in Equations 1.1., 1.2. and 1.3, respectively.

x_{ij} and y_{ij} are the variables that must be optimized in the problem. If x_{ij} is equal to 1, then i^{th} video is assigned to j^{th} VM. Otherwise, i^{th} video is not streamed from j^{th} VM. Likewise, y_{ij} gives us the video i is streamed from k^{th} storage. VM_j represents the cost of the number of Virtual Machines in a specific cloud service provider where j is between 1 and #VM(m). Each VM has several properties which are total number of cores of the corresponding VM_j which is stated as p_j, $z(vm_j)$ showing the location (zone) of the VM_j and bandwidth cost represented by B_j. Similarly, each storage is represented as S_k where k is between 1 and number of storage types (s). z_k represents the zone of the storage s_k.

User video requests are characterized in two different units, size in terms of GB and duration in terms of minute. The reason behind it is that cloud services are charged per minute or per minute depending on the type of them. While deciding the size and duration, the type whether it is High Definition or Standard Definition and number of frames per second are important.

During the problem construction, some assumptions are made to make it easier. In this study 70% of video requested are assumed to be SD videos. Play rate for SD video is assumed to be 30 fps and for HD video, it is assumed to be 24fps. Only JPEG2000 type of videos are used for both HD and SD videos.

There are also some constrains defined during formulation. The videos are not partitioned, streamed from only one VM. To reduce bandwidth cost and latency, cloud storage and VM are assumed to be selected from the same zone of each video.

Cloud computing providers charge their services in very different ways such as on demands, saving plans, reserved instances. In this study we use the way of paying on a Pay as you go basis (on demand). Cloud resource providers price the VM per minute, storage per GB and bandwidth cost between storage and VM and out of bandwidth generally. On the other hand, the bandwidth costs between the cloud resources of the same provider are not priced. Accordingly, only three costs are evaluated under objective function: VM, storage and bandwidth.

The more detail about the mathematical model is detailed in the study of [10].

Variables

$$x_{ij} \text{ and } y_{ij}$$

$$\forall i \in [1,n], \sum_{j=1}^{m} x_{ij} = 1 \,, x_{ij} \in \{0,1\}$$

$$\forall i \in [1,n], \sum_{k=1}^{s} y_{ik} = 1 \,, y_{ik} \in \{0,1\} \quad (1.1)$$

Objective Function

$$\sum_{i=1}^{n}\Big(\sum_{j=1}^{m}(x_{ij}.VM_j)\Big).z_i + \sum_{i=1}^{n}\Big(\sum_{k=1}^{s}(y_{ik}.S_k)\Big).r_i + \sum_{i=1}^{n}\Big(\sum_{j=1}^{m}(x_{ij}.B_j)\Big).r_i$$

$$x_{ij} = \begin{cases} 1, & \text{if video i} \in VM_j \\ 0, & \text{if video i} \notin VM_j \end{cases}$$

$$y_{ij} = \begin{cases} 1, & \text{if video i} \in S_k \\ 0, & \text{if video i} \notin S_k \end{cases} \quad (1.2)$$

Constraints

$$\forall i \in [1,n], \sum_{j=1}^{m} x_{ij} = 1 \,, x_{ij} \in \{0,1\}$$

$$\forall j \in [1,m], \sum_{i=1}^{n} x_{ij} = p_i \,, x_{ij} \in \{0,1\}$$

$$\forall i \in [1,n], \sum_{k=1}^{s} y_{ik} = 1 \,, y_{ik} \in \{0,1\}$$

$$\forall i \in [1,n], \forall k \in [1,s] \;\; zone_i = zone_k \quad (1.3)$$

III. Whale Optimization Algorithm

Whale Optimization Algorithm is a meta-heuristic optimization algorithm proposed by Mirjalili et al. [11]. The nature of the algorithm is based on the hunting behavior of humpback whales. There are three methods defined in WOA implementation: wrapping around the prey, moving to the prey, and searching for the prey. To summarize the behavior briefly, firstly, the location the prey is found by the lead whale and whale creates a series of bubbles spirally to communicate with other members. Then, other members respond to signal and prey is trapped in the middle of the blowing bubbles created by other members.

The position of other agents is updated according to the best agent previous position iteratively. The mathematical model for the continuous WOA in each iteration is represented in Equation 1 and 2.

In the following equations, *i* is the index of the iteration. $X^*(i)$ shows the best location among the whales in the i^{th} iteration. "Best" means the closest location of prey (optimum solution in that iteration). In the Equation 3, X^* is updated if any other whales find better location (superior optimum value). Whales can update their position, called as exploitation phase in optimization algorithms, in two different ways. The decision for the way of updating position depends on the randomly created number N_r. Selecting among these two ways have an equal chance. If N_r is bigger than the value of 0.5, then

shrinking encircling position update (top of the Equation 2) is applied. This equation corresponds to linearly decreasing vector update. Otherwise, spiral position update, mimics the helix-shaped movement is applied.

$$\vec{D} = \left|\vec{C}.\overrightarrow{X^*}(i) - \vec{X}(i)\right| \quad (1)$$

$$\overrightarrow{D'} = \left|\overrightarrow{X^*}(i) - \vec{X}(i)\right| \quad (2)$$

$$\overrightarrow{X^*}(i+1) = \begin{cases} \overrightarrow{X^*}(i) - \vec{A}.\vec{D} & if\ N_r < 0.5 \\ D'.e^{bl}.\cos(2\pi l) + \overrightarrow{X^*}(i) & if\ N_r \geq 0.5 \end{cases} \quad (3)$$

A and C are coefficient vectors, and the formula is given in Equation 3 and 4. $\vec{a}$ is linearly reducing vector and $\vec{r}$ is the uniformly distributed random value.

$$a = 2(1 - \frac{i}{MaxIter}) \quad (4)$$

$$\vec{A} = 2.\vec{a}.\vec{r} - \vec{a} \quad (5)$$

$$\vec{C} = 2.\vec{r} \quad (6)$$

In the spiral update formula, b corresponds to constant value, and l value corresponds to random number in [-1,1]. $\overrightarrow{D'}$ is the distance between the position of the whale and the current best location of the prey. In exploration phase, likewise, approach of exploitation shrinking phase is applied. In this phase, the position of whale is updated according to the randomly selected whale's position instead of using the best search agent found so far. If the $|\vec{A}|$ is smaller than 1, then exploration phase is begun. The mathematical formula for this phase is given in Equation 7 and 8. $\overrightarrow{X^{rand}}(i)$ is the random position vector selected from the current population.

$$\vec{D} = \left|\vec{C}.\overrightarrow{X^{rand}}(i) - \vec{X}(i)\right| \quad (7)$$

$$\vec{X}(i+1) = \overrightarrow{X^{rand}}(i) - \vec{A}.\vec{D} \quad (8)$$

Even though WOA is introduced firstly for continuous problems, due to need for binary search space which is the nature of most of the real-life problems, various novel binary WOAs are introduced. Furthermore, due to the nature of the cloud computing resource allocation problem, binary whale optimization algorithm (BWOA) must be considered in this study. In the literature, there are several different versions for BWOA are proposed. In the first approach, tangent hyperbolic transformation is used to transform real valued location to binary value. If the tangent hyperbolic value of the location is bigger than R value (randomly created value between 0 and 1), then the position becomes 0, otherwise, new position of the whale becomes 1. Secondly, arctangent transformation and S shaped transformation functions are used. The background idea for these two functions is akin to the hyperbolic transformation [12]. Over and above, many researchers proposes different kind of transformation functions [5] [7] [4] [8]. A few of the used transformation functions in the literature are summarized in the Table 1.

TABLE I. SOME OF THE TRANSFORMATION FUNCTIONS AND POSITION UPDATE FORMULAS FROM THE LITERATURE

Study Ref.	*Transformation and Position Update Models*
[9]	$X_i(t+1) = \begin{cases} 1\ if\ \left(s(X_i(t+1))\right) \geq rand() \\ 0\ otherwise \end{cases}$ $s(X_i(t+1)) = \frac{1}{1 + e^{10(X_i(t+1)-0.5)}}$
[4]	$T\left(\vec{X}(i+1)\right) = \tanh\left(\vec{X}(i+1)\right) = \left(\frac{\left(exp^{-\tau(\overrightarrow{X(i+1)})} - 1\right)}{\left(exp^{-\tau(\overrightarrow{X(i+1)})} + 1\right)}\right)$ $\vec{v}(i+1) = \begin{cases} 0, T\left(\vec{X}(i+1)\right) > R \\ 1, \quad otherwise \end{cases}$
[6]	$y^k = \lvert tanhx^k \rvert$ $X_i{}^d = \begin{cases} 0, if\ rand < S(X_i{}^k(t+1)) \\ 1, \quad otherwise \end{cases}$

IV. PROPOSED METHOD

In the previous section, original WOA algorithm and binary WOAs proposed by researchers are summarized. Due to the nature of the problem defined in Section 2, new modified binary WOA is introduced in this section.

In this approach, we use the novel binary PSO approach stated in the study of [13] to transform the position of real based search space to binary search space. After updating the position of the whale as in continuous WOA, two different position is defined as in the Equation 7. The d_{i10}, d_{i20}, d_{i11}, d_{i21} are decided by using the values of the position of best agent with the position of itself.

The problem formulation for the cloud resource allocation is stated in Section II. As explained in that section, the dimension of each position of the whales is the number of the type of cloud resources that are allocated. Each value for the jth dimension of the ith whale is handled one by one. Then, position of all these must be updated in each iteration.

$$X_i^0 = wX_i + d_{i1}^0 \quad (7)$$

$$X_i^1 = wX_i + d_{i1}^1$$

$$\text{If } X_i^* = 1 \text{ Then } d_{i1}^0 = c_1r_1 \,\&\, d_{i1}^1 = -c_1r_1$$

$$\text{If } X_i^* = 0 \text{ Then } d_{i1}^0 = -c_1r_1 \,\&\, d_{i1}^1 = c_1r_1 \quad (8)$$

$$\boldsymbol{X_i}' = \begin{cases} X_i{}^1, if\ X_i = 0 \\ X_i{}^0, if\ X_i = 1 \end{cases} \quad (9)$$

$$\boldsymbol{X_i}(t+1) = \begin{cases} 1, if\ r_i < X_i' \\ 0, if\ r_i \geq X_i' \end{cases} \quad (10)$$

The pseudo code for the main Whale optimization algorithm with the proposed method is given in Algorithm 1. Position of the whales are updated as in continuous WOA.

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Algorithm 1 *Binary Whale Optimization Algorithm Pseudo Code*

Input:
Maximum Iteration number (MaxIter)
Initial population size (n)

Output:
*Best whale position X**
Best fitness value fitness (X)*

Begin
Generate initial population of n whales X^i
Set counter= 0
For i ← counter : MaxIter
  Compute fitness value of each whale
  *Set best fitness value of whale as X**
  Set counter ++
  For each whale do:
    Compute the A and C, control coefficients
    Set N_r *uniformly distributed random number in [0,1]*
    If $N_r < 0.5$
      If $|A| < 1$
        Update the position of whale by using shrinking formula
      Else
        Update the position as in exploration phase
      End
    Else
      Update the position in spiral update positioning formula
    End
  End
  For each position in whale:
    Set c_1 *and* r_1
    If X =1:*
      Set $d_{i1}^0 = c_1 r_1$ & $d_{i1}^1 = -c_1 r_1$
    Else
      Set $d_{i1}^0 = -c_1 r_1$ & $d_{i1}^1 = c_1 r_1$
    End
    Estimate X^{*0} *and* X^{*1}
    If X =1:*
      Set $X^{*\prime} = X^{*0}$
    Else
      Set $X^{*\prime} = X^{*1}$
    End
Apply the sigmoid transformation function in the study of [5]
Return position of all whales
End

V. Results and Discussion

A. Data

For the case study, the cost of the Amazon cloud resources (EC2 and S3) is used. The costs of the services are acquired from https://aws.amazon.com/tr/pricing/. The services are charged on demand, pay as you go basis. 10 different data sets containing 40 videos requested are created by using the normal distribution with given mean and standard deviation defined in the study of [14]. The values are represented in Table II. All algorithms are run under 50 iterations and mean of the iterations are considered as the optimum value achieved by the algorithms.

TABLE II. Video Data Summary

Video Types	SD	HD
Percentage of Video Types	80%	20%
Mean of a video segment	250 frames	75 frames
Standard Deviation of a video segment	20 frames	7 frames
Play Rate	30 fps	24 fps

B. Results of Binary Constrained Whale Optimization Algorithm

WOA is implemented using Python and the algorithm is tested under 10 different datasets created randomly by using the normal distribution. The algorithms are repeated 50 times for each test case suite. The standard deviation value of Binary WOA is higher than other PSO algorithms which signifies that in each iteration, the range of the optimum values achieved is wide when compared with the other algorithms. Standard deviation and mean of the proposed binary WOA for the 10 data sets are given in Table III.

TABLE III. Statistical Summary of Binary WOA

Data Set Type	Mean	Standard Deviation
I	60.44	6.552
II	80.11	3.552
III	69.48	4.605
IV	77.94	5.892
V	64.69	6.003
VI	61.94	4.366
VII	71.99	3.134
VIII	68.12	4.648
IX	69.22	3.705
X	61.93	3.446

C. Comparison of WOA with PSO Algorithm

Linear programming (LP) is used to solve the problem to see the best minimum cost for the model. IBM Ilog Cplex is used for LP. All prediction accuracy metrics are estimated by using the values achieved by LP.

At first sight, the WOA does not seem superior to other algorithms as PSO and NPSO when we deeply analyzed the error metrics. Novel BPSO outperforms other algorithms in terms of means and three prediction accuracy metrics; mean squared error, mean absolute error, and mean squared log error. In terms of all three metrics, the metric values of WOA are higher than the algorithms' values.

TABLE IV. Statistical Summary of Binary WOA

Optimization Algorithm	Mean Squared Error	Mean Absolute Error	Mean Squared Log Error
Binary PSO	6.6747	2.4462	0.0016
Novel Binary PSO	3.2664	1.6442	0.0007
Proposed Novel Binary WOA	67.5167	6.3732	0.0214

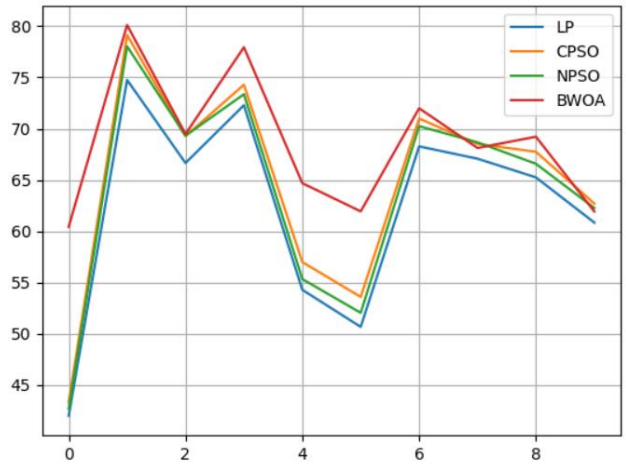

Fig. 3. Comparison of Optimized Cost of Cloud Resources estimated by LP, Classic BPSO, Novel BPSO and Binary WOA

Furthermore, Fig. 1 also supports the conclusion drawn from accuracy metrics. In each data set, WOA does not outperform the other algorithms in almost all test case suites. However, it still predicts the closely to the LP results and promises for further studies.

VI. CONCLUSION

To sum up, during this study, a novel binary whale optimization algorithm is introduced. This algorithm is applied to solve the problem of cloud resource allocation. It minimizes the cost of cloud computing services for video streaming applications in respect to requested videos. The results are compared with Linear programing, classical Binary PSO and novel BPSO. Novel Binary PSO technique yields better results than proposed Binary WOA and Classical Binary PSO. As a feature work, the proposed Novel WOA in this study will be used to solve the benchmarking problems and compared with other binary WOA algorithms proposed in the literature to measure the performance of it. Besides, it is aimed that extended version, including the neighborhood topology of binary WOA is proposed. In this extended approach, while updating the position of the whale in each iteration, the position of neighborhood and best position of this whale will also be considered. This approach will also be compared with other evolutionary algorithms like PSO and WOA to assess the performance.

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Artificial Intelligence Ethics: Requirements And Solution Recommendations

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***Abstract*—Artificial intelligence ethics has become an important issue not only in the future world but also in the world we live in today and in our daily lives. Many of the applications we use come through the artificial intelligence filter, on the other hand, the technologies we use make decisions about us and contain many value judgments, but the ethical part of the work is often ignored. Today, AI machines are used not** only **for processing power or action orders, but as decision-making mechanisms based on algorithms. It is used as decision-making mechanisms, the basis of which is formed by algorithms. In this article, How do we set rules for ethical algorithms? How do we make legal regulations? How do we design? Requirements have been determined for the question and solution suggestions are presented with examples.**

Keywords—Artificial intelligence, Ethics, Ethical algorithms

I. INTRODUCTION

Artificial intelligence can be defined as machine-side imitation of rational movements such as human learning, inference, generalization, and reasoning. Programmers, developers or entrepreneurs have to question and consider ethical values along with human behavior while planning processes. The inability of artificial intelligence to take responsibility, will, moral action and the increase in human production necessitate the existence of ethical studies [1]. What we express with artificial intelligence ethics: How algorithms are written result in good, beneficial and right decisions and actions that treat everyone fairly.

Although states, companies and institutions work and publish the principles of artificial intelligence ethics separately, there is no internationally agreed set of principles. The principle determined and put forward by one country is not binding for others. The area where these principles will be agreed on by everyone will be on ethical algorithms with a technical background.

When people do some operations, they are not really aware of how much analysis the algorithms are doing about them. In addition, it is not known how the analyzes made make decisions and what value judgments they have. In the study, the requirements for ethical algorithm design were determined by considering both social and technical criteria.Machine ethics includes the use of machines as subjects for machines, rather than as objects by humans. It is generally not clear whether this should cover all AI ethics or be a part of it [2-5]. The article consists of a set of criteria that include solution proposals for the design of ethical algorithms in line with the requirements set for artificial intelligence ethics.

II. REQUIREMENTS AND SOLUTION RECOMMENDATIONS

There are three different approaches in the literature regarding the teaching of ethical values that can be applied on artificial intelligence. The first of these is the determination of some moral rules or the application of normative moral rules that can be taken from traditional moral philosophy to the machine. These normative rules should be chosen so that there is no room for ambiguity and controversy in the algorithm. The other approach is that the machine grasps right and wrong on its own, without any set of rules dictated from the outside. There are examples of this approach, such as using evolutionary algorithms such as the genetic algorithm or adapting game theory for moral actions. There is a third approach in the literature that suggests combining these two approaches. In this approach, it is suggested that the machine starts with a set of rules and learn to use these rules by changing them over time [6].

As an ethical entity, there are decision moments in which human beings are caught between right and wrong, good and bad judgments. As an example of these situations; Choosing whether to have abortion or not, choice in euthanasia practice, legal choices, choices about who to save from accident, there is a constant choice in both daily and professional life. Both structure and Will artificial intelligence, which is intended to be similar structures in terms of intelligence, be able to make the right decision when it is in a dilemma as a system? and how correct will this decision be?

Questions like these show that ethical dilemmas are critical to artificial intelligence. It is a matter of debate how accurate it will be for everyone with conscience and moral value when artificial intelligence is given such an opportunity. Looking at the current legal and ethical regulations, it accepts human as a subject and establishes its principles on the subject. However, when it is possible for the artificial intelligence to become able to learn, the fact that the artificial intelligence is responsible for the conscious actions and legally accepted as a subject will cause an increase in ethical debates. Therefore, the aim of artificial intelligence studies is to produce machines that are intelligent, conscious, capable of learning, have their own moral behavior and think [7].

Day by day, AI is given the authority to make its own autonomous decisions. The acceleration of this process requires the programming of ethical understanding that will enable them to behave correctly in situations that even the designers of these systems cannot predict.

This requirement was first noticed and addressed by robotics scientist Asimov:

1) A robot cannot hurt a person or cause harm to a person by remaining immobile.

2) A robot has to obey orders that people give. However, when these orders contradict the First Law, the situation changes.

3) A robot must survive as long as it does not contradict the First and Second laws [8].

The rules set by Asimov have an important content in terms of preventing the abuse of artificial intelligence and its movements outside the system.

For example, in St. Since job applications for the Medical School at George Hospital took a lot of time, an artificial intelligence screening application was developed and this application carried out the acceptance / rejection procedures by activating the educational information of the applicants. While this app was initially praised for its success, the truth has emerged four years later. This practice has turned out to be a discriminatory practice against women and doctors who apply from countries such as Pakistan, ignoring their academic achievements and rejecting them based solely on their gender and name [9]. Since he is a person who created artificial intelligence and established his system, the direction in which he will program it will also belong to human. Therefore, it requires the evaluation of artificial intelligence as an ethical element and universal ethical rules.

Consider that there are many patients in urgent need in the context of work and profession at the same time, and when an AI-based doctor decides which one to intervene, he will enter into an ethical paradox [10]. When person A treats person B, when person B treats person B, person A will be left out. Hence, even the human being may sometimes be caught between an ethical paradox when deciding anything in these situations. Or, let's think of a person who helps the poor by committing crimes, and while an artificial intelligence-based dominant robot should judge the person in question, the situation he is in also contains ethical contradictions [10]. Therefore, against these paradoxical situations, it is necessary to integrate accurate and critical decisions with artificial intelligence-based robots in an ethical context.

As researchers, academics, and activists expressed concern over biased, malicious and deceptive practices with the rise of AI systems, technology-producing companies began to develop ethical principles in research, development and implementation. However, the number of technology companies implementing these regulations in concrete steps is few. While supporting the development of technology, it is critical to implement this by paying attention to the steps of responsibility, bias, justice, security and transparency and through concrete principles.

In the study, a set of criteria consisting of five criteria (Transparency and Controllability, Predictability, Robustness against Manipulation, Responsibility and Data sets) is presented as a solution proposal, including in every stage of the ethical algorithm development process in line with the requirements defined for artificial intelligence ethics.

B. Transparency and Audibility

Transparency and bias are fundamental issues that are nowadays sometimes referred to as "data ethics" or "big data ethics" [11,12]. Users want to be able to see how service applications work, evaluate their functionality, and know their strengths and limitations. Transparency allows AI users to better understand how the AI model or service was created. The transparent artificial intelligence system should be clear about who trained the system, the data set, the algorithm designed for data analysis, accessing and organizing them.

Despite the good performance of machine learning and deep learning algorithms, which have been increasingly used in recent years, in complex tasks, the transparency in the algorithms and the ineffectiveness of the software developer's role on the algorithm creates uncertainty. In an artificial intelligence algorithm developed in areas such as sentiment analysis, text analysis, visual recognition, video detection, the application outputs are completely dependent on the algorithm after the software developer creates the data and model. It is not known how much attention to which parameters the algorithms in the applications take any decision. Therefore, while the software developer loses his authority over the control of the algorithm, a wall of obscurity is built for the users. When designing artificial intelligence algorithms, they should be developed as systems that are open to inspection or auditing, as well as a strong and scalable design.

For example, it is very difficult for a person whose application has been concluded negatively in transactions such as risk analysis, credit rating or credit application using a machine learning algorithm in finance. If the machine learning algorithm is built on a complex artificial neural network, or if it is based on a genetic algorithm produced by controlled evolution, then it will be impossible to understand according to which feature the algorithm makes the decision by the applicants. On the other hand, decision trees or Bayesian networks are much more transparent to allow the programmer to review.

C. To be Predictable

The human, who enables artificial intelligence to reach a high level of intelligence, will have built a more productive and intelligent being with his own hand. This situation will reveal a superior intelligence that cannot be understood by human beings. According to some thinkers, this explosion of intelligence will cause "technological singularity", that is, great changes that cannot be predicted and controlled in the order of the world [9]. Concerning that artificial intelligence will create problems in the future, such as transforming from a human to a high-level entity and replacing human beings at a level that will make humans a slave or spreading dangers to the world in order to destroy humanity, constitutes a prediction that a safe artificial intelligence should be designed in today's conditions.

It is also important that artificial intelligence algorithms that take over social functions are predictable by the people they manage. The precedent in the legal literature arises when the same conditions in any given situation. One of the most important functions of the legal system is that it is predictable, that is, contracts are written by knowing how they will be executed. The job of the legal system is not to optimize society in all situations, but to provide a predictable environment in which citizens can optimize their own lives. In engineering science, it should be ensured that an artificial intelligence algorithm is maximum predictable with ethical rules.

D. Resistance to Manipulation

We can consider Facebook's "mood experiment" experiment in 2012. Facebook divided its users into two groups, A and B, for a week, showing mostly negative / unhappy content to one of these groups, and predominantly positive / happy content to the other. At the end of a week, those in the group with negative content shared more negative

posts, while those exposed to positive content shared more positive posts.

A technology that aims to control the mood of the users by manipulating a platform they use for a completely different purpose will bring serious ethical problems with it if it is not used for a good purpose. Although the system developed here is not "bad", it is necessary to impose restrictions on the area of use while developing this system to prevent abuse.

Social media, in particular, is now the most important place for political propaganda. This effect can be used to manipulate voting behavior, as in the Facebook-Cambridge Analytica "scandal" [13,14], and if successful, it could undermine the autonomy of individuals [15].

For this reason, the importance of artificial intelligence algorithms to be robust against manipulation is increasing day by day. A software that visually scans for bombs or hazardous materials in airports, passenger luggage, must be robust against enemies looking for vulnerability in the algorithm. For example, another object placed next to a gun may cause the software to perceive the combination of these two as a single object. Manipulation robustness is an ordinary criterion in information security. However, it is not a criterion that is often encountered in artificial intelligence algorithms and studied by experts.

E. Responsibility

The artificial intelligence technology we currently have is not perfect and makes many mistakes. For example, a computer system that partnered with a cancer center in Texas failed terribly because it offered patients the wrong drugs. Another mistake was that an artificial intelligence chatbot produced by Microsoft learned racist insults on Twitter in a short time, wrote them and ended up shutting them down. Artificial intelligence can also make mistakes more complex than that in the future.

Here some questions arise for consideration. Another important criterion when working with any organization is to find the person responsible for doing something. Who should be held accountable when an AI system fails in its mission? Programmers? End users? This ethical issue also needs to be considered in order to prevent the mistakes of artificial intelligence from becoming destructive.

For example, for the use of artificial intelligence on the battlefield, who will be guilty of attacking civilians, enemies who drop their weapons or committing a war crime? Is it the manufacturer of the artificial intelligence applications built to fight, the manager who uses the application, or the artificial intelligence itself that is produced to fight? If the responsibility is placed on an artificial intelligence, people will use it to do whatever they want, so people will not take their own ethical responsibility and the obligations will be eliminated. In addition, if the human does not take responsibility for the situations caused by himself and puts it on artificial intelligence, this will cause an unethical action on its own [16,17].

F. Datasets

Intelligence, whether human or machine intelligence, is achieved through learning. Systems usually go through a training phase to learn to perceive the correct patterns and act on their input. After a system has been fully trained, it is put into testing with more samples and then how it performs is monitored.

The training phase cannot cover all the possible instances a system can handle in the real world. For example, random dot patterns can cause a machine to see things that aren't there. For example, in artificial neural networks, the process is producing results with the data given to it. There are many benefits to this, but there are also risks that the entire system contains biases in an unexpected and potentially harmful way. Because the information we train the machines contains software developer bias (race, gender, religion, etc.).

The bias used to train the designed algorithms is machine bias. For example, an algorithm used to predict criminals turned out to be that black biased blacks are more likely to be stopped and punished than whites. If the data used carries our biases and our ethical values full of inaccuracies, we cannot expect this artificial intelligence to be less biased than us.

As the negative features of data sets that cause machine learning algorithms to behave biased:

- The data are not of sufficient quality due to the use of non-human data or they reflect existing prejudices in humans.
- If poor data, the machine learning algorithm sees more white-skinned people in a database of human faces, the facial recognition system will inevitably perform worse at detecting dark-skinned faces.
- Current biases, Amazon has been filtering recruitment applicants through computer programs in recent years. It does this based on previous hires with artificial intelligence. But it turns out that artificial intelligence has received the wrong training in the past because people preferred male candidates more than women. As a result, he trained himself like that and does the same thing.
- Even the preparation of data can be discriminated against. Going from the Amazon example, even if the database that the artificial intelligence reaches provides a fair data, if priority is given to certain races in the recruitment process, artificial intelligence will give biased results.

These are important criteria that apply to people performing social functions. Relationship with social functions and criteria that should be taken into account in an artificial intelligence algorithm intended to replace human judgment. If we do not consider these features in an algorithm development process and do not work on them sufficiently, it will be necessary to spend much more effort and resources to change the algorithms after the applications produce good or bad results.

III. CONCLUSION

The ethical debate comes before the law debate, so Ethics = Not Law. When should we talk about ethics? After the technology has fully developed and entered our lives? Or is it from the moment technology evolves and begins to enter our lives? In the article, the requirements determined for artificial intelligence ethics are determined to be included in every stage of the R&D process and algorithm development process.

The criteria determined within the scope of the article are important criteria that do not appear in scientific journals on

machine learning that focus on how an algorithm can be scaled on more than one computer. This list of criteria is not exhaustive, but they increasingly represent an important example of what a computerized society should consider. An ethical framework has been determined on which to agree on programmers and companies and institutions who will design ethical algorithms for artificial intelligence ethics.

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Artificial Intelligence as a Means for Public Relations

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***Abstract*— Lifestyles changing along with the developing technology shaped the application of professions, causing some professions to shine while paving the path for some to be lost. Prof. Dr. Michio Kaku from the USA, who studied theoretical physics and presented his predictions obtained as a result of his research with more than 300 scientists, states that there are innovation waves in certain periods and that these last approximately 80 years. This wave that started especially with the industrial revolution was replaced with electricity, then ever-developing technology, and currently with artificial intelligence. On the other hand, the fact that press release texts, which are one of the most important tools of public relations, are created and released in the name of institutions and even automatically published on corporate websites by artificial intelligence, i.e. the fact that we can see artificial intelligence in the content creation process is remarkable in terms of public relations profession. Similarly, automatic event organizations and automatic planning of the schedules of the participants by artificial intelligence or automatization of many tasks in press conferences that would have been carried out by public relations executives exceedingly indicate that artificial intelligence affects the public relations profession.**

Within the scope of study, the place of artificial intelligence in public relations was examined and its position in the public relations profession was assessed. At this point, field literature was reviewed and examined whether artificial intelligence can be a means for public relations with discourse analysis in addition to in-depth interviews.

Keywords—artificial intelligence, public relations, digitalization, creativity

I. INTRODUCTION

Along with the developing technology, many elements from smart systems to artificial intelligence rapidly came into our life and this change started to influence many fields of life from health to economy, law to architecture, communication to daily life. Some communication professionals conducted significant social science researches by focusing on this, some others put off this by suggesting some reasons like this would not have a direct influence on communication and kept focusing on society and human relations. There is a similar process for public relations practices and researches in which communication is at the center. Within the scope of this study, a synthesis will be presented by referring to the opinions of the field professionals about the effects of artificial intelligence on public relations profession which involves communication in its origin and whether or not artificial intelligence can be an means of public relations.

II. THE CONCEPT OF ARTIFICIAL INTELLIGENCE

Artificial intelligence is defined as the ability of understanding thinking structure of humans and the effort for developing computer operations which would introduce similar structures. Indeed, this is the effort of a programmed computer to think [12]. It also refers to obtaining necessary information about brain functions by trying to imitate behaviors of human brain by means of an electronic device [13]. The concept of artificial intelligence origin of which is based on human and that may be virtually expressed as artificial human provides the possibility of using science and technology with humanoid properties. In other words, almost artificial humans come to exist with artificial intelligences. This is because the thing expressed as artificial intelligence is actually based on presentation of the special codes existing in the neurons of individuals by means of a technological instrument. Today, it is possible to see many definitions about artificial intelligence.

The concept of artificial intelligence that receives its origin from artificiality and enriches by being articulated with the concept of intelligence actually has a content parallel with artificial life. In this context, the concept of artificial life is referred as a new scientific approach that aims to study on artificial systems displaying characteristic behaviors of natural life systems. This approach tries to synthesize life related behaviors of living organisms and develops traditional biological sciences with respect to its analyses in computers or other artificial environments [14]

Even some details about conceptual origin of robots in which artificial intelligence is frequently used give information about current status of artificial intelligence. In fact, Slavonic term robota refers to labor and at the same time forced labor in Slavonic languages. Indeed, the robots are positioned as slaves who are set to work in lieu of people and considered as the instruments which are developed to make people get rid of and free from compulsory works [15]. The point reached by artificial intelligence by the first quarter of 2000's is actually positioned on making the life of humanity easier by means of robots, devices or instruments, and humanity is indeed a part of them.

We encounter artificial intelligence as a science applicable in almost every field in such a way that operations, disease diagnosis, treatment and micro practices in healthcare sector; production, process management, control systems, supervision in industrial field; reactive studies orienting to customer trends and behaviors in marketing field [16], prescription and intervention systems orienting to human behaviors in security field; the systems supporting learning, measurement and evaluation in education field; special fictions created over games in entertainment field are progressed on the basis of artificial intelligence. In such a period during which everything around us begins to become intelligent, one of the aspects primarily drawing attention is the developments occurring in households we mostly spend our daily life. It is possible to make a considerably long list including refrigerators which may create a shopping list, washing machines which can display a better laundry performance, cookers and ovens which detect the object on

them and present an appropriate cooking model, special thermostats directing the heat systems according to number of people in the space, special mechanisms which can absorb noise in the house, wireless and chargeable small home appliances, robots which automatically provide home hygiene [17], and even bed and shower systems specially developed for elderly and disabled care.

Artificial intelligence is also utilized in e-mails we frequently use in our daily life [16]. This is because users who do not want to be exposed to mails with advertisement content within their intensive mail and work traffic can just achieve this by ticking one by one and suffer from significant waste of time. Thanks to the developed artificial intelligent system, content of a mail is automatically checked and necessary separations are made by checking whether or not it is an advertisement, so the mails with advertisement content can easily drop into junk mail box. On the other hand, this development brought along new advertisement models for service providers and came into our life in the form of sponsored mails limited with two messages among all mails, namely the mails seen only if the advertiser spends a budget.

Improving itself also in language performance each passing day, artificial intelligence draw attention on the subject of word recognition, converting text into voice or voice into text, translation [16], making meaningful sentences and even writing a story or poem etc. The success of artificial intelligence on language that is a human specific ability cleared its way of use in new fields and different job groups.

The applications commercialized as a result of artificial intelligence studies conducted in language field took their place in our life. IBM's program that provides translation from speech to speech, MASTOR is one of the examples to be set for this. By means of the speech processing systems developed by BBN Technologies, the archive of national television broadcasts may be uninterruptedly accessed and it is also possible to make a special search among them [17].

By comparison with human intelligence, artificial intelligence differs in terms of some aspects particularly like permanence, propagation, cost, consistency, measurement, power and solution [13]. Human brain has a computation and communicating power that emerges upon connection of the neurons in brain to each other with synaptic bonds, artificial intelligence corresponds to a computation power with hardware processor speed. In parallel with this, humans use analysis methodology and principles as a problem-solving method while artificial intelligence uses mathematical method [18]. If we consider in terms of permanence, humans firstly establish synaptic bonds between the concepts in their mind, then convey them to a meaningful whole by converting them into schemas and receive them in their memory. However, these relational connections not being used tend to break off in time, they are firstly pushed to the back side of consciousness and then tend to be forgotten. This sometimes turns into a form of forgetting that may be recalled by support but sometimes occurs in the form of complete loss. On the other hand, it is not possible to encounter such a situation in the case of artificial intelligence. It is possible for system components to restore themselves by means of backup when necessary and even to operate with much better performance than before. This sets forth an advantage that is not really possible for human intelligence.

When it is considered in terms of cost, the cost of generating artificial intelligence is considerably low. While at the same time, it is apparent that the money spent will return as a doubled profit since an output obtained with artificial intelligence is not required to be performed by tens of individuals. However, profitability obtained when the human intelligence is invested is lower compare to artificial intelligence but a considerably longer time and higher cost is spent for education. As a matter of fact, every education has the risk of being forgotten. On the other hand, human is an emotional creature. For this reason, human behaviors, decisions and statements always include an emotion. Even though this strengthens ability for empathy and provides humans a competence that may not possibly exist in artificial intelligence, this may lead human intelligence to fall behind artificial intelligence when it comes to consistency. Artificial intelligence makes decisions and takes actions only within the framework taught itself and defined to let it learn. However, human intelligence may be affected by the state of mind it experiences, this may sometimes result in making biased and wrong decisions.

Artificial intelligence is an activity focusing on bringing human specific intelligence in machines, while intelligence is a qualification indicated by foresights created by an object by blending the past and the future [17]. It is possible to see that humans will be robotized in the future while the artificial intelligence will become humanoid. Thus, most of human limbs like hands, arms, feet and legs may be slowly replaced by robotic limbs. On The other hand, it is foreseen that hybrid bodies might emerge as a result of association of genetics and robotics science. Such bodies are capable of displaying transformation, supporting carbon-based organs with synthetic organs and so they have competence of establishing superiority over ordinary human physically and mentally. Moreover, making human mind continue to live on the line of virtual reality by uploading it in computers and computer-based clouds is planned with the principle of common existence [15]. The approaches at this point are certainly the approaches that may be verifiable or falsifiable in the future. In order to analyze practicability of all these processes for public relations, firstly it is necessary to know what public relations is and to see the position of artificial intelligence among the instruments of public relations.

III. PUBLIC RELATIONS AND ARTIFICIAL INTELLIGENCE

The concept of public relations which particularly became important during the 20th century and is essentially based on communication have its origins in the past. Some researchers argue this discipline developed in parallel with socialization. Thus, human and human struggle was at the center of human-nature conflict people experienced in primitive times when the land had not been nationalized. This provided a basis for the fact that people having the ability of directing, persuasion and communication, namely those effectively using public relations activities unwittingly are in the stronger position against others even during that period [19]. The concept that is hard to define because it is a multidisciplinary field distinguishes itself fundamentally under the framework of communication [20]. In order to create a common language with respect to definition, 472 definitions made for public relations were analyzed with a study conducted by 65 researchers and a common inclusive definition was introduced in the research initiated by the Foundation for Public Relations Research and Education. According to this definition, public

relations; "is a distinctive management function which helps establish and maintain mutual lines of communication, understanding, acceptance and cooperation between an organization and its publics" [21].

There is no common integration in definition of public relations, likewise it is not possible to talk about a unity of language in the objectives of public relations [22]. Nevertheless, the frame objective of public relations is to interact with certain groups and segments in the society by means of various methods, touch feelings and thoughts of publics about the organization, and try to create trust, support and understanding towards the organization. Public relations utilize 'persuasion' that bases on accurate information and honesty while performing the efforts to achieve this objective [23]. Public relations, taking shape and acquiring dimension according to its practitioner in terms of definition and objectives, also acquire dimension according to preferences of its practitioners in instrumental sense. Some instruments including written, oral and visual instruments are used in public relations processes. These instruments include organization newspapers and bulletins, activity reports and special reports, banners, letters, announcements, almanacs and sometimes evet postage stamps are some of these instruments. [24]. In order to distinguish; written instruments include press releases, brochures, newspapers, magazines [25]. In addition to them, business cards, t-shirts, inserts, letterhead papers including organization logo, special envelopes, souvenirs, boxes and packages including

organization logo may also be listed among written instruments of an organization with their characteristics reflecting the corporate identity elements [22]. On the other hand, oral instruments include face to face meetings, conferences, open forums, panels, outdoor meetings, public days and public meetings. Finally, visual instruments include TV programs, video shows, films, slide shows, photographs, web pages, social media and billboards. [25]. Here, it is worth to remember that competitions, exhibitions, special interviews, introductory films, official approvals, mascots, fan clubs, openings, introductory booklets and many other elements [26] may also be considered as a means of public relations. Public relations may use a wide variety of elements as a public relations instrument with its multi-dimensional structure and put this into the center particularly in marketing oriented public relations works.

Bulletins are not only used as intended for press but also in communication with different audiences [26]. On the other hand, the most significant element in press bulletins is the newsworthiness of the topic to be announced to press. Newsworthiness that is surely a relative concept may be new license agreements, successes, changes or appointments to occur in a top management, technical inventions, new product or service presentations, a sectoral assessment or point of view, market analyses or even a statement about an agenda that is a current issue on social media [27]. The important thing here is to what extent the relevant information would inspire interest for the audience of the relevant newspaper.

One of the first press bulletin examples written by the artificial intelligence called MasterBot and creating the bot clones of real persons was published in Cyprus by September 2020 and it drew attention that its language is in a conversation style contrary to classical press bulletins [28]. This bulletin that also created reaction for readers indicates that some short-term changes may occur in general algorithm of press releases. If it is considered that the said bulletin is fed by language networks used by the audience, the necessity for using a new method in direction of audience expectations might probably arise and the press releases as the most fundamental instruments of public relations may be reshaped.

As an instrument having a significantly long-standing background, newspapers still maintain their importance even though they have currently shifted from printed to digital media particularly because of the rise in digital communication. The sensitive line between journalists and public relations always makes its presence felt and both parties need to comply with ethical rules in the process of news publishing [29]. It is currently possible to face with a concept that news contents are completely created by artificial intelligence that is expressed as artificial intelligence journalism. The concept refers to the process of creating unscripted contents automatically among certain data sets contains a remarkable difference compare to texts written by human journalists thanks to its natural language generation technology [30, p. 299]. By means of this technology, a much higher number of contents can be accessed by readers by completing a shorter and faster editorial process successfully. It is possible to determine a topic or point of view which has not been previously addressed by anyone and to present this in newspapers and magazines thanks to artificial intelligence. This gives rise to a period in which news gatherers are in the background and news generation process comes to the forefront. This situation may bring a new dimension in the communication between public relations practitioner and journalist. The AR technology operating as integrated with artificial intelligence that may appear with impressive presentations on the subject of visuality and page-setting also draws attention of audience.

Being an instrument appealing to both eyes and ears, television takes a considerably impressive role for masses. As a highly effective blending of picture and sound with technology, television is one of the ways to access millions of people in the easiest and most effective manner [22]. Today, it is possible to see some examples in which television is equipped with artificial intelligence. Particularly if we consider that smart assistants started to become integrated with many household appliances, watching television and managing other appliances visually on television at the same time paves the way for living an easier life. On the other hand, artificial intelligence that might also be effective in relation to generating program content may create video collages to draw attention of audience by finding the best frames and incidents among the visual archive having decades of background. To give an example to this subject, IBM Watson brought the most critical scenes of Messi in all world cup matches together. On the other hand, being an instrument in which electronic waves are converted into sound for mass communication and having occupied a significant place in our life for years, radio considerably lost its power by reason of new media instruments and television. However, it is still one of the significant instruments particularly because of sponsored broadcasts [22], oft-repeated corporate themes and the access network it provided with its local nature structure in many locations which are still lack of internet access.

With artificial intelligence, some changes have occurred in the perspective of listening presented music imposed by radio. For example, the digital German radio channel called Südwestrundfunk (SWR) may present different themes and

songs according to personal likes and tastes of users if the music being listened is not liked in addition to characteristics of classical radio. This does not flow with users' choices within a music list but occurs as shifting to another song to be liked at the same channel without switching the channel. SWR that does not present this as a streaming program meets its users as a transformation of radio giving a right of choice [31].

If we look at the use of artificial intelligence in intranet and extranet instruments which are significant in internal and stakeholder communication, particularly chatbots with artificial intelligence may provide support for the increase in accessibility of searched information with smart targeting in contents and images, improved employee experience, more accessible information, smart search options. Likewise, it may undertake a role in ensuring the intranet portals established as communication oriented to function properly. As a matter of fact, a newly hired employee generally acts without knowing how to do and who to ask something in an organization in which he/she is new. However, he/she will be able to easily access any details like name, duties, responsibilities, process flows, contact details etc. and complete his/her orientation faster in a customized way in case of an intranet portal developed with artificial intelligence [32].

As another group of instruments, brochures and banners are still in use because of their visual characteristics and low cost. Aesthetic concern, good command of corporate identity elements and even sometimes technical knowledge may be required in the process of preparing brochures and banners. It is possible to find foreign examples in which artificial intelligence is actively used in the process of banner production and development. Artificial intelligence being used in design process makes the business life dynamics easier and brings designs together with audience faster and with lower cost. In this regard, Nutella used the artificial intelligence algorithms effectively, ensured creation of special and brand-new designed labels and put Nutella as labeled with 7 million different tags on the market. More than 10.000 videos posted by consumers who bought the product and all the products sold-out in a period shorter than

30 days also displayed how strong artificial intelligence can be in field of design. Indeed, this case was visualized how a product can be made attractive by using artificial intelligence [33]. It is unavoidable to produce widely read and more attractive banners and brochures if the banners or brochures are designed with the same strategy.

Artificial intelligence also presents different solutions in relation to fairs and exhibitions as another instrument of public relations. It primarily presents solutions that create design related difference, on the other hand the subject how artificial intelligence would influence fairs was addressed in the roundtable discussion organized by Mathias 'Tesi' Baur' from MBB Consulting in collaboration with the Exhibition World and it was stated that matching of two individuals interested in similar subjects or meeting of buyers and sellers would become easier in conferences, exhibitions and fairs as one of the potential practices. Similarly, the fact that social media shares about a fair may be rated as positive, negative and neutral is among the practices which became much easier with the support of artificial intelligence [34].

Complete production of a film with artificial intelligence has also become possible. This means that one more means of public relations can be effectively used with artificial intelligence. On the other hand, cinema, that had previously utilized artificial intelligence in relation to consultation, box-office return and analysis, has started to provide service by producing a complete film in time. In addition to Sunspring that has the characteristic of being the first filmed produced by artificial intelligence, It's no Game is also considered as one of the leading ones in this field [35].

Signboards enriched with artificial intelligence also appear as the instruments experiencing transformation with technology. The versions that can measure emotional reactions of people standing in front of signboards which update their contents at certain intervals, follow-up the time spent by people in front of the signboard or provide instant information flow by means of their inbuilt chatbots provide easiness for public relations practitioners in relation to shaping signboard contents [36].

Highly impressive facilities are also provided for public relations practitioners in relation to the use of artificial intelligence in press release meetings. For example, invitation list for a press meeting is created manually at the present time. However, it becomes possible to target media organizations and individuals who have the potential of providing highest number of attendees based on categories and keyword searches with artificial intelligence rather than creating traditional manual lists. Stories and contents customized according to interests, past news contents, personal characteristics and sector trends of journalists may be presented in these meetings instead of a common message and a single bulletin for all journalists [37].

Social media is also among significant instruments of public relations practitioners. The instruments like BoomSocial, Semanticum, Radaar provides the possibility of following with considerably user-friendly interfaces for individuals and organizations in relation to social media follow. They follow-up social media keywords with respect to brands or individuals, makes three fundamental groupings for these contents as positive, negative and neutral and then send notifications to public relations practitioners accordingly.

Utilization of artificial intelligence actively by public relations practitioners both in the process of advertisement publishing and targeting and its reporting process is highly significant for success of advertisement and improvement of financial gain and corporate prestige. Particularly by means of analytic oriented artificial intelligence, it becomes possible to predict how products and services may be improved and how interactions with the target group can be made more effective. Some companies like Iden TV can measure even communication efforts of brands in a video. This takes a significant role of strength in relation to sponsorship works.

IV. Artificial Intelligence, And Artificial Intelligence According To Public Relations Practitioners

One of the most accurate ways to see the position of artificial intelligence in public relations practices is to ask practitioners about this. For this reason, in-depth interviews were conducted with professionals of the fields where public relations graduates are employed like advertisement, public relations, corporate communication, marketing, digital media, events, sponsorship, social media as well as with employees of the fields where artificial intelligence is effectively used like artificial intelligence engineering, software engineering and statistics in scope of our research. The first group was

determined with judgment sampling as one of the nonrandom samplings from the relevant universe due to the shortcomings of the study. By this means, it was determined "which samples will be able to represent the main group with the opinions of those sufficiently experienced and specialists" [38]. Within this framework, the first sample chosen is composed of the members of the Turkish Association of Public Relations (TÜHİD) as representatives of public relations practitioners and the members of the Turkish Artificial Intelligence Initiative (TRAI) as representatives of artificial intelligence practitioners in order to achieve a strong representation capability. Among the TÜHİD and TRAİ members chosen with judgment sampling; in-depth interviews were conducted with 26 participants including 8 female, 5 male public relations practitioners and 11 male, 2 female artificial intelligence practitioners. The interviews were recorded tape recorder and deciphered, then analyzed with the method of content analysis.

The answers given to the question "what is artificial intelligence" asked in scope of the in-depth interviews were classified for two different groups. Self-learning and human imitation placed at the center of the responses constitute the mostly repeated answers. Giving one of the most frequent answers, A.K stated that "I can define as the case of giving output, namely giving reaction by certain codes loaded in a card according to an input entered in the system" while M.Ü interpreted as "the case that the machines that carry out standard tasks are become able to learn, interpret new knowledge and use the same in different fields in their tasks".

All participants stated that artificial intelligence has technological and economic influences but emphasized positive aspects of this in relation to emergence of new opportunities and fields rather than the negative aspects. It draws attention that almost all participants gave examples both from Turkey and the world with respect to communication field, when the usage areas of artificial intelligence were asked about. The responses mostly related with defense, e-commerce, finance, geographical

recognition, automotive, retail, social media, education, space, image processing were received, while only worldwide examples were mentioned in relation to advertisement and natural language processing.

Pursuant to our question asked in order to learn about the position of artificial intelligence in the capability of acting creatively and introducing works touching emotion, some answers given in Table I were received. Even though both groups predominantly state that it cannot touch emotions, public relations practitioners tend to approach much more negatively than artificial intelligence practitioners. E.Ş. suggest the point of view underlying the negative situation by stating that "Artificial intelligence may be utilized for reading the society, reading humans, and philosophizing but artificial intelligence would come to a deadlock with respect to 6th Sense that we cannot describe but always comes true." The approach of both groups with respect to introducing creative works by artificial intelligence is more positive and its potential of introducing creative works is considered higher compare to touching emotion.

TABLE I. CREATIVITY AND TOUCHIONG EMOTION

How do you evaluate artificial intelligence in the aspect of touching emotion and creativity?		
Answers	***Artificial Intelligence***	***Public Relations***
It can Neither Touch Emotion nor Act Creatively	3	5
It can Both Touch Emotion and Act Creatively	3	1
It cannot be Creative	2	0
It cannot Touch Emotion	1	4
Its Aspect of Touch ing Emotion is Insufficient, Creativity is Doubtful	1	1
Why Not	1	2
At Basic Level	1	0
Its Aspect of Touch ing Emotion is Insufficient but Why Not?	1	0

When the participants are asked to make an evaluation about ethical dimension of artificial intelligence, they predominantly state that it is related with the intention of its user or encoder. However, particularly public relations practitioners tended to comment that it cannot act appropriately in ethical sense. Nevertheless, as stated by N.Y.K.: "It is still not possible to talk about an artificial intelligence that thinks, decides and performs complex functions like a human. Therefore, the ethical dimension depends on us. If you give wrong data, you would receive wrong and undesired results".

In the question we asked to determine what kind of a difference the participants consider between artificial intelligence and humans; public relations practitioners predominantly defined this difference as emotion while artificial intelligence practitioners stated that both are considerably different and characterized this difference as performance. The response of E.R.M. as "Artificial intelligence has already passed human. It always keeps learning. It has no fact of working hours." exceeded the difference between artificial intelligence and human and carried it beyond human.

When the participants were asked about professions which might be influenced by artificial intelligence, both groups predominantly stated that it will influence all professions and emphasized that particularly blue-collar workers and those having repeated works will be influenced more adversely. However, when the same question was asked for communication-based professions, the answers evolved as "will be influenced less" by highlighting the elements of emotion and creativity.

For the question we posed whether the activities performed in scope of public relations can be performed by artificial intelligence, the answers given in Table II were received.

TABLE II. CAPABILITY OF PERFORMING PUBLIC RELATIONS WORK

In your opinion, can the activities performed in scope of public relations works be also performed by artificial intelligence?		
Answers	***Artificial Intelligence***	***Public Relations***
Yes	8	5
Human is Needed, Not Possible Completely	2	2
No	1	1
No in the Short Term	1	2
Why Not	1	0
No But It May be Means	0	3

It draws attention that the answer yes was predominantly received for this question. E.R.M. summarized the reason behind his/her positive point of view by responding as "All behaviors can be modeled as long as data is present. These models will become more successful and work better than humans when machines keep learning". S.G. emphasized that public relations is text and communication oriented and stated that public relations practices may also be performed by means of artificial intelligence by responding as "artificial intelligence systems which can write articles by itself and they became very successful. We have even seen a speaker with artificial intelligence that broadcasts live". However, N.Z. answered as "Communication is not something directly related with human IQ but mostly depended on EQ. A communication professional must look at the background of anything displayed to him/her, see as 360 degree and also has to achieve tell as 360 degree."; Ü.K. emphasized that human is needed and it may not be completely possible by stating that "When it comes to human, people want to face someone who understands them. I think artificial intelligence falls short in this sense. But artificial intelligence may be utilized in many works with respect to other issues." The public relations practitioners who approach negatively in this question drew attention to the fact that artificial intelligence may be utilized as means even though not completely. Those who do not make an emphasis on means stated that human always needs human so they answered as no. A.K. who completely approaches negative in this regard responded as "I don't think they can be performed because public relations is an organism that produces something that is not physically existing. I don't believe that artificial intelligence can achieve this." Similarly, H.Ö. also approached negatively and responded as "Because artificial intelligence is productive in human field that requires mass behaviors involving plenty of data. If there is a mass in public relations, the case would be different". The thing desired to be emphasized here is a range of distinct, routine behaviors. If the concerned action, like writing a press bulletin in the light of a press meeting everyday within the framework of certain rules, is defined with its sub details and comprehensive data sets, artificial intelligence may possible become a process adaptable for the said public relations activity. Ö.A. responded as "Human brain functions both as a digital and an analog system. We, as scientists call this live hardware. However, the process of encoding everything performed by human brain to algorithms and uploading these codes to a robot shall be realized by the studies of scientists. This is also the case for public relations." Among the participants, a public relations practitioner who had worked as a content editor in a technology company for a long time stated that he/she became unemployed because artificial intelligence started to perform his/her job.

The answer given to the question whether artificial intelligence is always consistent was predominantly yes; while the answer for the question whether or not that might share a distorted information was mostly yes. This is because share of a distorted information also involves a consistency in itself and this is related with how it has been educated. It is remarkable that the answer no outstanding for the question whether artificial intelligence can be representative of an organization. The opinion suggesting that artificial intelligence that achieves many things may not undertake the role of an organization's spokesperson like a public relations practitioner takes a distinctive role in relation to the position of artificial intelligence in public relations practices. However, positive opinions declared by the participants regarding that it can speak the same language with the target group and may influence management decisions highlights that the power of artificial intelligence should not be underestimated.

CONCLUSION AND EVALUATION

Upon development of technology and penetration of artificial intelligence in our life effectively, the profession of public relations has been influenced like other professions. Slowly manifesting itself in public relations practices, artificial intelligence becomes prominent with its different dimensions in all instruments and ensures the relevant instrument to become more practicable and more effective rather than completely achieving its own auto-control for this instrument. Even artificial intelligence that is sometimes positioned as an instrument on its own in public relations practices is becoming important for both public relations practitioners and artificial intelligence practitioners.

However, artificial intelligence that failed in getting full marks from its target group in relation to touching emotion should make some more efforts for its own development process. On the other hand, it is necessary to make artificial intelligence, providing different viewpoints in terms of creativity, feed human and position it as an instrument that should always be applied in order to ensure introducing stronger outputs. Public relations and artificial intelligence, although they are two different disciplines, should be considered as an intersection set of the multidisciplinary field and effort should be made to utilize it with a cycle feeding each other. Public relations practitioners should carry out further studies with respect to touching emotion, introducing creative works and being an organization's agent distinguished with this research and they should focus their attention on these fields in order to avoid from falling behind artificial intelligence. However, this should not be considered satisfying alone, a mission not influenced by artificial intelligence but administering this should be undertaken in all other respects.

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Comparison of the Performance of Deep Learning Models in EEG-Based Emotion Analysis

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***Abstract*— Emotion has a vital role in people's daily lives. People intentionally or unintentionally use sound, facial expressions, body language, gestures to interact with the environment. In this respect, it is necessary to understand the behavior of emotions better in order to interpret emotions. There are many studies based on sounds, signs and gestures related to the analysis of emotions in the literature. However, the data obtained by these methods are not reliable because they can be manipulated by individuals. Therefore, a more reliable and more robust approach was needed and the importance of physiological signals such as EEG has increased. Although the studies performed with EEG have not reached the desired level yet, it is used effectively in the literature. In this study, emotion prediction process based on EEG signals was performed and various deep learning models were compared. The study consists of four different stages: obtaining EEG signal data, pre-processing the signals, classification and determining the evaluation matrices of deep learning models. AlexNet, VGG16, ResNet50, GoogleNet, InceptionV3 and DarkNet19 models were used as deep learning algorithms. Both binary classification (positive-negative) and multiple classification (arousal-valence) were performed in the study. After the classification process, high performance has been achieved for both the binary-class and the multi-class structure.**

Keywords—emotion prediction, EEG signals, deep learning

I. INTRODUCTION

Emotion has an important role in human life and behavior. Emotions are of great importance in their daily lives because people use their emotions, either knowingly or unknowingly. Emotions affect people not only psychologically but also physically [1]. While negative emotions cause people to be lonelier and unsuccessful in society, positive emotions make people more active and energetic [2]. Since the effects of emotions on human beings are great, there are many applications have been developed, including e-learning, health services, security, robotics, etc. [3-6]. However, although the working areas of these developed applications are wide, they have not yet reached the desired level. The biggest reason for this situation is that emotions are an abstract concept and they vary from person to person [7].

Emotions can be obtained by various methods including mimics, facial expressions, body language and voice signals.However, the data obtained by these methods can be manipulated by individuals and this causes the data to be unhealthy [8]. In addition, the size of the data obtained by these methods can be high and complex [8]. For these reasons, the importance and need for both computer-based and psychological signals such as EEG (Electroencephalography) have increased in this area [9]. EEG is a method used to track the activities and functions in the brain. Since people cannot manipulate brain signals, they are more effective and healthy than other methods. In the past, EEG signals can be obtained by traditional methods, but nowadays, with the development of technology and the increase in hardware quality, they can also be obtained with portable devices.

When studies in the literature are examined, it is seen that emotions fall into two different categories; Discrete emotions and dimensional emotions. There are eight main emotions in the discrete emotion model in total [10]. These emotions are anger, anticipation, joy, trust, fear, surprise, sadness and disgust. However, there is no such distinction in the dimensional emotion model. In this model structure, emotions are expressed on a certain plane [11]. The plane is divided into four separate regions. While emotions on the right side of the region express positive emotions, emotions on the left side indicate negative emotions. On the y-axis of the plane are the degrees of arousal of emotions. These degrees are ranked from low to high. The x-axis of the plane expresses the valence value of emotions. In Figure 1, an image of the arousal-valence space is given.

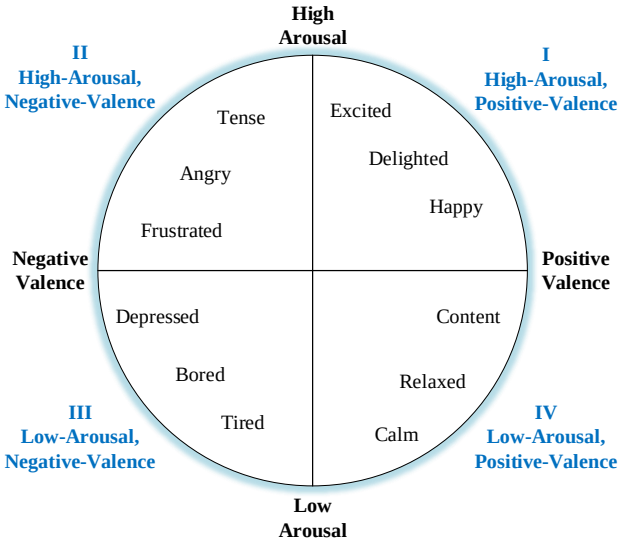

Fig. 1. Arousal-valence emotion place

According to the dimensional emotion model given in Figure 1, emotions are no longer expressed by their names, but according to their zones in the coordinate system. There are four zones in total in the dimensional emotion model. The first one is the HAPV (High-Arousal, Positive-Valence) zone and there are high stimulated and positive emotions in this zone. The second zone is the HANV (High-Arousal, Negative Valence) zone and there are negative emotions with high arousal in this zone. The areas at the bottom of the x-axis express emotions with low arousal. In the third zone, there are LANV (Low-Arousal, Negative-Valence) emotions, while in

the fourth zone there are LAPV (Low-Arousal, Positive-Valence) emotions. The dimensional model is a more universal model. The reason for this is that emotions are expressed in terms of the coordinate zone they are in, rather than their names.

In this study, emotions were predicted using the dimensional emotion model structure. In the study, GAMEEMO data set was used and EEG signals belonging to this dataset were evaluated. The prediction process consisted of four stages. In the first stage, EEG signals were obtained. In the second stage, spectrogram images of the obtained signals were generated. In the third stage, the classification was made using AlexNet, VGG16, ResNet50, GoogleNet, InceptionV3 and DarkNet19 deep learning algorithms. In the last stage, the performance of these methods was compared. The prominent features of the study can be expressed as follows;

- The performance of a new dataset, GAMEEMO, was examined.
- The effect of deep learning models on emotion analysis has been determined.
- Portable EEG device was used while generating the GAMEEMO data set. The place and performance of this device in the literature have been evaluated.
- The performance and success of EEG signals in emotion analysis were evaluated.

The rest of the study is organized as follows. In the second section, studies in the literature were examined. The classification results of the studies were discussed by providing information about the emotion data sets and methods. In the third section, technical information about the GAMEEMO data set was given. In addition, the deep learning models were mentioned. In the fourth section, application results were given including discussions and advantages and disadvantages of the study were emphasized. In the last section of the study, future studies were specified and the results were examined.

II. Related Works

In this section, emotion prediction studies based on EEG signals in the literature were discussed. The EEG data sets and methods used in the study were examined and the performance criteria of the classifiers were considered. In study [12], the researchers performed emotional analysis based on EEG signals independently of the subjects. EEG signals of the DEAP (A Dataset for Emotion Analysis Using EEG, Physiological and Video Signals) data set were used in the study. In the first stage, feature extraction from signals was performed and VMD (Variational Mode Decomposition) and EMD (Empirical Mode Decomposition) methods were used for this. After the feature extraction process, deep neural networks were designed and classified. Dimensional emotion model was used for classification process and arousal and valence values were classified separately. With EMD-based features, the highest accuracy of 60% was obtained for arousal, while this rate was calculated as 56% for valence. With the VMD-based features, the results did not differ much. An accuracy of 61.25% was obtained for the arousal. This ratio is calculated as 62.50% for valence. Researchers in study [13] made emotion prediction using dynamic graph structure. SEED (SJTU Emotion EEG Dataset) and DREAMER data sets were used in the study. In the first stage of the study, various features were extracted from EEG signals. These features are DE (Differential Entropy), PSD (Power Spectral Density), DASM (Differential Asymmetry), RASM (Rational Asymmetry) and DCAU (Differential Caudality). After the features were obtained, a dynamic graph-based convolutional neural network model was designed and emotions were analyzed. The performance of the classifier was determined only by the accuracy matrix and calculated separately for each feature. For the SEED dataset, the highest performance was obtained using the DE feature and the result was found to be 79.95%. For the DREAMER data set, the highest performance was obtained by using the PSD feature and an average performance of 85.26% accuracy was achieved. In study [14], the authors predicted emotion using a new fractal pattern feature. In the study, the GAMEEMO data set was used and in the first stage, the signals were transformed with TQWT (Tunable Q-Factor Wavelet Transform). Then, FFP (Fractal Firat Pattern) was applied to each EEG signal and its sub-signals and features were obtained. Then, the obtained features were combined and the features were selected by the IChi2 method. In the last stage, the classification process was made and SVM (Support Vector Machines) was used. The performance of each EEG channel was examined separately. At the end of the study, an average accuracy rate of 99.82% was achieved. In study [15], the researchers made emotion prediction using parallel convolutional neural networks. DEAP data set was used in the study. The study consisted of three stages: data acquisition, feature extraction and classification. In the feature extraction phase, 1-dimensional EEG signals were transformed into 2-dimensional EEG frames and prepared for classification with convolutional neural networks. The dimensional emotion model structure was used in the study and the classification performance was evaluated separately for both arousal and valence. The performance of the classifier was determined only by the accuracy score. With the proposed method, an accuracy rate of 90.80% for valence and 91.03% for arousal was achieved. In study [16], the researchers performed an analysis of emotions by designing a hierarchical convolutional neural network model. Data belonging to SEED data set were used in the study. In the feature extraction phase, the signals were decomposed into sub-signals using STFT (Shor-Time Fourier Transform) and the DE property was collected from each signal. Convolutional neural network was used for the classification process and the performance of the classifier was measured with the accuracy matrix. At the end of the study, an average accuracy of 55.62% was obtained with the proposed method.

III. Material and Methods

A. GAMEEMO Emotion Data Set

In this study, EEG signals of the GAMEEMO data set were used [17]. The data set contains EEG signals from a total of 28 subjects. While generating the data set, the subjects were played 4 different computer games and emotions were obtained from the subjects according to these stimuli. The games are horror, funny, boring and calming genres. Dimensional emotion model was used and each game belonged to a specific zone of the dimensional model. The

emotion of HANV by playing the horror game, the emotion of HAPV by playing a funny game, the emotion of LANV by playing a boring game, and the emotion of LAPV by playing a calming game were achieved. The subjects played each game for 5 minutes, and as a result, 20 minutes of EEG data were obtained for each subject. EEG signals were collected by a portable EEG device, the 14-channel Emotiv Epoc. More detailed and technical information about the EEG data used in the study can be found in study [17].

B. Deep Learning Models

Deep learning has become popular today with the development of technology, easier and faster data acquisition, and the increase in hardware power to process data. Deep learning is mostly used for classification, recognition and detection processes [18]. In machine learning, obtaining the features manually and requiring expert knowledge to interpret some features increased the interest in deep learning [19]. With deep learning, studies in various fields, especially bioinformatics [20,21], object recognition [22], biomedical [23,24], robotics [25], can be performed. The results of these studies have shown that deep learning models are effective and successful.

In this study, various deep learning models were used and emotion analysis was performed with these models. The deep learning models used in the study are AlexNet, VGG16, ResNet50, GoogleNet, InceptionV3 and DarkNet19. AlexNet architecture has 61 million parameters in total and takes 227x227 sized images to the input layer [26]. While there are 138 million parameters in total in the VGG16 architecture, unlike the AlexNet architecture, this architecture uses 224x224 images [27]. The ResNet50 model, on the other hand, can analyze 224x224 images just like the VGG16. The total number of parameters of this model is 25.6 million [28]. In the GoogleNet architecture, there are 7 million parameters in total and 224x224 images are used just like the VGG16 and ResNet50 models [29]. In InceptionV3 model, there are 23.9 million parameters in total and dimensions must be 299x299 in order to analyze images [30]. Finally, there are 20.8 million parameters in the DarkNet19 model, and the dimensions must be 256x256 in order to analyze the images with this model [31]. In the first stage of the study, spectrogram images of EEG signals obtained from the GAMEEMO data set. Then, spectrogram images were resized and classified according to each deep learning model. Both two-class and multi-class problems are emphasized in the study. Figure 2 shows the flow chart of the study.

IV. APPLICATION RESULTS

Pre-trained deep learning models were used in the study and emotion analysis was performed. Both the two-class and the multi-class problem were emphasized. The performances of the classifiers were determined with the only accuracy matrix. The same parameters were used for each deep learning model. Adam was chosen as the optimizer algorithm and the calculation was made with 500 iterations. While 80% of the data was evaluated for the purpose of training, the remaining 20% was tested. Table 1 shows the application results.

TABLE I. ACCURACY SCORES OF DEEP LEARNING MODELS FOR BOTH BINARY-CLASS AND MULTI-CLASS

Deep Learning Models	Binary-Class	Multi-Class
AlexNet	98.73%	98.08%
VGG16	92.04%	85.72%
GoogleNet	92.31%	93.74%
ResNet50	99.04%	97.63%
DarkNet19	92.31%	83.50%
InceptionV3	90.38%	94.59%

When the results in Table 1 are examined, it is seen that each deep learning model in binary-class classification performs above 90%. The highest accuracy score with 99.04% was obtained with the ResNet50 model. For the binary-class classification process, the lowest was obtained with the Inception V3 model and the accuracy score was calculated as 90.38%. In contrast, the highest accuracy score in the multi-class classification process was 98.08% with the AlexNet model. In this classification problem, the lowest accuracy score was calculated with the DarkNet19 model with 83.50%. ResNet uses the weight layer to output from a previous layer to a layer after it. In this way, the lost gradient problem can be reduced. The fact that ResNet50 has such a structure has made it ahead of other deep learning models [32]. When the results are examined, it is seen that AlexNet architecture has the best performance after ResNet50 architecture. The reason for this success is the reduction of overfitting in the AlexNet architecture [33]. In this way, the system can be successful in classifying even the data it has never seen. A similar inference can be made for the multi-class, since the highest performance was achieved with AlexNet and the second was ResNet50. The conversion of EEG signals into spectrogram images has led to a successful classification process. All methods have achieved successful accuracy in both binary and multi-class problems. It has been observed that spectrogram images are an effective feature in emotional analysis. The results obtained confirm this. In addition to these advantages, other feature extraction methods may improve classification performances. When the studies conducted with emotion analysis were examined, it was seen that the signals were decomposed into sub-signals by various methods and features were obtained from these sub-signals. The performance of this study can be evaluated by determining such a feature extraction scheme. In addition, more effective classification results can be obtained by using different deep learning algorithms. A subject-independent study can be performed. In this way, emotion analysis can be made for each subject and the differences between emotions from person to person can be determined.

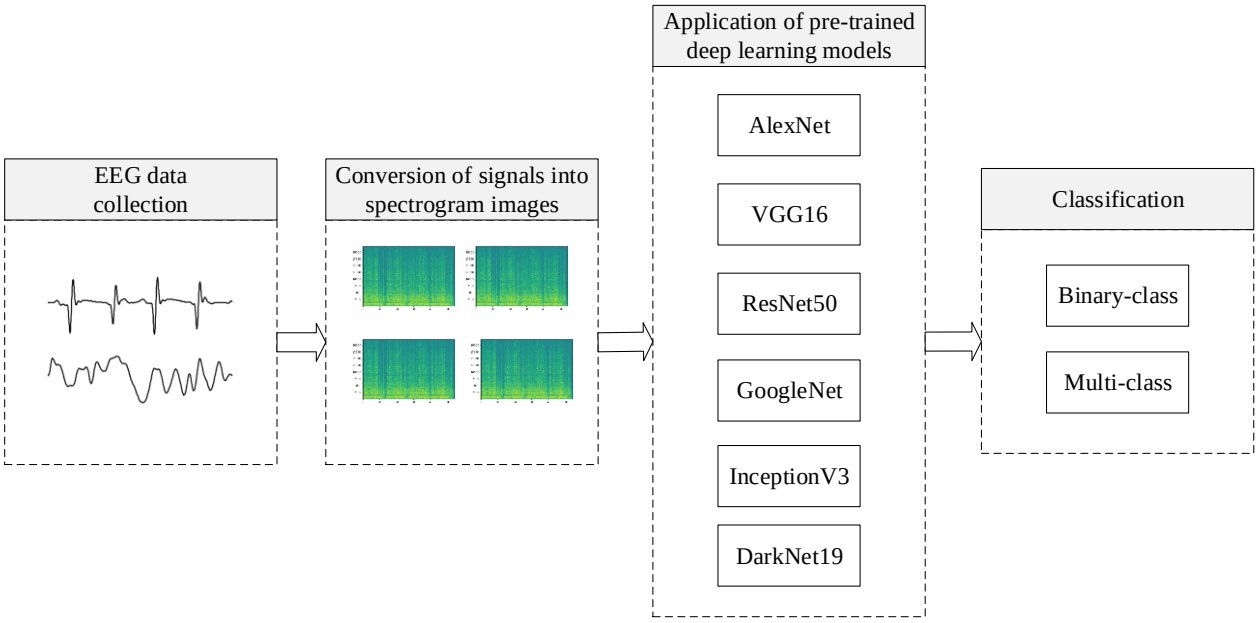

Fig. 2. Flow chart of the study

Additionally, a channel-based emotion analysis study can be conducted and the performance of the channels can be compared.

V. CONCLUSION

In this study, emotion prediction was made based on EEG signals. The study consisted of four stages. In the first stage, EEG data were obtained and a publicly available dataset, GAMEEMO, was used for this. EEG signals were then transformed into spectrogram images and resized according to the deep learning models that were used. Then, the classification process was made and the performances of the deep learning models were compared. At the end of the study, the highest accuracy was obtained with the ResNet50 model for the binary-class and it was calculated as 99.04%. For multi-class classification, the highest performance was obtained with AlexNet, with an accuracy score of 98.08%. When the results were examined in general, it was observed that all deep learning methods produced effective results. With this study, it was observed again that deep learning models were effective in this field and the achievements in the literature were reinforced. In future studies, by using different deep learning models and features, the achievements can be further increased and the desired level in this field can be reached.

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Artificial Intelligence Applications in Service Industry: Handling invisible part of the Iceberg

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***Abstract*— Artificial Intelligence (AI) has wide range of applications not only in research dimension but also in every aspect of our modern life. It is being utilized to provide smart solutions to problems through collecting, processing or sharing different kinds of information about people and notably the way they behave in their surrounding environment. In this aspect, machine learning which is a thrilling dimension of artificial intelligence is capable of converting large amount of data set in to meaningful predictions for business environment. This research explores a common use of AI applications in service industry. First, it investigates those who are likely to be negatively affected by AI systems and its consequences to the human environment. Second, it addresses potential threats in relation to AI systems such as global data privacy, data security and ethics. Therefore, third it debates an accountable business conduct by government policies to mitigate probable adverse effects of their transactions from the institutional point of view. The results of the research will shed light on artificial intelligence phenomenon through social science dimension and can make positive contribution to the research world for achieving a meaningful blend of two different scientific approach.**

Keywords*— *AI, machine learning, service industry, global data security, global data privacy, institutional policy

I. INTRODUCTION

An immense amount of unstructured data at a lesser cost has been continuously produced and stored as a result of big data every day. Indeed, this is the reason why big data has been a catch phrase in many disciplines at an increasing level day by day. Developments in software and hardware in big data has explicitly led investigation of this concept. Data mining and conversion and combining data with machine learning algorithms have had an extensive use in variety of fields. More specifically the issues which are investigated in these context has resulted in an elaborate delineation of situations, events or people [1].

Artificial intelligence, is on the other hand a kind of method, which has the potential of thinking and behaving like a human being in order to figure out big scale problems without human intervention. The paradox is that AI is used in situations that exceed the speed, flexibility, efficiency and physical capacity of the human.

In the meantime, internet of things (IoT) is one of the most used artificial intelligence applications among artificial intelligence forms. When we question artificial intelligence operations in different environments in terms of the value it creates, we encounter the reality of how it shapes our lives [2]. In fact, this concept has had profound impacts in every aspect of human life.

The purpose of the paper was to introduce and examine the problems of artificial intelligence implications, notably some of the companies' operations, from the point of global institutional framework and it consequences on human life and therefore to suggest solutions by employing an interdisciplinary approach for the research question. Section one outlines "Contingency and Situational" approach as a management theory within the study and machine learning concept in the literature. Section two reviews data privacy, data security issues with reference to relevant global institutional framework. Section three debates how data privacy and security violations occur in business operations of some of the technology giants in the context of AI implications and how to overcome this global problem through multidisciplinary and holistic approach. The study is followed by research methodology and discussion. The final part of the study reflects conclusion and suggestions.

II. THEORETICAL FRAMEWORK

Modern Management Theory examines and handles enterprises behavior within system theory. That's why it is possible to analyze and comprehend organizations' activities to gain better insight of their motivations by system theory. Thus, enterprises are accepted as social and open systems from management point of view. Organizations continuously interact with their surrounding environment to receive various inputs to process these inputs in the form of outputs so as to achieve their objectives [3].

There are three approaches in terms of the nature of the relations between business and its environment i.) changing the environment ii) adaptation of the environment iii) interacting with the environment [4]. In the first perspective organizations form a closed system and has no interaction with the external environment, whereas in the second approach organizations have realized the significance of interacting and adapting with the environment in order to attain their goals. In the last approach, enterprises are in a mutual interaction process with their environment due to the fact that they are dependent to one another and so interaction has a meaning for both sides. Although Albeneese [5], did not take into account the internal environment within open system theory, Mescon, Albert and Khodori [6] took into consideration of internal environment as a part of open system.

Another approach in system theory is Contingency and Situational approach. "Contingency and situational" approach

is stated within modern management theory as well. Enterprises in that sense are regarded as a social system and impacted by the external environment [7]. According to this management approach anything related to the enterprise may be subject to change due to internal and external factors within and outside the business, and therefore, there is no sole right for them depending on the situation and condition they have faced with [8]. As a result, organizations take decision depending on the conditions they have been under. It is clear to state that the internal factors that are affecting the organizations consist of goal, mission, vision, technology, the works to do, the quality of staff. But, on the other hand, the external factors include customers, market conditions, competition, government (legislations), social and cultural conditions and government interventions.

A. Positive and Negative Consequences of Artificial Intelligence Employments

Artificial intelligence ensures to reach a large number of people along with personalizing the message in digital environment. The factors stated below are among the negative consequences of artificial intelligences implications.

- Digital networks may become a malicious cyberattack with a single faulty action.
- Lack of control in algorithms may present enormous amount of inaccuracies.
- Inaccurate information circling around may bring about different kind of risks.
- Inaccurate information circling around may bring about different kind of risks.

B. Machine Learning and the usage of the concept in Service Industry

Majority of studies regarding artificial intelligence have predominantly concentrated on potential loss in employment in the literature. In that sense, latest developments in artificial intelligence are rooted of machine learning which is the subdivision in computational statistics. Business may choose to increase their operational capacities to understand business trends, to improve service and goods or to increase customer satisfaction by making predictions in machine learning [9]. This is largely because, machine learning specifically deals with a particular aspect of human intelligence, making prediction. Prediction refers to utilizing available data to fill out lacking knowledge [2]. Receiving feedback is a salient factor to increase accuracy in predictions. Thus prediction occurs as a result of processing some data and running of the algorithm. At this stage, the obstacle in the way seems to be obtaining educational data for predictions. Depending on the type of data, it may not be appropriate for customers to share their personal data at all times. But in some cases, customers may not prefer to share their data with a company since they would not want to unveil their business plans or personal information. Moreover, they would not to be willing to share their data regarding their movement or location in a specific situation. Another impediment in the way is that the need for educational data, that is it should be regularly updated. For instance; radiology service at a hospital may not require regular update since the department as a service may not differ at certain period of time. This is also valid for some of the personal data. On the other hand, at some instances, algorithms may require regular updates so as to reflect environment based alterations [2].

Machine learning has gained a usage in many aspects of our business world at increasing level. The decisions taken in the context of deep learning require using complex mathematical models. Another issue is that the environment in which machine learning works may vary according to the environment to work within the algorithm. Concept bias and covariate change are the foundations of this environment. However, these applications in medical service raise questions in regulations and ethic wise [10].

The differences between machine learning and other types of AI should be brought into day light in order to comprehend the usage of it and why it has been favored by several disciplines. These are as stated below;

- Machine learning may mean complicated decisions in the form of a single or separate decisions and have the ability of adjusting to new ones so easily.
- When machine learning makes a decision and how those decisions taken are compatible with global ethics understanding and concepts.
- During the decisions taken in these algorithms are made if they are acceptable or explainable by human.

C. The Importance of Data Environment and Open data as a Solution

The critical point of data mining in big data analytics is based on having to keep the identity of pattern owners anonymous [11]. Due to the fact that the data on the web is too much and cannot be stored has made it necessary to have certain quality that will facilitate the comprehensibility and usability of these data.

To create structured data, institutional data is required and collected from business world and public sector. Data obtained from the web is rapidly digitalized. This has led to evolution of semantic web and semantic data in the literature [12]. This means that the use of open data in digital environment increases transparency, efficiency, effectiveness and competitiveness for institutions. Obviously having open data will make smart systems even more effective and efficient. As a result of employment of semantic data, semantic web protocols has emerged and led to being attached to one another more easily and successfully.

Nowadays unstructured data gathering is also getting more important such as reading, hearing or seeing related to human and being produced from human activities through web sites, graphs, videos, and pictures. The data generated by the Internet of Things (IoT) is also another version of gathering unstructured data which is collected from machine to machine through mobiles, ctv cameras by audio, visual, active or temperature [12].

D. Discriminative Nature of AI Technologies

Although AI Technologies offer various advantages in different aspect of human life, it also contains challenges for human and therefore requires a supervised approach of applications. Connectivity, autonomy and data transparency are the discriminative features of AI, robotics and IOT technologies in order to execute tasks with limited human power or guidance. Because, AI systems are capable of upgrading its own system and learning through practices. A rational and reliable framework is critical in the case of application of AI, robotics and IOT technologies to be in line

with consumer safety and legitimate business environment [13].

Each meditator of Supply chain management such as software, services or systems together make up a technological environment for computers. Massive amount of data together with the dependency on algorithms and the incomprehensibility of decision making process are part of the AI and robotics, IoT technologies. Consequently, cyber threat seems inevitable due to openness and connectedness nature of AI, IoT and Robotics technologies [13].

Autonomy, is one of the major qualities of AI systems and haphazard usage of outcomes could lead to damage to the users and exposed persons. The powerful performance of AI practices could bring out mental health problems for users. Digital technology refers to health risks for human being not only in physical health but also in mental health as well. As a result, product safety legislation should be in use in accordance with EU legislative framework. Data dependency is also part of AI positioned products and systems. Opacity which is another component of AI related products and systems may arise from the capacity to enhance their performance by training from practices. Complicity of the products and systems may influence safety issues in a way of interfering in one another during functioning [13].

III. INSTITUTIONAL FRAMEWORK

This section outlines the institutional framework of personal data, global data privacy and global security concepts with reference to international law. By the use of AI, which emerges as more of a global trend, indicates that countries will be able to provide efficiency in state administrations. More governments have started to embrace AI and data science due to their gravity in business environments. It has also potential for public sector workers in decreasing the time they spend on simple tasks and giving them more time and space to improve their skills. The public sector should have pioneer role in embracing AI and related technologies and provide guidance to ensure ethical and safety standards for others in the system. For instance, in the UK for personal data use, organizations or bodies should adhere to three relevant legislations which are EU data protection regulation, data protection act 2018 and law enforcement directive [14].

A. Consumer Protection Act

Consumer protection law is basically concerned with legal and economic wellbeing of consumers along with health and safety issues [16]. Nowadays, digital technology alters the way consumers get in touch and shop online, then before. Therefore, protection of consumers is subject to systematic change in accordance with swift changing of digital setting. In that sense, Prosumers refer to consumers who are adjusting to technological progress within collaborative economic practices. More specifically the policy [16] includes that "the safety of product, digital market, food safety and labelling, financial services, travel and transport, energy, and financial services". European Consumer Agenda highlights "Europe for citizens" concept. Additionally, the agenda stresses on reinforcing applications, increasing information, and obeying the law.

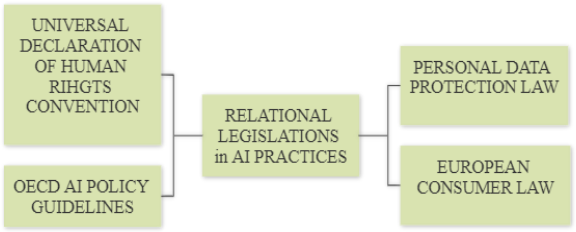

Fig. 1. Institutional Framework of Relational Legislations in AI Practices

Fig.1 shows how different institutional regulations interrelate with each other and help enlighten the personal rights and security issues.

Having explained European Consumer Law, definition of personal data needs to be explained. Personal data notion is defined below by a table [14]:

TABLE I. ARTICLES OF DEFINITIONS IN DATA PROTECTION ACT

	Data Protection Act
Article Number 3 Term 2	"Personal data" involves any intelligence with reference to defined or undefined existing person.
Term 3	"defined or undefined" involves an existing person who can be defined or, undefined attributer (a) through name, a definition number, location, (b) one or more components with respect to economic, social, cultural, physiological, physical, genetic, mental descriptive of the person.
Term 4	"Processing", refers to (a) structuring, collecting, accumulating or transcribing, readjusting, (b) modifying (c) regenerating, or capitalizing (d) exposing, (e) arrangement or blending, or (f) constraining, deleting, extinction.

B. OECD AI Policy Observatory

OECD has set up Policy Observatory organ, on the 29th of May in 2019, to define standards in leading artificial intelligence to highlight human rights and democratic values in the form of a guideline for both public and private sector operations. The following table indicates "five OECD AI principles" [17].

TABLE II. OECD ARTIFICIAL INTELLIGENCE PRINCIPLES

	OECD Artificial Intelligence Principles
1	AI should create value for people and the world through sustainable development.
2	AI operations should comply with the rule of law and respect democratic values and human rights, permitting human interference when a need arise for the wellbeing of a society.
3	AI should make sure that people become aware of AI related results.
4	AI system operations should continuously be appraised.
5	Institutions and people should be held accountable for their actions and should behave in accordance with AI principles stated here.

Value based principles are established to guide entrepreneurs' operations globally in order to promote sustainable development and wellbeing of societies, human centered values and fairness, transparency, security, safety and accountability terms in general sense.

According to Data Ethics Framework of Federal Government; privacy is described as "the state of being free from unwarranted intrusion into the private life of individuals, and confidentiality is the state of one's information being free from inappropriate access and misuse" [15]. Moreover, AI implications should also include honesty and integrity [15].

To sum up when a lot of combined appliances interact to one another, AI implications form complex IoT environments for users of these devices. Hence, because of the complexity of devices together with the multitude of players within environment can complicate the situation to identify the responsible individual in the course of the law [13]. On the other hand, Cyber security infringements in the appliances may bring about vulnerability issues of the operators as they are liable against device owners. However, the law does not explicitly delineate the liabilities of the operator [14].

IV. METHODOLOGY

A. The Purpose and Importance of the Study

The purpose of the study was to investigate some of the AI applications in service industry, i.e. communication, in terms of human rights violation, ethics, data security and privacy issues. The roots of the problems have been explored by modern management theory, "Contingency and Situational Theory". Majority of the research regarding AI implications have investigated the issue in computer programming, law, marketing, but the ties among public management, marketing, computer science and law have not been investigated simultaneously. The study is unique due to its design and approach as AI practices, that of applied science problem has been explored from social science point of view. Moreover, applied science and social science concepts and approaches are blended in one research in order to find a solution to the research question.

Therefore, the paper intends to suggest a synthesis and holistic perspective reflecting different school of thoughts from numerous disciplines. This is due to the fact that AI, robotics, IOT are deeply embedded in every aspect of human's life and hence a multidisciplinary and a holistic approach should be suggested to comprehend interrelated relations of the problem.

B. Type of Research and Techniques

As a research type, this is a secondary research which researchers utilize existing data to gain deeper insight about the explored issue. Descriptive research concentrates on a situation, event or phenomenon. Basically, it consists of defining

1) *only one variable*
2) *relationship between two or more variables*
3) *the pervasiveness of the phenomenon.*

Furthermore, it is a first pathway to get a better grasp of the problem. Additionally, it is an explanatory in nature when there is insufficient knowledge about the problem [18]. Additionally, descriptive researches have three major aims that are defining, elucidating, and justifying research findings. It is also powerful to analyze non-quantified subjects and issues [19].

As a technique, literature review for the study is rather suitable for three reasons [20]. First fragmented and interdisciplinary nature of knowledge production in the selected area justifies the use of this technique as a methodology. Second, it is virtually analytical ways of compiling and arranging former researches. Last but not least, through incorporating different findings and frame of minds, literature review explains the research question thoroughly. In that respect, the research focuses on "What sort of measures can be taken to prevent consumers' data privacy and data security, ethic violations in AI implications of organizations?" More specifically the aim of this paper is to produce an overview of different literature reviews in the explored subject area while investigating selective disciplines and to demonstrate the findings within a larger field of study [21].

The inclusion criteria to for the selected sources had started with search for key words in global data privacy and global data security, then related data bases were reached. To review the literature, other sources of information were libraries, archives, books, journals, dissertations, government websites and other related studies. The conceptual framework within the study based on the definition of data privacy and security issues from different related legislative frameworks and description of machine learning as a type of AI employments as a related concept and how they cause personal data security and privacy violations in terms of know-how setting was discussed. The study primarily aims to compile knowledge by defining, explaining the problem from different school of thoughts and then filling out the gaps with that collected knowledge in the searched area. Having explained data security and privacy issues from different institutional context, the next part pertains to different situations of privacy and security violation cases.

C. Research Limitations

Literature review as technique reflects rather subjective point of view in the inclusion of which research to add and the way the studies are examined and the conclusion drawn [22].

V. DISCUSSION

In the study different examples of AI implications in service industry such as in communication area are reviewed in the light of system and situational theory. According to BBC news [23] Arabic undercover investigations domestic laborers are being unlawfully sold on the net in growing underground market in Gulf. Part of the commerce has been performed on social media i.e. Instagram, where posts have been encouraged algorithmic devices label, and deals settled over individual messages. Other adds have been demonstrated in apps confirmed and supported through Apple's App Store and Google Play, along with the e-commerce owned websites. The supplier approximately all recommended confiscating the person's passport, constraining them to the residence, not allowing them a day off and permitting them very limited access to telephone or in some cases no access at all.

UN special rapporteur Urmila Bhoola, indicated that "What they are doing promoting an online slave market. If Google, Apple, Facebook or any other companies are hosting apps like these, they have to be held accountable" [23]. In the meantime, Apple and Google responded to this statement indicating that "they are in collaboration with app developers in order to halt this unauthorized operation". In the same way, Facebook stated that "the company restricted one of the hashtags included".

Similarly, another incident is that the sales of Amazon rainforest homelands over Facebook commercial market exemplifies another illegal online commerce. More specifically, the nationally preserved forests and indigenous people's land are being improperly sold on Facebook commercial. As a response Facebook alleged that they are willing to work with local authorities however, the company would not take a sole action to combat the illegitimate trade [24]. Additionally, it was demonstrated that Brazil's Amazon forest unlawful sellers are from indigenous people. Although some of the local people are trying to halt this trade, some of them perceive it as a lucrative business [24]. It should also be stated that removal of Amazon forest on earth has detrimental effects and it aggravates global warming. It is a widely known fact that Amazon forests act as lungs of our planet [24]. Glanville states that "entrepreneurs should protect the rights of vulnerable community if the host country is clearly not capable of doing so [25]. As mentioned within institutional framework earlier, the corporations are accountable in reference to AI implications to whole humanity as it was clearly stated in different legislations earlier. Therefore, they should put these principles into practice for the sake of creating a better world for the sustainable future.

Last but not least, nowadays privacy and security issues have drawn attention from social media users. WhatsApp, messaging application introduced and updated its privacy policy in 2016 indicating that to share users' intel and metadata with Facebook. It meant that the company allowed 30 days to user in order to consider their policy review offer. Depending on users' choice, the messaging app have utilized the users' data and metadata and conveyed them in to Facebook. Since 2016 WhatsApp has begun to share users' information with Facebook. At the time being it was optional for the users but in January 2021 the corporation obliged the users to have their data and meta data to be shared by Facebook within terms of service. This was the new policy shift which will become mandatary in mid-May 2021, and after that for those who are not willing to accept the new terms of service will no longer be able to utilize this messaging app [26] [27]. However, the situation in Europe is totally different from the rest of the world. European Union antitrust legislators levied Facebook a 110 million euros for misguiding WhatsApp messaging app' users in 2014. Additionally, the Italian authorities fined WhatsApp 3 million euro for allegedly obliging users to accept to share their personal information with Facebook [28].

After that Signal foundation has been set up by the WhatsApp co-founder, Brian Acton, and was designed an open source protocol along with end-to-end encryption [29]. Even though end-to-end encryption proposal provided within the messaging application, sharing metadata with Facebook seemed to be an ambiguous choice for the app developer of Brian Acton.

Protection of massages and meta data by encryption were the motivation of Signal app cofounder's, and hence both condition was reflected within the product and in the terms of service by Signal messaging app. Having provided that salient condition, Signal protected and secured message and meta data, and therefore the company had gained leverage in comparison to other messaging apps, particularly to WhatsApp.

Within "Contingency and Situational system theory" Facebook, Google or other kind of high technology giant enterprises behave like Closed systems that is not taking into account any related legislations in relation to their operations performed across borders. However, the law on the protection and privacy of personal data in Europe are properly implemented. Due to its personal data violation cases, Facebook and Google were up against with severe fine in EU countries, but the issue for the countries which are outside EU remain open for a debate [28, 29]. As clearly stated in the EU general data protection regulation, EC and OECD reports enterprises that are operating outside the borders, in countries which do not have comprehensive and preventive laws, rules or legislations; enterprises should comply with the law of their own country and hence protect the rights of those who are in vulnerable circumstances [13, 14, 16, 17].

Additionally, what seems to be problem in AI related technologies adopted by businesses is that the negative impact of data processing through third parties bring about certain violations on human rights, social values and ethics licensing schemes [30]. She argues that data security of information should exceed being clear in the written rules and hence needs to be in line with the practices of different aspects of human rights [30]. This is particularly evident, in service provision of health and security related domains where personal rights, social values together with freedom have become more prominent in the course of everyday life of human being. AI analytics and IOT decision making are extensively concerned with interfering increasing level of

personal data. Glanville [25] demonstrates that "based on responsibility to protect principle" the observer should defend populations beyond borders since it is the collective responsibility of the observer, particularly if the host country cannot manage to do so.

Apparently, all kinds of global law do exist in the global institutional framework, but the enforcement of the law seems to be the problem. Additionally, the use of technical know-how within AI implications raises questions for global data privacy and security.

VI. Conclusion And Suggestions

The study is fundamentally based on the results of existing previous studies in data privacy and security issues through reviewing of books, journals, articles and e-documents from different disciplines mainly in computer science, marketing, management, law, public management, and mainstream and social media sources. In this study the roots of the research problem are defined, explained and global data security and privacy issues are reviewed from the point of social science theories and concepts. As far as the written evidence collected for the research, the organization has changed its organizational behavior when the corporation had faced severe sanction by EU authorities. The result also justifies the employment of the Management theory, Contingency-Situational approach of System theory. The theory demonstrates that there is no right or wrong answer for the country in terms of operations and their answer may alter in accordance with the conditions they have been under.

This paper examined the AI practices within a dialectical thinking. The shortcomings and weaknesses inherited in the characteristics of AI, robotics, IoT, were examined through dual nature of science that is through a nice blend of applied and social sciences. Contemporary science requires to examine issues from holistic perspective in order to understand the connections and to fulfill gaps among various issues within different disciplines. This is largely because knowledge is produced in a complex environment by different layers of society in different disciplines, and hence investigation of these issues require a nice amalgam of relevant disciplines.

To draw a conclusion, the inclusion of external environment of enterprises in their operations require more supervision of different layers of society. That is the collaboration of applied and social scientists, governments and voluntary sector, those who are part of the local community, should work hand in hand to create a sustainable global future. Although technology giant organizations collect large amount of information about individuals to foster their businesses individuals don't gain anything in return. On the contrary, they compromise of their fundamental values. It should be noted that these enterprises should also adhere to the relevant rules and regulations just like rest of other institutions and individuals. Bearing in mind the leading role they have in the society large corporations should behave socially and ethically responsible in their operations for mutual gains. In conclusion, multi-disciplinary and multi stakeholder collaboration is necessary to draw the line in data security and protection of corporations.

In the light of the findings, some suggestions may be listed as follows;

1) Although legislative framework creates robust and concreate basis for enforcement of the regulations the host country seems to be insufficient or in a negligent manner.

2) Because of the reason stated earlier, incorporating multi stakeholder enforcement body needs to be assigned to control enterprises activities.

3) "Protect rights beyond borders"; since companies run across borders, they should protect the rights beyond borders. To counteract data security and privacy violations that of enterprises, the law must be enforced across borders so as to preserve individual's rights.

4) Multi-disciplinary and multi stakeholder collaboration is necessary in the enforcement of related laws to inspect organization's operations in accordance with data security and protection, ethics and human rights values.

5) To counteract third parties' intervention, open source protocol along with end-to-end encryption of massage and meta data should be promoted and clearly stated in terms of service.

6) For future research exploratory research is needed to determine patterns of the research subject among different disciplines. [31].

Acknowledgment *(Heading 5)*

The preferred spelling of the word "acknowledgment" in America is without an "e" after the "g". Avoid the stilted expression "one of us (R. B. G.) thanks ...". Instead, try "R. B. G. thanks...". Put sponsor acknowledgments in the unnumbered footnote on the first page.

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Comparing The Success Of Imputation Methods In Missing Data Analysis

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***Abstract*— Before analyzing data, one of the first checkpoints is whether there is lost / missing data. The difference between the data planned to be collected in research and the data that can be collected is called missing data. If the data cannot be obtained due to any reason in the studies performed or the obtained data cannot be recorded, the problem of missing data arises. Missing data generation mechanisms are used to analyze missing data problems. These mechanisms have three basic structures according to how the probability of occurrence of missing data is related to the data set. Understanding the missing data mechanisms in the data set is important in terms of which method to follow in the studies to be carried out on missing data. Two basic methods considered for missing data; It is either removing it completely from the data set or imputation it with the chosen methods.**

According to the World Health Organization (WHO), stroke, a brain disorder, is the second leading cause of death globally and is responsible for approximately 11% of total deaths.. In this study, on the stroke data set; The classification estimation performance was compared based on the full data set of the new data sets produced by the Missing Completely at Random – MCAR Mechanism and filled with 6 imputation methods at 7 different missing rates In the first phase of the proposed study, 5%, 15%, 25%, 35%, 45%, 60% and 80% data missing was created by using the MCAR mechanism as the missing data mechanism. In the second stage, missing data were imputationed by using Mean, Regression, Nearest Neighbor, Support Vector Mechanisms, Bayes Principal Component Analysis and Decision Trees as missing data imputation methods. In the third step, the results of these methods were compared with the full data set and the classification estimation performance.

Keywords*— *Missing Data, Machine Learning, Missing Data Mechanisms, Data Imputation Methods

I. INTRODUCTION

Before analyzing, one of the first checkpoints to successfully manage data is whether there is lost / missing value(s)[1]. The difference between the data planned to be collected in research and the data that can be collected is called missing data. In other words, the missing data problem arises when the data cannot be obtained for any reason or the obtained data cannot be recorded[2]. Missing data can occur on an observation or variable basis. When no information is collected from a subject, on the basis of observation, when missing information is collected from the subject, a missing data problem is encountered [3].

In case of variable-based missing data; Questions arise such as to what extent the missing data amount is, how the missing data mechanism is formed, and where the missing data structures are[3]. A classification system for how the missing data mechanism occurs has been proposed. This classification system is how the state of occurrence (probability) of missingt data relates to the data set. Missing at Random - MAR, Missing Completely at Random - MCAR and Missing not at Random - MNAR mechanism are divided into three different classes. Understanding the missing data mechanism has an effect that will increase the performance of which method to be followed in studies to be carried out on missing data[4]. Another question in missing data analysis; What is the amount of missing data? It is known that in studies where models such as Machine Learning and Data Mining are applied, performance decreases in data sets with a high rate of missing data[5], and it is difficult to work with missing data sets in Statistical Models[6]. In other words, most analysis methods do not have the capacity to work with data sets with missing values and require a full data set as input[7]. Because the success of the output / prediction performance of the models is low[8].

When the studies in the literature are examined, the missing data; Considering the mechanisms of occurrence, rates[9] and structures, it is seen that either completely removing (deleting) from the data set or imputation with the selected methods[10]. The first method to evaluate missing data is to delete (remove) the values containing missing data from the data set. In this method itself; It has applications such as row-based deletion, column-based deletion, and peer deletion. However, this solution approach negatively affects the performance in very small data sets or in which the rate of missing data is too high. In such cases, it is better to do the second method, imputation, instead of deleting the missing values from the data set[11]. The Imputation section is also divided into categories according to the structure of the data set (for Time Series and General Models).

Different imputation options according to these categories are visualized visualized in Figure'1[1].

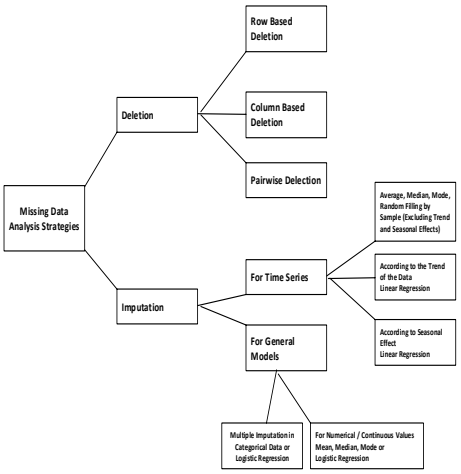

Fig. 1. Missing Data Analysis Strategies

In this study, classification estimation has been made by using machine learning algorithms on complete and filled incomplete data sets with different ratios. Stroke data set, which is a real data set, was used in the study The classification process consists of four stages. First stage; Classification was made using machine learning algorithms over the full data set. In the second stage; From the full dataset, artificial datasets based on the MCAR mechanism with different missing values were produced. In the third stage; The new data sets with missing values were filled with different imputation methods (statistical and machine learning models) and classification prediction was made using machine learning algorithms. In the last stage; Based on the complete data set, the performance of the classification performances was compared with the missing data sets imputed. The prominent features of the study can be expressed as follows;

- Examining the structure of Stroke data, which is a real dataset,
- Determining the effect of machine learning models on classification estimation,
- Generation of new data sets containing missing values at different rates from the full data set with the MCAR mechanism,
- The missing values in the newly produced data sets (artificial data sets) are completed with different imputation options and classification prediction is made,
- It is the comparison of classification performance of new imputed data sets based on full data sets.

In the second part, the studies in the literature were examined. The classification results of the studies were discussed by giving information about the different data sets and methods used in the studies. In the third chapter, technical information about the Stroke data set used in the study has been given and the data set has been examined. In addition, in this section, the missing data mechanisms used while generating the missing data and the machine learning models used in classification are also mentioned. In the fourth chapter, the results of the application are given, discussions are made and the advantages and disadvantages of the study are emphasized. In the last part of the study, the results were examined in general.

II. RELATED STUDIES

In this section, classification estimation studies based on the performance of imputation methods in missing data analysis in the literature are presented. Different data sets and methods used in the study were examined and the performance criteria of the classifiers were taken into account. In the study conducted to measure the amount of missing data affecting the classification results [12]; They classified the data sets with 0%, 10%, 20% and 30% missing data by Nearest Neighbor Method, Discriminant Analysis and Bayes Method. While the analyzes performed on datasets with more than two variables and missing data up to 20%-30% yielded productive results, they said that in cases with more than two variables, 10%-20% missing data could create problems. In another study[13]; It evaluates how the choice of different imputation methods affects the performance of classifiers used in conjunction with data obtained by post-imputation. Here, based on discrete data, five single imputation methods (Average method, Hot Deck method, Naive-Bayes method,...), a multiple imputation method (a Polytomous Regression Based method) and six popular classifiers (RIPPER, C4.5, K-Nearest Neighbor, Support Vector Machine with Polynomial and RBF Cores and Naive-Bayes) was applied on 15 data sets. This experimental study demonstrates that imputation with the tested methods improves classification accuracy on average compared to classification with non-imputated datasets. Although the results show that there is no universally best imputation method, the Naive-Bayes assignment has been shown to yield the best results for the RIPPER classifier for datasets with large amounts of missing data (i.e. 40% and 50%). Multiple regression imputation has been shown to be the best for the Support Vector Machine classifier with a Polynomial Core, and the implementation of the imputation framework has been shown to be superior for the RBF kernel and the K-Nearest Neighbor Support Vector Machine. Analysis of imputation methods due to varying amounts of missing data (i.e. between 5% and 50%) shows that all imputation methods except mean vs imputation improve classification error for data with more than 10% of missing data Finally, some classifiers such as C4.5 and Naive-Bayes have been found not to be data resistant, meaning they can produce accurate classification in the presence of missing data, whereas other classifiers such as K-Nearest Neighbor, SVMs, and RIPPER also benefit from this. In the study [14], its use for multiple imputation was demonstrated using the Approximate Bayesian Boostrap method. In the study[15], the propensity score was used as a method to scale down the variables so that imputation could be made by matching.Among the methods used to overcome the missing data problem in these last two studies, the advantages of the propensity score over other methods were revealed. In the study[16], the researcher revealed the differences between missing data structures and missing data mechanisms by conveying the importance and necessity of missing data and the stages he went through from past to present.. With the first application, the distribution of missing data mechanisms was visualized and the difference between them was made more understandable In the second part of the application, certain percentages of missing data were created over the obtained random data set and the results of different imputation methods on these data sets were examined It has been observed that imputation with model-based methods gives better results. In addition, it was observed that classical methods such as averaging and regression obtained results close to model-based methods in case of low missing data. As

a result, among the selected methods, it has been observed that TDA and multiple imputation methods give the best results for cases with low missing data, and multiple imputation methods for cases with high missing data.

III. MATERIALS AND METHODS

A. Stroke Dataset

In this study, the stroke data set was used. According to the World Health Organization (WHO), Stroke is the second leading cause of death globally and is responsible for approximately 11% of total deaths. Each row in the data set provides relevant information about the patient (from a total of 5110 people)[17]. While creating the data set, rows with missing values in the original data set were not taken into account in order to create synthetic missing data. Machine Learning models were used to predict whether a patient is likely to have a stroke based on 10 different input parameters such as gender, age, various diseases and smoking status from a total of 3426 people. More detailed information about the Stroke dataset used in the study can be found in[17].

B. Machine Learning Models

Machine Learning, a sub-discipline of Artificial Intelligence; It is the computer modeling of systems that make predictions by making inferences from the data with mathematical and statistical operations. Machine Learning has many methodologies and algorithms. According to the learning style; It is classified into three main groups as Supervised, Unsupervised and Reinforced Learning. In the Supervised Learning technique, a function is created that makes a mapping between the input values (marked data) and the desired output values. Training data consists of both inputs and outputs. This function can be determined by classification or regression (curve fitting) algorithms. If the outputs in the data set are categorical, classification algorithms are used, and if they are numerical, regression algorithms are used[18]. The mainstay of Machine Learning is to create algorithms that can take input data and use statistical analysis to predict an output while updating the outputs as new data emerges[19]. Machine learning is mostly used for classification, recognition and detection processes[20]. With machine learning, studies can be carried out in various fields, especially classification[20,21], clustering[22,23], risk analysis[24], data analytics[25]. The results of these studies have shown that machine learning models are effective and successful.

In this study, various machine learning models were used primarily to predict whether a patient is likely to have a stroke in the full data set (Stroke data set). Then, missing datasets were produced artificially at seven different rates with the MCAR mechanism. Missing datasets produced artificially at different rates were filled using six different imputation methods. Various machine learning models applied to the full dataset were applied to these completed new datasets and classification prediction analysis was made whether a patient is likely to have a stroke. The results were compared based on the results of the full data set Machine learning models used in the study; Logistic Regression, K-Nearest Neighbor, Support Vector Mechanisms, Bayesian Principal Component Analysis, Decision Trees, and Random Forests.

Logistic Regression (LR), is a classification algorithm used to assign observations to a separate set of classes LR transforms its output using the logistic sigmoid function to return a probability value. There are two types (eg Tumor Malignant or Benign) or more than two classes (eg Cats, dogs or Sheep)[26].

K-Nearest Neighbor (KNN), is an algorithm in which the proximity of the new individual to be classified to k in previous individuals is checked. During classification, test samples are compared with each other with training samples. Euclidean, Manhattan and Minkowski distance functions are used for neighborhood distance Estimates are based on a majority vote of neighboring samples. Care should be taken as it tends to over-comply with high k values [27].

Support Vector Machines (SVM), is an algorithm capable of defining nonlinear decision boundaries in high-dimensional variable space by solving the quadratic optimization problem. Basic SVM theory states that for a nonlinearly separable dataset containing scores from two classes, there are an infinite number of lines dividing the classes. The selection of a line that best separates the two classes (i.e. the decision boundary) is accomplished using a subset of only training samples known as support vectors. The maximum boundary distance between support vectors is taken to represent the optimal decision boundary. For problems where classes cannot be parsed linearly, SVM uses an implicit conversion of input variables using the kernel function. Kernel functions allow SVM to separate nonlinear separable support vectors using a linear plane. In most applications, it is necessary to select an appropriate kernel function and kernel width to optimize performance [28,29].

Naive Bayes (NB), is a supervised machine learning algorithm that predicts class condition probabilities unbiasedly, assuming that the inputs are independent of each other for a given class. NB reduces the problem of separator classes to find classes conditionally marginal densities, representing the probability that a given sample is one of the possible target classes. NB performs well against other algorithms unless they contain correlated inputs[30].

Decision Trees(DR) algorithm, a tree structure is created. At the level of the leaves of the tree, class labels, branches leading to the leaves and exiting from the beginning, and features are also indicated. In addition, the operations on it are expressed and the random forests algorithm is also derived from this algorithm. Nümerik ve It is a simple algorithm that can be used for processing numerical and categorical data and in terms of understanding and interpreting[31].

Finally, **Random Forests (RF)**, is an algorithm that increases the classification rate by generating more than one decision tree during the classification process. Randomly selected decision trees come together to form the decision forest. It produces more accurate results than Support Vector Machines for many data sets. It gives good results in datasets that contain categorical variables with a large number of variables and class labels, have missing data or exhibit an unbalanced distribution[31].

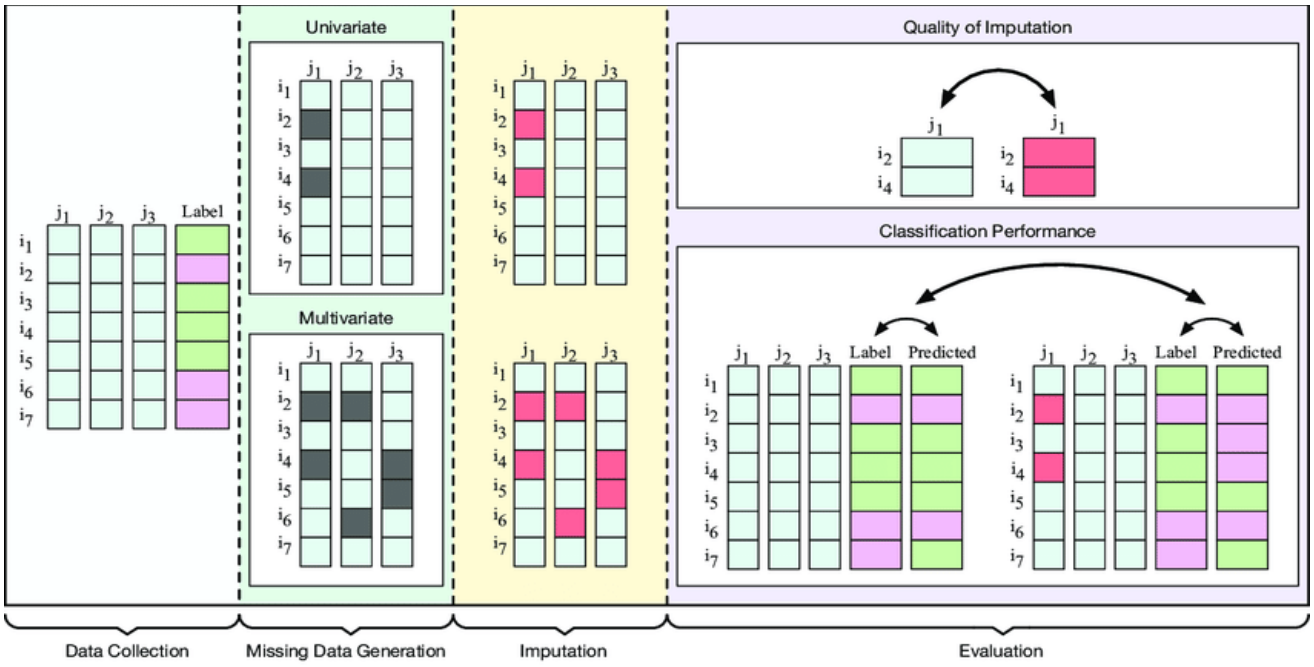

Fig. 2. Flow Chart of the Study

C. *Missing Data Types*

Missing data can potentially significantly impair performance in the analysis, interpretation, and validity of results[33]. Missing data; It is problematic because of the risk of bias, which depends on the type of missing data, the size of the missing data, and the way in which analyzes deal with missing data[34]. Missing data is generally divided into three types; Missing at Random - MAR, Missing Completely at Random - MCAR and Missing not at Random - MNAR mechanism[4,35]. If the loss does not depend on the data values themselves, then it is called MCAR. If it depends only on observed data, if the data itself is missing, it is called MAR. When lossy is independent of the missing data portion, it is said to be negligible. When the loss mechanism is MCAR or MAR, missing parts are ignored to overcome uncertainty due to loss. Only observed values are used or missing parts are fulfilled using imputation methods On the other hand, if the data belongs to a non-negligible MNAR mechanism, the loss is due to the missing values themselves and is no longer considered random. If the missing mechanism is related to the value of the variable itself, the missing is said to be non-random. This means that apart from the observed portion, there is additional information in the deficiency that cannot be ignored. Therefore, the distribution of the response and deficiency mechanism should be modeled together[36]. Loss can cause a bias on the inference of parameters. There are several methods available to solve this problem. The decision on which method to use is determined by the reason behind the missing data generation Knowledge of the missing data mechanism is important in choosing the appropriate missing data processing method. Relevant information can be collected by asking correct questions such as why the data is missing, whether it is randomly missing or not, and whether there is a specific reason for the data[37]. In this study, artificially produced missing data sets at seven different rates (5%, 15%, 25%, 35%, 45%, 60% and 80%) with the MCAR mechanism were tried to be filled with six different machine learning methods.

D. *Imputation Methods:*

There are many imputation methods according to the missing mechanism and the nature of the data. However, as shown in Figure 3, it can be basically categorized as single and multiple imputation methods[38]. Imputation of mixed datasets (that is, data with both nominal and categorical variables) is often a major challenge.

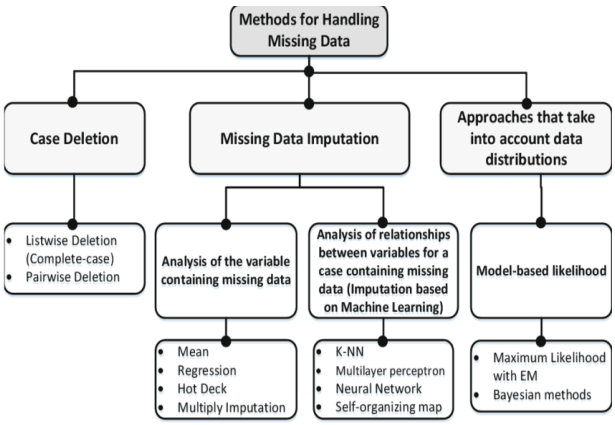

Fig. 3. Key Techniques for Dealing with Missing Data

For such reasons, there is great interest in using machine learning methods for missing data imputation[39]. In this study, there are new data sets containing artificial values subtracted at different rates on the Inme data set, which is a mixed data set. These new data sets; Imputation has been attempted by using methods such as Mean, Regression, k-Nearest Neighbor, Support Vector Mechanisms and Bayesian Principal Component Analysis, Decision Trees. Filling the missing data using the arithmetic mean value calculated from the complete data in the data set is called imputation with the mean and is based on the work of Wilks (1932)[40]. This method ensures that the sample size is maintained, but the variability of the data is reduced. Therefore, variance and standard error will be underestimated. Also, inferences for

parameters of interest may be biased, especially if the missing mechanism is defined as MAR or MNAR[41-42]. Imputation by regression is a method in which missing values are replaced with estimated values obtained from a regression model or a predictive distribution from available data [36-41]. Here, the predictions are based on the regression model, this imputation highly correlates with the regression model. Although this method also reduces the bias of the estimates, it may cause underestimated variance and standard error. Stochastic regression models are suggested to reduce the correlations of complements by adding residual terms equal to the residual variance of the estimated value, zero in the mean, and the variance and normally distributed residual terms in the regression model. This addition adds randomness to completions and reduces correlations, but the standard error is underestimated[41]. The KNN algorithm is the basis of the k-nearest neighbor (KNN) missing value assignment method. In this algorithm; One of the observations in an observation is obtained by calculating the distance of each observation according to a particular observation value and selecting the smallest k observations [43]. In the imputation algorithm with KNN, different functions have been determined for distance calculations. Examples include Euclidean (Euclidean), Manhattan, and Minkowski distance functions. This is the most common Euclidean distance function in distance functions. Where the dataset contains more than two variables, the standard Euclidean distance function is used[44]. Each variable is standardized by applying the z transform. Thus, the measurement differences between the variables are eliminated. When setting up this algorithm, attention should be paid to the choice of k value. If the neighborhood value is a small number, a deterioration in the estimation performance of the imputation method may occur due to overemphasis of dominant observations. On the other hand, a large neighborhood value can lead to observations that are quite different from the missing-valued observation in the estimation process and will produce inconsistent values as a result[45]. Imputation with a Support Vector Machine (SVM) is an algorithm based on SVM regression to complete missing data. While doing this, it accepts outputs or classes as inputs and inputs as outputs or classes, thus trying to predict data belonging to inputs with missing data[46]. Handling of missing data can also be accomplished using probabilistic principles. To address the shortfall[36,37,47], probability functions are used for observed or complete data with some specific model assumptions. These methods can be based on both Maximum Likelihood (ML) and Bayesian Approach. In Bayesian Methods, which is one of the multiple imputation methods; the posterior distributions for the relevant parameters can be obtained by combining probabilistic priorities for the unknown parameters[36]. Imputation with the Naive Bayes method is a simple probability classifier based on Bayesian decision theory. Probabilities are calculated for each class, and for each sample there is a tendency to find the highest probability. Good performance, simple structure, high computational speed and insensitivity to missing data make this method popular[48]. Imputation with Decision Trees; Based on the incomplete data, the conditional distribution is determined by CHAID(categorical) or CART(quantitative) methods and the appropriate mean imputation method is applied[49].

IV. RESULTS

Stroke data set was used as the full data set in the research Then, based on the MCAR mechanism, new artificial missing datasets were produced at 7 different rates(5%, 15%, 25%, 35%, 45%, 60% and 80%) based on this full data set. These newly created artificial missing data sets were filled with different imputation methods (Mean, Regression, k-Nearest Neighbor, Support Vector Mechanisms, Bayesian Principal Component Analysis and Decision Trees) and classified. Classification results were analyzed based on the classification results in the full data set. Using machine learning models (LR, KNN, DVM, NB, KA, RF) on the full data set, two-class classification (whether a patient is likely to have a stroke) was classified. At the same time, for the imputation of missing data in artificially produced missing data sets, statistical (mean and regression) and machine learning methods (KNN, DVM, NB, KA) were used to complete. The performances of the classifiers were determined by a single accuracy matrix The same parameters are used for each machine learning model in the complete and filled missing data sets. 80% of the data was evaluated for educational purposes while the remaining 20% was used for testing purposes. In Table 1, the results are given.

TABLE III. SUCCESS PERFORMANCES OF CLASSİFERS

Classification Methods	Full Data Set	Missing Data Imputation Methods	Data Completion Achievements to Missing Rates						
			%5	%15	%25	%35	%45	%60	%80
Logistic Regression Classification (LR)	**0.95**	Mean	%95	%95	%95	%95	%95	%95	%95
		Regression	%95	%95	%95	%95	%95	%95	%95
		KNN	%95	%95	%95	%95	%95	%95	%95
		SVM	%95	%95	%95	%95	%95	%95	%95
		NB	%95	%95	%95	%95	%95	%95	%95
		DT	%95	%95	%95	%95	%95	%95	%95
k-Nearest Neighbor Classification (KNN)	**0.94**	Mean	%94	%94	%94	%95	%94	%95	%95
		Regression	%94	%94	%94	%95	%94	%95	%96
		KNN	%94	%94	%95	%95	%95	%94	%95
		SVM	%94	%94	%94	%94	%95	%94	%96
		NB	%94	%94	%95	%95	%95	%94	%95
		DT	%94	%94	%94	%95	%94	%94	%95
Support Vector Machines Classification (SVM)	**0.95**	Mean	%95	%95	%94	%95	%95	%95	%95
		Regression	%95	%95	%94	%95	%95	%95	%95
		KNN	%95	%95	%95	%95	%95	%95	%95
		SVM	%95	%95	%95	%95	%95	%95	%95
		NB	%95	%95	%95	%95	%95	%95	%95
		DT	%95	%95	%95	%95	%95	%95	%95
Naive Bayes Classification (NB)	**0.95**	Mean	%94	%95	%95	%95	%95	%94	%94
		Regression	%94	%95	%95	%95	%94	%94	%95
		KNN	%94	%95	%95	%95	%95	%95	%94
		SVM	%94	%95	%95	%95	%94	%94	%94
		NB	%94	%95	%95	%95	%94	%94	%95
		DT	%95	%95	%95	%95	%94	%94	%94
Decision Trees Classification (DT)	**0.91**	Mean	%91	%93	%91	%95	%91	%93	%93
		Regression	%91	%92	%91	%93	%93	%94	%94
		KNN	%91	%92	%92	%91	%91	%90	%91
		SVM	%92	%92	%91	%95	%92	%90	%93
		NB	%92	%92	%92	%94	%92	%90	%93
		DT	%91	%92	%92	%94	%91	%91	%90
Random Forests Classification (RF)	**0.97**	Mean	%95	%95	%95	%95	%95	%95	%95
		Regression	%95	%95	%95	%95	%96	%95	%97
		KNN	%95	%95	%95	%95	%95	%95	%95
		SVM	%95	%95	%95	%96	%96	%95	%95
		NB	%95	%95	%95	%95	%96	%95	%95
		DT	%95	%95	%96	%95	%95	%95	%97

When the results in Table 1 are examined, it is seen that each machine learning model in binary class classification on the full data set performs over 90%. The highest accuracy score with 97% was obtained with the Random Forests model. For the binary class classification process, the lowest Decision Tree model was obtained and the accuracy score was calculated as 91%. On the other hand, it has been observed that the imputation methods made with statistical and machine learning models in artificially produced missing data sets at different rates produce results equivalent to the full data set in binary class classification performances. In all methods, successful accuracy was obtained both on the complete data set and on the problems on the complete datasets with different ratios of missing data. It has been seen that the Random Forests model provides better performance both in the classification process and in imputation methods compared to other machine learning models The results obtained confirm this.

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Real-Time Bicycle Detection with Deep Learning Network Using TensorFlow

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***Abstract*— Cameras are the eyes of computers opening to the outside. As the usage areas of computers and cameras become widespread, introducing images to the computer has become an important issue. Essentially, images recognized by computers need to be transformed into intelligible digital data for interpretation, and this is one of the problems of machine learning researchers. Fast introducing and interpreting the object to the computer in real time is seen as an important advantage in automation and robotics applications.**
In this study aimed to solve the object detection problem using deep learning. The bicycle object has been detected on the Coco data set and the MobileNet model has been preferred for these processes. In order to detect objects from real-time camera images with deep learning, TensorFlow Library and Convolutional Neural Network (CNN) have been used. Since this study has been performed using Raspberry Pi controller, it can be integrated into any system and detect real-time objects.

Keywords—machine learning, convolutional neural network, TensorFlow

I. INTRODUCTION

Machine learning, which is a sub-discipline of artificial intelligence, is a rapidly developing field that is formed on the problem of understanding human as a machine. It provides solutions to many problems today by minimizing human intervention and enabling computers to make decisions [1]. Machine learning is used in many fields such as industrial, military, health, entertainment and has a growing interest lately.

Daş et al. have been performed object detection and tracking system on videos and images using region-based convolutional neural network (R-CNN) with Tensorflow which is one of the deep learning libraries. While preparing the data set, LabelImg program has been used for labeling the images and they have been achieved 98% success rate on this model [2]. Visalatchi et al. have been tried the methods that used in deep learning and object detection on the same data set, and compared the average sensitivity values. In their study, Faster R-CNN, YOLO v2, YOLO v3 and SSD methods were trained on the COCO data set, and average sensitivity values have been obtained. As a result of the trainings carried out, the highest sensitivity value has been calculated at the rate of 79.1% with the YOLOv3 method [3]. Karahan and Akgül have been designed an artificial neural network using 66000 images from Caffe library to detect an eye. This designed network was tested with images from FDDB and CACD data sets, and it has been compared with the Haar method. As a result, it has been determined that the association value is better than the Haar method [4]. Kılıç and Aydın, have been studied on license plate recognition using deep learning and CNN. Researchers have been used Keras and TensorFlow libraries and they prepared the data set using real images taken from the security cameras of Fırat University. The accuracy rate in the test images of the study was 88.76%, while the test result based on plate recognition was 99.31% [5]. Kai and Xiaozhi have been proposed a new detection system in order to determine whether the personnel were wearing safety helmets in the transformer substations. They used TensorFlow library to identify pedestrians and analyze the detected pedestrian head-to-body ratio, and HSV color space transformation to detect safety helmets. The rate of recognizing wearing a helmet of this system has been measured as 89%. Also it has been found to be 1.6% higher compared to other helmet recognition methods [6].

When these studies are examined, it has been seen that the TensorFlow library is frequently used in applications on the object detection problem and gives high accuracy results. In addition, the popularity graph of the words 'TensorFlow' and 'Object Detection' in the last 5 years with the data obtained from Google Trends has been shown in Fig 1. When this graph is examined, it has been seen that object detection studies have experienced a stable trend between 2016-2021.

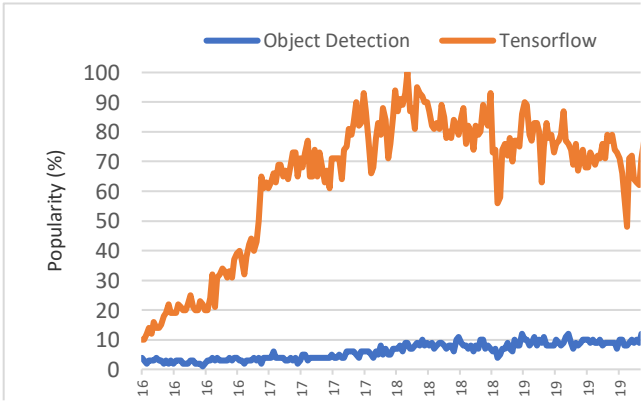

Fig. 1. Google Trends on keywords 'Object Detection' and 'TensorFlow' [7]

In this study, the bicycle object detection was carried out using the MobileNet model, which was trained with the TensorFlow library and MS COCO data set.

II. METHODOLOGY

Today, although there are many methods for detecting an object on any image, the basis of these methods is the use of visual attributes and motion information. While the methods in which these attributes and motion information are used together give more accurate results, there are also methods in which the processing load is less when used separately. While choosing the most commonly used temporary variables and optical flow methods in object detection, processing load and performance are taken into consideration. [8].

A. *Data Set*

When detecting objects, one of the most important factors affecting the success of the model is the quality of the data set. As the size of the images selected for the data set increases, the training time of the network increases, and the number of pictures positively affects the sensitivity of the network. In this study, MS COCO dataset which is reflecting scenes from daily life and licensed under the name of 'Creative Commons Attribution 4.0' was used. This data set, which contains natural images, consists of 91 separate object categories and 164,000 images segmented by labeling.

Fig. 2. Sample images of MS COCO data set [9]

In Fig 2, some of the bike images in the MS COCO data set and used in this study have been shown. The reason of using this dataset is that it contains natural images with mixed backgrounds compared to other datasets.

B. *Convolutional Neural Networks*

Convolutional neural networks, which are widely used in object recognition problems, are computer programs created by imitating biological neural networks. The widespread use of convolutional neural networks enables the use of large data sets, increase in computational power and development of regulation techniques. [10]. Convolutional neural networks have a structure that progresses in layers and as shown in Fig 3, the output of the previous layer constitutes the input of the next layer. While this structure solves the object recognition problem, it first identifies curves and edges on image, then more characteristic features, as the human brain does.

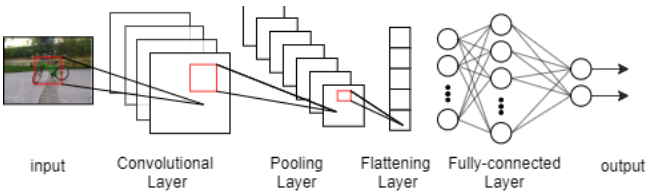

Fig. 3. The structure of a convolutional neural network

Convolutional neural networks, which have a layered structure, have 5 basic layers;

- Convolutional Layer

The first layer of a convolutional neural network is the convolutional layer where the properties of the image are basically perceived. It is aimed to reduce the noise of the image by making certain filtering processes on the image. The filtering process is important for the detection of the object. Convolutional neural networks consisting of a feature map for each filter can have more than one convolutional layer.

- Activation Layer

Activation layer is the layer where Relu function is applied to solve the linearity problem in the image. Although other nonlinear functions have been tried for this layer, the Relu function gives the best result in terms of training speed.

- Pooling Layer

Pooling layer is the layer in which the number of parameters and complexity of the model are reduced. This layer is based on taking only the highest pixel in the dimensions determined on the pixels of the image using the Max Pooling method. With this process, the complexity and processing load in the next layers will be reduced as the dimensions of the image are also reduced. In addition, the pooling layer also reduces the over fitting problems that create problems for any artificial neural network.

- Flattening layer

It is the layer where the data becomes a 1-dimensional array while transferring it to the next layer.

- Fully connected layer

Fully-connected Layer is the layer in which all layers are connected to each other.

C. *TensorFlow*

TensorFlow, an opensource library, is widely used in artificial neural networks research, developing deep learning algorithms, and machine learning projects. TensorFlow, an open access library where models trained on various data sets are shared, provides powerful APIs for developers to create their own models. It is very easy to make changes to source codes, as it does not require high system requirements and the source codes are accessible to everyone. [11]. Considering these features, TensorFlow library has been chosen for this study. In addition, the Keras library licensed by 'MIT License' that works with TensorFlow is also used. [12].

D. *SSD MobileNet (Single shot MultiBox Detector)*

SSD is an artificial neural network architecture that can recognize objects in one shot and has a feed-forward convolutional neural network structure. While the SSD model is running, first the input picture is passed through the convolutional neural network and the feature maps are created in different sizes. After the filtering process applied to the feature maps, both the boundaries and the classified object are predicted for each boundary box. Feature maps have been selected at different scales to increase accuracy in these predictions. In MobileNet architecture, deep wise separable convolution process has been used due to the limitation of model size and extraction time. [10]. During the training of the network, the correct boxes are compared with the predicted boxes. Boundary boxes with the best predicted and a ratio above 0.5 are labeled as positive. [13]. Since SSD MobileNet architecture can detect an object in one shot, it can detect objects quickly on low-end devices.

In this study, the SSD MobileNet network was not retrained. The SSDLite Mobilenet v2 model was used, which was shared open to use and trained on MS COCO dataset.

III. EXPERIMENTAL WORK

In this study, Raspberry Pi 4B 2Gb ram microprocessor and V2 raspberry pi camera module have been used as

hardware. During the experimental study, the bicycle object has been recognized on the image in real time. The pre-trained model has been detected the bicycle object on the acquired image with 99% accuracy.

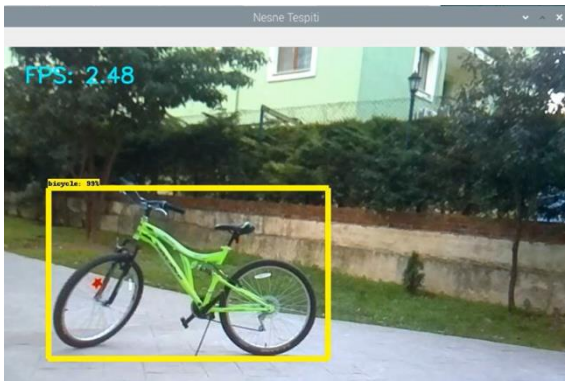

Fig. 4. Detecting the bicycle object

In Fig 4, when there is one bicycle in the image, the object has been detected and it is included in a contour showing the accuracy rate in the upper left corner..

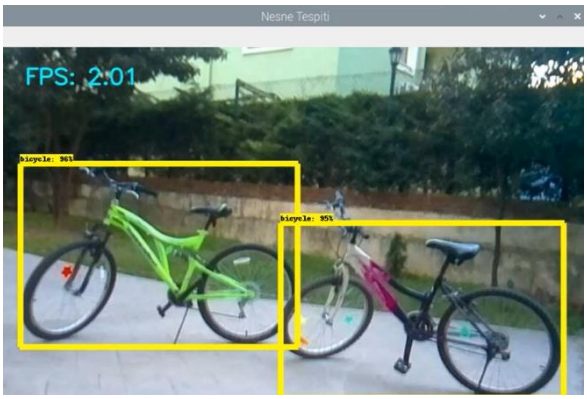

Fig. 5. Multiple bicycle object detection

When the number of objects expected to be detected more than one, in Fig 5, the accuracy rates were found to be 96% and 95%. The time taken for real-time detection of objects ranges from about 2 to 3 per second per frame.

IV. RESULTS

In this study, convolutional neural networks based object recognition process has been performed. MS COCO dataset with 91 object categories has been tested in a pre-trained model and high accuracy results were obtained on the bicycle object.

In future studies, it is aimed to perform a physical operation with any movement element after the system recognizes the object. After deciding what the object is, robotic applications that can perform operations such as selecting, tracking, sorting, and eliminating will take the study further.

ACKNOWLEDGMENT

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An Evaluation Of The Benefits And Problems Of The Use Of Artificial Intelligence (AI) In Human Resources Management (HRM)

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***Abstract*—In the contemporary world, good and high-quality businesses are founded by successful and eager employees. Moreover, the foundation of the performance, as well as the talents of employees, rests on human resources management. HRM prepares employee profiles and the development of enterprises. Considering the technological developments in the business world, HRM is an area where the use of improving technologies faces the slowest progress, even though artificial intelligence technology is being used in almost every sector today [15]. The reason is that HRM practices include a relationship-oriented approach, and the business execution and management aspect of it is carried out through human relations. In the rapidly changing contemporary world, a short glance at the HRM departments in enterprises indicates that they look favorably on the use of the advanced technology of AI, are assertive in adopting this technology, and intend to use it effectively [16]. In the worldwide studies on the use of artificial intelligence technology in HRM by enterprises, it was predicted that the rate at which this technology is used in HRM would be over 40% by 2022, but it will entail problems [1,2,3,4,5]. This study aims to evaluate the benefits and problems of AI technologies used in HRM in the context of the future of HRM.**

Keywords—Human Resources Management (HRM), Artificial Intelligence (AI), Benefits and Problems

I. INTRODUCTION

The sense of discovery and curiosity existing in human beings has constituted the basis for the developments for centuries. Human beings strive to create machines capable of acting and thinking like them on the one hand, and they try to understand and learn about the nature of the structure of themselves. Even today, both life science and social science investigate the mysteries of human intelligence and reasoning. With the combination of research and developments in technology, "Artificial Intelligence" has emerged as a key to the new technological era that would change the face of known management processes. This study tries to explain the benefits and the problems of using AI technologies in HRM.

II. CONCEPTUAL FRAMEWORK

With the rapidly developing technology, we are living in a new era characterized by such various titles as the second machine age, digital age, artificial intelligence age, and industry 4.0, and this is an era of transformation, especially with the developments in the field of artificial intelligence occurring at a dizzying pace. The transformation process, which has turned to a necessity in all areas of life in adapting to such extraordinary developments in technology, especially proved to have a rapid and powerful impact on business life. It is observed that the enterprises have put Human Resources Management (HRM) in a key position - to play a role in this changing process in the business world, to maintain their existence in the intensely competitive environment, and to recruit, train and maintain good talents - and they have gravitated towards to the use of artificial intelligence technology to carry out these functions in a healthier way. The concept of Artificial Intelligence (AI) was first used in 1950 in the famous article, "Computing Machinery and Intelligence" by the British mathematician and computer scientist Alan Mathison Turing, who is considered to be one of the pioneers in the field of modern computers and informatics [6]. However, "artificial intelligence" emerged in 1955 in the proposals of John McCarthy et al., a team of American computer and informatics scientists, prepared as a summer project of Dartmouth University in 1956 in Hannover, New Hampshire, USA [7, 8, 9]. An examination of the basis of AI shows that it is based on philosophy, mathematics, psychology, language, and computer science. Therefore, since AI is an interdisciplinary science, different definitions and approaches are found in the literature. In its most general sense, AI is defined as the ability of a particular computer or a computer-controlled machine to fulfill very high-level mental responsibilities, usually attributed to humans. Such responsibilities include reasoning, making sense, generalizing, and learning from past experiences [10]. Kaplan and Haenlein (2019) define artificial intelligence as a "system's ability to correctly interpret external data, learn from such data, and use those learnings to achieve specific goals and tasks through flexible adaptation" [11]. Human is the most fundamental resource of a successful enterprise. The ability of enterprises to achieve their future goals, ensure the continuity of their current success, and have a competitive advantage depends on the effective management of human resources. Human Resources Management (HRM) can generally be defined as the set of tasks and activities performed in human resources of organizations at an organizational and environmental level to effectively achieve organizational goals [12]. In other words, HRM is the implementation of plans, programs, and strategies to find, motivate, develop, reward, and maintain the needed human labor in the best possible way in line with the goals and objectives of an organization [13]. HRM is aimed at employing, training, and developing a sufficient number of employees and evaluating them to perform the functions necessary to achieve the organizational goals [14].

III. Artificial Intelligence And Human Resources Management

As we look at the issue of using AI technology from enterprises' viewpoint, HRM is regarded as one of the departments that would be affected the most by this technological change [15]. The reason is that HRM does not sufficiently benefit from technology alongside its existing functions (job analysis and job description, recruiting and selection, performance evaluation, etc.). However, when we look at the HRM units of contemporary enterprises, we see that they look favorably on adopting the advanced technology of artificial intelligence and want to use it effectively [16]. HRM plays two main roles in these developments and advances in technology. The first is to determine how this progress and development will be transferred to the department's dynamics and functions, and the second is to determine how the enterprise as a whole will be affected by this progress and what can be done in terms of compliance. As every institution carries out its existing activities under certain conditions in a specific environment, any change in this environment and conditions affects the institution. Such conditions include (but are not limited to) government policies, globalization phenomena, and technological innovations. However, technological innovations are considered the fastest-changing factor in terms of the environment and conditions and can directly affect an organization's functions. Today, known as the digital age, artificial intelligence consists of redesigning the functions of enterprises. Therefore, HRM should also reshape its current plans according to these functions redesigned by artificial intelligence [17].

Although there are many benefits provided by AI used by HRM, there are some problems brought about by this technology. These are provided in the table below [18,19,20,21,22,23,24,25].

TABLE I. Benefits And Problems Of Ai On Hrm

Benefits	Problems
1. It saves time by increasing the speed and efficiency of workflows and their execution, increasing at the same time the quality of the work done.	1. The fact that AI technology lacks the advantage of intuitive information makes it difficult for people to trust this technology.
2. Recruitment process, pricing, etc. It ensures that the costs resulting from HRM functions can be accurately determined.	2. Finding the right talent in their field by using AI is a difficult and costly process for HRM.
3. It ensures that the tasks are completed with the least error rate by minimizing the occasional errors caused by people's lack of attention.	3. With the active use of AI technology, companies' dependence on manpower will decrease over time, leading to unemployment.
4. AI provides HR managers with important information about improving competitiveness and productivity in light of its successful labor turnover estimations.	4. The lack of sufficient human resources to meet the update, inspection, and maintenance process needs of AI technology and the high costs of these processes create concern for enterprises about using this technology.
5. Utilizing AI technology in recruitment processes causes both enterprises to choose the right talent and the candidates to choose the most suitable business life for them.	5. There is a high chance for a performance drop with this technology since HR cannot produce as much data as other fields, requiring a large amount of data.
6. AI ensures being more objective and transparent by preventing negative situations such as prejudice and nepotism in recruitment processes.	6. As it comes to HR, there are sociological, psychological, and other factors in addition to the numerical data, making the process more complex and this technology insufficient.
7. It enables creating a competitive environment among the candidates under equal conditions and enables the enterprises to show a more professional image.	7. The possibility that this technology can be developed by people who are biased and ignore the principle of equality leads to such issues as ethics, justice, and the privacy of private life to be questioned again. This creates a concern that this technology may be a misleading and prejudiced system.
8. It enables employees to discover their talents that they cannot find in themselves.	8. As HRM makes the evaluations with the use of data, access by unauthorized persons causes concerns about the confidentiality and security of the data of both the enterprises and the employees in HRM, and puts under question the reliability of the AI technologies.
9. By using AI in the orientation process, where HRM should repeat in each new recruitment, candidates are allowed to discover the culture, structure, and workflows of the enterprise, and also time-loss is prevented in the existing workflow rates of HRM.	9. The adaptation process of technology is prolonged due to the increased concerns and fears of employees about unemployment caused by the full adoption of AI technology.
10. Using AI does not only evaluate staff productivity or the reasons for their inefficiency in performance evaluations at certain periods but also allows this to be carried out throughout the year with an unbiased perspective.	10. Although enterprises want to integrate AI into their systems, this situation causes large losses in terms of both material and time due to the insufficiency of the existing infrastructure.
11. It minimizes the mistakes that may be made due to the difficulty of wage management and payroll transactions and reduces the costs that may result from these mistakes.	11. This technology causes the HR department to restrict its decision-making process in daily life and therefore changes the authority and role of HR on the decisions taken.
12. Using AI reduces the current workload of HRM and quickly provides solutions needed by the personnel, enabling HRM and the personnel to focus their energy on higher value-added tasks.	
13. It allows the evaluation of more job applications.	
14. With AI algorithms, each employee's performance is evaluated separately, and the required training is personalized.	

AI technology, seen as the prelude of a new era and one which would change all known dynamics of both the private and business world, increasingly develops. With the use of this technology in the functions of HRM, many changes occur. Considering the effects of AI technology on society and the business world with the continuation of its development day by day, it is seen that the headings such as speed, efficiency, time-saving, increase in the speed of the work done, easy accessibility, flexibility, minimizing the error rate in the work done, improving processes and the emergence of new business lines come to the fore. Moreover, when an evaluation is made on the effects on HRM functions, it is seen that the topics such as speed, efficiency, time-saving, increase in the speed of getting the work done, easy accessibility, flexibility, minimizing the error rate in the work done, reaching the right skills faster come to the fore. In addition to this, in today's world where competition is getting more intense with each passing day, it enables companies to reach the right talents they want to incorporate, select them, and move the process more objectively. In training, considering the needs of the employees, AI applications enable personalized training to contribute to personal development at the desired place and time without any limitation of time and space and enable individuals to discover different aspects that they do not notice in themselves. Furthermore, this technology, which is used in the performance evaluations of the employees within the company, enables the evaluations to be made more objective and transparent. Especially, thanks to the "Chatbot" applications used in the continuous orientation processes of HRM, it enables new employees to adapt to the process more easily by using these applications. However, although there are many benefits provided by this technology, it is seen that there are some problems it brings with it. Especially in researches, it is seen that many managers have prejudices about adaptation during the transition to this technology. The main cause of this bias is the unpredictability of AI technology's growth, as well as the fact that it is a new technology. Besides all these problems, the lack of human resources that can perform the maintenance processes required by AI technology, it is being a costly technology, the resistance of employees who are not open to innovations to adopt this technology, and the concern that it will lead to unemployment are the problems brought by technology.

IV. CONCLUSION

Human beings are in a digital era that changes all known dynamics of both social and business life. The changes brought about by this digital era make enterprises reshape the patterns of their current business, the way they do business, and the road maps they follow in achieving their future goals. Besides, it can be observed that the use of AI in many functions of HRM has become widespread, especially in recent years. However, it is a fact that this technology is still developing and many studies are yet to be conducted on it. Therefore, considering this fact, it is seen that AI technology has many benefits in terms of HRM, but it also brings about some problems. It is anticipated that these problems will be solved in the future in line with AI technology developments, making this technology much more beneficial.

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Tooth Detection and Numbering with Instance Segmentation in Panoramic Radiographs

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***Abstract*— Deep neural networks have recently been used for detection and classification in medical imaging. Convolutional Neural Networks (CNN) is a neural network model that classifies images by processing various layers. Automatic detection of teeth in panoramic X-ray images is provided by computer-aided applications today. Panoramic radiology images, on the other hand, are frequently used by experts for diagnosis and analysis in the field of dentistry, due to the fact that they make each tooth visible by presenting a wide framed view of the mouth. Although panoramic radiology images are very important at the diagnosis stage, they may require a long time and require attention because the analysis is performed manually by a specialist. The main reason for this situation can be human errors such as fatigue, high stress level, mood changes, subjective opinion, inexperience. Aiming to reduce the workload of experts, a zone-based automatic segmentation system that segments each tooth with masks that will facilitate analysis is presented. The Mask R-CNN technique, which provides information about tooth pixels and tooth positions of interest, was used with ResNet-50 and ResNet-101 backbone networks for tooth detection and segmentation. The tooth numbering module classifies and numbering dental objects detected as a result of segmentation according to the FDI notation used universally by dentists. Designed system achieved a better result with the ResNet-101 backbone network with a precision of 96.42% and a F1-score of 93.97% for tooth numbering.**

Keywords*— *dentistry, dental images, panoramic radiography, tooth detection, tooth numbering, deep learning, instance segmentation

I. INTRODUCTION

Techniques and procedures that create visual representations of the internal functions of the body for medical imaging, medical analysis and intervention aimed at diagnosing and treating diseases. Over the past few years, medical imaging technologies such as computed tomography (CT) or X-rays have made it easier to treat and diagnose various illnesses [1]. Since the interpretation of medical images is usually done by radiology specialists and doctors, the diagnostic mechanism takes place considering human error. This situation is being replaced by computer aided applications over time. Computer-aided diagnostics (CAD) has become one of the important research topics in medical imaging and diagnostic radiology [2]. CAD helps doctors and radiologists make decisions considering the computer output. Automatic solutions that come with the processing of radiographic images, which have become an important part in image interpretation, diagnosis, monitoring of dental health and treatment planning in dentistry, help dentists as well as reduce the negative effects of time loss, stress, and fatigue in daily practice.

Dental radiographs taken using X-rays facilitate the detection of caries, bone loss and root canal problems that are not noticed during the examination. There are two radiographic methods commonly used for radiological diagnosis: a panoramic x-ray showing the entire mouth and teeth together, and a periapical x-ray with separate teeth [3]. Panoramic x-ray is a dental x-ray that is necessary for the detection of invisible formations such as cysts, caries and tumors in the jaw and teeth, where the whole mouth and teeth are seen together, allowing faster and more complete treatment planning. The periapical images contain only a few teeth.

Recently, some algorithms based on the convolutional neural network (CNN) have made significant progress in the field of computer vision. Detection algorithms based on region recommendations include R-CNN [4], Fast R-CNN [5], and Faster R-CNN [6]. Different radiographic imaging types such as bitewing, cephalometric and panoramic are used in dental imaging with these algorithms.

In object detection, the Region-based CNN (R-CNN) approach is to replace the section with a high probability of being an object [7, 8] and to evaluate convolutional networks [9]. These algorithms are widely used for medical image classification and detection. Silva et al. [10] provides a

comprehensive literature review of classical methods for separating each tooth into segmentation masks on panoramic x-rays. As a result of the study using 1500 images, it has been proved that the Mask R-CNN solution is better than the classical methods (region-based, threshold-based, cluster-based, boundary-based) used in dental images. In the study carried out by Oktay [11], after the oral cavity was determined, the identification of tooth types with classical artificial neural networks was revealed. In addition, only tooth types were determined, and no tooth numbering system was used. When later studies were examined, Tuzoff et al. [12] revealed tooth identification and numbering with Faster R-CNN. In this study, Mask R-CNN [13], an extension of the Faster R-CNN, is used for tooth segmentation, identification, and numbering after performing tooth labeling using the software designed by DentiAssist.

II. Proposed Solution

In the artificial intelligence-based analysis of the study, the Mask R-CNN network, which provides information about the location of the teeth in the area of interest and the pixels of the teeth, was used with the residual network backbone network for the detection and segmentation of the teeth.

A. Data collection

The dataset used in this study were obtained from the archive of the Karabuk Oral and Dental Health Training and Research Hospital by providing an ethics committee report from Karabuk University. The dataset consists of a total of 1030 anonymized panoramic dental images. 780 of these images constitute the train set, 150 of them constitute the validation set, and 100 of them constitute the test set, and they were randomly distributed from the dataset while creating the sets.

B. Image labeling and annotations

In this study, DentiAssist image labeling tool which is developed by the authors of this study is used. It provides tools for labeling object edges. An example of this software is shown in Fig. 1. Polygon coordinates, bounding box coordinates, ID information and tooth numbering according to Fédération Dentaire Internationale (FDI) notation are recorded in the annotations file for each image. The data set consisting of a total of 33 categories, teeth FDI number and the part considered background are labeled as BG.

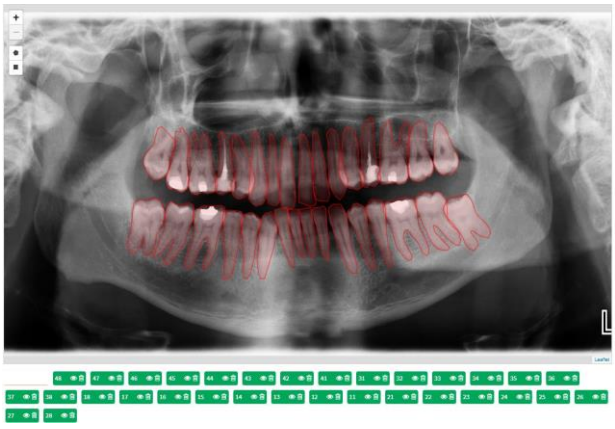

Fig. 1. Labeling a sample image in DentiAssist labeling software

There are different numbering systems commonly used by dentists. Since it is necessary to use a common notation system by gathering around a universal context, the tooth numbering system is used in images. In this study, FDI notation, which is a universal system, is used. FDI World Dental Federation is the world's leading organization representing the dentistry profession. As seen in Fig. 2, using FDI notation, the inside of the mouth is divided into four regions and numbered from the inside out.

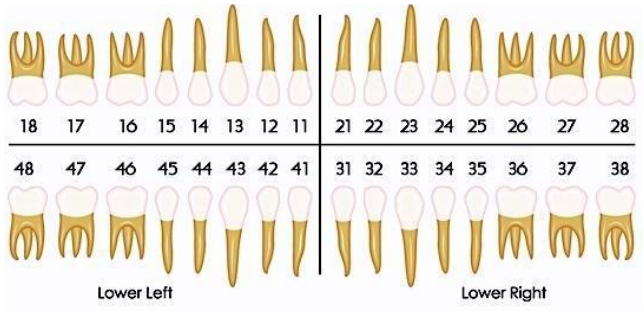

Fig. 2. FDI notation system

C. Deep network architecture details

Mask R-CNN expanded the Faster R-CNN [6] and attached a divaricate to use present detection to apply parallel prediction. Mask R-CNN performs better all single model inputs present on each mission. Mask R-CNN contains a branch of convolutional networks, a standard convolutional neural network that acts as a feature extractor to perform the sample segmentation task. As the backbone network, a network that extracts image features such as ResNet-50 and ResNet-101 has been preferred. Also, a Feature Pyramid Network (FPN) is used in the backbone network to perform multiscale detection. FPN improves the standard feature extraction pyramid by adding a second pyramid that takes high-level features from the first pyramid and transfers them to the lower layers [13].

As shown in Fig. 4, the dental objects that exist in the panoramic dental radiography are passed through the two-step RPN network. The features of the tooth images from the residual backbone network are sent to the pooling layer by mapping. The overlap boxes are scanned according to non-maximum suppression (NMS). Regions containing objects are divided into anchors with a certain threshold value with the anchor-based approach contained in the model. The maximum values in the pooling layer are selected to the CNN.

As a result of the network, the bounding box and mask per area of the relevant region in the images are formed. Thus, the specific objects to be identified are in the bounding boxes with segmentation masks of their own classes as shown in Fig. 3.

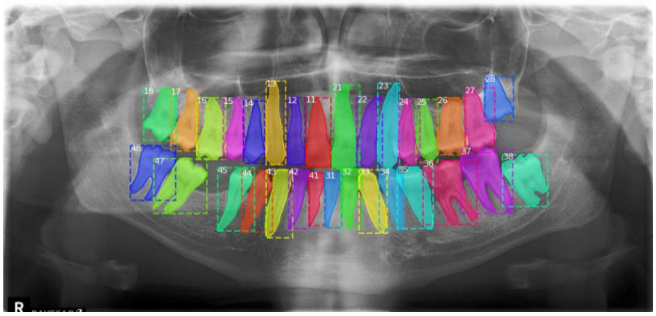

Fig. 3. Ground-truth of a sample image

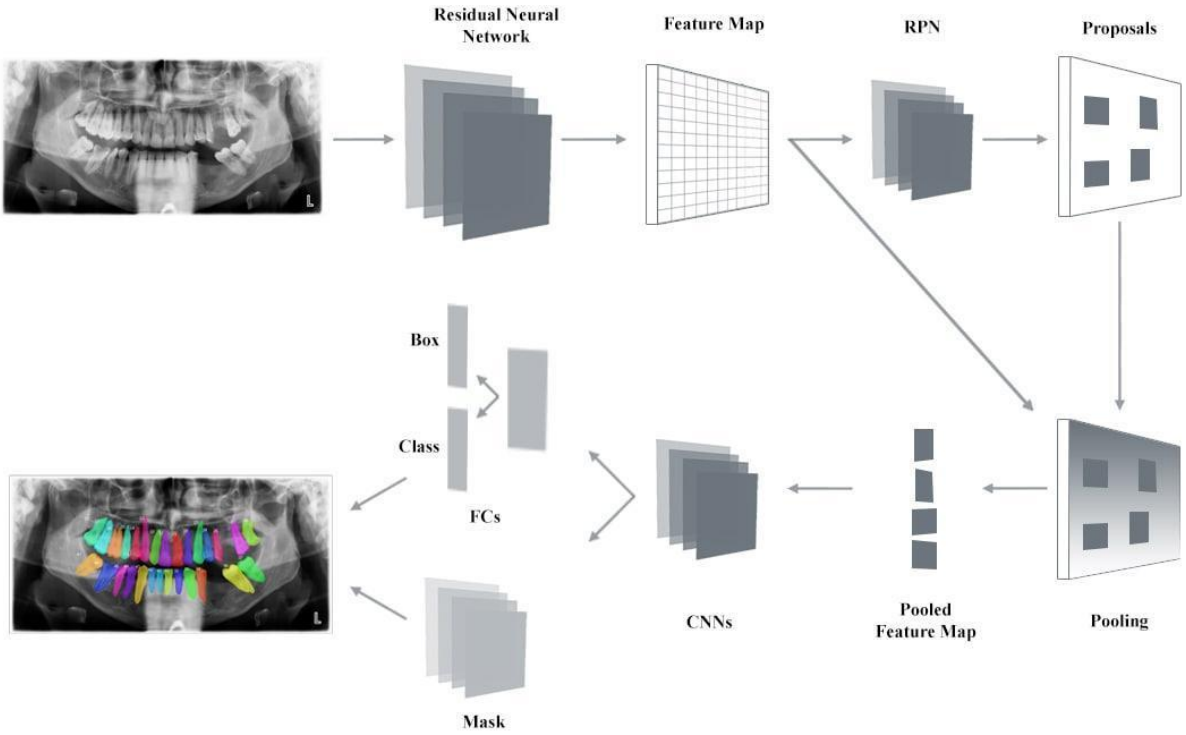

Fig. 4. System architecture and pipeline workflow

The loss function used in Mask R-CNN combines the classification loss, the ground-truth box coordinates and the masks taken from the segmentation.

$$L = L_{cls} + L_{box} + L_{mask} \quad (1)$$

In Equation (1), L_{cls} and L_{box} are the same as those used in the Faster R-CNN method [6] and L_{mask} refers to the masks taken from the segmentation. L_{mask} is expressed as:

$$L_{mask} = -\frac{1}{m^2} \sum_{1 \le i,j \le m} [y_{ij} log \hat{y}_{ij}^{k} + (1 - y_{ij}) \log(1 - \hat{y}_{ij}^{k})] \quad (2)$$

The total number of classes is denoted by k. A mask of size mxm is generated for each class and each RoI. The output size is taken as kxm^2. Here, y_{ij} is the label of a coordinate (i, j) in the generated mask, and $\hat{y}_{ij}^{k}$, is the predicted value for class k in (2).

III. Experimental Results

In the study, the training was carried out on a computer with i9 10980XE processor and NVIDIA Quadro RTX 5000 graphics card. For the experiments, all images are set to 1024x1024 so that the images of different sizes are become Mask R-CNN compatible. The residual network, which is the backbone network used when training the neural network, provides transfer learning as it is a pretrained model. The weights given to the neural network are taken from a pretrained Microsoft Common Objects in Context (MS COCO) [14] dataset. Therefore, time saving was achieved by using ready weights instead of repeating the training. The graphic shown in Fig. 5 belongs to the loss values resulting from the trained data.

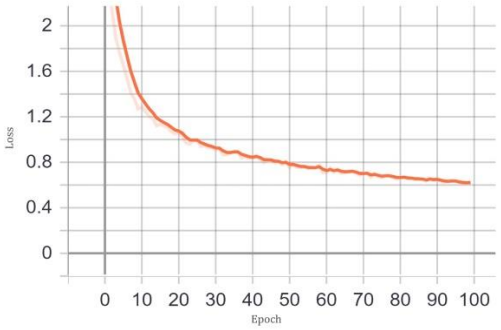

Fig. 5. Graphic of total loss

As you can see in Fig. 6, mAP (mean average precision) as accuracy, recall, F1-score, precision performance metrics were used to compare ResNet-50 and ResNet-101 networks. After the training procedure, Mask R-CNN obtained higher results in the training using the ResNet-101 backbone.

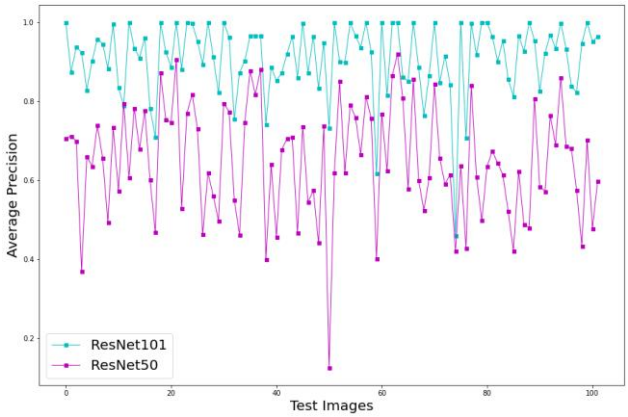

Fig. 6. Comparison of residual networks (ResNet-50 and ResNet-101)

As a result of the training, the mAP metric was used to evaluate the accuracy of the existing test images as shown in (3). After the neural network was trained with 780 training images, the model was verified with 150 validation images. Then, the performance of the model was evaluated using (4), (5), (6) with 100 randomly selected test images.

$$mAP = \frac{TP + TN}{TP + TN + FP + FN} \quad (3)$$

$$Precision = \frac{TP}{TP + FP} \quad (4)$$

$$F1 - Score = 2 * \frac{Precision * Recall}{Precision + Recall} \quad (5)$$

$$Recall = \frac{TP}{TP + FN} \quad (6)$$

The performance metrics in the Table 1 belong to the results of the comparison of ResNet-50 and ResNet-101 backbones. Considering these performance metrics, it was found that the ResNet-101 backbone network produced more successful results.

TABLE I. COMPARISON OF DIFFERENT BACKBONE NETWORKS WITH INSTANCE SEGMENTATION

Backbone Comparison	**Performance Metrics**			
	Accuracy	***Precision***	***F1-Score***	***Recall***
ResNet-50	% 90.47	% 92.85	% 90.89	% 91.31
ResNet-101	% 90.89	% 96.42	%92.41	% 93.97

The intersection scores of all models on the test set are shown in Fig. 7, taking the IoU (Intersection over Union) threshold of 0.5. The matching score, which is frequently used in the literature to visualize the confusion matrix has been used to compare ground-truth and prediction results.

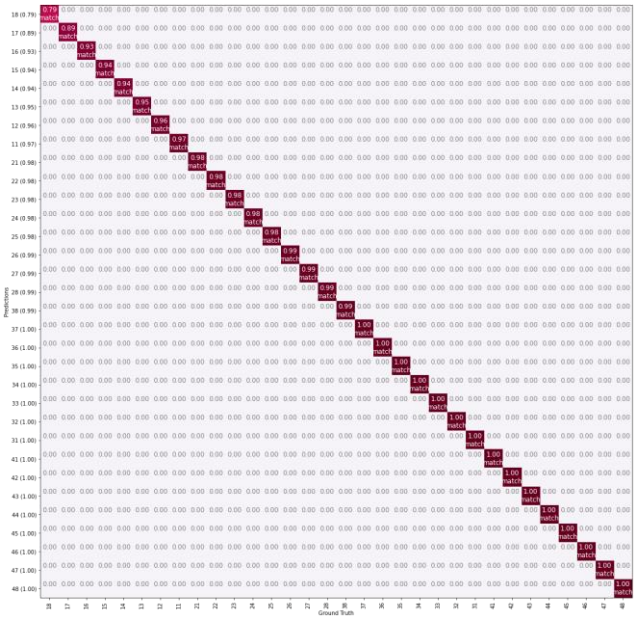

Fig. 7. Confusion matrix of the average results

IV. CONCLUSION AND FUTURE WORKS

In this study, it was confirmed that our CNN-based model, which we applied in panoramic radiographs, can be trained for automatic tooth detection, numbering and segmentation. With the proposed solution, it is aimed to support dentists in their decision-making processes. The designed system offers high precision performance despite missing teeth. Based on the results obtained, the deep learning-based automatic tooth detection, numbering and segmentation of the system has been verified by dentists in clinical practice. In future studies, it is aimed to eliminate symmetry-based and overlapping errors in panoramic tooth images with an intuitive approach.

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Efficiency of Fuzzy Approach Risk Assessment in Software Risk Management

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***Abstract*—Software engineering may be described as a department that performs the engineering tasks in order to develop a software. This computer software is a product or a service or a project: requirements are captured; specification document is prepared by requirements analysis; in/out architecture is designed; related source codes, variables, methods, classes, modules and relationships among these are written; necessary tests and integration operations are done; when needed, maintenance, repair and update operations are executed and applied by software or computer engineers. In addition, software has its own documentation jobs, user manual, and numeric, textual data and multimedia tools in its memory. Furthermore, software development projects have a big burden and need to be invested in high volumes. When looked at costs based on the international tangible data on software; it was $150 billion in 1985, it was $2 trillion in 2010 and it passed over $5 trillion after 2016. Despite the costs, expenses and investments that are exponentially going up each year, the rate of successfully accomplishment of the software development projects is not very high. Based on the "CHAOS" report prepared in 2016, only 17% of the software projects were developed in a timely manner, in the allocated budget and in accordance with the requirements. However, 53% of the projects were completed over time and over budget and also without fulfilling the requirements exactly, whereas 30% of the software projects cannot have been completed in the development phase and were cancelled. Because of that, an efficient software risk management has to be carried out and applied in order to determine and recognize software risks on time before causing problems and troubles into software development projects. So, success rate of software projects development is able to increase. In this paper, several software risk assessment approaches have been introduced, and also "fuzzy approach" technique corresponding to risk structure and mechanism has been explained in detail by related linguistic and logical rules to show its efficiency and usefulness underlying software risk management area for pointing out importance of fuzzy logic.**

Keywords—software engineering, software risk assessment, software risk management, fuzzy approach, fuzzy logic

I. RISK

Risk is the likelihood of not reaching a targeted result, and also it is the probability of any event that would prevent an organization from achieving its strategic, financial and operational objectives. In addition, risk has basic two factors: the possibility of occurrence – the likelihood of not achieving a particular result or the likelihood of an undesired occurrence –, size of loss – the effects of the consequences that would arise if the risks were realized [1].

Risks come in all shapes and sizes; risk professionals generally recognize three major types. Market risk is the risk that prices will move in a way that has negative consequences of a company; credit risk is the risk that a customer, a counterparty or a supplier will fail to meet its obligations; and operational risk is the risk that people, processes or systems will fail or that an external event (earthquake, fire, etc.) will negatively impact the company [2].

II. SOFTWARE RISKS

Building and keeping up software can be a hazardous business. Most endeavours depend on programming – so additional cost, delays or the failure to acknowledge objectives can have genuine results. Bigger dangers that can undermine long haul ventures require prompt consideration, and that implies putting the accentuation on danger (top 10) [3]:

Estimation and planning – The one of a kind sort of individual programming ventures makes issues for designers and administrators in assessing and booking improvement time. Continuously, screen existing activities so utilization of exercises learnt later on.

Sudden development in necessities – As a task advances, gives that are not distinguished before can make a very late obstacle to fulfilling time constraints. Attempt to plan for an impressive future from the get-go in extend and envision the most pessimistic scenario or heaviest-use situation.

Employee turnover – Every task has various designers taking a shot at it. At the point when an engineer leaves, the individual may take basic data with that person. This can postpone and now and then crash a whole venture. Guarantee to have assets where colleagues can work together and share information.

Breakdown of detail – During the underlying periods of mix and coding, prerequisites may strife. Besides, designers may locate that even the detail is indistinct or deficient.

Productivity issues – On undertakings including long courses of events, engineers will in general take things simple in any case. Accordingly, in some cases, they lose huge opportunity to finish the task. Set a practical timetable, and stick to it.

Compromising on plans – In request to stall out into the following 'genuine' assignments, engineers will in general surge the plan cycle. This is a misuse of programming hours as planning is the most basic piece of programming advancement.

Gold plating – Developers now and then prefer to flaunt their abilities by adding superfluous highlights. For example, an engineer may add Flash to a fundamental login module to make it look 'jazzy'. Once more, this is a misuse of programming hours.

Procedural dangers – Day-to-day operational exercises may hamper because of ill-advised cycle usage, clashing needs or an absence of lucidity in obligations.

Technical dangers – Sometimes programming improvement firms lessen the usefulness of the product to make up for invades relating to high financial plans and planning. There is consistently a contention between accomplishing most extreme usefulness of the product and pinnacle execution. To make up for inordinate spending plan and timetable overwhelms, organizations in some cases decrease the usefulness of the product.

Unavoidable dangers – These remember changes for government strategy, the out of date quality of programming or different dangers that can't be controlled or assessed. As the field of programming improvement turns out to be an ever increasing number of complex, the dangers related with it have escalated. It is essential that improvement firms around vital intending to relieve such dangers.

III. SOFTWARE RISK MANAGEMENT

Software risk management is one of the most significant occupations for a venture supervisor. You can think about a hazard as something that you'd lean toward not to have occur. Dangers may compromise the task, the product that is being created, or the association. Hazard the board includes envisioning dangers that may influence the undertaking plan or the nature of the product being created, and afterward making a move to maintain a strategic distance from these dangers. Dangers can be arranged by kind of hazard (specialized, hierarchical, and so forth.). A reciprocal arrangement is to characterize risks as per what these dangers influence [4]:

Venture dangers influence the undertaking calendar or assets. A case of a task hazard is the loss of an accomplished framework designer. Finding a supplanting engineer with proper aptitudes and experience may take quite a while; thus, it will take more time to build up the product structure than initially arranged.

Item risks influence the quality or execution of the product being created. A case of an item chance is the disappointment of a bought segment to proceed true to form. This may influence the general execution of the framework so it is more slow than anticipated.

Business dangers influence the association creating or getting the product. For instance, a contender presenting another item is a business hazard. The presentation of a serious item may imply that the suppositions made about deals of existing programming items might be unduly idealistic.

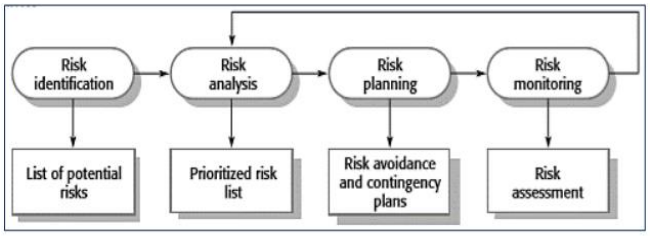

Fig. 1. Software risk management process.

IV. SOFTWARE RISK ASSESSMENT

Software risk assessment is a term used to depict the overall strategy or procedure where: One perceives threats and danger factors that can cause hurt (hazard recognizing evidence). One separates and evaluates the peril related with that risk (risk assessment and danger appraisal). One chooses fitting ways to deal with discard the risk, or control the danger when the hazard can't be shed (risk control) [5].

Software risk assessment is a cautious look at the workplace to perceive those things, conditions, structures, etc. that may cause hurt, particularly to people. After ID is made, one explores and evaluates how likely and genuine the risk is. Right when this affirmation is made, one can immediately, pick what measures should be set up to effectively take out or control the underhandedness from happening [5].

The CSA Standard Z1002 "Word related prosperity and security – Hazard ID and end and danger assessment and control" uses the going with terms: Hazard evaluation – the overall method of risk recognizing evidence, chance assessment, and peril appraisal. Danger recognizing confirmation – the route toward finding, posting, and depicting threats. Peril examination – a system for valuing the possibility of threats and choosing the component of risk. Risk evaluation – the route toward taking a gander at a normal peril against given danger measures to choose the tremendousness of the risk. Peril control – exercises executing danger evaluation decisions [5].

V. SOFTWARE RISK ASSESSMENT APPROACHES

The "Fault Tree Analysis" (FTA) was first presented by Bell Laboratories and is a standout amongst the most generally utilized strategies in framework unwavering quality, viability and wellbeing examination. It is a deductive methodology used to decide the different blends of equipment and programming disappointments and human blunders that could cause undesired occasions (alluded to as best occasions) at the framework level. The deductive examination starts with a general end, at that point endeavours to decide the explicit reasons for the decision by building a rationale outline called a blame tree. This is otherwise called adopting a best down strategy. The principle motivation behind the blame tree examination is to help recognize potential reasons for framework disappointments before the disappointments really happen. It can likewise be utilized to assess the likelihood of the best occasion utilizing diagnostic or measurable strategies. These counts include framework quantitative dependability and viability data, for example, disappointment likelihood, disappointment rate and fix rate. Subsequent to finishing a FTA, you can concentrate your endeavours on enhancing framework security and unwavering quality [6].

A "Decision Tree" is a decision help gadget that uses a tree-like model of decisions and their possible outcomes,

including chance event results, resource costs, and utility. It is one way to deal with show a figuring that just contains prohibitive control explanations. Decision trees are commonly used in exercises investigate, unequivocally in decision examination, to help recognize a technique bound to accomplish a goal, yet then again are a notable gadget in AI [7].

"Probabilistic Risk Analysis" (PRA) is exact and unquestionable expectations of stream examples and contaminant transport over an extensive variety of ecological streams are famously monotonous due to complexities presented by fierce streams, spatial geometries and normal vulnerabilities. The absence of adequate site portrayal, computational assets, and sometimes, the deficiency of conceptualizations and scientific models of significant physical wonders muddle demonstrating endeavours further. These issues present a principal absence of conviction about any anticipated stream and cast questions on the achievability of acquiring a solitary deterministic forecast of a pollution situation [8].

An "Event Tree" is an inductive expository graph in which an occasion is broke down utilizing Boolean rationale to look at a sequential arrangement of ensuing occasions or outcomes. For instance, occasion tree examination is a noteworthy segment of atomic reactor security engineering. An occasion tree shows succession movement, arrangement end states and grouping explicit conditions crosswise over time [9].

"Failure Modes and Effects Analysis" (FMEA) is a little by little methodology for recognizing each and every possible dissatisfaction in an arrangement, a collecting or get together cycle or a thing or organization. "Disillusionment modes" implies the ways or modes, where something may miss the mark. Dissatisfactions are any errors or deformations, especially ones that impact the customer and can be potential or certified. "Effects assessment" suggests thinking about the results of those mistake. Disillusionments are coordinated by how certified their results are, the methods by which routinely they occur and how viably they can be recognized. The purpose behind the FMEA is to take actions to clear out or decrease frustrations, starting with the most raised need ones [10].

"Hazard Analysis Critical Control Point" (HACCP) is an administration framework in which sustenance wellbeing is tended to through the investigation and control of organic, synthetic, and physical risks from crude material generation, obtainment and dealing with, to assembling, appropriation and utilization of the completed item [11].

"Root Cause Analysis" (RCA) is a system for basic deduction used for perceiving the fundamental drivers of issues or issues. A factor is seen as a fundamental driver if ejection thereof from the issue accuse progression shields the last undesirable come about because of rehashing; while a causal factor is one that impacts an event's outcome, anyway isn't a hidden driver. Despite the way that clearing a causal factor can benefit an outcome, it doesn't keep its rehash with sureness [12].

"Risk Ranking and Filtering" is a champion among the most generally perceived help methodologies used for Risk Management. This procedure is generally called "Relative Risk Ranking", "Danger Indexing" and "Peril Matrix and Filtering". Its will likely give more sharpened focus to the fundamental perils inside a structure – ordinarily, from an immense and complex game plan of danger circumstances. Peril Ranking and Filtering works by isolating overall risk into danger portions and surveying those fragments and their individual duties to as a rule threat [13].

The Center for Risk Management of Engineering Systems at the University of Virginia built up the strategy of "Hierarchical Holographic Modeling" (HHM) in the mid-1980s as a danger investigation instrument. Intended to catch the mind boggling interdependencies of basic foundations, HHM was created to defeat the difficulty of a solitary model's capacity to speak to all the significant parts of an unpredictable framework. In displaying huge scope, complex frameworks, numerous adequate numerical and theoretical models arise, each speaking to an alternate, yet exact perspective. The usage of HHM permits the advancement of numerous, substantial models that "catch the embodiment of the numerous measurements, dreams, and viewpoints of foundation frameworks." Hierarchical suggests the need to fathom chances as they appear at different measurements in a hierarchy (e.g., risks at the game plan of structures level, the individual system level, the sub-structure level and the portion level). Holographic suggests the need to will peril from different perspectives (e.g., monetary, security, geographic, particular, etc). The displaying approach is figured out to oversee both holographic and different levelled considerations and usages a formalized technique (Risk Filtering and Ranking Methodology) to arrange perils [14].

VI. Software Risk Assessment with Fuzzy Approach

"Fuzzy Logic" is expressed as a "Fuzzy Approach" based on "degrees of accuracy" rather than the "true or false" state which is the Boolean approach. The idea of fuzzy logic was first advanced by Dr. Lotfi Zadeh of the University of California at Berkeley in the 1960s. Fuzzy theory can be used for as a means of representing vagueness in constructing nonlinear relationships with heuristic information. The theorem basically works with the logic that instead of an expression being 0 or 1, its value may have a value that can vary in this rang [15].

"Fuzzy Approach" attempts to model the general working logic of the computer in a way that people can understand within the framework of logic. A computer's logic block receives absolute input from the user and gives the outputs TRUE or FALSE, which is equivalent to YES or NO results. According to the fuzzy approach, the user's decision states that there are a number of possibilities between YES and NO. Using fuzzy approach, it is aimed to model uncertain situations, improperly defined or complex systems [16].

"Fuzzy Approach" works according to "Fuzzy Logic", which is different from "Classical Logic" – either "0" or "1"; either true or false; either exists or not; either black or white. So, it is able to give, present and submit much more alternatives than just binary options. In addition, "Fuzzy Approach" has a working structure and mechanism like human thinking, and gives results and outputs based on ratios, probabilities, percentages or ranges. In this way, "Fuzzy Approach" has a very convenient and proper process for defining risks due to their nature that has no certainty – uncertainty – structure and principle [17].

The architecture of "Fuzzy Approach" based on "Fuzzy Logic" system consists of three main parts as shown in Figure 2 in the following. Firstly, it converts system inputs to the fuzzy sets provided in the fuzzification module. The rules

section describes the situations that determine the outputs of the system's fuzzy logic approach. These situations indicate which statement should be output against the changing input expressions of the system. Finally, the defuzzification module converts the fuzzy set generated by the inference engine to a net value. Thus, the system outputs provide different output values according to the rules [18].

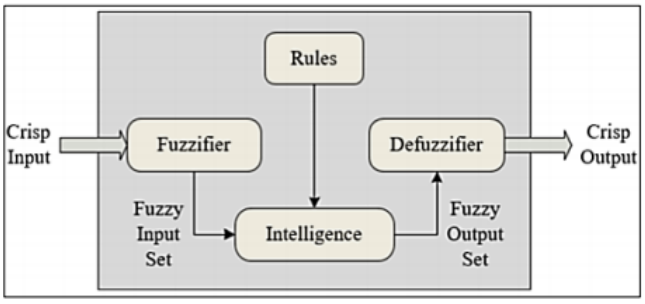

Fig. 2. Fuzzy logic process.

"Fuzzy Approach" facilitates the control of complex systems that may change over time. Also, the logic of its operation is not of certainty, but of partial nature and is human-like in this sense. In addition, it gives good results in nonlinear systems. Moreover, it is easy to apply and gives quick results [19].

Several "Fuzzy Approach" related linguistic and logical rules based on "Fuzzy Logic" have been shown and listed in the following [20]:

_If "PM" is high and "TZD" is low then Risk is low.

_If "F" is high and "LD" is low and "CI" is high then Risk is low.

_If "T" is high and "TZD" is low then Risk is low.

_If "RS" is high and "NP" is low and "LD "is low and "CD" is low then Risk is low.

_If "CE" is high and "TC" is low then Risk is low.

_If "AK" is high and "CI" is high then Risk is low. _

_If "Productivity" is high and "Communication" is high then Risk is low.

The abbreviations of the risk parameters, which have been used in the rules (7 rules in total) above, have been explained in the following [20]:

*PM: Process Maturity *TZD: Time Zone Difference

*F: Formality *LD: Language Difference

*CI: Communication Infrastructure *T: Transparency

*RS: Requirements Stability *NP: Novelty of Product

*CD: Cultural Differences *CE: Common Experiences

*TC: Task Coupling *AK: Application Knowledge

Furthermore, 18 linguistic rules about software risk assessment and management with 15 different risk parameters designed and developed by "Fuzzy Approach" have been figured out in the following [21]:

_If "IDP" is medium and "IC" is medium and "UMSR" is high, then risk is high.

_If "IDP" is low and "IC" is medium and "UMSR" is medium, then risk is medium.

_If "IDP" is low and "IC" is low and "UMSR" is low, then risk is low.

_If "PMNCD" is high and "LEPMM" is medium, then risk is high.

_If "PMNCD" is medium and "LEPMM" is low, then risk is medium.

_If "PMNCD" is low and "LEPMM" is low, then risk is low.

_If "IPP" is medium and "ITM" is high, then risk is high.

_If "IPP" is low and "ITM" is medium, then risk is medium.

_If "IPP" is low and "ITM" is low, then risk is low.

_If "PIUNT" is high and "ITDTM" is medium and "NUSMFS" is medium, then risk is high.

_If "PIUNT" is medium and "ITDTM" is low and "NUSMFS" is medium, then risk is medium.

_If "PIUNT" is low and "ITDTM" is low and "NUSMFS" is low, then risk is low.

_If "LAUI" is medium and "HLTC" is high, then risk is high.

_If "LAUI" is low and "HLTC" is medium, then risk is medium.

_If "LAUI" is low and "HLTC" is low, then risk is low.

_If "COMDP" is medium and "CPNEP" is high and "FIAS" is medium, then risk is high.

_If "COMDP" is low and "CPNEP" is medium and "FIAS" is medium, then risk is medium.

_If "COMDP" is low and "CPNEP" is low and "FIAS" is low, then risk is low.

The abbreviations of the risk parameters, which have been used in the rules (18 rules in total) above, have been explained in the following [21]:

*IDP: Inappropriate development process

*IC: Ineffective communication

*UMSR: Unclear or misunderstanding system requirements

*PMNCD: Project milestones not clearly defined

*LEPMM: Lack of an effective project management methodology

*IPP: Inadequate project planning

*ITM: Inexperienced team members

*PIUNT: Project involved the use of new technology

*ITDTM: Inadequately trained development team members

*NUSMFS: New and/or unfamiliar subject matter for the system

*LAUI: Lack of adequate user involvement

*HLTC: High level of technical complexity

*COMDP: Change in organizational management during the project

*CPNEP: Corporate politics with negative effect on project

*FIAS: Failure to identify all stakeholders

VII. CONCLUSION

In software development, there are 4 main reasons to implement and apply "Software Risk Assessment and Management" according to Boehm [22,23]: In order to avoid overruns in budget and planning and to ensure that the software products run flawlessly and that software companies are able to develop software projects in their red lines/frames. In order to prevent duplication of internal or external design or code resulting from defective, incomplete or unclear requirements that constitute in general 40% to 50% of the cost of software development. In order to avoid unnecessary risk analysis and detection processes in areas that have (almost) no risk. In order to promote a software solution when purchasing the software product/s that the customer needs, a win-win sat policy is applied to enable the sellers to obtain the desired profits and the customer satisfaction.

In this paper, the term "risk" has been defined. Also, "software risks" have been introduced. In addition, "software risk assessment and management" has been tried to explain. Moreover, the main and leading software risk assessment methods and techniques (9 in total) – Fault Tree Analysis, Decision Tree, Probabilistic Risk Analysis, Event Tree, Failure Modes and Effects Analysis, Hazard Analysis Critical Control Point, Root Cause Analysis, Risk Ranking and Filtering, and Hierarchical Holographic Modeling – have been figured out. Furthermore, software risk assessment with "Fuzzy Approach" has been told and explained in detail. Also, with the contribution of its linguistic and logical rules, that "Fuzzy Approach" based on "Fuzzy Logic" principle works more effectively in software risk assessment rather than the other techniques has been tried to show out.

"You can't manage the process which you don't measure." This statement which is claimed to be said by Peter DRUCKER shows that software risk assessment process has to be measured by clear and objective software risk parameters. With the contribution of "Fuzzy Approach", software risk parameters linguistic rule set can be generated and created. Thus, some reliable data have been specified and determined so that this software risk assessment process under software risk management can be arranged and adjusted by benefiting from these trustworthy results. According to the results of this evaluation of developed software risk rules based on "Fuzzy Logic", "manpower", "time" and "price" what are the main resources of software development process may be used more effectively. And then, the benefits of the "Software Risk Assessment and Management" under "Software Engineering" may be seen more tangible in the scientific area.

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Rolling Bearing Fault Diagnosis Under Variable Working Conditions with Artificial Intelligence

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***Abstract*—Artificial intelligence (AI) applications have started to be used frequently for predictive maintenance in automotive, aviation, machinery, and wind turbine fields with the developing technology. Rolling bearings are one of the most significant components of rotary machine systems. The rolling bearings can be damaged with the long run and high-load operations, resulting in severe potential damages that could affect the entire system. In this regard, early fault diagnosis is vital in terms of the effective functioning of the mechanical systems. It is observed that the constant working conditions are taken into account in many studies in recent years. However, it should be noted that the variable working conditions can reduce the fault detection accuracy of the AI algorithms. This paper deals with an early fault diagnosis method based on a one-dimensional convolutional neural network (1D-CNN) using vibration signals. The inner raceway and rolling element faults are detected under variable motor loads and operating speeds. The efficiency of the proposed method is evaluated with the Case Western Reserve University (CWRU) dataset. As a result, it is observed that the proposed approach is suitable to identify rolling bearing faults. The method can be used for preventing rotary machine failures, and maintenance costs can be optimized by early fault detection.**

Keywords—artificial intelligence, fault diagnosis, rolling bearing, variable working conditions

I. INTRODUCTION

Rolling bearings are core machine elements used in many industrial applications, and their health conditions directly affect the performance of the entire system. According to statistics, 30% of malfunctions in mechanical systems are caused by bearing failures [1]. The rolling bearings can be damaged by long operating times and variable loads. If the bearings fail, the whole system can collapse, and huge economic losses are inevitable. Thereby, the precautions to be taken are valuable in terms of safety and reliability. In this regard, early fault detection in bearings emerges as a critical and up-to-date topic.

Data collected through vibration, acoustic, current, and torque sensors can be utilized for fault diagnosis in rotary machines. However, among them, it is observed that the main instruments used in bearing fault detection are vibration-based techniques [2]. Vibration-based approaches to fault diagnosis in bearings offer an advantage in terms of low cost and rapid measurement [3]. Today, the remarkable improvement in data collection and processing capabilities has caused artificial intelligence (AI) algorithms to be more involved in our lives. It is possible to obtain vital diagnostic information regarding the health conditions of mechanical systems by adapting AI algorithms to industrial applications. In many studies, traditional machine learning (ML) methods such as support vector machines (SVM), decision tree classifiers (DTC), and k-nearest neighbor (KNN) are used for the classification of damage severity [2]. Despite the relative success of these methods in diagnostics and classification, there are some shortcomings. The first is that traditional ML methods require signal processing expertise in order to select the most sensitive features for fault detection and are prone to uncertainty. Second, depending on the type and severity of the fault and component, damage information in the signal is complex and unique. As a result, the performances of the fault features become inconsistent and unreliable [4]. The signals collected from a mechanical system are generally exposed to noises that do not contain damage information due to the ambient conditions [5]. In this regard, the third and last shortcoming is that traditional ML structures consist of shallow structures that make the process of learning hidden information related to the fault more difficult, especially for noisy vibration signals.

Artificial neural networks (ANNs) and their variations have increasingly been utilized in bearing health monitoring and fault diagnosis in recent years due to the shortcomings of traditional ML methods. ANNs consist of many simple and interconnected neurons which are connected by a related weight. The weights between each neuron determine the importance of input to the relevant neurons. Moreover, variations of ANNs such as deep neural networks (DNN), convolutional neural networks (CNN), recurrent neural networks (RNN), and long-short term memory (LSTM) have begun to be used frequently in bearing fault diagnosis. Deep learning (DL) algorithms are considered a breakthrough in rotary machine fault diagnosis, considering their success in processing big data [6]. There many studies in the literature in which DL algorithms are used for rotary machinery fault detection. Qiao et al. proposed a dual-input model based on CNN and LSTM and investigated the bearing faults under different noise and load conditions. The model's

generalization ability was tried to be improved by using both time and frequency data. As a result, the accuracy obtained with the proposed method was around 90% under variable loading conditions and 86% in different noise interference environments [1]. Karpat et al. presented an AI-based approach for early fault diagnosis in railway gearboxes. In the study, the transferability of AI-based methods used in different industries to railway gearboxes was investigated. In this regard, a CNN model was utilized for gear crack diagnosis. Besides, a test setup for determining root crack in gears operating at different speeds has been proposed. [7]. Karpat et al. developed a one-dimensional convolutional neural network (1D-CNN) architecture for fault diagnosis in spur gears. A six-degree of freedom dynamic model of a single-stage spur gear mechanism was created to simulate the vibration response for healthy and four different degrees (25-50-75-100%) of crack. Consequently, the fault was detected with an accuracy of 96.04% [8]. Eren et al. studied a real-time induction rolling bearing fault diagnosis system with a compact adaptive 1D-CNN model. When the proposed network was appropriately trained, it can make optimally feature extraction and classification. The performance of the method was evaluated by comparing it with two common benchmark real vibration datasets. As a result, the 1D-CNN model achieved an average accuracy of 93.9% and 93.2% for the Intelligence Maintenance System (IMS) and Case Western Reserve University (CWRU) datasets, respectively [9]. Lei et al. proposed a novel nonlinear analysis method to analyze the measured signals for bearing fault monitoring. In this regard, the symplectic entropy method was used to analyze the bearings' dynamic characteristics. It was indicated that the proposed method is suitable for fault detection in rolling bearings [10].

Many studies in the literature have been conducted for stable working conditions [11]. However, mechanical systems generally operate under variable operating speeds and loads. As a result, varying working conditions can affect the fault recognition accuracy of the algorithms and lead to erroneous diagnoses [12]. In this regard, it is critical to evaluate the ML and DL algorithms' fault diagnosis performances under variable working conditions. Boudiaf et al. conducted a comparative study using the CWRU dataset. In the study, two fault types (inner and outer raceway), loading conditions (0 and 3 HP), and operating speeds (1730 and 1797 rpm), were considered. In this regard, the advantages and disadvantages of vibration analysis methods used in bearing fault detection were evaluated [2]. Dong et al. proposed a fault diagnosis method based on sparse denoising autoencoder for rolling bearings. Autoencoder network was used to extract deep adaptive features in the vibration signal. The efficiency of the proposed method under variable working conditions was interpreted with two different experimental setups. Consequently, it was indicated that the results obtained reveal the feasibility and effectiveness of the proposed method [11]. Liu et al. presented an approach based on Hilbert-Huang transform and singular value decomposition for bearing fault diagnosis. The inner raceway, outer raceway, and rolling elements faults were examined. In this regard, the performance of the proposed approach was tested under variable working conditions using the CWRU dataset. It was observed that the proposed approach has advantages over the SVM and extreme learning machine in terms of classification accuracy [13]. Pham et al. presented a novel CNN-based approach that reduces the computational costs for bearing fault classification. The performance of the proposed approach was experimentally evaluated at different operating speeds. As a result, fault detection was made with an accuracy of 99.58% [14]. Chen et al. proposed an end-to-end CNN and LSTM-based model that utilizes raw vibration data as input and has automatic feature learning capability. The proposed compact network structure provides an opportunity to detect the bearing health condition in real-time. CWRU dataset was used to test the model, and average accuracy of 98.46% was obtained. The feature visualization based on the t-distributed stochastic neighbor embedding (t-SNE) supported the proposed CNN and LSTM-based model superiority [15]. Tian et al. presented an intelligent bearing fault diagnosis method based on local mean decomposition-singular value decomposition and extreme learning machine. The effectiveness of the method was validated through the CWRU dataset. Three different bearing faults (inner raceway, outer raceway, and rolling bearing faults) were evaluated in the study. The experimental results indicated that the proposed method can be used for bearing fault diagnosis under variable working conditions and is also promising for other rotary machinery applications [16]. Chen et al. proposed a 1D-CNN model for bearing fault diagnosis, highlighting the shortcomings of the traditional methods. It was indicated that the proposed method can improve the classification accuracy by reducing the number and size of the convolution kernel. The t-SNE visualization algorithm showed that the 1D-CNN model can classify with high accuracy under different loads. The proposed method showed an average accuracy of 99.2% under a single load. Besides, the accuracy was obtained as 98.83% under different loads [17]. Che et al. proposed a deep transfer learning method for rolling bearing fault diagnosis under variable working conditions. In the study, both model-based and feature-based transfer learning were utilized to improve the generalization capability of the CNN architecture. As a result, it was indicated that the proposed method can learn features from noisy data and increase the accuracy rate between 2% and 8% [18]. Zhao et al. presented a normalized CNN model for identifying the bearing health condition. The proposed model was applied to different data imbalance cases and operating conditions. It was indicated that the model has excellent accuracy under variable working conditions and sufficient stability on the data imbalance [19].

This study proposed a 1D-CNN model for fault diagnosis in rolling bearings operated under variable working conditions. Two fault types (inner raceway and rolling element faults), loading conditions (0 and 3 HP), and operating speeds (1797 and 1730 rpm), were considered. The efficiency of the proposed method was evaluated with the CWRU dataset. As a result, the proposed 1D-CNN model has shown great success in identifying rolling bearing faults. The method can be utilized to optimize maintenance strategies and costs through the early diagnosis of rotary machinery faults.

II. MATERIAL AND METHODS

A. Rolling Bearing Fault Signature

Fig. 1 shows a typical rolling bearing structure contains an outer raceway mounted in the bearing housing, an inner raceway mounted on the shaft, rolling elements, and the cage. Bearings are one of the most sensitive and fault-prone machine elements. In this regard, a malfunction that will occur causes the bearing to degrade, considering the wear and tear on the internal balls. Bearings can be damaged due to incorrect size selection, electrical leakage, variable loading, etc. [15].

Therefore, the system produces periodic abnormal vibration responses whose magnitude depends on the fault size.

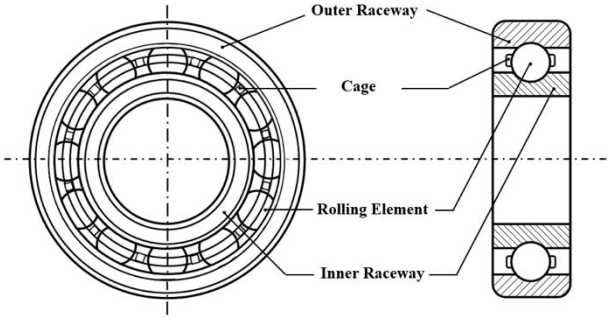

Fig. 1. Typical rolling bearing structure

Besides, fault vibration-frequency characteristics may also vary due to fault type, shaft speed, loading condition, and fault location. Consequently, rolling bearing early fault diagnosis under variable working conditions is a subject that needs to be addressed extensively.

B. Experimental Setup

This study utilized the CWRU vibration dataset to validate the proposed 1D-CNN model [20]. The CWRU experimental setup consists of a 2 HP motor, a torque transducer, and a dynamometer. The 6205-2RS SKF rolling bearing was used at the drive end of the experimental setup.

Faults in diameter of 0.54 mm were introduced to the inner raceway and rolling element separately using electro-discharge machining (EDM). Finally, the vibration data were collected under variable loads (0 and 3 HP) and operating speeds (1797 and 1730 rpm) through the accelerometer attached to the housing with magnetic bases.

The proposed 1D-CNN network was trained with a dataset consisting of four different faults and two healthy status signals. Thus, the effectiveness of the proposed model was evaluated under variable working conditions. The CWRU bearing experimental setup is presented in Fig. 2.

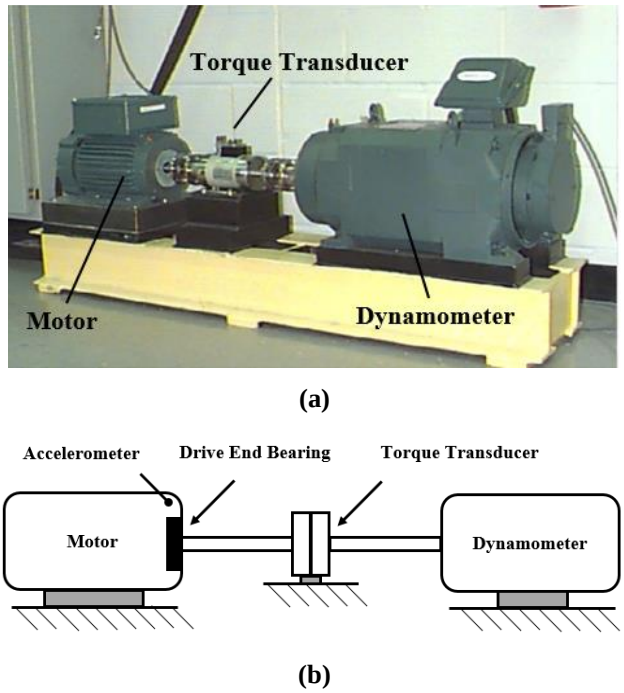

Fig. 2. Experimental setup of CWRU

C. Convolutional Neural Network

CNN is a type of feed-forward neural network with convolution computation and deep structure. The convolutional layer extracts the characteristics of the input signal through a filter with shared weights to map the local signal of the previous layer to the next layer. In this regard, the shared weights provide a benefit by reducing the computational burden in complex and nonlinear transformations [15].

This study proposed a 1D-CNN architecture for classifying bearing faults under variable working conditions. Therefore, 500 signal pieces for training, 100 for validation, and 100 for testing were utilized in the dataset, each containing 25000 (window size) consecutive points, obtained from each signal belonging to six (healthy, inner raceway, and rolling element faults) conditions. The dropout ratio was assigned as 0.2. The properties of the 1D-CNN model are presented in Table 1.

TABLE I. THE STRUCTURE OF THE 1D-CNN MODEL

Network Structure		
Layer (Type)	***Output Shape***	***Param #***
conv1d_98 (Conv1D)	(None, 25000, 4)	8
max_pooling1d_77 (MaxPooling)	(None, 12500, 4)	0
conv1d_99 (Conv1D)	(None, 12500 , 4)	20
max_pooling1d_78 (MaxPooling)	(None, 6250, 4)	0
dropout_51 (Dropout)	(None, 6250, 4)	0
flatten_51 (Flatten)	(None, 25000)	0
dense_132 (Dense)	(None, 128)	3200128
dense_133 (Dense)	(None, 64)	8256
dense_134 (Dense)	(None, 6)	390

The model includes two convolutions and pooling layers (Table 1). This study used 4 feature maps with kernel size 1 and Rectified Linear Units (ReLu) function as activation function in the first layer. The output of the first neural network layer is a 25000 x 4 neuron matrix. The basic ReLu graph is given in Fig. 3.

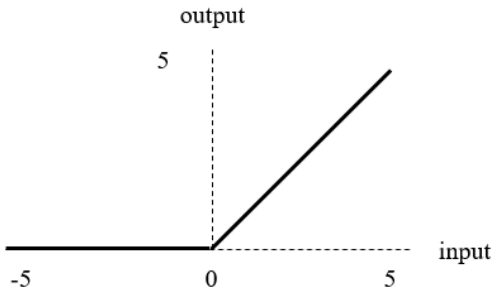

Fig. 3. Rectified linear units

A buffer between learned features and outputs was provided to interpret learned features before making predictions from 6 health classes with the fully connected layer. In the second layer, the Hyperbolic Tangent function (tanh) was used as the action function. The basic Hyperbolic Tangent graph is presented in Fig. 4.

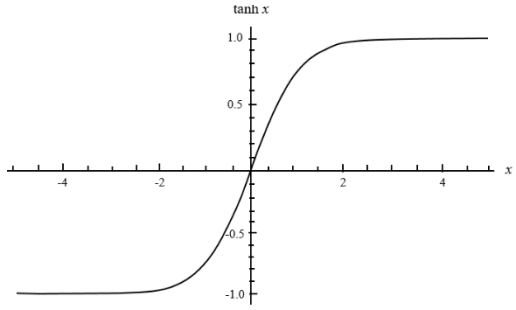

Fig. 4. Hyperbolic tangent function (tanh)

This study utilized the efficient Adam optimizer to optimize the network. Besides, it was benefited from the categorical cross-entropy loss function to learn a multi-class classification problem.

III. Results and Discussion

A 1D-CNN architecture was presented to perform early fault diagnosis for rolling bearings under variable working conditions. In this regard, the artificial faults were seeded with EDM to the inner raceway and rolling elements, and motor bearings were reassembled at the drive end of the experimental setup.

The rolling bearing was operated at 0 HP loading / 1797 rpm and 3 HP / 1730 rpm. Fig. 5 shows vibration graphs collected from healthy bearings operated under variable working conditions.

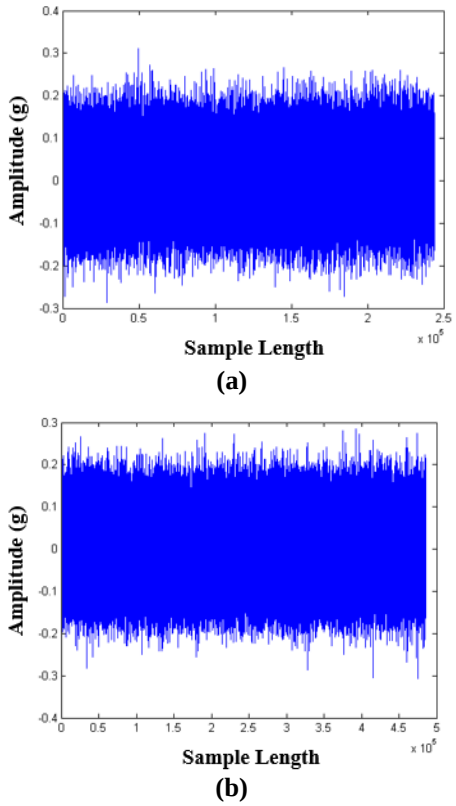

Fig. 5. Vibration signals of healthy bearings (a) 0 HP / 1797 rpm and (b) 3 HP / 1730 rpm

This process was repeated for both healthy bearings with no-fault introduced and faulty (inner raceway and rolling element) bearings. The vibration responses obtained for bearings with inner raceway fault are presented in Fig. 6.

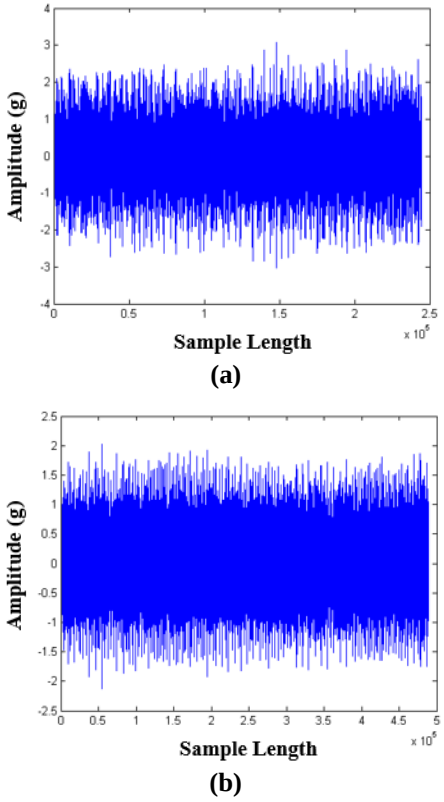

Fig. 6. Vibration signals of bearings with inner raceway fault (a) 0 HP / 1797 rpm and (b) 3 HP / 1730 rpm

The collected signals for rolling element faulty bearings under different conditions are presented in Fig. 7. In this regard, the sensitivity of bearing vibration responses to rolling element faults can be easily seen from Fig. 7.

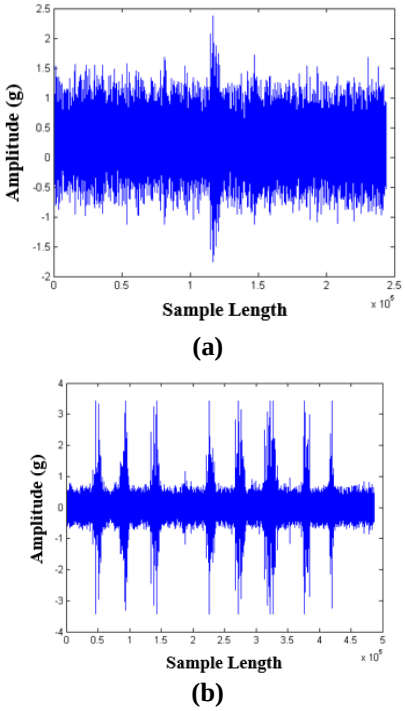

Fig. 7. Vibration signals of bearings with rolling element fault (a) 0 HP / 1797 rpm and (b) 3 HP / 1730 rpm

In this study, vibration signals collected for healthy and faulty bearings under variable working conditions were input to the 1D-CNN model. As a result, health conditions were

determined with 100% classification accuracy. The findings are promising for the performance of the proposed 1D-CNN model to be tested with more fault types and sizes.

The CWRU dataset is widely used in bearing fault detection and diagnostics and is considered a standard reference for model validation [21]. Tong et al. presented a novel bearing fault diagnosis method based on domain adaption using transferable features. Vibration signals were collected from raw data for both healthy and faulty bearings under variable working conditions. The performance of the proposed method was validated through the CWRU dataset. The nearest-neighbor (NN) classifier was employed to identify bearing faults. Consequently, it was stated that the NN classifier trained with the transferable features can identify the varying faults accurately [22]. Shenfield and Howarth proposed a novel dual-path RNN with a wide first kernel and deep convolutional neural network (RNN-WDCNN) to utilize on raw temporal data. The effectiveness of the proposed RNN-WDCNN model was tested using the CWRU benchmark dataset. The method was observed to perform better compared to some existing DL algorithms [23]. Chen et al. proposed a transferable CNN model for rotary machinery fault diagnosis under variable working conditions. The performance of the CNN model was evaluated with the data collected through the three experimental setups. The method was found to be suitable for condition monitoring and anomaly detection [24].

In summary, bearings are one of the components most likely to be damaged in mechanical systems operating under variable working conditions. Therefore, early fault diagnosis in rolling bearings is a critical subject and should be addressed in detail. In this regard, ML and DL algorithms that are successful in bearing fault diagnosis can be adapted for other rotating machine elements. Hereby, rotary machine health monitoring processes can be improved, and better maintenance strategies can be developed.

IV. CONCLUSIONS

This paper aims to present an AI-based method for early rolling bearing fault diagnosis that is needed in terms of safety and reliability. A vibration-based 1D-CNN method is utilized for the early bearing fault diagnosis under variable working conditions. Consequently, the proposed 1D-CNN architecture classified the healthy state, inner raceway, and rolling element bearing faults with an accuracy of 100%. The proposed approach can be used to optimize the maintenance costs and can potentially fault detection in rolling bearings operated under variable working conditions.

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An Evaluation of Machine Learning Algorithms for the Prediction of QSAR Bioconcentration Classes

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***Abstract*—** Measuring the extent to which contaminants arising from the acceleration of urbanization and industrialization accumulate in biotic phases after spreading is very important in environmental risk assessment. Especially bio-accumulative chemicals that accumulate in nature and are not easily removed from the body of living things can reach alarming levels for both the environment and the health of living things. The Bioconcentration Factor (BCF) is used as a criterion for the identification and elimination of bioaccumulative chemicals. In this study, the prediction of the BFC was made using different machine learning algorithms within the framework of Quantitative Structure-Activity Relationship (QSAR) and its performances were evaluated.

Keywords—bioconcentration, bioaccumulation, QSAR, machine learning, classification

I. INTRODUCTION

People have met their vital needs such as eating, drinking, and heating by making use of chemicals found in nature since ancient times. However, with the industrial revolution, it has started to be synthesized in artificial chemicals in the last century. As a matter of fact, there has been a rapid development in the amount and type of these chemicals, especially since 1960 [1]. According to the researchers conducted in recent years, it has been observed that artificially produced chemicals have negative effects on human health and the environment [2-5]. For example, long-term and high-dose exposure of people to these artificial pollutant chemicals; can cause serious problems in the kidney, cardiovascular, reproductive, immune system and skin [6]. Moreover, these artificial harmful chemical substances can cause accumulation in humans and other living things. This accumulation can be in the form of bioaccumulation, biomagnification or bioconcentration. This work focuses on bioconcentration, which is the accumulation of chemicals in aquatic living organisms.

There are various methods for measuring and evaluating bioconcentration. One of them is the bioconcentration factors (BCF) method. BCF is a proportional constant obtained by comparing the concentration of a chemical in an organism (usually fish) with its concentration in fixed water. Determining this ratio is very costly and requires the examination of many living things. Therefore, models such as the n-octanol-water partition coefficient (KOW) and Quantitative Structure-Activity Relationship (QSAR) are developed to predict BCF [7].

QSAR is a method of categorizing chemicals based on similarity. In the QSAR model, the biological effects of chemical compounds can be predicted, and these compounds can be separated into bioaccumulation classes based on these effects. Recently, many studies have been conducted in the literature for the prediction and analysis of QSAR. Grisoni et al. developed a classification process using classification and regression trees with a genetic algorithm to measure lipid-derived bioconcentration for 779 organic compounds [8]. The non-error rate performance results are 0.62 for class 1, 0.76 for class 2 and 0.66 for class 3. Czerminski et al. compare the performances of support vector machine (SVM), artificial neural network (ANN) and linear discriminant analysis (LDA) methods simulated and real (antihistamine and antibacterial agents) biological data [9]. Although both SVM and ANN give similar results and perform better than LDA, SVM method (Antihistaminic = 0.90, Antibacterial = 0.96) achieves better performance in real data sets. Ancuceanu et al. determine the cytotoxic effect of diverse chemical compounds on the SK-MEL-5 cell line using k-nearest neighbors (KNN), random forest (RF), gradient boosting machine (GBM) and SVM methods. RF showed the better results based on the precision performance metric (>85%) [10]. Hao et al. estimate the mutagenicity of nitroaromatic compounds (NAC) with seven machine learning methods, namely, KNN, decision tree (DT), Naive Bayes (NB), random forest (RF), Logistic regression (LR), neural network (NN), SVM [11]. According to the performance results, the highest scores are obtained with LR and NN methods and they both achieve 0.997 accuracy. Fan et al. also used the same machine learning methods in [11] to predict the rat acute oral toxicity of N-nitroso compounds [12]. Among the methods used, the NN (0.992) method revealed the better performance according to the area under the receiver operating characteristic curve.

In this study, the success of widely known machine learning methods (Naive Bayes, decision tree and SVM) is compared to predict bioaccumulation classes. QSAR Bioconcentration data set that contains the 779 compounds are separated according to bioaccumulation classes. Accuracy, sensitivity, and specificity performance metrics are used to measure the success of the compared methods. According to the experimental results, SVM demonstrates the better performance in the determination of these three classes.

This article is organized as follows. In section 2, details of the data set are provided. In section 3, compared machine learning methods are described. In section 4, performance measurement methods are explained and experimental results are discussed. In the last section, conclusions and suggestions for future studies are given.

II. DATA SET

In the study, the "QSAR Bioconcentration classes" data set is available on the UCI Machine Learning Repository is used [13]. It contains the 9 molecular descriptive features of 779 compounds and details of these features are demonstrated in Table I [14]. These compounds are partitioned into 3 bioaccumulation classes that are class 1 (Inert chemicals) (460), class 2 (Specifically bioconcentrating chemicals) (64) and class 3 (Less bioconcentrating chemicals) (255).

TABLE I. DETAILS OF FEATURES IN THE DATA SET

Compounds of Name	***Description***
nHM	Number of heavy atoms
piPC09	Molecular multiple path count of order 9
PCD	Difference between multiple path count and path count
X2Av	Average valence connectivity index of order 2
MLOGP	Moriguchi octanol-water partition coeff. (logP)
ON1V	Overall modified Zagreb index of order 1 by valence vertex degrees
N-072	RCO-N< / >N-X=X
B02[C-N]	Presence/absence of C - N at topological distance 2
F04[C-O]	Frequency of C - O at topological distance 4

III. METHODS

A. Naive Bayes

Naive Bayes is a classification method based on Bayes' theorem [15]. This method decides the classes after making samples conditional probability calculations on the samples. Bayes theorem is expressed as

$$P(A|B) = \frac{P(B|A) \times P(A)}{P(B)} \quad (1)$$

where P(A) and P (B) are the a priori probabilities of events A and B; P(A|B) is the probability of A, given B; P(B|A) represents the probability of B, given A. The most important thing to consider when creating a model in the Naive Bayes classifier is the selection of the features. Because this method gives equal importance to all features in the data set. Naive Bayes classifiers can give more successful results with far fewer samples in the training sets than other methods when the features of the data set are uncorrelated. The disadvantage of this method is that the parameters of the model are limited, and feature selection may be required by the user in some data sets, due to the equal importance of each feature.

B. Decision Tree

Decision tree is a widely used supervised machine-learning algorithm due to its simplicity and interpretability. The model of this method is tree shaped and consists of root nodes, branches, and decision nodes [16]. While creating the tree structure, uncertainty calculations are made between the features. In uncertainty calculations entropy and gini are used, but the entropy method is generally preferred. The reason for this is that the entropy method tends to produce a more balanced tree. The feature that best divides the data set into two equal parts is determined by using the uncertainty calculation and this creates the root node. Then the same processes continue for branches and end at the decision nodes. Through this tree model, simple decision structures are obtained from complex data sets. The advantages of the decision tree algorithm are that after the model is trained, the classification process is extremely fast, and the data does not need to be scaled. Despite these advantages, small changes in the data set can greatly affect the constructed model and affect the performance.

C. Support Vector Machine

SVM is a powerful method that can be used for both classification and regression problems. SVM aims to find an optimal hyperplane that can separate classes. For this purpose, it initially finds the closest samples between each class, and they are called support vectors. Then, the optimal hyperplane is founded by utilizing the support vectors. SVM performs well in linearly separable data, but in real life most of the data sets are not linearly separable. To work on non-separable data, SVM uses a powerful tool called a kernel trick. By this way, input feature space can be mapped to the higher dimensional features space and the data, which is not separable in input feature space, becomes linearly separable. Although different kernels are proposed to operate on specific situations, commonly used kernels are linear, polynomial, sigmoid, and the radial based functions[17].

IV. RESULTS AND DISCUSSION

A. K-fold Cross Validation Method

In supervised machine learning methods, the data set should be separated into train and test sets in order to train the method and evaluate success. At this stage, splitting the data set randomly or separating the first part as a train and the rest as a test is insufficient in evaluating the success of the methods. For this reason, the k-fold cross validation method is used in the literature to obtain more accurate and comparable results [18]. In k-fold cross validation, the data set is randomly divided into k equal parts according to the k value determined by the user. k-1 of these parts is used as training data and the remaining part is used as test data. For this purpose, the method is run k times, as each part must

be used as test data once. Then, the performance of the method is computed by taking the average of the results obtained.

B. Performance Criteria

The confusion matrix is utilized in the calculation of performance metrics. The confusion matrix used for multi-class machine learning problems is given in Table II. There are a number of classes in this representation. Columns show predicted classes and rows demonstrate actual classes.

C_{AK} represents the number of samples falsely estimated from class A to class K; the C_{AA} represents the number of correctly classified samples in class A. The diagonal elements of the confusion matrix, which is a square matrix of AxA, gives the number of correctly classified samples in each class, and the values outside the diagonal elements give the number of incorrectly classified samples. In Table II, N refers to the total number of samples in the data set, N_A value equals to the total number of samples belonging to class A, and N'_A is the number of samples falsely estimated as class A.

TABLE II. CONFUSION MATRIX FOR MULTICLASS

		Predicted Class					
		1	***2***	***….***	***K***	***A***	
True Class	***1***	C_{11}	C_{12}	….	C_{1K}	C_{1A}	N_1
	2	C_{21}	C_{22}	….	C_{2K}	C_{2A}	N_2
	….	….	….	….	….	….	….
	K	C_{K1}	C_{K2}	….	C_{KK}	C_{KA}	N_K
	A	C_{A1}	C_{A2}	….	C_{AK}	C_{AA}	N_A
		N'_1	N'_2	….	N'_K	N'_A	N

Accuracy (ACC), sensitivity (SN) and specificity (SP) metrics are frequently used to compare the performance success of the methods, and they are calculated separately for each class in multiclass classification data. The ratio of the correctly estimated number of samples to the number of samples in the whole data set gives the accuracy metric. The Acc performance metric of the A class is calculated as follows:

$$ACC_A = \frac{(C_{AA} + \sum_{k=1}^{A}(N_k - C_{kA}))}{N} \quad k \neq A \tag{2}$$

Sensitivity, called the true positive ratio, represents how accurately samples of the evaluated class are predicted and the SN performance metric of class A. It is calculated as follows:

$$SN_A = \frac{C_{AA}}{N_A} \tag{3}$$

The specificity value, also known as true negative rate, represents the success of a model in discriminating samples that do not belong to the class under evaluation. The specificity rate of class A is calculated as follows:

$$SP_A = \frac{\sum_{k=1}^{A}(N_k - C_{kA})}{N - N_A} \quad k \neq A \tag{4}$$

C. Experimental Results

In this study, 3 different machine learning methods are used for estimation of the bioaccumulation classes. Data set comprises 9 molecular descriptive attributes of 779 compounds which are separated into 3 classes. ACC, SN and SP performance metrics are used to evaluate the benchmarking methods. To obtain the more reliable results, k fold cross validation with k=10 is applied and is iterated 10 times. Accuracy results of the compared methods are demonstrated in Table III. As can be seen from Table III, the highest accuracy result is obtained as 0.9392 with SVM method in class 3. The NB method (0.6416) is given the lowest accuracy result for class 1. According to the accuracy results, the SVM method achieved the best performance for the 3 bioaccumulation classes compared to the benchmarking methods. The lowest performances in the three classes are obtained by the NB classification method.

TABLE III. ACCURACY RESULTS OF THE METHODS

	Class 1	***Class 2***	***Class 3***	***Average***
NB	0.6416	0.8890	0.6921	0.7409
DT	0.6824	0.909	0.7264	0.7726
SVM	**0.7033**	**0.9392**	**0.7404**	**0.7943**

Sensitivity and specificity results are presented in Table IV and Table V, respectively. As can be seen from Table IV and Table V, all of the methods give high sensitivity and low specificity values for class1. However, low sensitivity and high specificity values are obtained for class 2 and class 3. The low sensitivity ratio indicates that the class 2 and class 3 samples are not sufficiently differentiated by the models. The high specificity rate reveals that the models are more successful in classifying those that do not belong to class 2 and class 3. Based on the experimental results, it is seen that the models are successful in finding samples of the class 1, but they cannot demonstrate the same performance in distinguishing the other classes (class 2 and class 3). The reason for this situation is that the number of compounds belonging to class 1 in the data set is higher than the compounds of other classes. Therefore, there are not enough samples in the data set to construct a better model for the class 2 and class 3.

TABLE IV. SENSITIVITY RESULTS OF THE METHODS

	Class 1	***Class 2***	***Class 3***	***Average***
NB	0.7039	0.3038	**0.5216**	0.5098
DT	0.7929	0.2969	0.5081	0.5326
SVM	**0.8754**	**0.3090**	0.4558	**0.5467**

TABLE V. SPECIFICITY RESULTS OF THE METHODS

	Class 1	***Class 2***	***Class 3***	***Average***
NB	**0.5517**	0.9414	0.7750	0.7561

DT	0.5232	0.9638	0.8327	0.7732
SVM	0.4552	**0.9956**	**0.8789**	**0.7766**

V. CONCLUSION

In this study, the performances of NB, DT and SVM are compared in predicting the bioaccumulation classes of compounds. Since the parameters affect the success of the methods, hyperparameter adjustment is made with grid search for each method. Accuracy, sensitivity and specificity performance metrics are calculated to evaluate the performance of the methods. Also, k-fold cross validation method (k = 10, iteration = 10) is applied to obtain more reliable results. According to the results, the highest accuracy (average: 79.43 %) is obtained in SVM for the 3 bioaccumulation classes.

In future studies, the number of class 2 and class 3 compounds can be increased in order to eliminate the imbalance data set distribution problem. Different machine learning methods can be applied to achieve higher performance. In addition, feature selection methods can be applied to determine more effective features. This may enable to increase both time and memory efficiency.

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The Performance Comparison of Machine Learning Algorithms in a Heart Disease Data Set

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***Abstract*—The heart disease has increased significantly worldwide and has become one of the leading causes of death in recent years. It is very important to make the right medical decision in this disease, to observe the symptoms and course of the disease and to evaluate the effect of treatment methods. Many different factors can make it difficult to detect possible heart abnormalities and cause a delay in making an accurate diagnosis. This situation has made it more convenient to use statistical analysis and machine learning algorithms in the diagnosis of heart disease. Towards achieving this goal, in this paper, we present decision support system based on Multilayer Perceptron (MLP), Support Vector Machines (SVM) and Radial Basis Function Networks (RBFN) methods could be used to predict a heart disease. The Cleveland heart disease database that has donated by UCI repository, was used as the main database for the training and testing of developed systems. The proposed models were run with 10 fold cross validation for different epoch number, activation function, kernel function, neuron number, training and test ratios. As a result of our work, the highest accuracy rates were obtained as 89.2% in the MLP with 30-10 neuron and two hidden layers based on tangent-sigmoid and linear function, 85.4% in the SVM with linear kernel function and 87.6% in the RBFN with 13 neurons.**

Keywords—Machine Learning, Heart Disease Prediction, Multilayer Perceptron, Support Vector Machines, Radial Basis Function Networks

I. INTRODUCTION

Nowadays, heart disease that caused by smoking and alcohol use, obesity, lack of exercise and genetic factors, has increased significantly worldwide and has even been one of the most important causes of deaths in the last 10 years. For this reason, physical signs and medical controls must be taken into attention in order to provide early diagnosis and minimize risks in heart diseases.

A large amount of data is produced on a daily basis by the health sector; however, it has not an effective analysis tool to discover hidden relationships in the data. In this regard, data mining provides a multidisciplinary field of study based on statistics and machine learning, which enables large amounts of data to be processed to extract meaningful information and patterns [1]. Data mining is necessary to make effective decisions in the links of healthcare data that need to be analyzed. Data mining can evaluate the effect of action paths to be applied by comparing the causes, symptoms, and course of diseases in medical decision making.

Heart disease prediction is considered one of the most complex applications in the field of health sciences. Many different factors can make it difficult to detect possible heart abnormalities and cause a delay in making the correct diagnosis. This situation has made it more suitable to use techniques such as statistical analysis, machine learning techniques, artificial intelligence, and database management systems in the diagnosis of heart disease.

Recently, many machine learning-based studies have been conducted to improve accuracy in diagnosing heart disease. For example, Boshra Bahrami et al. worked on the evaluation of the accuracy obtained from different classification techniques in the diagnosis of heart disease. Four different classifier algorithms such as J48 decision tree (DT), Nearest Neighbor Classification (NNC), Naive Bayes (NB), and SVM were used to classify the data set, and 83.73%, 82.77%, 81.81% and 82.77% accuracy values were obtained, respectively [2]. Olaniyi et al. applied MLP and SVM methods to prevent misdiagnosis in heart diseases. The obtained results are 85% with MLP and 87.5% with SVM [3]. Abushariah et al. worked on two basic methods: MLP and Neuro-Fuzzy Inference Systems (NFIS) for the heart disease diagnosis system. The best accuracy rates obtained with MLP and NFIS methods are 87.04% and 75.93%, respectively [4]. Gokulnat and Shantharajah used a genetic algorithm to select features in the dataset. According to the seven selected features, heart disease prediction accuracy is determined with SVM, multi-layer sensor, J48 DT, and NNC methods. By comparing the results with the models built on the original data set; showed that the genetic algorithm gave the highest accuracy of 88.34% when used with SVM [5]. Yan et al. achieved 85.15% accuracy with the SVM, although they achieved an 89.23% accuracy from the dataset by supporting this method with independent component analysis (ICA) [6]. Durairaj M. and Sivagowry S. observed that preprocessing that can be applied to the dataset in the diagnosis of heart disease have an important effect in increasing the diagnostic accuracy. In their experiments, they achieved approximately 91% accuracy with both MLP and RBFN methods. [7]. K.Sathya et al. analyzed SVM, MLP and K-Nearest Neighbor (KNN) classifier algorithms for seer heart disease dataset. SVM classifier is superior to KNN and MLP and it achieves the highest classification accuracy of 85.9% with minimum false positive of 15.3% [8]. Kaan Uyar et. al proposed a genetic algorithm (GA) based trained recurrent fuzzy neural networks (RFNN) for investigation of heart diseases. The result of the approach was evaluated with RMSEs, sensitivities, specificities, precisions, F-scores, PMEs and accuracies of the training set, testing set and overall. They showed that 97.78% accuracy was obtained from testing set [9]. Halima El Hamdaoui et al. worked machine learning algorithms such as Naive Bayes, KNN, SVM, Random Forest,

and Decision Tree for predicting Heart Disease. The obtained results are 76.56% with KNN and 79.2% with SVM, 69.3% with RF 75.27% with DT and Naive Bayes outperforms using both cross-validation and train-test split techniques with an accuracy of 82.17%, 84.28%, respectively [10].

In the literature, the number of studies on various machine learning applications based on heart disease prediction algorithms is quite high. However, since the parameters of each proposed algorithm have not been determined properly, effective accuracy rates have not been achieved. Complex pre-processing methods have been applied to increase accuracy rates, which results in increased calculation time of the applied algorithm. In this study, three different machine learning methods have been proposed to overcome the above mentioned problems. Simple architectural network designs have been created in order to analyze the parameters in detail and achieve the highest accuracy.

II. RESEARCH ALGORITHMS AND CONCEPTS

A. *Multilayer Perceptron (MLP)*

Multilayer Perceptron method is one of the most frequently used the machine learning algorithms in medical decision support systems. This architectural structure of the controlled neural network class consists of at least three layers of nodes: the input layer, the hidden layer, and an output layer [3].

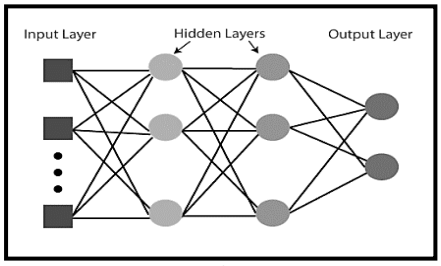

Fig. 1. The Structure of Multilayer Resceptron

Except for input nodes, each node has neurons that have used a nonlinear activation function. We can express the mathematical structure of the structure of this network architecture as follows:

$$V_j = \sum_{i=1}^{P} W_{ij} X_i + \theta_j$$

$$y_j = f_j(V_j)$$

where

V_j: *The linear combination of inputs* $X_1, X_2, \ldots X_p$

θ_j : *The bias*

W_{ij}: *The connection weight between the input* X_i *and the neuron* j

$f_j(.)$: *Theactivation function of the* j *the neuron*

y_j: *The output*

$$F(\alpha) = \frac{1}{1 + e^{-\alpha}}$$

MLP, the training stage updates the each weights value of the network based on the learning algorithm. The algorithm network weights are updated in a supervised mode using the Back Propagation (BP) algorithm and according to the following formula.

$$Wij\ (t{+}1) = Wij(t) - \varepsilon \frac{\partial Ef}{\partial Wij(t)}$$

Where;

ε: *The learning rate and,*

Ef: *The error function*

Its multiple layers and nonlinear activation separate this neural network architecture from a linear sensor and can distinguish data that cannot be linearly separated.

The basic principle of Multilayer Perceptron methods is that when the input layer is accessible, network neurons perform computations in hidden layers until an output variable is obtained in output neurons. Here, the output layer should be able to represent the related class for the each input data.

B. *Support Vector Machine (SVM)*

Support vector machine is a supervised learning method used for classification, regression and have been applied in medical diagnosis for diseases classification. The basis of SVM classification is the linear classification of data. Basically, when classifying data, it is based on the principle of identifying the hyper plane, which can find the closest examples to each other and can separate the two classes at the maximum distance from each other. [14]

As the separator surface can have many different alternatives without changing the accuracy of the data set, the separator surface is at the same distance and maximum distance to both classes thanks to SVM. We can show the classification line equations where the entries are in the form (x_i, y_i) and this is created accordingly:

$$W^T X + b = 0$$

$$W^T X_i + b \geq 0 \; for \; y_i = +1$$

$$W^T X_i + b \leq 0 \; for \; y_i = -1$$

The Lagrange relation $(\alpha_i \geq 0, i = 1, \ldots m)$ we obtain with these linear equations can be reduced to a mathematical evaluation function. According to this mathematical relation, x_i models corresponding to non-zero Lagrange coefficients are called support vectors. The resulting decision function has the following form:

$$L(W, b, a) = \frac{w.w}{2} - \sum_{i=1}^{m} \alpha_i (d_i (W.x_i + b) - 1)$$

A kernel function is used to convert nonlinear datasets into a higher dimensional area in which SVM theory can be separated linearly.

$$L(a) = \sum_{i=1}^{m} \alpha_i - \sum_{i=1}^{m} \sum_{i=1}^{m} \alpha_i \, \alpha_j d_i \, d_j K(K(x_i, x_j))$$

The kernel operation returns the dot product of two instances in a higher dimensional space without actually converting it to this space. This concept, called the kernel trick, allows us to transform into large-sized spaces for

classification purposes. The most commonly used kernel functions are linear, polynomial and RBF functions.

$$K(x_i, x_j) = \begin{cases} (x_i x_j), & lineer \\ (1 + x_i x_j)^p, & polinom \\ \exp\left(\frac{1}{2}\|x_i - x_j\|^2\right), & RBF \end{cases}$$

C. Radial Basis Function Network (RBFN)

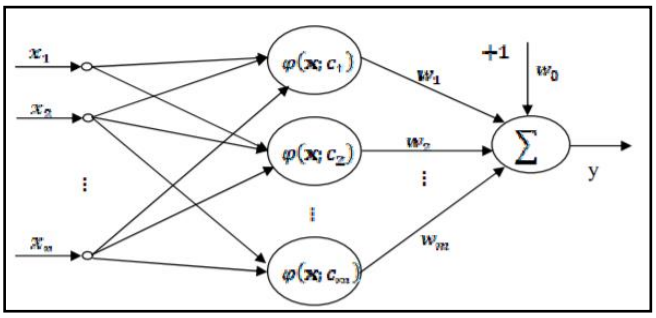

Fig. 2. The Structure of Radial Basis Function Network (RBFN)

The radial-based function network is a two-layer feed forward neural network. In this neural network architecture, Gauss, or radial functions with a central point (X_i) covering a certain radius are used. The mathematical output relation for each neuron of radial-based basic functions is as follows:

$$y(x) = \sum_{i=1}^{N} W_i \emptyset(\|x - x_i\|$$

In this mathematical relation, x is the weight vector and (x_i) is the input vector. In Figure 3, the mechanism of the RBF neural network can be seen [13].

In this study, three different machine learning-based algorithms, "Support Vector Machines", "Multilayer Layer Perceptron" and "Radial Basis Function Network" were used to classify the heart disease estimation dataset with the MATLAB program.

III. EXPERIMENTS AND RESULTS

The data set used in our machine learning based decision support systems is the Cleveland Heart Database taken from Detrano donated UCI learning dataset [11]. This database consists of 303 records, each of which has 13 clinical features such as age, gender, type of chest pain, resting blood pressure, cholesterol, fasting blood sugar, resting ECG, maximum heart rate, angina due to exercise, old peak, slope, number. However, 6 records with missing values were removed from the dataset. In the database, 0 corresponds to the absence of any disease and is divided into five classes, 1,2,3,4 corresponding to four different disease types. In the systems that we recommend, the binary classification method is utilized in this database to separate between the absence (0) and presence (1, 2, 3 or 4) of a disease.

A. The Experimental Results for MLP

In the multilayer perceptron technique, a basic algorithm structure was created, in which we obtained a high accuracy rate. This proposed structure, binary classification was made by separating 77% of the data for train and 23% for testing. The consisting of two hidden layers based on tangent-sigmoid and linear function, the structure has 1000 epochs number. In addition, 10-fold cross-validation technique is integrated into our proposed algorithm for this method. The main reason for choosing this technique is that it has a lower variance compared to other evaluative methods. In addition, in extensive tests on a large number of different data sets with different techniques, K = 10 has shown that there are the correct number of layers to achieve the best error estimate [12].

The multilayer perceptron technique based supporting system achieved best values that 89.2% accuracy, 86.0% sensitivity, 94.1% specificity and 95.6% precision. As the number of epochs increases, the accuracy rate obtained from the algorithm created increases. One can examine the results data from Table 1.

TABLE I. IN MULTILAYER PERCEPTRON, INCREASING METHOD EPOCH NUMBER EVALUATION

Epoch Number	Accuracy	Specificity	Sensitivity	Precision
100	86.7%	82.7%	86.5%	84.7%
250	86.9%	86.2%	87.6%	88.2%
500	87.3%	89.5%	85.7%	91.7%
1000	87.9%	88.5%	87.3%	90.6%
1500	88.1%	89.7%	86.8%	91.7%
2000	88.4%	91.9%	86.0%	93.8%

In the two-layer based Multilayer Perceptron algorithm, the effect of different activation functions on our results data is shown in Table 2. Accordingly, the use of tangent-sigmoid and Gauss functions has been choices that can positively affect the accuracy rates we have achieved.

TABLE II. IN MULTILAYER PERCEPTRON METHOD, THE EVALUATION OF ACTIVATION FUNCTION TYPES IN HIDDEN LAYERS

Activation Function					
First Layer	Second Layer	Accuracy	Specificity	Sensitivity	Precision
Tang-Sig	Tang-Sig	86.2%	89.1%	83.2%	84.7%
Pure-Lin	Pure-Lin	85.4%	84.3%	87.0%	89.6%
Log-Sig	Log-Sig	84.7%	82.4%	88.1%	91.0%
Gauss	Gauss	86.6%	91.5%	81.9%	82.6%

By keeping the number of hidden layers constant, the number of neurons has been changed and in Table 3. The number of neurons is shown for each layer separately. A certain increase in the number of neurons used has increased the accuracy value obtained in our algorithm.

TABLE III. THE MULTILAYER PERCEPTRON METHOD, EVALUATION OF NEURON NUMBER EFFECT IN HIDDEN LAYERS

Neuron Number	Accuracy	Specificity	Sensitivity	Precision
[5 5]	87.9%	88.5%	87.3%	90.6%
[10 10]	87.2%	95.4%	82.4%	96.9%
[5 15]	87.9%	85.8%	89.7%	87.5%
[20 20]	88.2%	96.2%	83.4%	97.5%
[10 30]	88.9%	91.9%	86.7%	93.8%
[30 10]	89.2%	94.1%	86.0%	95.6%

B. *The Experimental Results for SVM Technique*

In the Support Vector Machines method-based decision support system, 70% of the data is reserved for training and 30% for testing and binary classification is made by adding 10-fold Cross Verification technique to our algorithm. Experimental results (Table 4) were obtained in a way that we can observe the effect of Kernel function types on changes in accuracy, sensitivity, specificity, and precision.

TABLE IV. IN SUPPORT VECTOR MACHINE METHOD, KERNEL FUNCTION TYPE EFFECT EVALUATION

Kernel Function	Accuracy	Specificity	Sensitivity	Precision
Gaussian	84.3%	97.1%	75.9%	97.6%
Linear	85.4%	88.2%	83.2%	92.0%
Polynomial	80.9%	76.7%	84.8%	79.6%

C. *The Experimental Results for RBFN Technique*

In the proposed radial-based function networks decision support system, 70% of the data is reserved for training and 30% for testing, and dual classification is made. When this structure is supported with 25 epoch numbers and 13 neurons, 87.6% accuracy, 85.2% sensitivity, 91.4% specificity and 93.9% precision ratio were obtained.

We observed the effects of parameter values changes on the obtained accuracy using this basic algorithm structure. In Table 5, the values that we obtained as a result of the change in the train and test rates are shown.

TABLE V. IN RADIAL BASIS FUNCTION METHOD, TEST & TRAIN RATIO EFFECT EVALUATION

Train Ratio	Test Ratio	Accuracy	Specificity	Sensitivity	Precision
70%	**30%**	87.6%	91.4%	85.2%	93.9%
60%	**40%**	86.5%	85.4%	87.8%	83.7%
50%	**50%**	84.5%	81.2%	87.3%	84.1%
40%	**60%**	83,7%	81.7%	85,4%	84.5%
30%	**70%**	81.7%	85.7%	79.0%	89.1%
20%	**80%**	80.3%	89.7%	74.8%	92.6%

In RBFN, as the number of periods increases up to a specific value, the accuracy rate obtained from the created algorithm increases. The values that we obtained as a result of the change in the train and test rates are predicated in table 6.

TABLE VI. IN RADIAL BASIS FUNCTION NETWORK METHOD, EPOCH NUMBER EFFECT EVALUATION

Epoch Number	Accuracy	Specificity	Sensitivity	Precision
5	82.0%	82.5%	81.6%	85.1%
10	86.5%	78.9%	92.2%	85.5%
25	87.6%	91.4%	85.2%	93.9%
50	86.5%	85.4%	87.8%	83.7%
100	83.1%	85.3%	81.8%	90.0%

According to the changes in the number of neurons that shown in Table 7, the increasing the number of neurons to a certain level improves accuracy; however, we cannot observe a positive effect afterwards.

TABLE VII. IN RADIAL BASIS FUNCTION NETWORK METHOD; NEURON NUMBER EFFECT EVALUATION

Neuron Number	Accuracy	Specificity	Sensitivity	Precision
5	82.0%	82.4%	81.8%	88.2%
10	83.1%	80.0%	85.7%	84.0%
13	87.6%	91.4%	85.2%	93.9%
20	85.4%	87.2%	84.0%	89.4%
30	80.9%	79.5%	82.2%	80.4%
50	79.8%	86.5%	75.0%	88.6%

The classifiers presented, MLP, SVM and RBFN are compared in Figure 3 based on the accuracy, precision, specificity, and precision of the result obtained.

It is clearly seen from the Figure 3, the MLP has higher accuracy (89,2%) than SVM (85.4%) and RBFN (87.6%). Generally, all classifiers can be considered good classifiers to diagnose heart disease, and there are only minor differences between the accuracy results. Despite minor differences, MLP stands out as the best classifier for diagnostic heart disease.

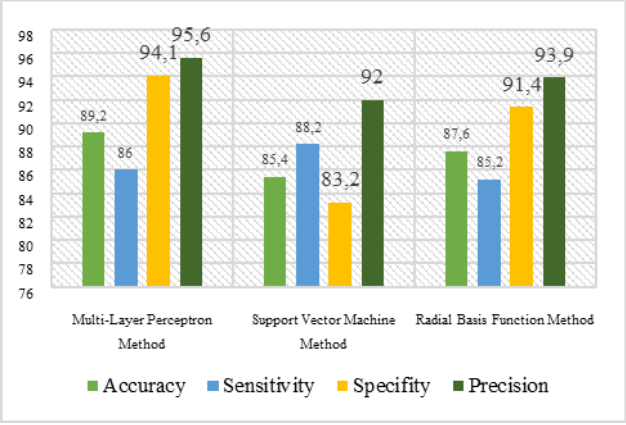

Fig. 3. The Graph of Proposed Machine Learning Methods Results

IV. CONCLUSION

The prediction of heart disease is an important problem for human life that needs to be diagnosed quickly in advance. In this study, three different machine learning algorithms (MLP, SVM, and RBFN) are analyzed in detail to quickly detect heart disease in advance. For this purpose, the proposed machine learning models are run with 10-fold cross validation for different epoch number, activation function, kernel function, neuron number, training and test ratios. The results of the experiments have the best performances in which we reached an accuracy of 89.2% with the Multilayer Perceptron method, 85.4% with the Support Vector Machine method and 87.6% with the Radial Basis Function Network method. In addition, we also examined the parameters of algorithm structures and, we recorded the successful evaluation results.

All three proposed methods provide high accuracy for classifying heart disease data with their architectural structure and parameters. Therefore, decision support systems created by the methods examined can be recommended to healthcare professionals and researchers to help predict heart disease.

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Analysis Of Bitcoin Returns By Machine Learning Algorithms: Comparison And Forecasting

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***Abstract*— Cryptocurrencies are the decentralized version of the money which are stored online. These currencies are attracted by more investors in recent years as an effect of digitalization. Volume of these currencies are increasing day by day and there is no government or groups of governments which has control on it, so the price dynamics differ from the classical currencies. In this study, it is aimed to forecast daily returns of Bitcoin, it is a well-known cryptocurrency, by utilizing various machine learning algorithms including decision trees regression, support vector machines, ensemble algorithms and boosting algorithms. Daily returns of 1664 observations are used for the periods between July, 2016 and December 2020. 20 cryptocurrencies are used as features for the algorithms. Also, it is aimed to compare the performance of utilized algorithms and identify the key cryptocurrencies which are the highest importance on predicting the returns of Bitcoin.**

Keywords—forecasting; support vector machine; ensemble algorithms; decision tree algorithms; boosting algorithms; feature importance.

V. INTRODUCTION

At the present, with the increasing world population, the basic requirements of people are increasing at the same time. Increasing population brings some problems with it. Inflation comes first among these problems; in which countries always have difficulty solving it in their economic markets. Inflation is defined as the wholesale increase emerging in prices due to the growth of the gap between the amount of money in circulation and sum of goods and purchasable services. Accordingly, an increase in inflation of a country results in an increase in the amount of money that people have to pay in order to meet their basic needs. To overcome this problem, people have to protect their money against inflation with various financial instruments. Precious metal purchases, deposit accounts, stock exchange transactions could be given as examples of such financial instruments. However, inflation increase as a result of decrease in value of currency of developing countries in the last few years. Also the demand for the investment instruments mentioned above in which people living in developed countries visibly decreased because of a long time of the return time and unsatisfactory of return rate. Therefore, people started search of different investment instruments.

The use of cryptocurrencies is increased in recent years which continue to rise rapidly to the top, leaving behind many global companies and even most precious metal in terms of transaction volume in global markets.

Cryptocurrency is an application including consensus mechanism, encryption algorithm, distributed node for data storage and point-to-point transmission under a new scenario dependent block-chain technology. Forecast of return rate of commercially available cryptocurrencies are very difficult due to limitations of traditional methods. Therefore, researchers have started to use mathematical algorithms to analyze and process data of home and abroad cryptocurrencies markets with artificial intelligence algorithms being a hot topic today.

[3] used GARCH-MIDAS model to extract the long-term and short-term volatility components of cryptocurrencies. The results showed that realized a negative and highly significant effect on long-term among S&P 500 and Bitcoin, and Bitcoin volatility is closely linked to global economic activity. [11] adopted the impacts of structural breaks (SB) on the dual long memory levels of Bitcoin and Ethereum price returns being the two from most known of cryptocurrencies. The results showed that structural breaks findings have important implications for both cryptocurrency allocations and portfolio management. [9] adopted the dynamics of multiscale interdependencies among five leading and liquid cryptocurrencies by using wavelet analyses that account for the heterogeneous behavior of crypto-traders and crypto-investors. The results showed that wavelet analyses emerged the short and long-run market integration among different cryptocurrency pairs. [4] adopted market integration among twelve most known cryptocurrencies by using the dynamic equicorrelation (DECO) model. The results showed that among cryptocurrencies explored trading volume and measures of uncertainties are main determinants of integration.

As seen in the above, the use of methods based artificial intelligence is not common on cryptocurrencies market. Therefore, in this study we aimed to try and compare various machine learning algorithms to analyze and forecast cryptocurrencies returns. Also, it is aimed to investigate the capabilities of the algorithms.

VI. METHODOLOGY

A. Support Vector Regression

[1] introduced support vector machine (SVM) which can be used for both regression and classification. The algorithm optimizes its structure according to data. In regression, Ɛ-insensitive loss function is used. More details can be found in [10]. In this section we try to give the fundamentals of the algorithm. Let, $T = \{(x_i, y_i)\}$ be the set of training samples, where $x_i \in \Re^n$ represent the inputs values while $y_i \in \Re$ represents the output values for $i = 1, 2, 3, ..., N$. In SVM the goal is to find a flat function $f(x)$ which has at most ε deviation from each output values y_i of training set.

The function for the linear case is as follows

$$f(x) = \langle w, x \rangle + b, \tag{1}$$

where $\langle .,. \rangle$ represents the dot product with weight coefficients w and constant b. For the linear case by using the kernel function Φ, which is a non-linear mapping, (1) is transferred to

$$f(x) = \langle w, \Phi(x) \rangle + b. \tag{2}$$

The function $f(x)$ fits the data but to avoid overfitting the norm value of *w* i.e. $\|w\|^2 = \langle w, w \rangle$ is minimized. This minimization problem can be written as a convex optimization problem as

$$\begin{aligned} &\text{minimize } \frac{1}{2}\|w\|^2 \\ &\text{s.t: } \quad y_i - \langle w, x_i \rangle - b \le \varepsilon \\ &\qquad \langle w, x_i \rangle + b - y_i \le \varepsilon \end{aligned} \tag{3}$$

This optimization problem is feasible with the assumption that a function exists that approximate each pair of training set with ε accuracy. In order to allow some errors, slack variables ξ_i, ξ_i^* are introduced. Then the optimization problem can be rewritten as:

$$\begin{aligned} &\text{minimize } \frac{1}{2}\|w\|^2 + C\sum_{i=1}^{n}(\xi_i, \xi_i^*) \\ &\qquad y_i - \langle w, x_i \rangle - b \le \varepsilon + \xi_i \\ &\text{s.t: } \quad \langle w, x_i \rangle + b - y_i \le \varepsilon + \xi_i^* \\ &\qquad \xi_i, \xi_i^* \ge 0 \end{aligned} \tag{4}$$

where C is the penalty factor which characterize the relation between the flatness of $f(x)$ and ε. In the nonlinear case, by using Φ the optimization problem (4) can be rewritten as

$$\begin{aligned} &\text{minimize } \frac{1}{2}\|w\|^2 + C\sum_{i=1}^{n}(\xi_i, \xi_i^*) \\ &\qquad \Phi(y_i) - \langle w, x_i \rangle - b \le \varepsilon + \xi_i \\ &\text{s.t: } \quad \langle w, x_i \rangle + b - \Phi(y_i) \le \varepsilon + \xi_i^* \\ &\qquad \xi_i, \xi_i^* \ge 0 \end{aligned} \tag{5}$$

Introducing Lagrange function and a dual set of variables lead the followings

$$\begin{aligned} L = &\frac{1}{2}\|w\|^2 + C\sum_{i=1}^{n}(\xi_i, \xi_i^*) - \sum_{i=1}^{n}(\eta_i \xi_i + \eta_i^* \xi_i^*) \\ &-\sum_{i=1}^{n}\alpha_i(\varepsilon + \xi_i - y_i + \langle w, x_i \rangle + b) \\ &-\sum_{i=1}^{n}\alpha_i^*(\varepsilon + \xi_i^* + y_i - \langle w, x_i \rangle - b), \end{aligned} \tag{6}$$

where L is the Lagrangian and $\eta_i, \eta_i^*, \alpha_i, \alpha_i^*$ are Lagrange multipliers. We have

$$\partial_b L = \sum_{i=1}^{n}(\alpha_i^* - \alpha_i) = 0. \tag{7}$$

$$\partial_w L = w - \sum_{i=1}^{n}(\alpha_i - \alpha_i^*)x_i = 0. \tag{8}$$

$$\partial_{\varepsilon_i^*} L = C - \alpha_i^* - \eta_i^* = 0. \tag{9}$$

After solving the optimization problem w and $f(x)$ can be found as

$$w = \sum_{i=1}^{n}(\alpha_i - \alpha_i^*)x_i. \tag{10}$$

$$f(x) = \sum_{i=1}^{n}(\alpha_i^* - \alpha_i)\langle x_i, x \rangle + b, \tag{11}$$

where

$$b = y_i - \langle w, x \rangle - \varepsilon \text{ for } 0 \le \alpha_i < C \tag{12}$$

$$b = y_i - \langle w, x \rangle + \varepsilon \text{ for } 0 \le \alpha_i^* < C \tag{13}$$

For the non-linear case we have

$$f(x) = \sum_{i=1}^{n}(\alpha_i^* - \alpha_i)K(x_i, x) + b. \tag{14}$$

where $K(x_i, x_j) = \Phi^T(x_i)\Phi(x_j)$ is the non-linear mapping. The choice of the kernel *K* depends on the pattern of data. Possible kernels that can be utilized in this work are RBF Kernel $K(x_i, x_j^T) = \exp\left(-\frac{\|x_i - x_j^T\|^2}{2\sigma^2}\right)$ and polynomial kernel $K(x_i, x_j^T) = \left(x_i x_j^T + 1\right)^d$ for any $d > 0$.

B. k-Nearest Neighbors Regression

k-Nearest Neighbor (k-NN) algorithm is a lazy supervised algorithm. It is lazy because it does not form any model or learning in the training phase. k-NN makes decisions according to the closet k nearest data point. Assume that there exists training set $x \in \Re^d$. The algorithm stores n-dimensional training data $(x^i, f(x^i))$, where $f: \Re^d \to \Re$. Then it calculates the distance between the data points by using Euclidian distance that is

$$\|x^{(1)} - x^{(2)}\| = \sqrt{\sum_{j=1}^{d}(x_j^{(1)} - x_j^{(2)})^2}. \tag{15}$$

Algorithm of k-NN is as follows:

1) Find example $(x^*, f(x)^*)$ closest to the test point x. That is

$$x^* = \arg\min D(x^{(i)}, x), \tag{16}$$

where D is the distance function.

2) Output $y = f(x)^*$.

Usually continuous output is calculated as the average target value over k nearest neighbors such as

$$f(x^i)^* = \frac{1}{k}\sum_{i=1}^{k} f(x^i). \quad (17)$$

More details can be found in [8].

C. Decision Tree Regression and Random Forest Regression

Tree based algorithms are in class of non-parametric models. It contains two main steps.1) Divide the feature space in to J mutually exclusive subsets. 2) For every observation in these sets make the prediction as the mean response values in each set.

Now, let $R_1, R_2, ..., R_j$ be the subsets, the goal of the algorithm is to form these sets in a way that minimize the Residual Sum of Squares (RSS) that is

$$\sum_{j=1}^{J}\sum_{i\in R_j}\left(y_i - \hat{y}_{R_j}\right)^2, \quad (18)$$

where $\hat{y}_{R_j}$ is the mean of the target value of the j[th] subset. To find every subset is costly for that reason Recursive Binary Splitting (RBS) algorithm can be used. In the first step predictor X_j and the threshold point s is chosen to split the regions $\{X \mid X_j < s\}$ and $\{X \mid X_j \geq s\}$. The RSS is calculated for these regions and the algorithm considers all predictors $X_1, X_2, ..., X_p$ and all possible thresholds level which leads the lowest RSS. In the second step the algorithm repeats the same procedure in order to minimize the RSS. But this time instead of splitting the whole feature space previously chosen regions are split. This procedure continues until a stopping criteria achieved. After the regions or subset $R_1, R_2, ..., R_j$ are obtained, the output value is calculated as the mean of the training points on the given region.

RBS may cause overfitting that is it may have good performance on the training test but this may not the case for the test set. To overcome this problem tree pruning can be considered. The algorithm contains 4 steps. These are 1) Until each sub sets contains few number of observations use RBS to grow a large tree. 2)As a function of α apply cost complexity pruning to the whole tree to obtain best subtrees. 3) Use cross-validation to choose α. 4) Return the subtree obtained in Step 2 with respect to the tuning parameter α [5].

α is the tuning parameter and each value of α there exists a subtree T such that

$$\sum_{m=1}^{|T|}\sum_{i:x_i\in R_m}\left(y_i - \hat{y}_{R_m}\right)^2 + \alpha|T|, \quad (18)$$

where $|T|$ represents the number of nodes of the trees. The algorithm aims to find subtree which minimize (18).

Trees in tress algorithms can be used to construct more powerful regression algorithms. In trees algorithms when data set is divided each split part may result different output. Thus the variance of the algorithm may be high. This is an unwanted situation in regression. To overcome this problem bootstrap aggregation or bagging have employed to reduce the variance of the models.

Random forest improves the bagging procedure by decorrelating the trees. It is a modified bagging algorithm which has the following steps: 1) Train each tree by using different bootstraps of the whole data set. 2) Randomly select a set of predictors form the set of predictors. 3) From the set selected in step 2, choose the optimal predictor and the optimal threshold level. The main difference between random forest and bagging is that; in bagging all the features set is considered but in random forest a subset of features is selected randomly and the best split features of the set is used to split each node in a tree.

D. Boosting Regressions

Boosting is an approach to improve the prediction power of the trees like bagging and random forest. In bagging the main idea was to create multiple trees by using bootstrap methodology and use all of the trees to form a single prediction or regression model. In the case of boosting trees are grown sequentially which means each tree is formed based on the previously grown trees. In the boosting bootstrap is not employed instead each tree is grown based on the adjusted original data.

In boosting the procedure can be summarized as: from a given tree model residuals are extracted and fit another tree model to the extracted residuals. Tree model fit on the residuals instead of the outputs. Then this fitted model is added to the original tree to adjust the residuals and to improve the performance of the algorithm.

It is a slow learning algorithm and in general such algorithms fit the data better. The main difference between the bagging and bosting is that in boosting construction of each trees depends on the previously build tree but in bagging there exists multiple trees [5]. Some popular boosting algorithms are Gradient Boosting (GB) [7], Extreme Gradient Boosting (XGB) [8], Light Gradient Boosting (LGB) [6] and Cat Boost [2].

VII. EMPRICIAL RESULTS

Our data set contains 20 different crypto currencies namely: Augur, Basic Attention Token, Bitcoin Cash, Bitcoin, Dash, DigiByte, Dogecoin, EOS, Ethereum Classic, Ethereum, IOTA, Litecoin, Monero, NEM, NEO, Stellar, Tether, Waves, XRP and Zcah. The data covers the period between September, 2017 and December 2012. Before starting our analysis, we calculate the logarithmic returns of each series and also we have divided our data set as 20% for testing and 80 % for training.

We forecast the returns of Bitcoin by using alternative coins. We start with SVM and hyper-parameters are optimized by using grid search. The employed other algorithms hyper parameters are also optimized by grid search. As evaluation metrics mean squared error (MSE), mean absolute error (MAE) and R-squared (R^2) are employed.

For linear kernel of SVM the best hyper parameters are observed when C=1000 and Ɛ = 0.01. With these parameters, on the test set we calculated MSE as 0.00031, MAE as 0.012441 and R^2 as 0.638827. For the Radial Basis Kernel, the best hyper parameters are C=1000, Ɛ=0.0001 and γ = 5. These hyper parameters lead MSE of 0.006402, MAE of 0.037763 and -6.3 as R^2. For the SVM the last kernel to use is the polynomial kernel. The best performance of this kernel achieved when the hyper parameters are C=1000, d=2 and

Ɛ=0.005. This setting has the following evaluation metrics. MAE=0.028249, MSE=0.0031211 and R^2 =-2.57849.

The second algorithm to forecast returns is KNN. Again, we apply grid search to find the best hyper parameter. KNN has only one hyper parameter and it is the number of neighbors. According to our search the best is found as 1. Its MAE is 0.0182128, MSE is 0.00645 and R^2 is 0.238037.

The third and the forth algorithms employed in this section is decision trees and random forest. Also we identify the importance of the features by random forest algorithm and they are given in Figure 1. For the decision tree algorithms, the best parameters are estimated as when maximum tree depth is 20 and minimum sample split is 5. These parameters have MSE as 0.000671, MAE as 0.0181661 and R^2 as 0.24. The best parameter for random forest is found as maximum depth equals 10, maximum features equals 10, minimum samples split equals 2 and number of estimator equals 200. This setting has MSE as 0.0003275, MAE as 0.01242 and R^2 as 0.6245.

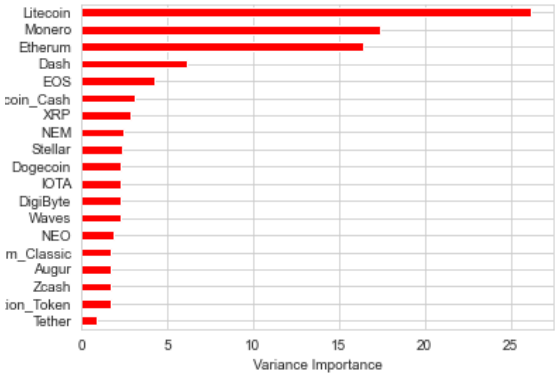

Fig. 1. Importance of the *features* according to Random Forest

Figure 1 shows that Litecoin, Monero, Ethereum , Dash and EOS has the highest impact on predicting the returns of Bitcoin.

Lastly, we will test boosting algorithms. We start our analysis with GB Regression. The best hyper parameters are the followings: 0.1, least square, 8, 500 and 1 for learning rate, loss function, maximum depth, number of estimators and subsample, respectively. The MSE of this setting is 0.00039 with MAE of 0.013771. Lastly R2 is calculated as 0.55. The second boosting algorithm is XGB Regression. The best parameters are calculated as: 0.4, 0.5, 8 and 1000 for sample tree, learning rate, maximum depth and number of estimator, respectively. This architecture has 0.000601 of MSE, 0.01799 of MAE and 0.31 of R2. The best parameters for LGM is obtained as learning rate equals 1, maximum depth equals 5 and number of estimator 1000. MSE of this setting is 0.00069 with MAE of 0.01932 and R2 as 0.21. For the CAT boost the best hyper parameters are obtained as 8,500 and 1 for depth, iterations and learning rate. This setting 0.00033, 0.01277 and 0.6 for MSE, MAE and R2.

VIII. Conclusion

In this study we aimed to forecast the Bitcoin returns by using alternative coins returns as the features. We employed SVM, KNN regression, RF regression and boosting type regression. Our findings show that the best performance achieved by SVM with linear kernel and RF regression among the compared algorithms while the worst performance is obtained by SVM with RBF and polynomial kernels. Also we identified that the five most importance coins on predicting the Bitcoin returns are Litecoin, Monero, Ethereum, Dash and EOS.

In the future, we plan to forecast other alternative coins returns by employing various coins returns. Also, it would be interesting to see causal relationship with in the alternative coins. In this sense vector auto regression frame work can be considered. Also, the usage of machine learning algorithms to identify the causal relations between these coins should be considered.

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An Investigation with Deep Learning Algorithms for Earthquake Prediction: An LSTM Network Approach

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***Abstract*— Solving the future value estimates of the earthquake that exhibits nonlinear behaviour is a rather complicated problem. There are various methods (statistical analysis, mathematical analysis, machine learning, etc.) in the literature for the solution of these problems. In particular, deep learning methods, which have become increasingly popular in recent years and widely used in machine learning, have yielded very successful results in solving** of the **complex problems. Deep learning automatically learns attributes from the available data, and this feature makes deep learning superior to other classical methods. The aim of this study is to investigate and improve the performance of deep learning methods on earthquake prediction studies. For this purpose, in our study, LSTM (Long Short-Term Memory) deep neural network architecture, which is widely used to classify process and predict to time series data problems, was used. The seismic activity of Yalova, Bursa, Bilecik, Sakarya, Kocaeli, and Istanbul provinces in the Marmara Region, which is selected as the study area and located within the active North Anatolian Fault Zone, was examined between 2007-2010. The data used in our study were subjected to normalization with min-max normalization before the deep learning model was trained. Then, in the training of the network were used as inputs meteorological data, total electron content, earthquake depth, latitude and longitude values of the locations where the earthquake occurred, radon activity concentrations. Output of the network was used as earthquake magnitude values. 80% of all data was used to train the network, and 20% was used to test it. Metrics representing the performance of the applied method were calculated. This technique may offer new opportunities for earthquake prediction in the future.**

Keywords—^{222}Rn, Total electron content, Deep Learning, LSTM, Earthquake Prediction, Modelling

I. INTRODUCTION

Radon (^{222}Rn) is a colourless, odourless and radioactive noble gas originating from uranium (^{238}U). Many scientific studies have benefited from this radioactive gas because of the properties of radon gas such as not entering into chemical reactions with any molecule, being radioactive, soluble in water, and being easily detected even at very low concentrations in the atmosphere. The change in radon concentration is also affected by meteorological parameters besides seismic activity [1,2]. Many studies have been conducted in the literature examining the relationship between radon gas and meteorological parameters [3-10]. In addition, in many studies, it has been reported that seismic activity causes significant changes in electromagnetic signals, the electrical and magnetic structure of the Earth and the chemical structure of the Atmosphere as a result of coupling with the Lithosphere, Troposphere and Ionosphere [11-17]. In the ionosphere, one of the important parameters that change with seismic activity is Total Electron Content (TEC). TEC provides important information about the structure of the ionosphere. TEC is expressed as the total number of electrons calculated along a signal path between the satellite and the receiver. TEC data used in this study were obtained with the web-based TEC estimation application developed by the IONOLAB research group.

Effective algorithms are always needed to make predictions about earthquakes that exhibit nonlinear behaviour. In recent years, many methods have been developed to provide solutions to nonlinear problems. Among these methods, there are especially Deep Learning (DL) methods. In this study, earthquake prediction was made with LSTM networks using Earthquake Magnitude-Rn Gas (^{222}Rn)-Some Meteorological Parameters (MP) and TEC data. This study is the first in the literature to use an LSTM algorithm by examining the possible relationships between Earthquake Magnitude- Rn-MP and TEC together.

II. STUDY AREA AND DATA COLLECTION

North Anatolian Fault Zone begins in the Karlıova Region and extends from eastern to western Turkey until the Gulf of Saros along 1200 km length. Data's used in this study is collected from Marmara Region stations (Yalova, Bursa, Bilecik, Sakarya, Kocaeli, and Istanbul). The soil gas radon data is given in kBqm^{-3} and recorded at 15-minute ranges. AlphaMeter 611 sensors are used for continuous monitoring [18]. Rn data is collected from (AFAD, Republic of Turkish, Ministry of Interior Disaster and Emergency Management Presidency (https://en.afad.gov.tr/). MP data is collected from Turkish State Meteorological Service (https://mgm.gov.tr/). Earthquake data is from Kandilli Observatory and Earthquake-Tsunami Monitoring Center, Bogazici University (http://www.koeri.boun.edu.tr/ sismo/2/earthquake-catalog/). TEC data were taken from IONOLAB (http://www.ionolab.org/webtec/single.html?locale=t) [19]. In the study, the years 2007-2010 were examined. The characteristics of the datasets used and some sample data are given in Table I.

TABLE I. DATA USED IN THE MODEL

Station no		1	2	.	.	.	930
Depth (km)		4.7	5				22
Earthquake (M)		2.3	2.5				2.5
Rn (kBqm^{-3})		160	166				3
TEC (TECU)		18.294	21.449				7.241
Soil temperature (°C)	05 (cm)	6	5.8				3.1
	10 (cm)	6.2	6.3				3.5
	20 (cm)	6.9	7.2				4.6
	50 (cm)	7.8	7.9				7
Vapour Pressure (hPa)		7.4	7.4				12.5
Dry bulb Temp (°C)		8.3	4				2.5

III. LONG SHORT TERM MEMORY (LSTM) MODEL FOR EARTHQUAKE FORECAST

LSTM were developed by Hochreiter and Schmidhuber (1997) with the aim of developing a network that learns long-term relationships in the dataset [20]. LSTM is a special case of RNN. Short-term memory is very well modelled by standard RNN, but it is not effective for long-term dependencies due to the problems that gradient calculations quickly reset after a certain time step or go to infinity. LSTMs solve the long-term dependency problem by preserving the internal memory state. LSTM has a chain structure similar to repetitive modules like RNN structure. The difference from RNN is the structure of the repetition module [21]. Structures that have the ability to add or remove information from the cell state are called gates in LSTM. Gates allow information to be transported to the next cell state. Fig. 1 shows the input, output and forget gates and the activation functions used in these gates. The sigmoid layer is the layer that generates values between 0 and 1. If the generated value is 0, it means "pass no information", and a value of 1 means "pass all information" [22].

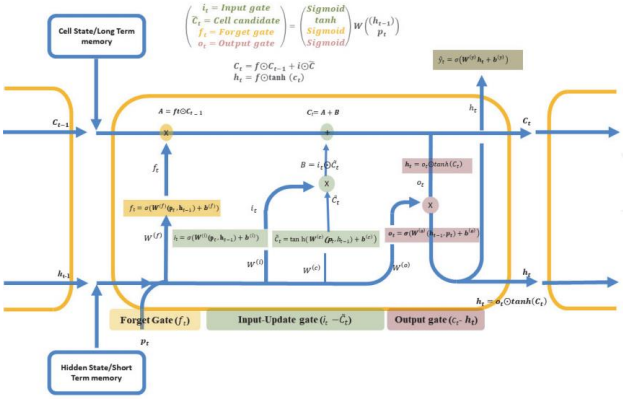

Fig. 1. LSTM block structure [23].

In Fig. 1, the operator "⊙" denotes the element-wise multiplication. The C_{t-1}, C_t, h_t and h_t are previous cell state, current cell state, current hidden state and previous hidden state, respectively. The f_t; i_t; o_t are the values of the forget, input and output gates, respectively. The $\tilde{C}_t$ is the candidate value for the cell state, $W^{(f)}$, $W^{(i)}$, $W^{(c)}$, $W^{(o)}$ are weight matrices consist of forget gate, input gate, cell state and output gate weights, and $b^{(f)}$, $b^{(i)}$, $b^{(c)}$, and $b^{(o)}$ are bias vectors associated with them [23].

In the training of the model, MP, Rn and TEC data were used as the input of the network, while the earthquake magnitude was used as the output of the network. 80% of the available data was used to train the LSTM deep learning model and 20% to test it. Modelling was carried out with MATLAB programming language for LSTM deep learning architecture. Before model training, the commonly used min-max normalization technique was applied to scale the available data (Eq. 1). Thus, the data to be used in the training of the network has been made more efficient and useful, and it has become easier to process in this way.

$$data_{norm} = \frac{data - \min(data)}{\max(data) - \min(data)} \quad (1)$$

One of the important factors directly affecting the success of the LSTM model is the selection of the training parameters (hyper parameters) of the LSTM. The parametric values used for training the network are given in Table II. The architecture used includes an input layer, LSTM layer, dropout (DO) and an output layer. Flow diagrams of the architecture of the proposed network are given in Fig. 2.

TABLE II. SUMMARY OF THE DESIGNED LSTM MODEL

Parameter	Value
Dropout Layer	0.2
Batch size	27
Learning rate	0.001
Epoch number	450
Optimization algorithm: ADAM	

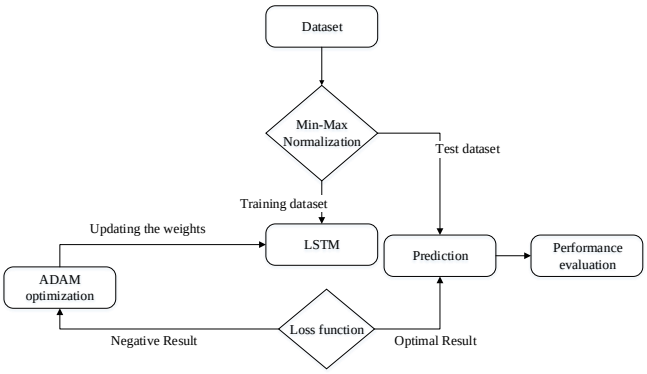

Fig. 2. Flowchart for LSTM training

IV. RESULTS

Earthquake is an extremely destructive natural disaster. The fact that the occurrence of earthquakes includes processes that require very high complexity and depends on many factors that are difficult to analyse has made the prediction of earthquakes difficult. In addition to methods such as statistical and mathematical methods for earthquake prediction, machine learning algorithms have been proposed with the developing

technology and studies have shown that DL methods can capture nonlinear correlations between data.

In this study, the relationships between soil gas Rn, MP and TEC data and seismic activities in the Marmara Region of the North Anatolian Fault Zone were investigated. The estimation of earthquakes occurring in the study area was carried out by using different input parameters, which were not found in previous studies, and a new model was proposed. In particular, earthquake prediction was made using the LSTM network with strong nonlinear learning capability, even on data containing long-term interval correlations that RNN could not obtain. In order to process the data more efficiently in the training of the network, all data were subjected to min-max normalization. The best result was obtained when the learning rate was 0.001. For better normalization, the Rectified Linear Unit (ReLU) activation function was used. As for testing the trained network, we used real earthquake records that were not used in the training dataset. The results show that our proposed model achieves good performance. The Loss function graph showing the performance of the model is given in Fig. 3. The training and test graphs of the trained network are given in Figure 4. In addition, the training and test graphs obtained as a result of the training of the network and the model and the graphs showing the correlation coefficients between them are given in Fig. 5. In the best LSTM structure, MSE values should be close 0 and R^2 should be close to 1 [24]. It was calculated as MSE:0.0001348 and RMSE:0.01161 in the training of the network.

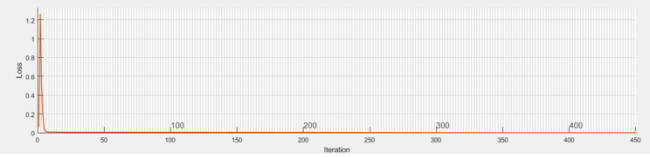

Fig. 3. Loss function performance graph

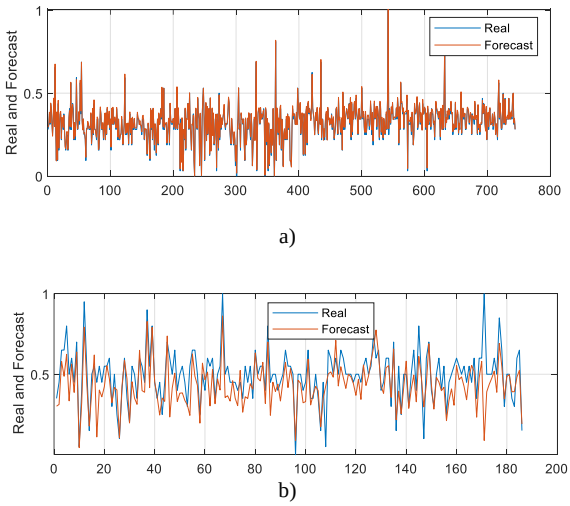

Fig. 4. Model Outputs and Real Data: a) training dataset b) testing dataset graph

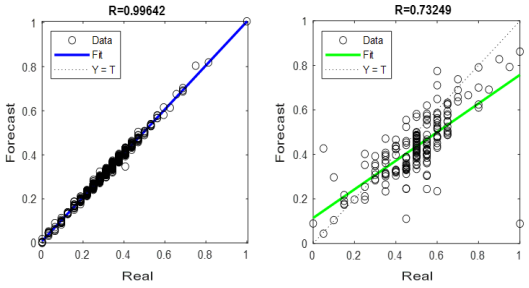

Fig. 5. Fit plot for a) Training data and b) Test data

V. Conclusion

In our study, a new application was made in which different input parameters that were not used in previous studies for earthquake prediction were considered. The LSTM networks used in our study are widely used especially for classifying, processing and estimating time series data problems and are accepted in the literature for these issues. The results obtained showed that DL methods were successful in earthquake predictions. In our study, the hyperparameters used in the training of the network were determined by trial and error. Determination of hyperparameters by optimization methods in later studies can further increase the performance of the network. In this way, both times is saved and optimum parameter selection is made.

VI. Acknowledgments

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Deep Reinforcement Learning Based Mobile Robot Navigation in Unknown Indoor Environments

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***Abstract*—The importance of autonomous robots has been increasing day by day with the development of technology. Difficulties in performing many tasks such as target recognition, navigation, and obstacle avoidance autonomously by mobile robots are problems that must be overcome. In recent years, the use of deep reinforcement learning algorithms in robot navigation has been increasing. One of the most important reasons why deep reinforcement learning is preferred over traditional algorithms is that robots can learn the environments by themselves without any prior knowledge or map in environments with obstacles. This study proposes a navigation system based on the dueling deep Q network algorithm, which is one of the deep reinforcement learning algorithms, for a mobile robot in an unknown environment to reach its target by avoiding obstacles. In the study, a 2D laser sensor and an RGB-D camera has been used so that the mobile robot can detect and recognize the static and dynamic obstacles in front of itself, and its surroundings. Robot Operating System (ROS) and Gazebo simulator have been used to model the robot and environment. The experiment results show that the mobile robot can reach its targets by avoiding static and dynamic obstacles in unknown environments.**

Keywords—deep reinforcement learning, mobile robot, navigation, dueling deep Q network, ROS, Gazebo

I. INTRODUCTION

One of the most important competencies expected from mobile robots is navigation skills. In order for a mobile robot to be considered successful in the navigation process, it has to reach the given targets as soon as possible and avoiding obstacles [1]. There are various algorithms and methods in the literature used for mobile robots to navigate more efficiently [2]. In addition to traditional navigation algorithms, deep learning-based approaches such as deep neural networks (DNNs) have been used widely in recent years. However, both the large amount of data required for the training processes and the difficulties in interpreting the data have been made it necessary to use new methods and algorithms. Among these new approaches, reinforcement learning (RL) algorithms come forward.

The use of RL algorithms has been seen in many different areas in recent years. It has been observed that these algorithms obtain successful results, especially in studies conducted on video games. Studies on the use of RL in mobile robot navigation have increased in parallel with the developments in hardware technologies.

The concept of Deep Reinforcement Learning (DRL) came up with the combined use of DNN and RL algorithms and has been successfully applied in solving mobile robot navigation problems. Mnih et al. [3] tested 49 Atari 2600 games using DQN with raw images. The game images used as states were 80×80 in size and their numbers were four. One of them was the current state and the other three consist of previous images. The different aspect of the study was the use of convolutional neural networks. In addition, experience replay is one of the important innovations of the study. Experiences during a certain iteration were recorded in the database. Then, during the training phase, learning occurred by taking uniform examples from these experiences. They stated that 75% success was achieved in the process of playing Atari 2600 games. Surmann et al. [4] used Asynchronous Advantage Actor-Critic Network (GA3C), one of the Deep Q Learning (DQN) algorithms, for the robot to reach the given targets while avoiding obstacles. They tested their models in a simulation environment using Turtlebot 2 and stated that they got successful results. In their study, Quan et al. [5] presented a model based on DQN and recursive neural networks. A grid-map-based two-dimensional environment, a three-dimensional simulation environment, and a physical environment were used to test the proposed model. They achieved successful test results in finding the target and shortening the arrival times of the robot. Xie et al. [6] developed a model that enables a mobile robot to avoid obstacles in both simulation environment and physical environment using a single RGB camera. They presented a dueling double Q network algorithm, which combines double Q network and dueling Q network algorithms.

In recent studies, camera and sensor data are used for robots to perceive their environment and to perform their actions according to the observations obtained. Some studies are only sensor-based [7], while others are performed using camera images [6]. Hybrid approaches that use both camera and sensor data together are also preferred, as we have used in this study [4]. In this study, we propose a Dueling DQN using a 2D laser sensor and RGB-D camera for mobile robot navigation. The reason for such a preference is that the laser sensor gives more accurate results than deep cameras in calculating the distance of objects to the robot. The mobile robot is expected to reach the targets as soon as possible and avoid obstacles in different unknown simulation environments. In recent studies, static obstacles are widely used. However, in the real world, there are also dynamic obstacles in the environments, such as humans or animals. Both static and dynamic obstacles were used in simulation studies, and thus, it has been shown that the proposed model could produce a solution to the real-world problem.

The contributions of this paper are the following:

- A Dueling DQN model has been applied using the 2D laser sensor and RGB-D camera. The proposed model has been trained with only the data from the laser sensor without the need for image processing.

- Since the 2D laser sensor only gives 2-dimensional data, the RGB-D camera data has been converted into laser

data and used in the training of the network so that the robot has a 3-dimensional view.

• Simple and complex simulation environments with static and dynamic obstacles have been used to create an environment similar to the real world and to show the performance of the model.

• Under the specified conditions, the mobile robot is able to reach the specified targets using the shortest path.

II. Background

A. Reinforcement Learning

RL is a field of machine learning affected by behaviorism. Learning occurs as a result of successful and unsuccessful attempts by the structure called the agent using the previous experiences. The agent is expected to find the most appropriate action sequence on its own without being told what actions it should take [8]. RL differs from both supervised and unsupervised learning in terms of features such as not providing a certain data set beforehand, being based on a reward and punishment system, and aiming to maximize reward. It has a similar approach to human learning. Algorithms learn a policy that determines how they should behave in a given environment. Each action also affects the environment. The environment guides the agent with the help of the rewards.

The basic components of RL can be listed as agent, environment, policy, reward, and value function [9]. The agent is defined as the algorithm that performs actions. The environment is where the agent acts. The reward indicates how good or bad the actions by the agent are in the short term. The reward, R obtained depending on the action, A performed in a certain situation, S is shown in (1).

$$R_s^a = E[R_{t+1}|S_t = s, A_t = a] \quad (1)$$

The value function, V indicates the largest reward amount that the agent expects to collect from start to finish. The values are calculated using (2).

$$V_\pi(s) = E_\pi[R_{t+1} + \gamma R_{t+2} + \gamma^2 R_{t+3} + \ldots | S_t = s] \quad (2)$$

where γ is a discount factor which is a range of [0, 1]. It is used to determine the importance of future rewards. If set to 0, only the first reward will be used, and others will have no effect. If it is set to 1, all rewards will have equal importance.

Policy, π are reference charts or functions that guide agents in the performs of their actions. It determines the behavior of the agent at a specified time. The main purpose of RL is to find the most appropriate policy to solve the problem.

B. Q Learning

Q learning is an off-policy RL algorithm that does not need any environmental model [10]. It is based on the Bellman Equation. It is classified as an off-policy because the policy used to carry out the actions and the updated policy are different. The main aim is to learn the policy that maximizes the total reward. When the algorithm is run, a matrix in the form of [action, state] called Q-table is created and initial values are set to 0. At each iteration, Q values are updated and at the end of the algorithm, the best policy that provides the solution is obtained. The updating of the Q-table is shown in (3).

$$Q(s,a) \leftarrow Q(s,a) + \alpha[r(s,a) + \gamma \max_{a'} Q(s',a') - Q(s,a)] \quad (3)$$

where s is the state or observation, a is the action the agent takes, r is the reward, t is the time step, α is the learning rate, γ is the discount factor. The discount factor causes rewards to lose their value over time, so more immediate rewards have higher values.

C. Deep Q Network

When the number of state-action pairs is large, it becomes difficult to show the policy parameters in a table. Therefore, it is not appropriate to use Q-tables in solving complex and large scale problems.

DQN has been developed with the combined use of DNN and RL algorithms. DNN is used to obtain appropriate Q values in DQN. In addition, the agent's experiences are stored using experience replay memory. The agent is expected to learn from experiences by taking uniform samples from the stored experiences using (4). It has been stated that the use of experience replay is successful in providing stability [11].

$$e_t = (s_t, a_t, r_t, s_{t+1}) \quad (4)$$

where e_t is the experience stored at time t, s_t is the state at time t, a_t is the action at time t, r_t is the reward at time t, s_{t+1} is the state at time $t+1$.

D. Dueling Q Network

Dueling DQN, introduced by Wang et al. [12], uses the same network structure as DQN. The fully-connected layer is divided into two parts, unlike DQN. In the first part, the value V of the state s is estimated and shown as $V(s)$. In the second part, the advantage A of the action a performed in a certain state s is estimated and shown as $A(s,a)$. Thus, some unnecessary actions are avoided and the performance increases. The Q values obtained are shown in (5).

$$Q^\Pi(s,a) = V^\Pi(s) + A^\Pi(s,a) \quad (5)$$

III. Dueling Q Network Based Mobile Robot Navigation

In this section, firstly the current problem situation is explained and then the observations, action space, and reward and punishment system used in the learning phase are introduced. Finally, the proposed Dueling DQN model is presented in detail.

A. Problem Statement

The aim of the developed model is that the mobile robot can reach the given targets as soon as possible by avoiding the obstacles in simple and complex unknown environments with static and dynamic obstacles.

In our study, we used Turtlebot3 mobile robot and two different environments designed in Gazebo simulator integrated with Robot Operating System (ROS). In the training process of the model, the data obtained from the robot's 2D laser sensor and RGB-D camera were used, and thus, the distance between the mobile robot and the objects was determined. Then, actions that enable the mobile robot to move in different directions were obtained. When the robot hits obstacles, it receives penalties, and when it reaches the targets, it is rewarded. The aim of the learning process is to

maximize reward on a policy Π(s). Dueling DQN is used to obtain the Q values of each action.

B. Learning Setup

• Observations: We used a 2D laser sensor that can obtain 360 degrees of data and an RGB-D camera to obtain a 3-dimensional view. 3D point cloud data from the camera was converted into 2D laser data. Point cloud to laser scan package that is one of the packages in ROS was used for this purpose. The obtained data then were filtered according to the height (Z-axis) of the robot. In addition, the distance and angle of the robot to the target were used in the training of the network.

• Action space: Linear and angular velocities can be determined for Turtlebot3. Two different linear velocities (0.2, 0.4) m/s and five different angular velocities $\left(\frac{\Pi}{4}, \frac{\Pi}{8}, 0, -\frac{\Pi}{8}, -\frac{\Pi}{4}\right)$ rad/s were used in our study. Our agent can choose seven different actions. Since the camera is only located on the front of the robot, it is limited to forward movement only.

• Reward design: The aim of the agent is to reach the target as soon as possible avoiding obstacles. For this purpose, a reward and punishment system (6) is used. The robot receives a negative reward when it hits obstacles and a positive reward when it reaches the target. In addition, the agent receives rewards in each time step depending on its speed and heading to the target. Thus, the mobile robot is aimed to reach the target as soon as possible.

$$r = \begin{cases} +2 & Target \\ -1.5 & Collision \\ v\cos(\theta) - 0.01 & Other \end{cases} \quad (6)$$

where r is the reward, v is the linear velocity and θ is the heading to the target.

C. Model and Network Architecture

In the study, obtaining the Q values and choosing the actions to perform were done using the Dueling DQN algorithm. As input layer, we created a 39 dimensional vector which contains 37 laser range data, the distance and angle to the target. After the input layer, a fully connected layer consisting of 128 neurons was used. Then, two fully connected layers of 64 neurons were used to calculate the value and advantage separately. As output layer, 1 output for value and 7 outputs for advantage values depending on the number of actions were produced. In the last stage, Q values were obtained by using these values. Details of the proposed Dueling DQN model are shown in Table 1 and the architecture of the model is shown in Fig. 1 (b). The standard DQN was also used in the same simulation environments to demonstrate the performance of the proposed model. Details of the standard DQN model are shown in Table 2, and the architecture of the model is shown in Fig. 1 (a).

TABLE I. DETAILS OF THE DUELING DQN MODEL

Layer Name	No of Neurons	Activation Type
Input	39	-
Shared FC	128	ReLU
FC1 for value	64	ReLU
FC1 for advantage	64	ReLU
FC2 for value	1	Linear
FC2 for advantage	7	Linear
Output	7	-

TABLE II. DETAILS OF THE STANDARD DQN MODEL

Layer Name	Number of Neurons	Activation Type
Input	39	-
FC1	128	ReLU
FC2	128	ReLU
Output	7	Linear

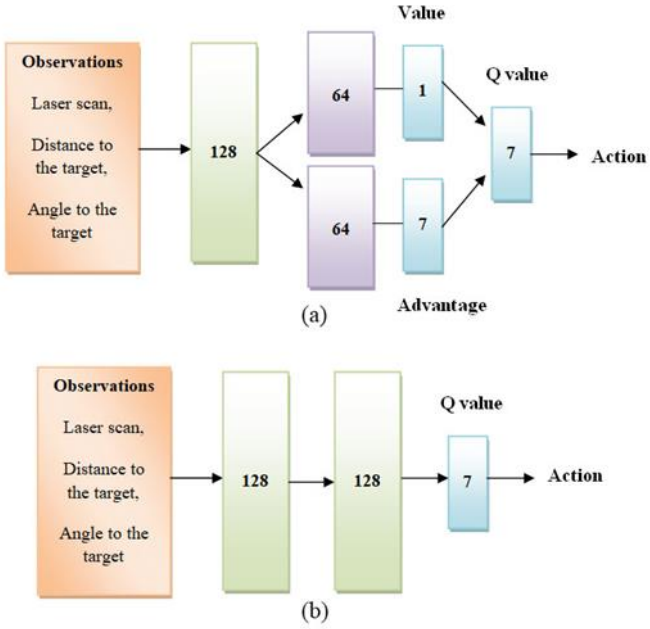


Fig. 1. Network structures (a) standard DQN (b) Dueling DQN

The training process begins with the initialization of the environment and experience replay memory used for data storage. Then, the robot is supposed to reach the surrounding targets by avoiding the obstacles. While there are static obstacles in the simple environment, in addition to static obstacles, dynamic obstacles have also been used in the complex environment. Maximum episode steps have been defined for each episode. When the maximum step is reached, it is passed to the other episode. The locations of the targets are changed in each new episode. If the robot hits any obstacle or reaches the target, the episode ends and the next episode starts. An epsilon value is used to determine the probability of choosing a random action, and an epsilon decay value is used to reduce the probability. The data stored in the experience replay memory is taken as mini batches. Table 3 shows the hyper-parameters and their values used in the training process of the model.

IV. EXPERIMENTAL RESULTS

Our model has been trained on two different environments designed in Gazebo simulator. In the simple environment, there are 8 box-shaped obstacles placed regularly inside the

room. The robot, which starts its movement in the middle of the room, is supposed to reach the target that is changed its location in each episode as soon as possible by avoiding the obstacles.

TABLE III. HYPER-PARAMETERS AND VALUES FOR THE MODEL

Hyper-parameter	Value
Maximum episode step	5000
Epsilon	1
Epsilon decay	0.99
Epsilon minimum	0.01
Batch size	64
Memory	1000000

The complex environment is aimed to resemble a real room. For this purpose, household items have been also placed in the room and the robot is supposed to reach the specified targets in the same way. Besides, a box-shaped dynamic obstacle has been added to the complex environment. As mentioned in the reward design section, the robot receives a negative reward when it hits the obstacles, and a positive reward when it reaches the target positions. Fig. 2 and Fig. 3 show the view of the simple environment from different angles, while Fig. 4 and Fig. 5 show the complex environment.

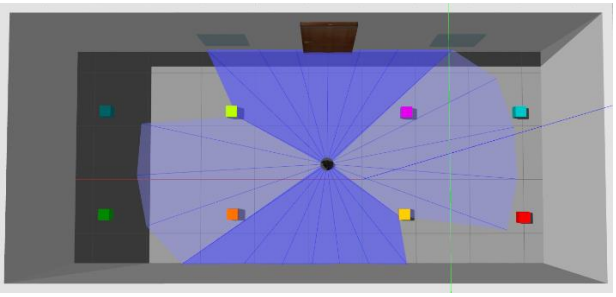


Fig. 2. Top view of the simple environment

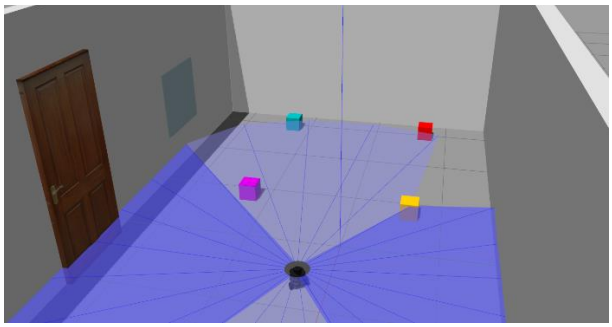


Fig. 3. Side view of the simple environment

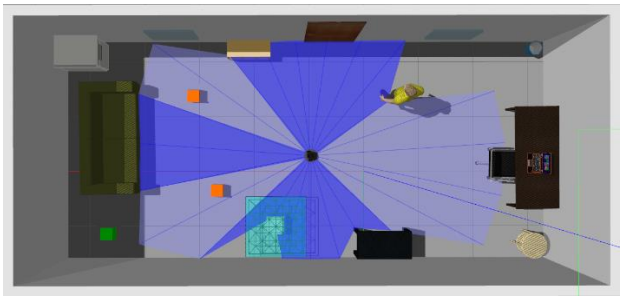


Fig. 4. Top view of the complex environment

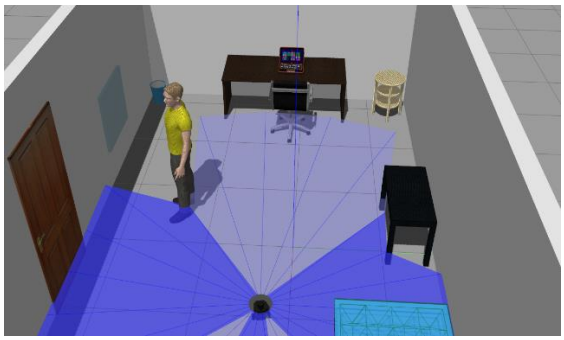


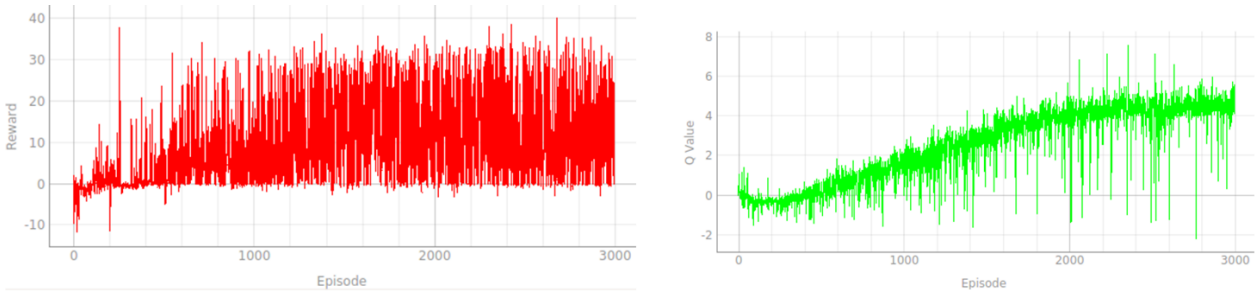
Fig. 5. Side view of the complex environment

The proposed Dueling DQN model has been trained on both environments. As a result of the training process, the total reward and average Q values have been obtained. Fig. 6 and Fig. 7 show the results of the Dueling DQN for the simple environment and the complex environment, respectively. Fig. 8 and Fig. 9 show the results of the standard DQN model for the simple environment and the complex environment, respectively. When the total amount of rewards and average Q values have been evaluated, it is seen that the proposed model gives more successful results than the standard DQN algorithm.

V. CONCLUSION

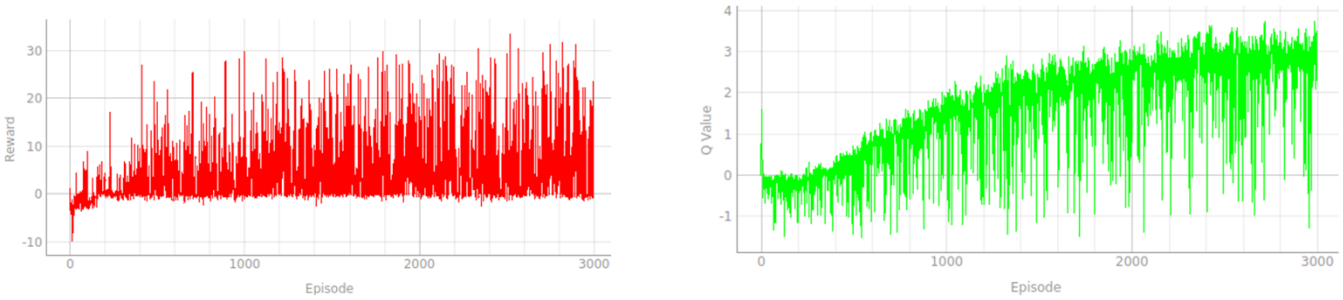
Autonomous mobile robots are expected to perform tasks such as target recognition, navigation, and obstacle avoidance on themselves, without human assistance. There are various algorithms developed to fulfill these tasks, and new algorithms and methods continue to be developed. In this study, a model based on the Dueling DQN algorithm has been proposed for the autonomous navigation of a mobile robot in an unknown environment. In addition, the standard DQN has also been used in the study and a performance comparison has been made with proposed model.

Robot Operating System (ROS) and Gazebo simulator have been used to model the robot and its environment. Experimental results show that the mobile robot can reach its targets in environments with previously unknown in which static and dynamic obstacles using both Dueling DQN and standard DQN. On the other hand, it is seen Dueling DQN achieves better results than standard DNQ.



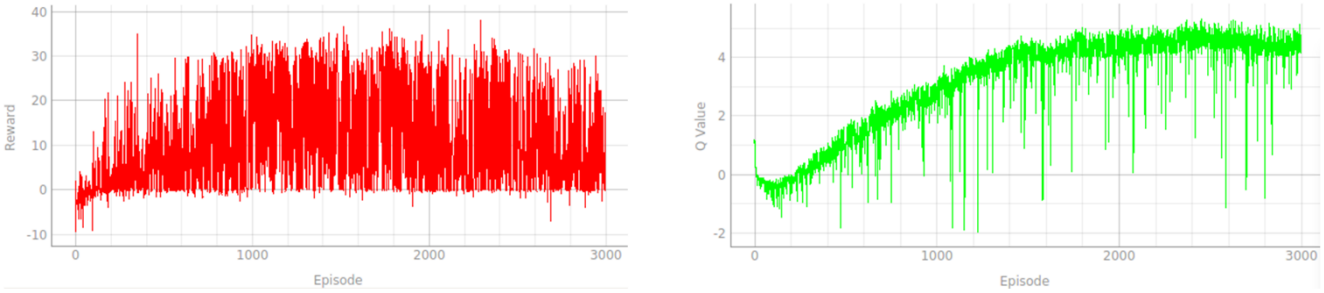
(a) (b)

Fig. 6. Simple environment training results for the Dueling DQN model



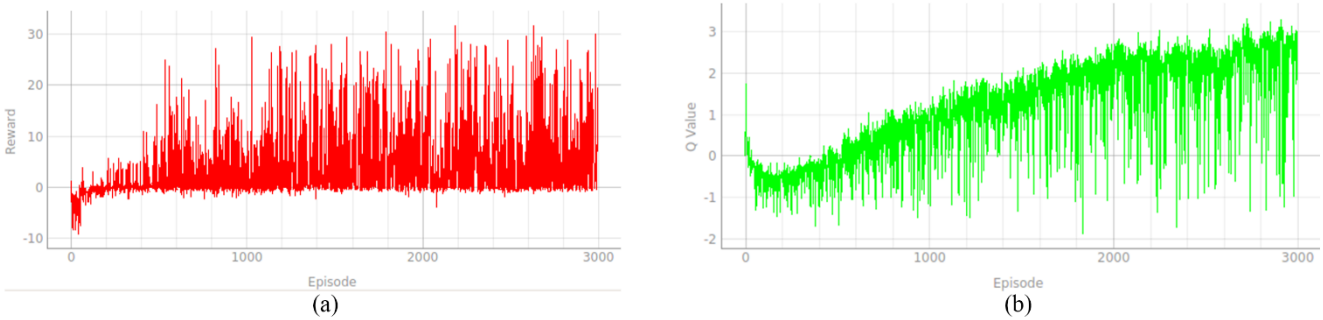
(a) (b)

Fig. 7. Complex environment training results for the Dueling DQN model



(a) (b)

Fig. 8. Simple environment training results for the standard DQN model



(a) (b)

Fig. 9. Complex environment training results for the standard DQN model

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Can Artificially Intelligent Robots Have Legal and Moral Personality? - An Evaluation from the Perspective of Islamic Law and Ethics-

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***Abstract*—As we are getting closer and closer to end the first quarter of the 21st century, we witness an improvement that is at an unprecedented pace in artificial technologies. It has been emphasized that the accession of artificially intelligent robots will be available for household chores soon in addition to their existence in several fields such as health, education, industry, defense and agriculture. Robots are no longer regarded as devices which only carry out activities that are specific to humans. Today, artificially intelligent robots are considered to have reached a certain level including the ability of developing cognitive features, adapting to changing conditions and making their own decisions. These developments lead to a series of arguments to which it is necessary to approach legally, morally and theologically in addition to the concerns about controlling artificial intelligence.**

What is the meaning and value of being human? Does artificial intelligence pose a threat to humanity? Does an artificially intelligent robot mean an artificial human? Does that imply an intervention to God's creation? Is it possible for an artificially intelligent device to have consciousness, will and reason? Is it likely to accept it as a legal personality? In case of a damaging act carried out by autonomous robots, will people put the blame on them, or will the producing company, the software developer, or the customer be held responsible for? Who will set the principles and boundaries for the usage of robots concerning the protection of personal independence, honor, privacy and data? These questions indicate that there are different extents to the issue beyond technical aspects and the ones related to engineering.

In parallel with their increased usage in social life, it has been especially discussed, as a current legal issue, whether it is possible to attribute artificially intelligent robots a legal personality. In this regard, it has been suggested that artificially intelligent devices can be evaluated within the scope of legal entity, or that they can be given a new status like an electronic personality, whereas it has also been suggested that they should, no matter how much they are developed, be regarded as objects and that they cannot be accepted as entities. However, the moral aspect to the issue is as considerable as its legal aspect. Artificial intelligence technologies aim to integrate the level of thinking and consciousness of human intelligence with artificial intelligence. While some people believe that this goal can be achieved, some others believe that artificial intelligence cannot reach the level of thinking and consciousness no matter how much developed it can be. Beyond the arguments on whether artificial intelligence can reach the level of thinking and consciousness, the idea that devices with artificial intelligence, which are the products of human intelligence, will once again be developed through human intelligence and exceed it is shared by these two perspectives.

Having a certain level of thinking and consciousness, human intelligence can live with these values and keep them alive thanks to this skill. It can tell right from wrong and keep away from what is harmful. Similarly, it can avoid the things that can be harmful for the society in which it lives and for other people. Contrarily, the very same human intelligence can challenge them. It is possible to think that a robot that can only act according to the systems which have been programmed for itself and is not yet able to go beyond them is harmless. However, will people who suggest that artificial intelligence exceed human intelligence be able to develop artificial ethics, will and consciousness that can be integrated with artificial intelligence?

This study will focus on robotic artificial intelligence through the perspective of Islamic law in terms of the concepts of entity, personality, capacity, commitment, and, within the context of ethics in terms of consciousness, will and liability after addressing the aforementioned arguments based on scientific documents.

Keywords—robotic artificial intelligence, personality, consciousness, will, Islamic law, ethics

I. INTRODUCTION

With Industry 4.0, we are now in a new era in which various appearances of artificial intelligence such as bots, robots and androids are mentioned. Robot is defined as "any automatically operated machine which replaces human effort, even though it may not resemble human beings in appearance or perform functions similar to those of humans". Robotics is "the discipline of engineering that deals with the design, construction and operation of robots" (1). The concept of artificial intelligence is known to have been used for the first time by John McCarthy in the Dartmouth Conference in 1956. McCarthy defined artificial intelligence as "the science and operation of making intelligent machines, especially intelligent computer programs" (2). On the other hand, Marvin Minsky, who is known as the father of artificial intelligence, defined the term as "making machines do things that would require intelligence if carried out by men" (3).

Generally, artificial intelligence is classified into three types in terms of capacity: 1. Artificial Narrow Intelligence (ANI): This category refers to the artificially intelligent robots that can specialize at one single human-specific task through algorithms. Siri app of Apple Inc., navigation app and the autonomous vehicles are some examples to this type of artificial intelligence. 2. Artificial General Intelligence (AGI): This category refers to the artificially intelligent robots that can perform any task which can be carried out by humans and that are at the human-level intellectually. Some experts suggest that humanity can witness this type of artificial intelligence in the coming decades, whereas some others think

that this will not be possible. 3. Artificial Super Intelligence (ASI): This type of artificial intelligence refers to the robots that are estimated to surpass human intelligence at its best in every scientific and social field and that are estimated to pose a threat to humanity. The lead actress named "Eva" from the movie, "Ex Machina", and the human-looking robots in "The Matrix Trilogy" are some examples to this type. It is assumed that artificial intelligence can reach the super level rapidly if it is developed via exponential growth, which is called "intelligence boom" or "singularity" (4). In the recommendation report of the European Parliament's Commission of Civil Law Rules on Robotics, which was dated 27.01.2017, in order to identify autonomous smart robots, the criteria including "the acquisition of autonomy through sensors and/or by exchanging data with its environment, the trading and analysis of those data, self- learning from experience and by interaction, at least a minor physical support, the adaptation of its behavior and actions to the environment, and the absence of life in the biological sense" were mentioned. Even though this is something that can be seen only in science-fiction movies for the time being, the report put an emphasis on the fact that whereas developing autonomous smart robots that can make their own decisions has some advantages, it also leads to some concerns regarding their direct and indirect social effects, and that artificial intelligence reveals the possibility of exceeding human intellectual capacity in the long term (5). Today, the usage of robotic artificial intelligence increasingly continues in numerous areas, including industry, defense, agriculture, space research, health and education. Robot exhibitions and robotics competitions are held, and a huge boom is expected in robotics in the near future.

As the usage area of robotic artificial intelligence expands, the scope of ethical and legal debates expands, and the debates become varied, as well. Is artificial intelligence a threat or opportunity? It is a fact that robotics and artificial intelligence technologies make life easier, and using them in challenging and dangerous works contributes greatly to the protection of human life and health. Indeed, favorable outcomes of using robots have been experienced at hospitals during the pandemic both for nursing and care, which necessitated close contacts with patients and for hospital disinfecting services (6). Nevertheless, answers to some questions such as "Will it be possible for robots to surpass humanity in the days to come, and will they present a threat to humanity? Can artificially intelligent robots have consciousness, will and reason? Is it possible to acknowledge them having a legal personality?" are yet to come.

II. Robotic Artificial Intelligence And Its Legal Position

With the increased usage of artificial intelligence in social life, some issue areas concerning several branches of law including civil, criminal and financial law have emerged, too. The issue in particular in terms of civil liability is related to the person who will bear the legal/ criminal responsibility for the damaging acts belonging to robotic artificial intelligence. In such a case, will people put the blame on the robots, or will the producing company, the software developer, or the customer be held liable for, or will the responsibility be shared among them? Despite the fact that interested parties might be liable for retrieving a loss in case of an error based on production or usage, the existing rules of law are claimed to be too inadequate to create legal liability for the damage caused by the robots that can make their own decisions. Creating an insurance system for robots for the possible damages caused by them has also been suggested (7). The existence of legal liability is needed in order to talk about criminal responsibility. Thus, the major point of legal debates is about whether artificially intelligent robots can be accepted as subjects in law. Hoping to analyze the issue of legal liability in artificial intelligence in another study, we will be evaluating the issue of legal status in the first part of the paper.

A. The Concepts of Entity and Personality

Entity (person) is a human being who is given a legal right to be a subject of law by legal order. In other words, entity refers to a person who has lawn capacitas, the capacity to have rights and obligations. The legislator determines which entities can have the right to be a subject of law. Also, the legislator is authorized to accord this right to any being or object. In the history of law, slaves could not be acknowledged as entities in spite of the fact that they were human beings, as can be seen in the example of Rome. In the light of this, it can be suggested that the concept of entity refers to a legal being, not a natural one. Although it might be suggested that an entity refers to a real human being, by force of providing the needs of social life and people in general, human or property groups possessing certain characteristics are identified as entities by law, as well. The former one is called "natural entity (real person)", whereas the latter one is called "legal entity (juridical person)" (8). Natural entity refers to a human being; and, according to the Turkish Civil Code, "all the persons possess the capacity to have rights". Thereafter, "all the persons are equal in using rights and fulfilling obligations within the legal limits" (TCC, art. 8). "The capacity to act" refers to the capacity of the person to possess rights by his/her own acts and undertake any obligation thereof (TCC, art. 9). Legal entity, on the other hand, is defined as "a group of persons organized to create a single body and independent property groups constructed for special object" (TCC, art. 47). The law qualifies legal entities for all kinds of rights and obligations except from the ones that are related to the human-specific characteristics by nature such as marriage, divorcement, affinity and inheritance. Legal entities have the capacity to act by possessing the required organs according to the law and articles of formation. The will of legal entities is clarified via their organs (TCC, art. 48,49,50). In companies possessing a legal entity, units consisting of natural entities like a general manager or the board of management are legal representatives of the legal entity. The doctrine, on the other hand, defines personality as all the legal, physical and spiritual properties of a person that the law legitimates to protect (9).

Islamic law defines personality mainly by referring to liability, which means possessing rights and obligations. Capacity is associated with the concepts of "human" and "human-specific". Legal capacity of a person is evaluated in two categories: the first one is the capacity of obligations/ rights, and the latter one is the capacity of performance/acts. The capacity of obligations refers to possessing rights and undertaking obligations. The capacity of performance refers to the power of disposition that creates rights and obligations for the person. In order to be liable for the rights and obligations, being a human/possessing human characteristics is accepted as the only necessity. The capacity of obligations improves through the stages of human life. Islamic law legists explained the term by associating it with good debt (obligations and the capacity to obligate); and, accordingly, they emphasized the fact that human beings have some rights

by birth such as virtue (immunity), exemption (inviolability), freedom and property. The Quran established that all human beings are held responsible for their acts (İsrâ, 17/13), and that they took over the trust that was declined by the heavens, the earth and mountains (Ahzâb, 33/72), which have been interpreted by legists as the foundation of human beings acting by their own will to possess rights and obligations/ possessing the capacity of performance. While the capacity of obligations is related to obligations and legal personality, the capacity of performance is about reason, discrimination, maturity and discernment (10). The person who is smart and has reached puberty, and whose acts are evaluated in the scope of law is identified as "liable". The liable person who is the object by the divine will is accepted as liable to all kinds of religious, legal and moral obligations.

The explanations on liability and obligation in classical Islamic law literature point to the fact that these features are associated with natural entities. Nonetheless, by looking at the functioning of the institutions such as government, state treasury, foundation and masjid, and by the judgment based on them presented by Islamic law, it can be suggested that in Islamic law, although legal entity was not used by name, it was embraced mentally, and that legal persons were held liable with obligation and liability (11). These institutions in Islamic history possessed properties like natural entities, undertook debt and obligations, and some essential situations that life brought about led to the evaluation of these institutions as spiritual personalities in the scope of public welfare (12). Nevertheless, legal entities can exercise this right only through their legal representatives, that is to say, natural entities.

In the light of these insights on entity and personality, is it possible to give robots personality, in other words, the capacity to act and have rights? Is it possible for robots to be accepted as liable entities in terms of Islamic law?

B. Can an Artificially Intelligent Robot Be an Entity?

There have been various ideas about legal status of artificially intelligent robots until today. Among them, especially four different approaches consisting of the attribution to artificially intelligent robots an object status, a kind of slavery status, a legal status and an electronic status come into light.

People who rejected the legal personality of artificially intelligent robots have claimed that no matter how developed they are, they still should be accepted as objects that humans created, that the entities which are not flesh and blood cannot possess a personality, and so, that artificially intelligent robots should be the property of natural or legal entities. This idea has been criticized on the grounds that artificially intelligent robots are not simply tools, that there will be autonomous and smart artificially intelligent robots in the near future, that there can be some unforeseen outcomes if artificially intelligent robots are allowed to learn by themselves, and so, that they cannot be seen like objects belonging to human beings (13).

According to some other approach which opposes the personalization of artificially intelligent robots, and instead, supports the object status, these robots can be owned by human beings due to the fact that they are the ones who created them. It is not possible for them to be accepted as human beings no matter how many superior features they have been equipped with. According to this approach, which is based on the property approach of J. Locke, the right to design, produce, own and use the robot belongs to humans. Therefore, it is plausible to give robots a slavery status. Considering the nonhuman entities to be slaves does not indicate a violation of personality. Here, the term, slave actually refers to humans' helpers (14). The doctrine, on the other hand, opposes this idea on the grounds that reawakening slavery, which was nothing but a shame in the history of mankind, is improper, and that it cannot solve legal problems whatsoever (15).

According to the people who embraced the idea of the legal personality of artificially intelligent robots, since they cannot be regarded as natural entities, it is possible to give them legal or electronic personality. According to the approach supporting the idea that artificially intelligent robots should be given legal personality similarly to companies, the relationship between artificially intelligent robots and the people who have produced and are using them is similar to the one between an association and the members of its board of management (16). It was emphasized that the legal personality given to companies, which includes rights and obligations, can also be given to artificially intelligent robots (17), that legal personality includes the right of property, and the liability to file suit and be sued for (18). On the other hand, this idea has been rejected on the grounds that the legal entity is liable to the instructions and administrations of the representative people, and so, that this status cannot be valid for artificially intelligent robots, that attributing legal personality may remove the legal obligations of other actors, particularly of the developers, and that such a case may lead to malfunction (19). In the aforementioned report of the European Union, the suggestion related to giving artificially intelligent robots electronic status, which is a novel type besides natural and legal personality, was presented. In the same report, it was also stated that via common contribution of the developer, programmer, owner and user, a compensation fund can be furnished, and that an insurance can be allowed jointly in order to guarantee the compensation in case of a damage caused by the robot (20). This model leads people to exercise caution due to the fact it consists of some uncertainties about accountability, and that giving the personality status may require a perspicuous frame since it can cause a cash flow into the system, as well (21).

The approach supporting the personality of artificially intelligent robots claims that giving a legal status actually stands for making the robots responsible rather than making them owners of a right. In fact, accepting the robots as legal entities means that they are liable to rights and obligations, and that they can undertake legal and criminal obligations. Personality is a status that brings along rights in addition to obligations. Indeed, some people believe that the demand for personality is not limited to taking the responsibility, that giving the legal status to powerful artificially intelligent robots leads to determining their fundamental rights and freedoms, making some essential regulations including law in domestic relations, law of property, and law of inheritance (22), and, furthermore, putting an emphasis on the necessity for the robots to possess the same rights that people have (23).

From our point of view, giving personality status to artificially intelligent robots is not a decision to be made quickly. Even though Islamic law consists of the idea of legal personality by conception, if not by name, all in all, people are liable to be involved in an activity in behalf of legal entities like companies and foundations. Despite the fact that the proposal on considering artificially intelligent robots to be

legal entities, or, as the European Parliament noted, to be electronic entities may be accepted, it is important to regulate this in such a way that this cannot cause the limitation of human factors and human responsibilities, including those of the developer and the user, or in a way that would not eliminate it completely.

III. Robotic Artificial Intelligence And Its Moral Position

The lexical meaning of the word, "ethics", which is the plural form of the word, "hulk" in Arabic, refers to some terms such as "temper, characteristics, temperament, faith, nature, manner" (24). As a term, its meaning varies from person to person, or, depending on the ideology. For instance, according to Al Ghazali, who was an Islamic philosopher, "ethics is such a notion of temper and natural capability dwelling on human personality that acts can easily and readily emerge without any external/outer pressure thanks to it" (25). The reason why we chose to focus on the definition presented by Al Ghazali out of all the others is because he exemplified what we have tried to represent under the title. Personality, natural capability, and, accordingly, the concepts of consciousness and liability are the concepts we will be dwelling upon while evaluating moral personality of artificially intelligent robots.

According to Islamic belief, the Creator created the man and breathed soul into him (Hicr, 15/29, Secde 32/9, Sâd, 38/72). Thanks to this soul, the man was placed on earth to become Allah's caliph, and the heaviness of this liability was described in the Quran with the metaphor of earth (Ahzâb, 33/72). Besides, having this soul and liability qualified humans as "the honorable creature".

A. The Concepts of Soul, Consciousness and Liability

Today, the concepts of soul, consciousness and liability underlie the ethical problem that awaits artificial intelligence technologies, which have modeled human intelligence. In the history of philosophy, while some philosophical systems that were developed on sense of self (consciousness), which refers to the self-recognition of the soul and mind, exhibited an attitude rejecting personality, and accordingly, consciousness, some others identified personality as non- material, and believed that the self-recognition of the mind was the possibility of being a proof that made the soul independent from the body. Avicenna and Descartes are the two philosophers who claimed this view in the first place.

Whereas Avicenna focused on the balance of the soul and body, Descartes represented the dualism of soul-body vehemently. This gap, which was caused by Cartesian philosophy, was constantly discussed during modern philosophy. Even though Descartes' cogito was greatly mentioned in the history of philosophy, the way Avicenna evaluated self-recognition was not focused on adequately. Descartes' "cogito" appears to be a great column on which the whole modern philosophy would be built, and Locke, Hume and Kant seem to have used this opportunity upon such an efficient foundation of the modern subject. Avicenna's flying man theory could not be used significantly in terms of the foundation of a philosophical future. However, in terms of the re-foundation of the traditions of Islamic philosophy, it might have been some opportunities to build systems of thought upon such a significant assumption (26).

Avicenna's "flying man" metaphor refers to the idea that even when a human's organs are removed, there still would be a sense of self that can be conscious of itself, and that by getting rid of the heaviness, the human can turn into a flying man. This leads to the fact that the soul, in the scope of consciousness, has a realm of existence that is independent from the physical world. In addition, another significant point in this context is the continuous existence of a conscious creature even without its organs.

Aside from the historical, psychological, philosophical and conceptual foundations related to consciousness, the daily usage of the word, consciousness refers to some practical expressions such as wakefulness, the capacity of reaction to stimuli, attention or awareness. However, complexity of the mind poses an obstacle to define consciousness with absolute and clear expressions (27). The factor making the issue of consciousness difficult and complex and causing the term to be accepted by some people as an "uncertain phenomenon" is not about discovering how the brain functions for some activities such as perception, speaking, perceiving, memory, and problem- solving, but about explaining how we become conscious. Analyzing the brain requires more than just studying the map that explains the relationship between the brain and behavior, the connection between neurons, and finding out which part of it is responsible of which body function (28).

When we analyze the theories on consciousness that were presented by some philosophers and scientists such as Francis Crick, Gerald Edelman, Roger Penrose, Daniel Dennett, David Chalmers and Israel Rosenfield, we can clearly notice that there are five approaches on consciousness: computational approach, material approach, cognitive and qualitative approach, reductionist approach and rejective approach. Except from rejective approach, these approaches share the idea that the brain creates conscious experiences. The conflict is about explaining how the brain creates them. Conscious experiences are internal, qualitative and subjective conditions. How does the brain, which is a physical and biological thing, cause these internal, qualitative mental processes? This is something that even the theories which lean on scientific world these days cannot explain. John Searle touched upon this issue by saying: "Actually, we have a lot of insights on what happens in the brain; however, we do not have a unifying theoretical explanation on neurobiological level that can explain how the brain creates, structures and organizes our mental world." (29).

Today, mental philosophy has numerous approaches on consciousness. We do not aim to explain all of them. Nonetheless, when we analyze all of these things and the insights we have, it would not be mistaken to arrive at this conclusion: "The mystery of consciousness is still unsolved in the 21st century." How the brain manages mental processes of consciousness, whether it performs this in a causal context, a biological context, or in a context of arranged series of calculation like a computer is a phenomenon that is still being discussed and that brings about three different types of artificial intelligence: Artificial narrow, artificial super and artificial general intelligence. Some people believe that the mystery of consciousness will be unclothed, and that artificial intelligence technologies will be able to integrate artificial consciousness in coming centuries. We hope that artificially intelligent robots are aware of the responsibilities that await them.

B. *Can Artificially Intelligent Robots Have a Moral Personality?*

Robotic artificial intelligence technologies aim at simulating human brain. The human brain has conscious acts no matter how many rejective manners there are on it. Conscious acts are mental processes. All these conscious circumstances or self-awareness present a person the capacity to be liable to the outcomes of his/her acts. Liability contributes to his/her moral personality. In fact, a person can be selective for his/her tendencies thanks to his/ her will. Being selective represents the premise of undertaking the outcomes of an act. Can an artificially intelligent robot have some mental processes such as making a decision independently from the program that has been uploaded or identified in its system, changing its decision in case of emergency, and even realizing in the very context of the phenomenon that some truths are not valid in some conditions and attributing a new value for them? There are some views regarding whether it is possible for artificially intelligent robots to have a moral personality:

1) If scientists succeed at developing these artificial intelligence systems to human intelligence or natural intelligence level, and make them capable of imitating and even acting consciously, then these systems would require artificial ethics, as well. No matter how difficult it would be, many artificial ethical factors like liability and will need to be available for being integrated artificially in the scope of the concepts of good and evil, which are the fundamentals of ethics so that humanity can keep artificial intelligence systems which they have created under their control and stop these systems to harm human race. In the contrary case, artificial systems might get out of the developer's control and cause innumerable chaotic situations. Thus, a process of integrating liability that will guarantee the artificially intelligent system being liable to the person who has developed itself in the first place is required. Unless artificial ethics is not integrated into an artificially intelligent system, it will be hazardous for human race and for all the living creatures (30).

2) According to the outcome of the question based on ethical reality of artificial intelligence, "Will the machine or the person be ethically liable in case of possible mistakes that might be made by the machine?", if an artificially intelligent robot is liable, people would use it at their services to get everything they want, and this will lead to the fact that people would not undertake their own ethical liability, and even try to get rid of their obligations. This question also points to another issue on whether it would be ethical to develop artificial intelligence in this way. A possible condition involving people being reluctant to undertake the liability of the situations that they have caused and making the artificially intelligent robot responsible instead would cause an unethical act all by itself. The ultimate result that we have obtained by evaluating all these aspects indicates that it seems more realistic that people will most probably use an artificially intelligent robot as an unprecedented tool to tyrannize over other people, aside from the concern emerging with the possibility that artificial intelligence can be troublesome in the future. In fact, since it is a human being that has developed the artificially intelligent robot and operated its system, after all, it will be the same human being who gets to decide how he/she will program it. Therefore, it is fundamental to consider artificial intelligence to be an ethical factor and establish universal ethical laws about it (31).

3) Although the designers who actually develop more sophisticated machines expect these machines to think and act better than human beings, it does not seem possible for now. However, when it is possible, robots and androids that cannot carry out ethical principles will lead to some ethical, psychological, social and cultural problems. Making conscious robots different than machines will cause an expectation regarding some ethical factors that the robots can possibly consist of. It might be immoral to treat them merely like "machines" if they become conscious. Roboethics, which deals with interesting philosophical and speculative issues about conscious androids and their developers, owners and users, focuses on the morality of robots. In terms of moral dimensions of the robots turning into androids, roboethics can be associated with the issues on robots and their interactions with humans, animals, the society, nature and the world.

Asimov, who established the first ethical laws of roboethics, presented these three articles (32):

a) A robot may not injure a human being or, through inaction, allow a human being to come to harm.

b) A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.

c) A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

However, Asimov's three laws of roboethics appear to be insufficient in terms of providing the certainty of the morality of artificial intelligence.

IV. Result And Suggestions

According to Islam, scientific studies are accepted, in a way, as researching the verses that Allah placed in the universe, and they are encouraged. The Quran motivates believers for discovering the earth and contemplating, it also points to the power and supremacy of the knowledge by commanding: "Are those who know equal to those who do not know?" (Zümer,39/9). It is possible to analyze the studies on artificial intelligence in this respect. Owing to the fact that technological production is not detached from Allah's wisdom and might, there is no way that this can be regarded as an intervention to God's creation. Besides, it was expressed clearly in the Quran that human beings cannot even create a mosquito, which was mentioned as a simple biological creature (Hac, 22/73-74; İsrâ, 17/85). On the other hand, in Islamic law, it is a fundamental principle that judgments should be presented in a way that can guarantee people's benefits and can prevent situations which might cause people getting hurt. It is necessary to state that technological studies which are beneficial for people are supported in this respect, as well. However, they are supported only on the condition that they should not include any individual, social and environmental harm whatsoever.

Here are the results we have obtained and our suggestions according to this brief research:

- No matter how developed artificially intelligent robots are, it would not change the fact that they are actually machines. No matter how developed artificially intelligent robots are, it is not possible for them to surpass the human level and possess a biological existence. Similarly, the fact that people establish a bond with the robots, name them, have a chat with them, and even give them civil rights would not change the fact that robots are actually machines.
- Even if they are described as strong or super, artificially intelligent robots cannot be accepted as human beings ontologically because human beings, by their nature, are more than being creatures that can practice some acts such as moving, seeing, hearing and speaking. Therefore, it would be meaningless to talk about giving robots some rights that are specific to humans such as marriage, reproduction and inheritance.
- The fact that humans are creatures that have rights and obligations is directly related to some capabilities such as reason, mental capacity, discernment and will. Even if artificially intelligent robots, which cannot have these things naturally, are given legal status, it can be stated that accepting them as independent beings which are detached from humans would not be appropriate from the perspective of Islamic law. Ultimately, autonomous artificially intelligent robots make a decision and act according to it through the algorithms with which they have been programmed. Thus, since they are not exactly autonomous without human interference, it is not acceptable for people to attribute legal and moral status to the robots, and, with this way, try to eliminate their own obligations.
- Robots should be used for people's benefit in various areas such as defense, medicine, education and service industry, and especially for the works which are dangerous for people, but establishing a future involving human beings being under the tyranny of robots must be avoided. The scientists of today have a great responsibility of leaving a future full of safety and security to the generations of tomorrow.
- Robots might be regarded as digital assistants or electronic helpers. Some suggestions involving giving legal entity to robotic artificial intelligence sector, creating abstract of record, giving the right of property, and compensating material damage caused by artificial intelligence through this fund seem plausible.
- Robots should be able to undertake the liability of the outcomes of their acts if they are considered to have a legal personality. Universal laws of ethics should be established; people who develop these technologies should not be able to monopolize ethical values and ethical concerns; both robots and the systems that program the robots should obey these universal laws of ethics.
- Technological developments cannot be evaluated independently from ethics, morality and law. The ones who might weaken the values and damage human beings by leaning on some reasons like accelerating technological developments or individual and social benefit should not be authorized in the future.
- It is crucial to continue interdisciplinary scientific conferences in which such a complicated issue related to some areas such as ethics, law and theology is evaluated on an international level. Different parts of the society constituting of a well-attended representation of it should also be included to the arguments related to artificial intelligence, which concerns the future of the whole humanity.
- All things considered, attributing personality to artificially intelligent robots does not seem like a solution for legal and moral issues. Maybe, the essential question here to which an answer is required is whether the people who develop technology have the right to try to form a creature that might replace humans.

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Performance of Machine Learning Techniques to Predict Monthly Stock Prices

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***Abstract*—Estimating daily stock prices is a difficult problem for data scientists and researchers. Some studies show that stock price movements can be predicted with a reasonable degree of accuracy if appropriate variables are selected and appropriate predictive models are established. Many artificial intelligence programs and machine learning techniques have been developed in this field. However, the prediction ratio of the daily stock prices is still not accurate. In this study, we provide a robust and accurate stock price prediction framework using statistical machine learning methods. Monthly data on stock prices and the detailed data have been properly combined to form the prediction framework for stock prices. We argue that this framework, by combining several machine learning algorithms can accurately model the volatility of stock price movement and hence be used in short and mid-term forecast of stock price. Comprehensive results of these models based on the prediction performance have been presented.**

Keywords—machine learning, stock market, big data, stock prediction

I. INTRODUCTION

The stock market prediction has been of interest to many researchers and investors. This kind of interest has been at focus for many years because it can involve high profit when the stock market can be predicting accurately. However, prediction of the stock market is not a simple task due to the complex structure of the stock data. Stock markets where stocks are traded are dynamic, non-linear and chaotic, it is difficult to make predictions in these markets. There can be many factors that affects the stock prices such as the policies of the companies, the general economic situation, investor expectations, the movements of other stock markets and the psychology of the investors. Data analysts have applied different statistical methods for stock price prediction. For instance, many linear modelling techniques for stock market prediction have implemented by researchers related to the business marketing field [1]–[3] or the prediction might often relate to machine learning in computer science [4]–[6].

Artificial Neural Networks (ANNs) is one of the most commonly used method in stock market prediction [7]. However, support vector machines (SVMs) and its extended methods are an alternative technique in stock market prediction [8], [9]. There are many other methods used in the stock market prediction such as deep learning [10], Hierarchical clustering [11], K-means algorithm[12] and hybridized approaches [13], [14].

[15] compared the performance of SVM and ANN approaches in financial time series data and the results revealed that SVM is more applicable in terms of parameter selection and prediction error rates compared to ANN and produces better results. [16] estimated Indian stock market prices by using SVM, Random Forest and ANN. They found that the Random Forest produced better classification results than the other techniques. ANN and Autoregressive integrated moving average (ARIMA) techniques are used in order to predict KSE-100 index in [17]. [18] presented machine learning techniques to predict stock market movements.

The aim of this paper is to estimate selected stock prices (GOOG, MCD, WMT, INTC, KO, NKE, AAPL, MSFT, AMZN) by using machine learning techniques for the following 24 months. To do so; ARIMA, ANN, Holt Exponential Smoothing and Seasonal and Trend decomposition using Loess (STL) are applied to the dataset of the selected stock prices between the periods of January 2010 and July 2018, and the following 24 months are estimated. Each model is evaluated separately for 9 stocks and the models making the best estimation are determined.

II. METHODOLOGY

A. STL Decomposition

This method is using for decomposing seasonal time series into three parts: trend, seasonal, and reminder. The basic idea of the STL is that time series can be decomposed into three parts: seasonal, trend and reminder. It can be shown as $Y_v = T_v + S_v + R_v$ for v = 1 to N observations. The most important part of the STL is that STL consist of a smoothing operation. It uses local regression, for observations y_i and x_i, to smooth estimate g(x) for y at all values of x. The theory and fundamental behind the STL can be found in [19].

B. Holt-Winters Exponential Smoothing

Holt-Winters Exponential Smoothing is a technique applied to time series data to forecast future observations. Holt-Winters Exponential Smoothing consist of three equations:

$$\hat{y}_{t+h|t} = \ell_t + hb_t \tag{1}$$

$$\ell_t = \alpha y_t + (1-\alpha)(\ell_{t-1} + b_{t-1}) \tag{2}$$

$$b_t = \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)b_{t-1}. \tag{3}$$

The first equation represents the forecast equation, the second equation shows the level equation and the third equation represents the trend equation. In the level equation, ℓ_t show a prediction of the level of the observations at time t and b_t represents the prediction of the trend of the observations at time t, α is the smoothing parameter for the level and β^* is the smoothing parameter for the trend.

C. *Artificial Neural Networks*

Artificial neural networks are a system inspired by biological neural networks and containing some performance characteristics similar to biological neural networks. An artificial neural network consists of many processing units called neurons. Generally, neurons are located in logical groups called layers. The network has a hierarchical structure consisting of 3 or more layers. ANNs, which simply imitate the way the human brain works, has many important features such as able to learn from data, make generalizations and work with an unlimited number of variables.

The simplest artificial neural network consists of 5 main components: inputs, weights, combining function, activation function and output.

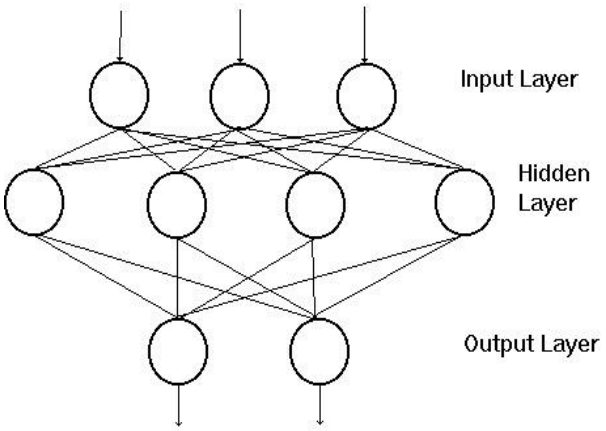

Fig. 1. Simple Neural Networks

Inputs, ($x_1, x_2, \ldots, x_n$), are information that enters the cell from other cells or external environments. These are determined by the variables which the network is asked to learn. Weights, ($w_1, w_2, \ldots, w_n$), are values that express the effect of another processing element in the input set or a layer. Each input is combined with the sum function after multiplying by the weight value that connects the corresponding input to the processing element. The calculation of the sum function is as given in the below equations.

$$net = \sum_{i=1}^{n} w_i x_i + b \tag{4}$$

$$f(net) = f\left(\sum_{i=1}^{n} w_i x_i + b\right) \tag{5}$$

The structure of the basic statistical model of the neuron is used in many neural network models. Modification of the weight values can help networks to learn in response to external data.

D. *ARIMA*

ARIMA is one of the most popular statistical models for forecasting time series. The acronym AR (p) represents the Autoregressive model and MA (q) is known for a moving average model. So, we can define an ARMA model as below:

$$Y_t = \sum_{i=1}^{p} \phi_i Y_{t-i} + a_t - \sum_{j=1}^{q} \theta_j a_{t-j}, \tag{6}$$

$\Phi_1,\ldots,\Phi_p$ are the AR parameters to be predicted, $\theta_{1,\ldots}\theta_q$ are MA parameters to be predicted and $\alpha_1,\ldots, \alpha_t$ are random errors. Finally, ARIMA model can be defined by using ARMA as follows:

$$\phi_p(B)(1-B)^d Y_t = \theta_q(B) a_t \tag{7}$$

Here, B is the Box-Jenkins backshift operator and replacing Y_t in the ARMA model help us to obtain above ARIMA equation.

III. RESULTS

Monthly stock prices of 9 companies from January 2010 to July 2018 were used to estimate the stock prices. The statistical analysis was used in order to compare the limits, reliability and accuracy of the selected methods. Below table provides the inputs for the selected stock datasets.

TABLE I. DATASET PROVIDED FOR STATISTICAL ANALYSIS

Dates Included	01.01.2010 to 01.07.2018
Stocks	GOOG, MCD, WMT, INTC, KO, NKE, AAPL, MSFT, AMZN
Forecasting	For the next 24 months

The statistical models are applied in order to estimate the stock prices of the selected companies for the following 24 months. Firstly, the STL decomposition is applied to the actual dataset. The statistical analysis was applied to all companies. However, the graphs for the four companies have been given in the main text. Figure 1 shows the actual stock prices and STL trend of these prices.

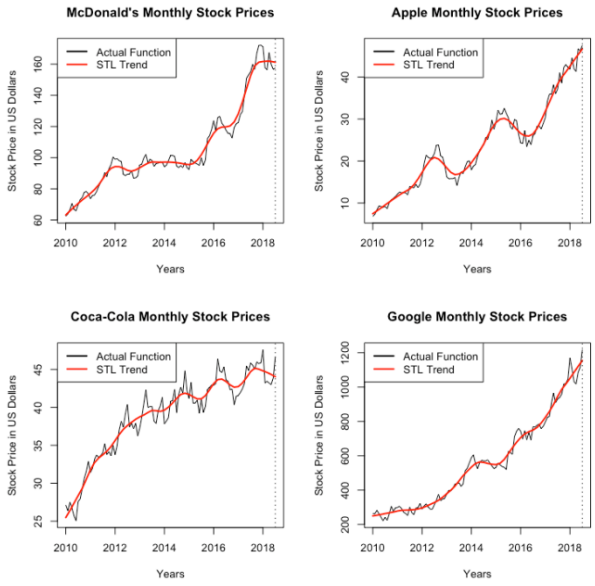

Fig. 2. Actual Stock Prices vs STL Trend

There are many different types of trend techniques which can be applied to the stock price data. However, many of the trend lines fails due to the seasonality. Therefore, we applied the STL trend in the analysis because it deals with the seasonality significantly. As it can be seen from the Figure 1, the STL trend fits the actual observations. STL is a very effective technique for the capturing the seasonal effect from the stock price data.

After applying the STL decomposition, we applied ARIMA, Neural Network, STL and Holt-Winter Exponential smoothing to the stock price prediction. The dataset is divided into trained and test data for this purpose. The predictions of the stock prices for the four companies are given in Figure 3.

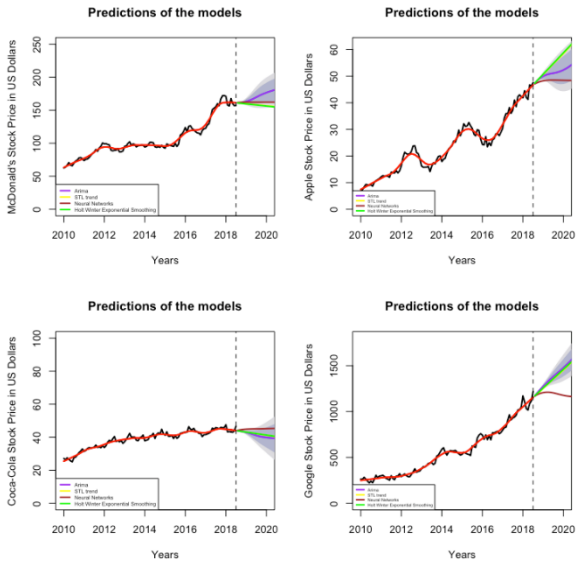

Fig. 3. Predicitions based on the selected models

While some models produce similar results, the results of the models vary by company. The performances of the models are compared based on the mean absolute error (MAE). The model which has the lowest MAE score is selected as the best model for each company. Below table presents the MAE scores for each company based on the selected statistical methods. Although all forecast methods have some errors, Neural Networks was selected as the best model for the four stocks. The STL decomposition and Holt-Winter Exponential smoothing technique were selected as the best model for two stocks. ARIMA has selected only for one stock.

TABLE II. MAE SCORES OF THE MODELS

Stocks	ARIMA	STL	ANN	HW	Min MAE
GOOG	70.31	332.29	245.73	138.62	ARIMA
MCD	131.43	144.01	10.16	80.445	ANN
WMT	75.18	193.43	75.13	94.79	ANN
INTC	8.52	12.9	17.75	6.77	HW
KO	41.26	19.84	12.48	15.05	ANN
NKE	177.06	225.43	92.54	176.81	ANN
AAPL	38.14	25.92	54.26	95.26	STL
MSFT	15.94	6.57	7.88	15.93	STL
AMZN	69.6	79.54	56.3	64.16	HW

IV. DISCUSSION AND CONCLUSION

In this study, we have successfully presented the comparison of four models according to nine different stocks. With the results from the forecast accuracy of the nine stocks, Neural Networks outperform the other models. Since the stock market prediction is very challenging, different models may need to be used for different stocks. In addition, since the stocks used in the study are reliable stocks, monthly stock prices of these companies do not fluctuate significantly. Therefore, the predictions were more robust. However, this scenario may be different for speculative stocks.

The robustness of stock estimates can be achieved by programming reliable models into artificial intelligence, enabling investors to obtain fast and effective forecast results. Therefore, future studies should focus on increasing the robustness of the models.

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Artificial Intelligence in the Context of Marketing 5.0: A Critical View of Applications

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***Abstract*—Big data has formed the basis for the transformation of marketing activities with the extraordinary speed of many interconnected objects and technologies. All information generated as a result of mobile internet, information system automation and the internet of things has been processed, and it has laid the groundwork for producing flexible, personalized, customer-oriented products by revealing useful data. Artificial intelligence technologies have also been integrated into the marketing field, enabling businesses to develop customer-oriented strategies and increasing the use of the data obtained. These data, together with artificial intelligence technologies, can also be beneficial in interacting with new customers, ensuring continuity in decision-making processes, customer relations, producing personalized products, pricing, promotion and brand communication. In this context, the new Marketing 5.0 era offers both businesses and consumers a market where technology is at the forefront. From this point of view, in this study, it is aimed to examine the benefits of artificial intelligence to businesses and customers, as well as its effects on marketing, by analyzing its applications in this field. For this purpose, active roles in customer relationship management, unmanned devices, smart robots, internet of things (IoT) and marketing were taken as a basis, and the areas of artificial intelligence in marketing were focused on.Artificial intelligence applications in research secondary data research was performed in order to reach the examples. In this context, domestic and foreign websites in order to reach artificial intelligence applications in the field of marketing It has been examined.**

Keywords—component, formatting, style, styling, insert

I. INTRODUCTION

Considering the technological advances in the 21st century, which is called “the information age or digital age”, the concept of artificial intelligence has attracted the attention of many different disciplines. Artificial intelligence has found a place in almost all areas and has become an important subject of study. When considered on the basis of economic and administrative sciences, it has become a necessity to follow the reflections of the transformation of technology and information over time. For this reason, one of the disciplines in which changes in technology are followed and adapted is marketing that enables multidisciplinary studies. Marketing is one of the fields that has an important place in artificial intelligence and its applications due to its dynamic nature. One of the most important reasons for this is that the transformation process of marketing is also a parallel structure with technology [1][2].

The Digital Age is gradually narrowing the distinction between marketing and sales. Although the basic distinction between marketing and sales appears clearly in the transformation processes of marketing, marketing has now begun to focus directly on target audiences, exhibiting characteristics similar to sales. In this context, artificial intelligence supports marketing to deliver the right product to the right person at the right time. In this study, marketing 5.0, which is a new generation business model, in other words "Internet marketing of objects" has been discussed and the reflections of artificial intelligence applications on marketing have been examined.

II. ARTIFICIAL INTELLIGENCE.

Robotic tools and artificial intelligence which are said to will replace human, did not say that they will gain importance in today's world, where information and technological development take place at high cruises. Artificial intelligence is "the general name of the technology of developing machines that can exhibit human-like behaviors and movements, created with completely artificial tools, without benefiting from any living organism".(Aydın [3].According to Felix, artificial intelligence (AI) is "the term used to describe smart machines" [4]. Speech and language in building artificial intelligence communities, research and analysis processes, computer games, military fields; It is used in audio and visual computer languages and applications, in many stages of production processes [5]. In addition, artificial intelligence has started to take place in many areas that affect the lives and future of people today such as education, consultancy, law, energy, finance and economy, security, internet, virtual assistance, health and medicine, agriculture, transportation and traffic, space research. Autonomous vehicles, navigation systems can be given as examples [6].

In the past AI was seen as an imaginary product which was featured in science fiction books and movies. Today, it is a real technology in robots, vehicles and computer programs that can answer our questions and find solutions for different problems [7]. Although some experts and people have the belief that artificial intelligence will harm people and our future and even take over humanity, human life has become easier thanks to the existence of artificial intelligence and its applications. To give an example in the context of military

applications; Instead of using it for a malicious purpose such as war and attack, it is seen as an effect of the human factor, not the fault of artificial intelligence, in using it for a good purpose such as defense and security.

III. Artificial Intelligence And Marketing 5.0 Relationship

Better to understanding the periods and approaches related to marketing, it is necessary to know what marketing is. According to the definition of the American Marketing Association, " Marketing is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large ' [8].

Before reaching Marketing 5.0, marketing went through a number of stages with different approaches in different periods. Marketing 1.0, the first stage of marketing, adopts a product-oriented approach, while marketing 2.0 has a customer-oriented approach. Marketing 3.0, which includes the next stage, is a human-centered period (Ertuğrul & Deniz, 2018). Marketing 4.0 is "a marketing approach that combines online and offline interaction between companies and customers, blends style and essence in brand development, and finally completes the machine-to-machine connection with a human-to-human touch to increase customer engagement" [9]. The evolution of marketing, which includes the stages before Marketing 5.0, is given in Table 1 below.

TABLE I. Conversion From Marketing 1.0 To Marketing 4.0

	Marketing 1.0 (Product oriented)	**Marketing 2.0 (Customer-oriented)**	**Marketing 3.0 (Value oriented)**	**Marketing 4.0 (Virtual marketing oriented)**
Aim	Sell product	Satisfy the customer	Making the world a better place	Creating the future from today
Power that Allows Possibility	industrial Revolution	Information Technology	New wave technology	Cybernetic revolution and Web 4.0
Market seen by companies	Mass buyers with physical needs	Smarter consumer withmind and heart	All human with mind, heart and soul	Fully conscious buyers, a community of co-creation products.
Key Marketing Concept	Product developmen t	Differentiation	Values	Production according to the customerand just in time production
Company marketing guides	Product features	Corporate and productpositioning	Corporate vision and values	Values, vision, expectation
Value Propositions	Functional	Functional and emotional	Functional, emotional and spiritual	Functional, emotional, spiritual and self-creativity
Interaction with Customers	One to Many transaction	One-to-one relationship	Cooperation from Many to Many	Many-to-Many co-creation andcollaboration

Source: [10] [11].

Aktürk emphasized in her study that the key marketing concept included in marketing 4.0 is customer satisfaction and just-in-time production [12].

Marketing 5.0 should be addressed based on the experiences related to all stages including Marketing 4.0. According to Öz and Arslan, marketing 5.0 is the more advanced version of Marketing 4.0, which covers the first three marketing phases [13]. According to the authors, marketing 5.0, " objects, sensors, etc. enables buyers to integrate and communicate with digital devices and technologies by making these objects smart and feel, and the bridge that connects physical and digital turns into a platform "(p.246).

Based on the definition of Marketing 5.0, communication

5.0 to utilize all kinds of technological assistance to optimize communication and communication with a growing customer base between channels and contact points. In this context, artificial intelligence manifests itself in marketing applications in order to present the right message in the right channel at the right time. In addition, while finding a place in

all processes, it is thought to have a large desire in choosing target customer and expanding market opportunities.

Based on Marketing 5.0, with the development of artificial intelligence-supported marketing technologies, many inefficient operational jobs of marketing professionals are eliminated and it is easier for individuals to focus on their core business. When considered on the basis of Marketing 5.0, artificial intelligence is basically open to the following contributions [14].

- Accelerates income growth
- Creates personalized consumer experiences at scale
- Reducing costs
- Creates a higher Return on Investment in campaigns
- Gain more actionable insights from marketing data
- More accurately predicts consumer needs and behavior
- Reduces time spent on repetitive, data-driven tasks
- Shorten the sales cycle
- Provides more value from marketing technologies.

IV. Methodology

Since the use of artificial intelligence applications in different areas has reached a very high level, the reflections of artificial intelligence on marketing applications have been examined in this study. In this context, Marketing 5.0, which has taken a new structure with the digital transformation process, is based on. In the research, "In which areas of marketing does artificial intelligence find application?" In order to find an answer to the question, examples of artificial intelligence applications in areas such as voice, text, image recognition and decision making were examined. Secondary data research was performed in order to reach the mentioned

examples. In this context, domestic and foreign websites have been examined in order to reach artificial intelligence applications in the field of marketing. Since the main purpose here is to reveal the equivalent of any artificial intelligence application in marketing 5.0, the findings presented were created in the light of the data collected from the websites examined. Findings are presented with the help of tables.

V. FINDING AND RESULTS

While artificial intelligence shows itself in different sectors, it also reshapes the marketing sector. This situation arises on the basis of Marketing 5.0. From this point of view, the applications in Marketing 5.0 based on the structures categorized based on artificial intelligence are given in Table 2.

TABLE II. FINDINGS REGARDING ARTIFICIAL INTELLIGENCE APPLICATIONS BASED ON MARKETING 5.0

Category	Application Area in Marketing
Smart Assistants	· Intelligent assistants, also known as virtual assistant or digital assistant (helpful tools such as sharing weather forecast, creating meeting requests, reporting a sports score or phone call · Voice purchase requests made through a device · GPS navigation system showing the route to the selected destination and suggesting the need-based places on the road
Recommendation Systems	· On application platforms, suggestions such as "recommended for you", "the customer who bought these products also bought X products" (These algorithms include actions such as each page views, purchases made in that application.
Customer Segmentation	· To perform dynamic micro-segmentation and predict future behavior by analyzing customers according to their movements between segments over time · Creation of a consolidated customer record that links together customer data from each company domain, regardless of the products purchased and used. · Synchronization of customer data from all possible contact points with the brand (social media, website, e-mail, phone call).
Purchasing in Program Environment	· Programmatic media buying process, trend models generated by machine learning algorithms to direct content towards target customers more effectively
Predictive analytics (Smart Assays)	· Predict the likelihood that a particular customer will convert, predict at what price the customer will convert, or predict customers who are most likely to repeat purchases, etc.
Advertising and Retargeting	· Handling historical data to determine which ads are performing the best with machine learning algorithms, analyzing according to the stages of the purchase process and providing the most effective content at the right time. · Matching ads to user attributes based on the customer's online history · New product suggestions · Developing a marketing campaign to offer a new product or service model using data provided by a selected target group
Web and App Personalization	· Serving that customer with the most relevant content in an app or web page, using a trend model to predict a customer's purchasing stage
Chatbots	· Chatbots that imitate human intelligence, which are communicated as if communicating with a human through messaging in digital media and used for various purposes such as obtaining information and performing transactions
Visual Artificial Intelligence	· An artificial intelligence supported structure that can make inferences with the help of images obtained from cameras and photographs and compile the results by making sense of things that were not possible to analyze in previous periods.
Visitor Analysis	· Ability to analyze the experience of customers visiting traditional and online shopping stores, to determine their routes within the store and website and to make businesses more efficient
Customer Experience	· Developed in accordance with the needs of different markets with the help of facial biometrics · Face recognition, facial biometrics identification and authorization-based applications
Dynamic Pricing	· Dynamic matching of prices according to users' purchases

SOURCE: [15] [16] [17] [18] [19] [20] [21]

Smart assistants, recommendation systems, customer segmentation, purchasing in the program environment, predictive analytics (smart analysis), advertising and retargeting, web and application personalization, chatbots, visitor analysis, visual artificial intelligence, customer experience and dynamic pricing, as indicated in Table 2. are important categories for the application areas of artificial intelligence in marketing. These categories consist of many important applications that facilitate the daily life of consumers and have important functions in terms of the process of marketing activities for business and marketing practitioners. For example, while ease of use is offered to consumers with mobile applications and interfaces such as navigation, virtual assistants with smart assistants, on the other hand, customer segmentation applications provide a convenience for businesses by analyzing and synchronizing customer data. As can be seen from the table, the common purpose of the categories and application areas in artificial intelligence is to raise the standards of their users (business or consumer) in practical life.

VI. CONCLUSION

Artificial intelligence is a term that covers a wide range of different technologies. For this reason, artificial intelligence includes many technologies that want to imitate human intelligence, such as voice and image recognition, machine learning techniques. These techniques are not only the techniques that big technology giants allocate to resources, but are also seen as artificial intelligence techniques that can be applied by businesses of all sizes when used correctly.

When all techniques are considered in terms of technology type, we come across as machine learning techniques, applied trend models and artificial intelligence applications. These techniques and applications based on these techniques have important marketing implications. The findings of this study have shown that considering that each consumer can play different roles in different shopping journeys, some businesses use artificial intelligence applications to attract customers, while some enterprises use artificial intelligence applications to regain their old customers and / or re-influence them in the transformation process.

The results of the research have shown that artificial intelligence is an important structure on the basis of marketing 5.0, to communicate with customers at the right time, to interpret data based on data and analytics in the best way, to take action and to provide personalized products and services. Considering the value-based nature of marketing, the appropriate design of artificial intelligence systems will guide marketers in determining human values in a much better way and presenting a new value-oriented product or service model.

Artificial intelligence technology, mobile technology and applications that enable digital transformation of businesses, Internet of Things (IoT), virtual reality (VR), augmented reality (AR), autonomous robots, blockchain, smart sensors, cloud computing, cyber physical systems, biometric and cyber security It has a very important role in the context of the holistic solutions of its technologies [1]. Therefore, considering the application area of artificial intelligence based on Marketing 5.0, it becomes possible to create an automatic structure in the design and adaptation of the digital journey that will occur for each customer. The results show that marketers can segment audiences by forecasting using artificial intelligence to determine the future actions of customers. On the other hand, with the help of predictive analytics, marketers will almost always be able to present the best product, content or offer every time. Considering the possibility of the customer to interact with the product or service, it is ensured that the messages can be sent at the right time. For this reason, it is an important structure that should be taken into account by marketers and practitioners that artificial intelligence is a tool but its deployment in marketing applications will be among the key success factors.

Considering the application of artificial intelligence, it appears as a structure that contributes greatly to marketers and practitioners in subjects such as customer segmentation, smart prediction, advertising and campaign management, visitor analysis and digital pricing. Considering systems such as smart assistants and advice systems, web and application personalization operations, purchasing in program environment and chatbots are among the determinants of the transformation process of marketing.

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Binary Sooty Tern Optimization Algorithms for solving Wind Turbine Placement Problem

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***Abstract*—Sooty Tern Optimization Algorithm (STOA) is a recently developed nature-inspired continuous optimization algorithm. Sooty Tern is a sea bird and STOA is mathematically modeled the attacking and migration behaviors of Sooty Tern is a continuous optimization algorithm. The continuous optimization algorithms are converted to binary optimization algorithms with transfer functions. In literature, 17 transfer functions are used for mapped continuous search space values to binary search space values. In this work, 17 different binary variants of STOA (BSTOA1-BSTOA17) are proposed for solving the wind turbine placement problem (WTPP). 100 dimensional (10x10 grid type) WTPP is solved by these 17 variants of STOA. Experimental results have shown that binary variants of STOA are produced competitive solutions for WTPP.**

Keywords—Sooty Tern Optimization Algorithm, Binary Sooty Tern Optimization Algorithm, Wind Turbine Placement Problem, transfer functions

I. INTRODUCTION

Sooty Tern Optimization Algorithm (STOA) [1] is a continuous optimization algorithm modeled the life behavior of a sooty tern. Sooty tern is a sea bird lived in nature and its attacking and migration characteristics are modeled as a smart search algorithm as a metaheuristic. Sooty tern is a sea bird that lives in nature and its attacking and migration characteristics are modeled as a smart search algorithm. STOA is a metaheuristic algorithm that only can solve continuous optimization problems. Continuous optimization algorithms have continuous variables in a predetermined search space. Binary optimization problems have only two decision variables 0 and 1. The continuous optimization algorithms cannot solve binary optimization algorithms directly and they must be remodified for binary search space. Transfer functions [2] are commonly used for transferring the continuous variables to the binary search space. In literature, as far as now, 17 transfer functions [3] are used for mapping continuous variables to binary variables.

In this work, STOA is combined with these 17 transfer functions. Consequently, 17 novel binary STOAs (BSTOA1-BSTOA17) are proposed in this work. To determine the quality of these binary variants wind turbine placement problem (WTPP) [4] is used as a benchmark problem. 100 dimensional (10x10 grid type) WTPP is solved by these 17 variants of STOA.

The remainder of the paper is organized as follows. STOA briefly explained in Section 2. Transfer functions and, binary variants of STOA are described in Section 3 and Section 4, respectively. The details of WTPP and parameters of the experimental setup are given in Section 5. Results and Discussion are presented in Section 6. Finally, the work is concluded in Section 7.

II. SOOTY TERN OPTIMIZATION ALGORITHM (STOA)

Sooty terns live in colonies and attack their prey with their intelligence. Sooty terns migrate to rich food areas. The attacking and migrating behaviors are mathematically modeled and a new nature-inspired continuous optimization algorithm, Sooty Tern Optimization Algorithm (STOA) is proposed by Dhiman and Gaur [1]. The pseudocode of STOA is given in Fig.1.

Fig. 1. The pseudocode of STOA [1]

```
Input: Population X
Output: Best search agent, Xbest
FUNCTION STOA
Initialize the peculiar parameters
Calculate the fitness of each search agent
Xbest ← best search agent
   WHILE (iteration < Maxiterations) DO
      FOR each search agent DO
      Update the positions of search agents
      END FOR
   Update the peculiar parameters
   Calculate the fitness value of each search agent
   Update Xbest if there is any better solution than Xbest
   iteration ← iteration + 1
   END WHILE
   return Xbest
END FUNCTION
```

The detailed explanation about STOA can be found in [1].

III. TRANSFER FUNCTIONS

The details and equations of transfer functions that used in this work can be found in [3]. The continuous variable given as an input to transfer function and the output maybe 0 or 1. To facilitate the understanding Sigmoid transfer function (Transfer Function 1, i.e.) is given in Eq. 1.

$$STFR = \frac{1}{(1 + e^{-c})} \tag{1}$$

where c is the continuous input variable. If the Sigmoid Transfer Function result (STFR) is bigger than a random number between 0 and 1 the binary value is 1 otherwise the binary value is 0 as presented in Eq.2

$$ctob(STFR) = \begin{cases} 1, & rand < STFR \\ 0, & rand \geq STFR \end{cases} \tag{2}$$

where ctob is a function that produces a binary output.

IV. Binary Variants of Sooty Tern Optimization Algorithm

The scheme of the binary variants of Sooty Tern Optimization Algorithm (STOA) is given in Figure 2.

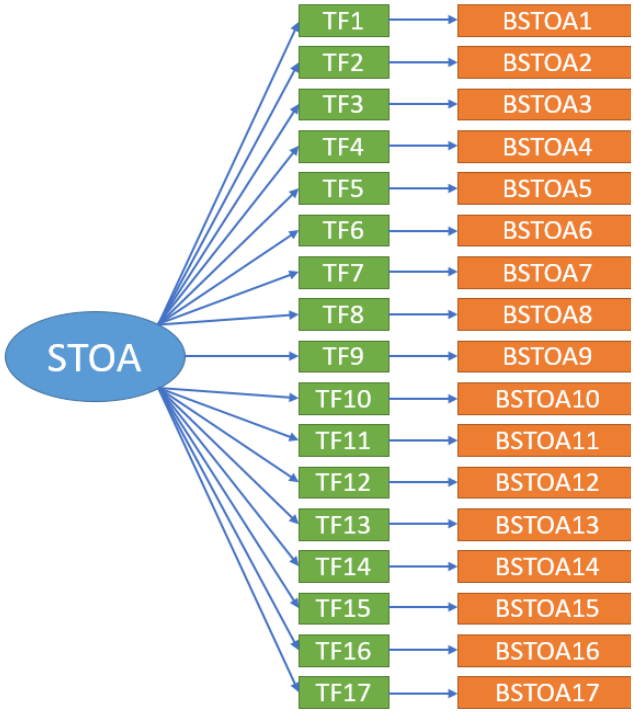

Fig. 2. Binary variants of STOA

The continuous variables are converted to binary variables before they sent into the objective function.

V. Experimental Setup

The details of the WTPP can be found in [4]. In this work, 100 dimensional (10x10 grid type) WTPP is solved by 17 binary variants of STOA. 2^{100} possible solutions are optimized by these binary algorithms. The wind direction is fixed as 0^{o} and the wind speed is fixed as 12 m/s.

The sooty tern population size is set as 50 and the maximum iteration number is set as 12000. The maximum function evaluation number is fixed as 600000 same as the works in [4, 5]. The upper bound of the continuous search space is set as 8 and the lower bound of the search space is set as -8. 30 different runs were conducted to cope with the random nature of the algorithms.

VI. Results and Discussion

The fitness value, the total produced power, the number of tribunes (NoT), the average power and the efficiency values are given in Tables 1-5 for 17 BSTOAs. The mean values are given in Table 1. The maximum values are given in Table 2. The minimum values are given in Table 3. The median values are given in Table 4. The standard deviation values are given in Table 5.

TABLE I. The Mean Values

	Fitness	Total Power	NoT	Average Power	Efficiency
BSTOA1	0.00155971	14720.6273	33.33	442.6088	0.8538
BSTOA2	0.00156049	15210.7763	34.63	440.3015	0.8493
BSTOA3	0.00158828	15079.0592	35.53	425.7536	0.8213
BSTOA4	0.00159755	13106.8915	30.23	436.1978	0.8414
BSTOA5	0.00162536	12535.9746	30.43	419.1184	0.8085
BSTOA6	0.00159793	13047.9339	30.00	437.6431	0.8442
BSTOA7	0.00233848	26284.1378	100.00	262.8414	0.5070
BSTOA8	0.00160718	12361.4186	28.67	432.5338	0.8344
BSTOA9	**0.00155655**	14897.4385	32.63	456.8835	0.8813
BSTOA10	0.00155744	14893.2590	32.80	454.9095	0.8775
BSTOA11	0.00162691	21453.2664	66.83	324.7075	0.6264
BSTOA12	0.00165091	547.5380	1.07	515.6890	0.9948
BSTOA13	0.00163808	15391.6237	40.30	383.1015	0.7390
BSTOA14	0.00160366	12721.3824	29.60	432.8648	0.8350
BSTOA15	0.00164878	13761.6470	34.27	403.5679	0.7785
BSTOA16	0.00159944	14914.0673	33.37	447.4497	0.8631
BSTOA17	0.00162647	16147.8925	40.30	402.5844	0.7766

The best variant is BSTOA9 in terms of the mean values. The worst variant is BSTOA7 in terms of the mean values.

TABLE II. The Maximum Values

	Fitness	Total Power	NoT	Average Power	Efficiency
BSTOA1	0.00159523	15988.8082	38	470.9151	0.9084
BSTOA2	0.00157570	17197.4310	42	470.3435	0.9073
BSTOA3	0.00164280	17457.9199	46	453.0915	0.8740
BSTOA4	0.00164397	17287.2006	43	480.1804	0.9263
BSTOA5	0.00181546	20555.5139	66	482.8890	0.9315
BSTOA6	0.00163385	15710.2159	40	474.6995	0.9157
BSTOA7	0.00239014	26284.1378	100	262.8414	0.5070
BSTOA8	0.00164717	13982.0089	35	461.3128	0.8899
BSTOA9	**0.00157444**	16471.8481	38	472.8759	0.9122
BSTOA10	0.00157769	16154.7858	38	474.1882	0.9147
BSTOA11	**0.00241272**	26284.1378	100	356.1447	0.6870
BSTOA12	0.00166147	1036.8000	2	518.4000	1.0000
BSTOA13	0.00168423	17714.9196	49	419.0931	0.8084
BSTOA14	0.00164474	16503.8937	43	475.0159	0.9163
BSTOA15	0.00166889	16210.4544	44	446.9484	0.8622
BSTOA16	0.00163401	16164.8310	37	469.9922	0.9066
BSTOA17	0.00165800	17766.5446	48	443.0681	0.8547

The best variant is BSTOA9 in terms of the maximum values. The worst variant is BSTOA11 in terms of the maximum values.

TABLE III. THE MINIMUM VALUES

	Fitness	Total Power	NoT	Average Power	Efficiency
BSTOA1	0.00154754	11772.8768	25	405.4547	0.7821
BSTOA2	0.00154623	13468.6278	29	409.4626	0.7899
BSTOA3	0.00155273	13067.2139	29	379.5200	0.7321
BSTOA4	0.00157512	10349.5985	23	399.9196	0.7714
BSTOA5	0.00158676	9056.4452	19	311.4472	0.6008
BSTOA6	0.00157243	8544.5906	18	392.7554	0.7576
BSTOA7	**0.00229447**	26284.1378	100	262.8414	0.5070
BSTOA8	0.00157199	10063.9044	23	399.4860	0.7706
BSTOA9	0.00154609	14115.6997	30	433.4697	0.8362
BSTOA10	**0.00154292**	13666.4349	29	422.3040	0.8146
BSTOA11	0.00157104	19479.8689	55	262.8414	0.5070
BSTOA12	0.00161763	518.4000	1	437.0695	0.8431
BSTOA13	0.00158707	13200.6175	32	356.3481	0.6874
BSTOA14	0.00157727	10124.9739	23	383.8115	0.7404
BSTOA15	0.00162164	10240.7888	24	368.4194	0.7107
BSTOA16	0.00156533	13629.7752	29	431.6931	0.8327
BSTOA17	0.00157771	13575.7327	31	368.1134	0.7101

The best variant is BSTOA10 in terms of the minimum values. The worst variant is BSTOA7 in terms of the minimum values.

TABLE IV. THE MEDIAN VALUES

	Fitness	Total Power	NoT	Average Power	Efficiency
BSTOA1	0.00155904	14646.2272	34	445.7286	0.8598
BSTOA2	0.00155986	15166.8584	35	440.2213	0.8492
BSTOA3	0.00158788	15039.7566	35	430.3446	0.8301
BSTOA4	0.00159394	12810.2497	29	442.0757	0.8528
BSTOA5	0.00161637	12424.7990	29	421.6447	0.8134
BSTOA6	0.00159511	13288.4902	30	437.9103	0.8447
BSTOA7	**0.00233801**	26284.1378	100	262.8414	0.5070
BSTOA8	0.00160748	12471.9151	30	435.3162	0.8397
BSTOA9	0.00155701	14790.5955	32	458.2211	0.8839
BSTOA10	**0.00155592**	14815.7222	32	457.3932	0.8823
BSTOA11	0.00158883	20827.0338	63	329.1148	0.6349
BSTOA12	0.00165358	518.4000	1	518.4000	1.0000
BSTOA13	0.00163959	15585.5988	41	381.7001	0.7363
BSTOA14	0.00160245	12561.6731	29	430.6622	0.8308
BSTOA15	0.00165151	14036.0269	35	404.7432	0.7808
BSTOA16	0.00160069	14869.8674	33	447.2999	0.8628
BSTOA17	0.00163041	15984.3317	40	404.6043	0.7805

The best variant is BSTOA10 in terms of the minimum values. The worst variant is BSTOA7 in terms of the minimum values.

TABLE V. THE STANDART DEVAITION VALUES

	Fitness	Total Power	NoT	Average Power	Efficiency
BSTOA1	0.00000987	819.5627	2.67	15.2839	0.0295
BSTOA2	0.00000732	767.2321	2.82	15.5572	0.0300
BSTOA3	0.00001712	867.7527	3.22	19.1999	0.0370
BSTOA4	0.00001883	1501.9520	4.72	20.3497	0.0393
BSTOA5	0.00004125	2189.7509	8.30	30.3635	0.0586
BSTOA6	0.00001457	1718.0434	5.00	18.8788	0.0364
BSTOA7	0.00002042	0.0000	0.00	0.0000	0.0000
BSTOA8	0.00001753	999.2733	3.04	17.0108	0.0328
BSTOA9	**0.00000623**	512.7619	1.65	8.7694	0.0169
BSTOA10	0.00000822	670.5566	2.34	13.1509	0.0254
BSTOA11	**0.00015361**	1716.6185	11.01	23.6624	0.0456
BSTOA12	0.00000899	112.9263	0.25	14.8488	0.0286
BSTOA13	0.00002099	1143.4987	4.05	15.6865	0.0303
BSTOA14	0.00001765	1559.7370	4.97	21.7597	0.0420
BSTOA15	0.00001209	1290.0554	4.38	19.5858	0.0378
BSTOA16	0.00001550	690.6007	2.09	8.9985	0.0174
BSTOA17	0.00002239	900.0362	4.07	20.6884	0.0399

The robust variant is BSTOA9 in terms of the standard deviation values. The no robust variant is BSTOA11 in terms of the standard deviation values.

VII. CONCLUSION

This paper presents 17 new binary optimization algorithms that combine the sooty tern continuous optimization algorithm and 17 widely used transfer functions in literature. Wind Turbine Placement Problem (WTPP) is a binary optimization problem and WTPP is used as a benchmark problem in this work. 100 dimensional (10x10 grid type) WTPP is solved by these 17 binary variants of STOA.

This work is a work-in-progress study. This short paper/extended abstract is prepared for presenting the preliminary results of this work in the International Conference on Interdisciplinary Applications of Artificial Intelligence (ICIDAAI-2021) to be held Online, Yalova, Turkey, 21-23 May 2021.

In future, the full paper of the work will be include these information: The peculiar parameter analysis of STOA, The determination of the effects of the different iteration numbers, The analyzing the solution quality of the new binary variants on the 400 dimensional (20x20 grid type) WTPPs.

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Optimization Used in Deep Learning Investigation of Algorithms and Application Areas

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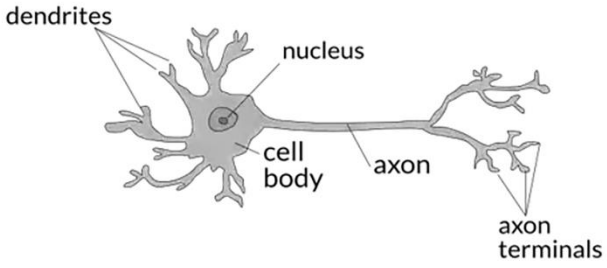
***Abstract*—The aim of this study is to examine the optimization algorithms used in deep learning and their application areas. In the study, firstly, information was given about the concept of deep learning and its fundamental theorem. Deep learning (multi-layered artificial neural network) is a sub-branch of machine learning that enables learning from large data sets with its layered architecture. Increased processor speeds and storage, inexpensive computer hardware and machine learning gains are factors that boost deep learning development. Then, optimization types, steps and parameter selection in simple deep learning algorithms were examined. Gradient descent based optimization algorithms (Stochastic gradient descent (sgd), momentum, adam, adagrad, rmsprop, and adadelta) used to minimize error in deep learning are also part of this success. Literature research has been done for the applications of optimization algorithms used in deep learning in various fields. The areas that are seen to be widely applied have been examined as general and special areas. In addition, in order to shed light on researchers, the areas where it can be applied more widely in the future have been determined.**

Keywords—Deep learning, optimization Algorithms, Application Areas

I. INTRODUCTION

Artificial neural networks (ANN) are defined as computer systems that perform the learning function, which is the most basic feature of the human brain [1]. This system has emerged as a result of mathematical modeling of the learning process by taking the human brain as an example. It mimics the structure of biological neural networks in the brain (Fig. 1), their ability to remember, learn, and generalize [2]. In artificial neural networks, the learning process is carried out by using sample data.



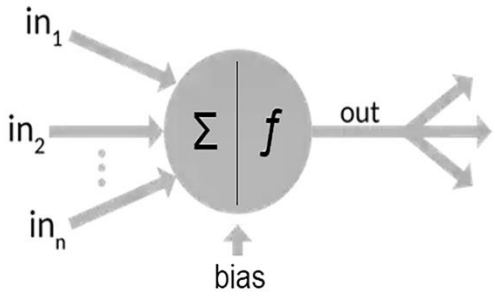


Fig. 1. Biological Neuron *and* Artificial Neuron [3]

The mathematical definition (1) of the artificial neuron is as follows.

$$y(k) = F\left(\sum_{i=0}^{m} Wi(k)Xi(k) + b\right) \quad \textbf{(1)}$$

xi (*k*): input value at discrete time k as i goes from 0 to m

wi (*k*): weight value at discrete time k as i goes from 0 to m

b: deviation

F: Transfer function

y (*k*): output value at split time k

With the advancing technology, the increase in data volume, the excess of variables in the data set, the efforts to analyze the complex and hierarchical relationships between variables increase the interest in the deep learning approach based on artificial neural networks. Deep neural networks are defined as the structurally deeper and expanded form of artificial neural networks. Deep neural networks are when the number of hidden layers in artificial neural networks is more than two and the number of neurons in these layers is high. Therefore g reputation for deep learning from one of our most popular technology used in the data analysis (deep learning - DLA) has taken its place as. Deep learning, from time to time machine learning (ML) and artificial intelligence (AI) concepts are used but in the same sense, although different concepts [4].

Deep learning is a sub-branch of machine learning. Machine learning is to provide an appropriate answer to situations that have not been encountered before by learning existing problems over a specific data set. Machine learning algorithms, to collect data from various sources, transforming the rich data sets and help us to take action based on the results achieved are. Machine learning algorithms are designed to be efficient and accurate.

Machine learning is also a sub-branch of artificial intelligence. Artificial intelligence aims to adapt human skills

such as self-learning, judgment and logical decisions to machines. The field of artificial intelligence has developed in a short time, especially with the effective solutions it offers to real-world problems in different disciplines [5, 6]. Mathematical and logical can be expressed in the plane around all kinds of problems can be presented. The different artificial intelligence approaches, methods and techniques developed offer successful solutions in subjects such as making advanced mathematical analysis, prediction - estimation, pattern recognition, audio-visual - linguistic recognition and description, adaptive control and interpretation - diagnosis [7, 8].

Artificial without intelligence, deep learning concept continues to evolve the way as profound learning today. In this context, we can generally evaluate the rapid rise of these technologies as two main reasons. Primarily, the area in question is applied because it can successfully solve problems that have not been solved. Another is why, the classic method you want to with it has become the preferred level of efficiency and effectiveness in the implementation process because it can give you some fairly good solutions to problems that cannot be obtained solution. When considered in terms of different disciplines, we can express problem solutions more specifically by taking into account the target disciplines. On the other hand, there are solutions where classical approaches, methods and techniques are insufficient and artificial intelligence has taken over the solution flag and different disciplines need together. Optimization is only one of these solutions. It is possible to define the concept of optimization as selecting the best element from a specific set of alternatives [9].

This study utilized in deep learning optimization algorithms different disciplines and profound learning applications between the review aims. In the second part of the study, information about deep learning and layers of deep learning will be given. In the third part, the most preferred optimization algorithms in deep learning will be mentioned. In the fourth section, different interdisciplinary applications of deep learning applications will be discussed. In the last section, the results of the study will be evaluated in order to guide future studies.

II. DEEP LEARNING

Deep learning is a sub-field of machine learning and consists of advanced artificial neural networks. Deep learning first appeared in a study by Hinton. This study is included in the literature as a deep neural network [11]. The development process of neural networks is given in Table 1.

TABLE I. HISTORICAL TURNING POINTS OF NEURAL NETWORKS

1940	Electronic Brain (1943)	S. McCulloch , W. Pitts
1950	Perceptron - Single layer perceptron (1957)	M. Hoff , B. Widrow , F. Rosenblatt
1960	Adaline (1960) Multi Layer Perceptron - Multilayer perceptron (1965)	AG Ivakhnenko , VG Lapa
1970	Neocognitron (1979)	K. Fukushima
1980	Backpropagation (1986)	D.rumelhart , g.hinto's , r.williams
1990	Emergence of the XOR prolem (1991) Support Vector Machines (SVM- Support Vector Machine)	S. Hochrelter Schölkopf , Burges , Vapnik
2000 - 2010	Deep Nural Networks - Deep Neural networks (2006)	G. Hinton

Deep learning, a computer with the speech recognition, identification, or a kind of images that educate people to perform similar tasks, such as making predictions is a set of machine learning algorithms. Instead of editing data to work with predefined equations, in deep learning, data form the basic parameters, and the computer is trained by recognizing patterns using many process layers. Deep learning algorithms consist of models based on artificial neural networks [11].

Although the first studies conducted with deep learning date back a long time, one of the main reasons for their successful use in recent years is that there is enough big data. The algorithms that train deep learning models used in complex tasks today simplify the training of very deep architectures.

With the emergence of deep learning, image and sound analysis, robotics, autonomous tools, gene analysis and medical diagnostics v b. to be used in many areas has begun. The main reason for its use in a very common area is shown to its high accuracy in solving problems. It has even been observed that human performance is exceeded in some problems such as voice recognition and image identification.

A. Deep Learning Layers

1) Input Layer

It is known as the data entry layer. The data set to be created in neural networks should be determined according to the architecture of the network. Each sample that will enter the neural network is used as input data for the training of the network to the input layer. The data of each item comes one after another and creates a data set. The size of this data set increases the speed of the network, test time and memory requirement [12, 13] . The resolution and size of the input data should be determined according to the architecture of the model to be designed. Since the suitability of the input data will affect the performance of the model , training time, test duration and memory need, it should be chosen well. Choosing a high number of input data can increase the success rate [14].

2) Convolution (Convolution) layer

It is the layer that forms the basis of coproduction neural networks. It aims to reveal the specific features of the input by moving a predetermined filter over the input data on the input data. As a result of filtering, it provides a smaller matrix than the input data [15] . Since the filter to be preferred will affect the training process and the success rate of the network, an ideal filter should be selected [12, 15].

As a result of the calculations made in convolution neural networks, differences occur between input and output size. The size of the new image (matrix) that will be created after the convolution process is calculated by the equation (2) [16].

$$nout = ((nin + 2p - f) / s + 1) \quad (2)$$

According to this equation, the size of the output matrix varies depending on, the size of the input picture nin , the pixel addition padding (p), the filter size f, the step shift stride (s).

3) Activation Function

This is most commonly used for neural network layer is the layer. The activation function is the function that generates a new output value in response to the value that comes as input to the neural network. Each convolution neural network to produce a new matrix was subjected to activation function value d [17]. In this way, it forms the input value of the layer that comes after the k end. Therefore, activation functions play an important role in neural networks. When the activation function is not used in the convolutional neural network, the output value behaves like a simple linear function [18].

Although there are many activation functions, Relu (Rectified Linear Unit) (Fig. 2) $f(x) = \max(0, x)$ function is used in deep learning architectures [19, 20].

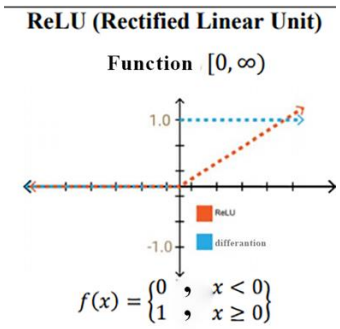


Fig. 2. Relu Activation function

The value obtained as a result of the activation process is 0 if it is negative and 1 if it is positive. This situation is shown in Figure 2. Other actively used activation functions and their mathematical expressions are shown in Figure 3.

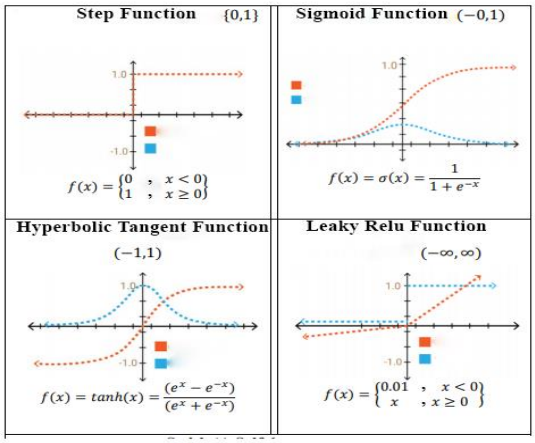


Fig. 3. Activation function and mathematics defination

4) Docking Layer

It is the layer used to reduce the parameter and data size in the network after activation. Reducing the data size as a result of pooling reduces the computational amount of the neural network and the amount of memory used by making the neural network faster [21]. The reduction of the data size is achieved with a certain filtering process. This filter processing, the maximum value (maximum pooling), the minimum values (minimum pooling) or average values (average pooling) operate by taking dry-dock. In this layer, the method of pooling the highest values generally gives more successful results.

5) Dropout Layer

It is the layer that eliminates over-learning and memorization between the network layers. In this layer, the elimination of random nodes in the neural network prevents the network from memorizing [22]. Therefore, using this layer increases the performance of the network [23, 24].

6) Fully Connected Layer

The data sets used in the applications can consist of multi-dimensional structures. This layer transforms all the neurons in the preceding layer into a single-line array [25, 26, 27].

7) Classification Layer

The task of this layer is to produce the output value by classifying the data obtained from the fully connected layer as much as the specified number of classes. Softmax and sigmoid activation functions are generally used in the classification layer [28].

8) Softening (Softmax) Layer

The softmax layer, which is the classification layer, receives the input data from the preceding fully connected layer and uses it to classify. It reveals the status of a probabilistic input data belonging to a certain class. It produces value as to which class it is closer to. It extracts the probability value for each class by performing probabilistic calculation produced within the deep learning network [29].

9) Normalization (Normalization) Layer

Deep convolutional since i network operations training is a serious process as. One way to reduce training time is to normalize the activation of neurons. The normalization layer is very effective in stabilizing the states in the hidden layers in feedback networks. Normalization affects the performance of the network. For this reason, the data coming from the layers must be in a certain order. Input data may contain too large or too small. Normalizing these values and using them within a certain range is important in terms of education and process. Input data must be normalized and represented at certain intervals. Usually normalization is performed after the Relu layer [29,30, 31].

III. Optimization Algorithms

There are different optimization methods that are frequently used to minimize the error rate in machine learning. These; SGD, Momentum, Adagrad, RMSProp, Adam, Nesterov Accelerated Gradient (NAG) are NADAM and Adadelta methods. Apart from these methods, different optimization techniques are constantly developing.

In deep learning applications, the absolute minimum value of the error function must be found in order for the learning process to result in a healthy way. This process is carried out using optimization methods. Optimization is the

method used to make the difference between the output value produced by the network and the actual value, that is, the error to the smallest. Artificial neural network optimization one of the most widely used method for gradient is the descent (gradient descent). There are three gradient descent methods (Batch Gradient Descent, Stochastic Gradient Descent, Mini-Batch Gradient Descent) depending on the size of the data set used in a single iteration. Gradient descent method based on various algorithms (Rmsprop, Adagrad, Ada m, Nadam) available [32].

A. SGD

Gradient descent; It is an iterative algorithm that starts at a random point in the function and gradually descends down the slope of the function until it reaches the lowest point of the function. This algorithm is suitable for situations where optimal points cannot be found by setting the slope of the function to 0. Weights must be changed for the function to reach the minimum value. Thanks to back propagation, the loss is transferred from one layer to another and the loss is minimized by changing the "weights" parameter depending on the losses. SGD is an extension of Gradient Descent where the Gradient Descent algorithm overcomes some of its drawbacks. SGD tries to overcome the disadvantage of computational density by computing the derivative of one point at a time. Due to this fact, SGD updates the weights randomly with some gradients instead of all gradients [9, 34, 35, 36]. In this way, possible memory deficiency problems can be prevented (3).

$$\theta t + 1 = \theta t - n\nabla\theta J(\theta t; x^{(i)}; y^{(i)}) \quad (3)$$

B. Momentum

It is an adaptive optimization algorithm that exponentially uses weighted average gradients over previous iterations to stabilize convergence and provides faster optimization. There is a lot of oscillation when looking for the optimum point in SGD. The momentum method (4), (5) is recommended in order to reduce these oscillations and therefore increase the speed of going to the target. In this method, momentum gradients are used instead of existing gradients [9, 34, 35, 36].

$$w_{t+1} = w_t - aVt \quad (4)$$

$$V_t = \beta V_{t-1} + (1 - \beta)\frac{\partial L}{\partial Wt} \quad (5)$$

Here, the initial value of Vt is 0. β is between 0 and 1, the commonly used value is 0.9, and is used to set how much past gradients will be included in the process.

C. Adagrad

Adaptive Gradient adopts the learning rate of the parameters, updating them with each iteration depending on the location where it is available. They are algorithms that happen by adapting slower learning rates when features occur frequently and higher learning rates when features are sparse. It has been proposed to eliminate the constant learning coefficient problem in SGD and Momentum methods. It makes different updates for each parameter, using t different learning coefficients for each step for each parameter. Thus, it eliminates the need to manually adjust the learning coefficient. In Adagrad (6), (7), each parameter has its own learning speed, and the learning coefficient becomes extremely small as a result of the growth of the expression in which the learning coefficient value is divided in the update process during education [9, 34, 35, 36].

$$g_{t,i} = \nabla\theta_t J(\theta_{t,i}) \quad (6)$$

$$\theta_{t+1,i} = \theta_{t,i} - \frac{n}{\sqrt{G_{t,ii}+\epsilon}} + g_{t,i} \quad (7)$$

D. RMSprop

It has been proposed to solve the problem of constant learning coefficient as in Adagrad (8), (9), (10). The difference is, adagrad in the method of the gradient instead of square momentum of the gradient is the square [9, 34, 35, 36].

$$E[g2]t=0.9E[g2]t\text{-}1+0.1gt2 \quad (8)$$

$$\theta t+1=\theta t\frac{n}{\sqrt{E[g]2+\epsilon}} + g_t \quad (9)$$

$$gt=\nabla\theta tJ(\theta t) \quad (10)$$

E. Adam

It is a combination of RMSProp and Momentum. This method calculates the adaptive learning rate for each parameter. In addition to storing the distorting average of the square gradients, it also keeps the average of the past gradient similar to Momentum (11), (12), (13), (14). Thus, Adam behaves like a heavy ball with friction, preferring flat minima on the fault surface. The default values are 0.9 for β1; for 0999 and β2 $\epsilon\epsilon$ 10 -8 it is expressed in [9, 34, 35, 36].

$$mt=\beta 1mt-1+(1-\beta 1)gt \quad (11)$$

$$vt=\beta 2vt-1+(1-\beta 2)gt2 \quad (12)$$

$$m't=mt1/1\text{-}\beta 1t\ ,v't=vt/1-\beta 2t \quad (13)$$

$$\theta t+1=\theta t-\frac{n}{\sqrt{v't+\epsilon}} + \mathrm{m't} \quad (14)$$

F. Nesterov Accelerated Gradient (NAG)

Momentum based optimization, the current gradient next step according to the previous iteration value is set. But who knows what will stop the slope of the time as we need to grow more intuitive to a more intelligent algorithm is located. So the next iteration of the algorithm should have an approximate idea of the parameter values (15), (16). It was realized that, according to the future location of the parameter gradient in an efficient manner by calculating the value of the forward is examined [34, 35].

$$\mathbf{V\ (t) = \gamma V\ (t-1) + \alpha.\nabla J\ [\theta\text{-}\gamma V\ (t-1)]} \quad \mathbf{(15)}$$

$$\mathbf{\theta = \theta\ \text{-}\ V\ (t)} \quad \mathbf{(16)}$$

G. NADAM

It consists of a combination of Nadam, Adam and NAG (Nesterov accelerated gradient) methods. In order to include the NAG algorithm in the Adam algorithm, the current update rule is obtained by making changes in the momentum expression [34, 35].

H. Adadelta

It is an extension of AdaGrad that tries to reduce the monotonously decreasing learning rate. In the Adadelta method, unlike the adagrad and RMSProp methods, there is no obligation to choose a learning coefficient. Instead of the learning coefficient (17), (18), (19), (20), momentum sums of the squares of delta values expressing the difference between valid weights and updated weights are used [9, 34, 35, 36].

$$\mathrm{Wt+1= Wt-}\ \frac{\sqrt{D_{t-1}}}{S_t+\epsilon}\cdot\frac{\partial L}{\partial wt} \quad (17)$$

$$\mathrm{Dt=\beta Dt\text{-}1 + (1 - \beta)[}\Delta Wt]2 \quad (18)$$

$$St = \beta St\text{-}1 + (1 - \beta)\left[\frac{\partial L}{\partial Wt}\right]2 \quad (19)$$

$$\Delta Wt = Wt - Wt\text{-}1 \quad (20)$$

IV. APPLICATION AREAS OF DEEP LEARNING

With the emergence of deep learning, the main reason for its use in a very common area is the high accuracy it has achieved in solving problems. According to some studies;

A repetitive neural networks (RNN) application has been implemented, which is synthesized from people's speech and combined and spoken so that a text that has never spoken is vividly vocalized. In this practice, they took a video image of the former president of the United States of America, Barack Obama, and adapted the different speeches he had previously made to this video image [37].

Coloring of a black and white picture was carried out using deep learning algorithms based on Convolutional neural networks. Similar to the coloring of black and white pictures, colorless films that were shot in the past were also done with Deep Learning [38, 39].

Studies have been carried out in Deep Learning for the prediction of the momentary movement and posture of people. In the study, movements in the human skeletal structure were predicted in 2 dimensions. In an environment where many people are present in real-time video images, every person is shown in 2 dimensions [40].

There are many studies done with image classification. Within the scope of these studies; Classification of traffic signs, classification of satellite images, face recognition-classification and classification of 3D images, classification of land cover and agricultural products, classification of malware [41], classification of land use [42], classification of sound recordings, classification of medical images. Many classification studies have been done. Convolutional neural network for the classification of images and repetitive neural networks have been used to form sentence structures by defining these classes [43]. In their study, Nguyen et al. Tried to create new photos from a photograph using deep learning. In this study, it is shown how it is created with an object that was not included in an image before [44]. Isola et al used deep learning networks to obtain a new color and completed image from a mapped image. In their study, this deep learning approach was used in pix2pix software [45]. In a different study, changing the view of people in a picture was done with Deep Learning [46] Tagging, object identification and classification of images used by big companies such as Facebook and Google were performed by Deep Learning models [47, 48, 49, 50].

Deep learning algorithms are frequently used in the realization of object detection. In object detection, an object is searched in an image. Where this object is in the image is predicted. The cancerous region is identified, classified and interpreted from medical images for a type of skin cancer [51]. In another study, they proposed a new deep learning structure for face detection through an image. They performed superior to other face detection structures [52]. In a study conducted to identify pedestrians, a deep learning structure where feature extraction, degradation and classification can be used together was proposed [53]. In object detection algorithms, studies have been carried out to determine the location of the object. For this, many methods such as selective search, suggest independent object forward, edge box determiner have been developed [54, 55, 56].

In automation systems, as an effective solution to data benefited from deep learning, they presented an approach to create reliable and stable online estimates of these data through data-oriented sensors. Studies on deep learning approach have been conducted to predict the heavy diesel cut-off point by creating sensors [57]. In another study, a robot vision system is presented for robotic systems to predict the posture of objects, grasp them and move towards a specified target. The study also proposed a deep learning system that determines object posture and position [58]. In a study, a deep learning approach was used to provide hand-eye coordination for robots. An approach has been presented to facilitate the detection and capture of objects [59].

Apart from all these studies, it is possible to see deep learning architectures in many areas. Many studies on language translation, dictionary and natural language translation are included in the literature [59, 60].

V. RESULT

Artificial intelligence architectures are used in many areas from the past to the present. The historical development of artificial intelligence approaches shows how rapidly machine learning is developing. Deep learning (multi-layered artificial neural network) is a sub-branch of machine learning that enables learning from large data sets with its layered architecture. Increased processor speeds and storage, inexpensive computer hardware and machine learning gains are factors that boost deep learning development.

Deep learning architectures seem to bring a new approach to artificial intelligence technologies and break new ground. The studies of deep learning architectures for future predictions are thought to carry today's technologies a few years forward. It is seen that deep learning architectures have started to take place in our lives very effectively in order to facilitate human life and to lead a healthy life. Although the foundations of Deep Learning are based on the past, the most important reasons why it has become popular especially in recent years is that there is enough data for education and secondly, it has a hardware infrastructure to process this data. This detailed information about Deep Learning at work s are given. In further learning studies, the properties of optimization algorithms are also mentioned. The choice of these optimization algorithms show different performances depending on the nature of the problem and the parameters. Therefore, different deep learning optimization algorithms can be used according to the area to be applied and the problem situation.

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Classification of Demand Management Data By Means of Machine Learning Algorithms: An Application About Demand Management For A Municipality

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***Abstract*—In this study, which is a natural language processing project, it is known that these learning methods and word representations have given the best results in multiple classification problems. The main purpose of these studies is to reach syntactic, semantic, and morphological information. With these studies in this field, different meanings arise within the text spaces and texts. Bag-of-Words and TF-IDF methods, which are frequently used to represent textual expressions with numerical expressions, come to the fore. In the continuation of these methods, different methodologies such as Word2vec, Glove, Fasttext, Doc2vec and features such as meanings in text spaces and degrees of the proximity of words have come to the fore. However, since many types of morphological research have been conducted in English, research on rich languages such as Turkish has been limited. In this study, it has been aimed to develop the project by observing the results in an unusual data set, and to add a new one to the studies on the Turkish language, and to shed light on the studies made in this language. In this study, a district municipality in Istanbul has been considered. The aim of this study is to analyze and separate the requests from the people living in the district to the municipality and transfer them to the correct units of the municipality. As a result of this study, it has been gathered the results of machine learning algorithms by observing how the frequencies of the words in the text give results, and the difference between different parameters and constraints with methodologies such as Bag-of-words, TF-IDF, and FastText. This study has been developed by IND Information Technologies and Esenler Municipality within the scope of TÜBİTAK 1507 project.**

Keywords—machine learning, supervised learning, demand management, big data, smart city

I. INTRODUCTION

This project has been developed in Esenler Municipality. It has been planned to direct the requests to the right teams and classify them. With this project to be produced, it has been aimed to process citizen feedback from different sources, to deliver these notifications to the correct department, and to rank these requests in order of importance. To carry out these studies, it has been aimed to make sense of the incoming requests and to determine which subjects the request is related to. Afterward, it has been aimed to check the fields (such as an address, phone) that are mandatory to include the subject of the request, and if there are any, these fields are requested by this software from the citizen who sent the request. After these procedures are completed, an emotional state analysis will be performed from the incoming request text, and a degree of importance will be calculated for the incoming request, taking into account the emotional state information (such as emergency, congratulatory message, anger) and the subject to which the text is related. At the end of the project, it is thought that the demands of citizens coming to the municipality from any source 24 hours a day or in emergencies such as floods or earthquakes can be managed. With this project, it has been planned not to miss any requests and to provide the necessary directions for intervention, especially in emergencies where the number of demands will be intense.

In this study, our plan to increase speed, accuracy, and quality in public services provided to citizens by municipalities, which is one of our main objectives, is realized with the correct management of the demand management process. Demand management is the supply chain management process that balances the needs of customers with the capabilities of the supply chain. [12] shared their knowledge about the importance of the demand management process and what steps should be taken into account when creating a demand management project. They noted that when the correct process has been implemented, management can proactively match supply and demand and the process can be carried out with minimal disruption.

In the ongoing processes, many companies working from businesses to consumers (B2C) have collected data such as ideas, emotions, etc. via social media and e-commerce websites. In this process, business-to-business (B2B) enterprises have been slow to adopt natural language processing methods, sensitivity analysis, text classification, etc.[13] has worked on the related statement in the polystyrene

industry. It has been observed that the problems that occur in local governments have expressed in written form rather than individual interviews in today's digital world with the works it has been done within the scope of this project. Written communication channels are the points where the municipality receives high demand. In this study it has been also aimed to reduce the density, to provide correct information and the correct support. [2] studied text classification methods, which are part of the field of Natural Language Processing, are to classify complex data by making a semantic conclusion. A common situation in text classification is the way texts have been expressed. Words, roots, character n-grams, and semantic spaces are the most commonly used methods. In this study, the hidden meaning indexing and the combined transition matrix-based semantic space methods have been compared with other methods on a dataset with 30 classes. It has been observed that the crossing matrix-based method achieved much higher success than all other methods.

Text classification and multi-class problems have also been frequently encountered in research. [3] stated that the multi-class problem, the imbalanced data sets problem, and a unifying classification are an active research area. It has been focused on the difficulties of multi-class classification. It has been developed a heterogeneous ensemble model that combines various strategies and ensemble techniques for multi-class classification and outlier detection. The process of binarization of data sets have been done using the OnevsOne decomposition technique. It has been created the heterogeneous community model using Adaboost and random forests as the basic classifier.Text data requires special preparation before using the predictive model. Each text that is parsed into words with the tokenize method must then be encoded as an integer or float to input into a machine learning model called feature extraction. [4] used a simple way of converting a text document to a feature vector, the "Bag of words" representation where each feature is a single symbol. They stated that preprocessing is required to convert a document into a feature vector. They stated that this includes feature formation, feature selection, and feature score calculations. They also stated that different linguistic components of a document can create different types of properties, and properties such as single symbols or single root markers are mostly used in text classification. As a result, they explained that TF-IDF feature vectoring provides better classifier performance compared to other feature types.

Unlike previous studies, word and sentence analysis in this study have been conducted to analyze demand management in Esenler Municipality in İstanbul. Algorithms such as Support Vector Machines, Random Forests and Artificial Neural Networks have been used. Support Vector Machines Linear form algorithm has achieved the highest success with 93%.

II. LITERATURE REVIEW

Text classification methods, which are part of the field of Natural Language Processing, are to classify complex data by making a semantic conclusion. A common situation in text classification is the way texts are expressed. [1] Words, roots, character n-grams, and semantic spaces are the most commonly used methods. In this study, the hidden meaning indexing and the combined transition matrix-based semantic space methods are compared with other methods on a dataset with 30 classes. They observed that the crossing matrix-based method achieved much higher success than all other methods.

Text classification and multi-class problems have also been frequently encountered in research. In the literature [2], they stated that the multi-class problem, the imbalanced data sets problem, and a unifying classification are an active research area. In this study, they focused on the difficulties of multi-class classification. They have developed a heterogeneous ensemble model that combines various strategies and ensemble techniques for multi-class classification and outlier detection. The process of binarization of data sets was done using the OnevsOne decomposition technique. They created the heterogeneous community model using Adaboost and random forests as the basic classifier.

In the literature [3] they have shown that it is a successful methodology to overcome multi-class classification problems. However, this methodology is limited to classifiers that return only one true value for each forecast. In the study, they proposed expanding the normalization method and corresponding three different addition strategies for the ranges. Voting, Weighted Voting, WinWV.

Text data requires special preparation before using the predictive model. Each text that is parsed into words with the tokenize method must then be encoded as an integer or float to input into a machine learning model called feature extraction. In the literature, Ciya Liao et al. [4] use a simple way of converting a text document to a feature vector, the "Bag of words" representation where each feature is a single symbol. They stated that preprocessing is required to convert a document into a feature vector. They stated that this includes feature formation, feature selection, and feature score calculations. They also stated that different linguistic components of a document can create different types of properties, and properties such as single symbols or single root markers are mostly used in text classification. As a result, they explained that TF-IDF feature vectoring provides better classifier performance compared to other feature types.

In the literature [5], they explained that the XGBoost algorithm, one of the machine learning models, has obvious advantages in both feature selection and classification performance compared to Logistic Regression.

III. DATA SET & ADDITIONAL INFORMATION

Esenler Municipality, which will be the data provider for the product to be developed, started to use our company's demand management system as of June 2019. Before this date, approximately 360,000 requests were recorded by the municipality between 2010 and 2019. 60% of the requests recorded during this period were faced. With the active use of our online demand management system, 65% of the received requests have started to be received over the phone and internet, and we believe that this rate will increase over time.

In the work flow chart, it has been managed the communication, pre-process, information extraction analysis, automation process of the municipality, and the requirements we want to achieve. The work flow chart, which you can see in Fig. 1. is valid for the entire project, and the necessary information about the incomplete parts is explained in detail in the results and future tasks section.

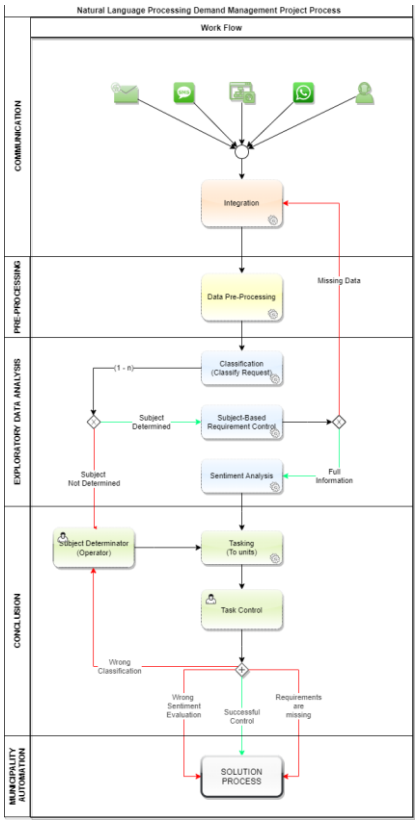

Fig. 1. Demand management project process work flow

The data recorded by the municipality of Esenler has been using in this product development process. For the estimation model, 102 different topics that demand the class value of the data set were targeted. 102 different topics correspond to approximately 95% of the decrease in the personnel need of the available data to meet the demand. Apart from these 102 most used topics, there are about 125 of them, which are rarely used. Various analysis scenarios were carried out within these. We implemented the traditional methods in natural language processing projects step by step based on the process in Fig. 2.

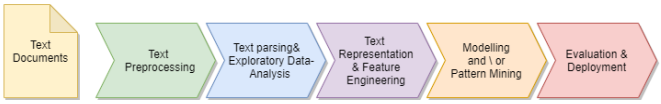

Fig. 2. Natural language processing project steps

A. *Text Preprocessing & Exploratory Data-Analysis*

In the first stage, our data collected under the title of "Yetki Değişikliği" was extracted and reduced to a data set of 99.334 rows. The empty data in the reduced data set have detected and the determined rows have removed in Fig. 3 and Fig. 4.

Value	Count	Frequency (%)
Yetki Değişikliği	343809	77.6%
YARALI,HASTA VE YAVRULAYAN S...	7544	1.7%
BÖCEK,SİNEK VE HAŞERE İLAÇLA...	6863	1.5%
ATIK EŞYALARIN ALINMASI TALEBİ	4786	1.1%
KALDIRIM YAPIM VE ONARIM TALE...	4236	1.0%
RUHSAT VE DENETİM MÜDÜRLÜĞ...	4164	0.9%
SOKAK YIKANMASI TALEBİ	4029	0.9%
AĞAÇ BUDANMASI,AĞAÇ VE DALL...	3189	0.7%
MOLOZ ALINMASI TALEBİ	3176	0.7%
YOL YAPIM VE ONARIM TALEPLERİ	2982	0.7%
Bilgilendirme	2884	0.7%
KALDIRIM İŞGALİ (İŞYERİ,SEYYAR ...	2806	0.6%
İMAR VE ŞEHİRCİLİK MÜDÜRLÜĞÜ...	2628	0.6%
BİNA VE DAİRE UYARILMASI TALEP...	2564	0.6%
İŞ YERLERİNİN RUHSAT DENETİM ...	2490	0.6%

Fig. 3. Raw data set

Value	Count	Frequency (%)
YARALI,HASTA VE YAVRULAYAN S...	7533	8.7%
BÖCEK,SİNEK VE HAŞERE İLAÇLA...	6857	7.9%
ATIK EŞYALARIN ALINMASI TALEBİ	4773	5.5%
KALDIRIM YAPIM VE ONARIM TALE...	4230	4.9%
SOKAK YIKANMASI TALEBİ	4028	4.7%
AĞAÇ BUDANMASI,AĞAÇ VE DALL...	3188	3.7%
MOLOZ ALINMASI TALEBİ	3171	3.7%
YOL YAPIM VE ONARIM TALEPLERİ	2980	3.5%
Bilgilendirme	2881	3.3%
KALDIRIM İŞGALİ (İŞYERİ,SEYYAR ...	2801	3.2%
BİNA VE DAİRE UYARILMASI TALEP...	2564	3.0%
İŞ YERLERİNİN RUHSAT DENETİM ...	2457	2.8%
ÇÖP ALINMAMASI ŞİKAYETİ	2319	2.7%
YAPI DENETİM	2232	2.6%
SOKAK AYDINLATMA TAMİRİ TALEBİ	1650	1.9%
İŞYERİ GÜRÜLTÜ ŞİKAYETİ (MAKİ...	1447	1.7%
SEYYAR ŞİKAYETİ	1389	1.6%

Fig. 4. Cleaned raw data set

After these operations, there are 42 to 7533 data within the classes in our target area in the data set. For this reason, clusters have not evenly distributed, which is one of the biggest problems, it has been aimed to reach a close distribution of the classes by artificial data production or the addition of data in the "Authority Change" class. In our data set, which contains 26 columns of information, the requests, the directed department, and the date of the request are taken into account as the target point. In the future, it has been aimed to examine the relevant columns compatible with developments such as mood analysis, state urgency, mapping, entity name recognition, and add them to the research and development project.

As a result of our researches, it has been made some pre-processing and cleaning applications on the data. With the work of [8] about regular expressions, it has been cleared the parts except for the parts we wanted to leave in our text from our data. At the same time, [9] developed a Python library called NLTK to assist in data preprocessing for English and many other languages. The cleaning process has been made with the part where the words frequently used for the Turkish language will be separated. Since it has been tried to extract the semantic spaces or the frequency of each word on the data, we cleared street numbers or any numerical values from our

data. In the first place, the following parameters such as word count, character number, average word length have been added before cleaning to make sense of the data. The parameters have been given respectively in below.

talep_aciklama: The data set containing the request texts created.

talep_tarihi: Date of requests created

konu_adi: Relevant departments to which requests are directed (string)

konu_int: Relevant departments to which requests are directed (integer)

word_counts: the number of words contained in the text in the demand_ description column.

char_counts: the number of characters contained in the text in the request_description column.

avg_word_len: char_counts / word_counts

talep_aciklama_cleaned: cleared version of claim deploy column

By cleaning parts such as URL, e-mail, and numerical values other than Turkish and English characters in the future. As a result of the processes, it has been made the word spaces ready to form their frequencies. However, we will share our works that we examine the word spaces and represent the texts with you in a separate study. Besides, requests such as private meetings, license application, zoning research, license renewal, zoning application, and private meeting, which we think will confuse the data set. And our data set has been reduced to 86,291 lines by removing the empty requests from the data. Finally, it has been made ready for the statistical methods Term Frequency-Inverse Document Frequency, Bag of Words, and FastTex methods, which are statistical methods that show the importance of a term in a document by separating words from each other with the tokenization method.

IV. MODELLING AND PATTERN MINING

The CountVectorizer method, which is one of the word count methods, has been applied for the 10,25,50 and 102 classes after the edited demand explanations. Modeling has been started with the Bag of Words [14] method. In the first process, it has been observed how the machine learning algorithms would yield results and the first results of the classes have been determined in the first stage in Fig. 5.

	adreste	belirtilen	ederim	no	olunur	onemle	rica	talep	var	yapilmasini
0	0	0	0	1	1	1	0	0	0	0
1	0	0	1	0	0	0	1	0	0	1
2	0	0	0	1	0	0	0	0	0	0
3	0	0	0	0	0	0	1	0	0	0
4	0	0	1	1	0	0	1	0	0	1
5	0	0	0	1	1	1	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	1	1	0	0	1	0	0	1
9	1	0	0	0	0	0	0	1	0	0
10	0	0	0	1	1	1	0	0	0	0

Fig. 5. Bag of words based on one-hot encoding method

In this context, a limitation has been made on a specific word as in the example in Fig. 5. The Bag of words method, which has been shaped according to how much each restricted word is used in the sentence, has been applied. Frequent words and conjunctions such as "ve", "gibi", "-de, -da", which are used many times in languages such as Turkish, come to the forefront in Bag of Words method and may cause false estimation between classes. For this reason, the Term Frequency-Inverse Document Frequency (TF-IDF) [15] method comes to the fore in the following stage.

TF-IDF is the weight factor calculated by statistical method that shows the importance of a term in a document. Term Frequency is the method used to calculate term weights in a document. Inverse Document Frequency shows how many terms the texts have. It is the logarithm of the total text quantity divided by the number of text that contains the term. As a result of the studies, it has been tried with some parameters with the scikit-learn library, except that TF-IDF gives better results. In both approaches, analyzer = word and ngram_range parameters that analyze between words have been limited by (1,2). In the following processes, the analyzer = "char_wb" parameter has been fixed between the formation of n-gram characters only from the text within the word boundaries and the ngram_range parameter (3,6) as seen in [10]. In addition to these two approaches, results have been obtained with the 300-dimensional Turkish ready-made model of FastText [11], and the results of our dataset between the approaches have been observed.

During this whole process, various inferences have been obtained by testing machine learning algorithms such as Support Vector Machine [17] [18] [19], Multinominal Naive Bayes [20], Random Forest [20] [21] and XGBoost in our multi-class problem. Since the Multinomial Naive Bayes method has not been given negative results, the data have been normalized between 0 and 15 using the min-max scalar method, one of the normalization techniques [23]. This method has been used at the points where FastText and Multinominal Naive Bayes results are passed.

A. *Train/Test Split*

In order to find out which parts of the train-test phase data set gives better results, a decomposition has been made. At this point, the dataset has been randomly divided into 80% train-20% test and 66% train-34% test data. Later, by dividing the whole data set into 10 with the cross validation [16] method, the difference in results obtained in each test slice has been observed.

V. RESULTS AND FURTHER STUDIES

In the first stage, the results of the data set on the 10-25-50-102 classes in the changes made at different stages have been examined. In a similar job classification study, a machine learning model was created to classify job positions on the Internet using a single-label classifier using both titles and descriptions [6]. At this point, a data set consisting of 75,546 vacant positions has been studied in the study. With algorithms such as Support Vector Machine, Random Forest and Artificial Neural Network, SVM Linear achieved the highest success rate of 93%. In this study, the highest success have been obtained with TF-IDF character n-grams and SVM algorithm. The classes of the studies and the results obtained have been examined separately below in 10-25-50-102 categories.

A. *Results for 10 Classes*

The classification of the data set, which we have limited to 10 classes, has been given in Fig. 6. When we examine the requests received in Fig. 6, we can state that the treatment demand of injured, sick and breeding street animals is at the forefront in Esenler Municipality. In addition, when we examine the increasing demands, we observe that environmental problems are at the forefront.

Value	Count	Frequency (%)
YARALI,HASTA VE YAVRULAYAN S...	7533	17.7%
BÖCEK,SİNEK VE HAŞERE İLAÇLA...	6857	16.2%
ATIK EŞYALARIN ALINMASI TALEBİ	4773	11.2%
KALDIRIM YAPIM VE ONARIM TALE...	4230	10.0%
SOKAK YIKANMASI TALEBİ	4028	9.5%
AĞAÇ BUDANMASI,AĞAÇ VE DALL...	3188	7.5%
MOLOZ ALINMASI TALEBİ	3171	7.5%
YOL YAPIM VE ONARIM TALEPLERİ	2980	7.0%
Bilgilendirme	2881	6.8%
KALDIRIM İŞGALİ (İŞYERİ,SEYYAR ...	2801	6.6%

Fig. 6. First 10 classes

When we look at the incoming request texts, it has been seen that there is enough data for each group. We analyzed our predictions under the headings of cross matching, 80% -20% and 66% -34% training and testing in Fig. 7.

Class	Classifier	Tokenizer	Accuracy(Mean)
10	Multinomial Naive Bayes	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	84.63
10	Multinomial Naive Bayes	Bag of Words (analyzer = 'word' , n_gram=(1,2))	83.90
10	Multinomial Naive Bayes	FastText	69.35
10	Multinomial Naive Bayes	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	81.47
10	Multinomial Naive Bayes	TF-IDF (analyzer = 'word' , n_gram=(1,2))	80.30
10	Random Forest	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	91.87
10	Random Forest	Bag of Words (analyzer = 'word' , n_gram=(1,2))	89.30
10	Random Forest	FastText	80.82
10	Random Forest	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	91.85
10	Random Forest	TF-IDF (analyzer = 'word' , n_gram=(1,2))	89.41
10	Support Vector Machine	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	91.84
10	Support Vector Machine	Bag of Words (analyzer = 'word' , n_gram=(1,2))	89.57
10	Support Vector Machine	FastText	91.01
10	Support Vector Machine	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	93.44
10	Support Vector Machine	TF-IDF (analyzer = 'word' , n_gram=(1,2))	91.85
10	XGBoost	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	93.11
10	XGBoost	Bag of Words (analyzer = 'word' , n_gram=(1,2))	91.66
10	XGBoost	FastText	86.75
10	XGBoost	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	93.06
10	XGBoost	TF-IDF (analyzer = 'word' , n_gram=(1,2))	91.46

Fig. 7. Cross match (10) results

When looking at the results in Fig.7., SVM and XGBoost algorithms come to the fore with TF-IDF 3-6 character n-grams. These results obtained by cross matching have been reflected as the average of 10 results. Later, when the training-test phase has been set to 80 to 20, the SVM algorithm, TF-IDF and XGBoost algorithm Bag of words methodologies come to the fore with 3-6 character n-grams in Fig. 8.

Class	Classifier	Tokenizer	F1-Score	Recall	Precision	Accuracy
10	Multinomial Naive Bayes	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	82.51	85.21	87.27	85.21
10	Multinomial Naive Bayes	Bag of Words (analyzer = 'word' , n_gram=(1,2))	81.74	84.41	86.76	84.41
10	Multinomial Naive Bayes	FastText	66.17	72.20	76.82	72.20
10	Multinomial Naive Bayes	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	78.99	81.91	85.27	81.91
10	Multinomial Naive Bayes	TF-IDF (analyzer = 'word' , n_gram=(1,2))	78.59	81.27	85.07	81.27
10	Random Forest	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	93.04	93.03	93.08	93.03
10	Random Forest	Bag of Words (analyzer = 'word' , n_gram=(1,2))	90.95	90.97	90.97	90.97
10	Random Forest	FastText	82.26	82.31	82.71	82.31
10	Random Forest	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	92.97	92.95	93.02	92.95
10	Random Forest	TF-IDF (analyzer = 'word' , n_gram=(1,2))	90.33	90.86	90.86	90.86
10	Support Vector Machine	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	92.62	92.54	92.96	92.54
10	Support Vector Machine	Bag of Words (analyzer = 'word' , n_gram=(1,2))	91.73	91.43	91.73	91.43
10	Support Vector Machine	FastText	92.06	92.07	92.14	92.07
10	Support Vector Machine	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	94.15	94.14	94.18	94.14
10	Support Vector Machine	TF-IDF (analyzer = 'word' , n_gram=(1,2))	93.03	93.03	93.10	93.03
10	XGBoost	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	93.85	93.85	93.87	93.85
10	XGBoost	Bag of Words (analyzer = 'word' , n_gram=(1,2))	92.65	92.65	92.72	92.65
10	XGBoost	FastText	87.46	87.45	87.67	87.45
10	XGBoost	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	93.52	93.51	93.54	93.51
10	XGBoost	TF-IDF (analyzer = 'word' , n_gram=(1,2))	92.25	92.24	92.35	92.24

Fig. 8. 8. 80-20% Train / Test results

At this point, when we took the training-test phase as 66-34%, the SVM algorithm achieved the highest result in our 10-class problem with 94.14% success with TF-IDF 3-6 character n-grams. As a result of the experiments, the high number of samples for each class helped us to obtain a successful estimate in Fig.9.

Class	Classifier	Tokenizer	F1-Score	Recall	Precision	Accuracy
10	Multinomial Naive Bayes	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	82.51	85.21	87.27	85.21
10	Multinomial Naive Bayes	Bag of Words (analyzer = 'word' , n_gram=(1,2))	81.74	84.41	86.76	84.41
10	Multinomial Naive Bayes	FastText	66.17	72.20	76.82	72.20
10	Multinomial Naive Bayes	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	78.99	81.91	85.27	81.91
10	Multinomial Naive Bayes	TF-IDF (analyzer = 'word' , n_gram=(1,2))	78.59	81.27	85.07	81.27
10	Random Forest	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	93.04	93.03	93.08	93.03
10	Random Forest	Bag of Words (analyzer = 'word' , n_gram=(1,2))	90.95	90.97	90.97	90.97
10	Random Forest	FastText	82.26	82.31	82.71	82.31
10	Random Forest	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	92.97	92.95	93.02	92.95
10	Random Forest	TF-IDF (analyzer = 'word' , n_gram=(1,2))	90.33	90.86	90.86	90.86
10	Support Vector Machine	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	92.62	92.54	92.96	92.54
10	Support Vector Machine	Bag of Words (analyzer = 'word' , n_gram=(1,2))	91.73	91.43	91.73	91.43
10	Support Vector Machine	FastText	92.06	92.07	92.14	92.07
10	Support Vector Machine	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	94.15	94.14	94.18	94.14
10	Support Vector Machine	TF-IDF (analyzer = 'word' , n_gram=(1,2))	93.03	93.03	93.10	93.03
10	XGBoost	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	93.85	93.85	93.87	93.85
10	XGBoost	Bag of Words (analyzer = 'word' , n_gram=(1,2))	92.65	92.65	92.72	92.65
10	XGBoost	FastText	87.46	87.45	87.67	87.45
10	XGBoost	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	93.52	93.51	93.54	93.51
10	XGBoost	TF-IDF (analyzer = 'word' , n_gram=(1,2))	92.25	92.24	92.35	92.24

Fig. 9. 66-34% Train / Test results

B. *Results for the 25 Classes*

The range of samples we have for the 25 Classes ranges from 891 to 7533. We analyzed the results we obtained on the dataset as on 10 classes in Fig. 10.

Class	Classifier	Tokenizer	Accuracy(Mean)
25	Multinomial Naive Bayes	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	79.01
25	Multinomial Naive Bayes	Bag of Words (analyzer = 'word' , n_gram=(1,2))	76.27
25	Multinomial Naive Bayes	FastText	57.97
25	Multinomial Naive Bayes	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	71.89
25	Multinomial Naive Bayes	TF-IDF (analyzer = 'word' , n_gram=(1,2))	71.44
25	Random Forest	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	84.64
25	Random Forest	Bag of Words (analyzer = 'word' , n_gram=(1,2))	80.98
25	Random Forest	FastText	71.24
25	Random Forest	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	85.64
25	Random Forest	TF-IDF (analyzer = 'word' , n_gram=(1,2))	82.76
25	Support Vector Machine	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	84.82
25	Support Vector Machine	Bag of Words (analyzer = 'word' , n_gram=(1,2))	81.29
25	Support Vector Machine	FastText	83.22
25	Support Vector Machine	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	87.73
25	Support Vector Machine	TF-IDF (analyzer = 'word' , n_gram=(1,2))	84.65
25	XGBoost	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	86.24
25	XGBoost	Bag of Words (analyzer = 'word' , n_gram=(1,2))	84.78
25	XGBoost	FastText	78.06
25	XGBoost	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	86.82
25	XGBoost	TF-IDF (analyzer = 'word' , n_gram=(1,2))	84.98

Fig. 10. 66-34% Train / Test results

With the cross matching method SVM classifier, TF-IDF 3-6 character n-gram has achieved a success of 87.73%. Up to this point, the SVM classifier stands out with character n-grams. When we set the Training-Test phase as 80 to 20, the SVM algorithm stands out with a success of 89.16% with TF-IDF 3-6 character n-grams in Fig. 11.

Class	Classifier	Tokenizer	F1-Score	Recall	Precision	Accuracy
25	Multinomial Naive Bayes	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	78.36	79.96	81.90	79.96
25	Multinomial Naive Bayes	Bag of Words (analyzer = 'word' , n_gram=(1,2))	75.36	77.07	80.80	77.07
25	Multinomial Naive Bayes	FastText	60.54	59.17	66.81	59.17
25	Multinomial Naive Bayes	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	71.51	73.86	76.13	73.86
25	Multinomial Naive Bayes	TF-IDF (analyzer = 'word' , n_gram=(1,2))	71.05	73.36	80.16	73.36
25	Random Forest	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	85.39	85.51	85.43	85.51
25	Random Forest	Bag of Words (analyzer = 'word' , n_gram=(1,2))	82.04	82.59	81.96	82.59
25	Random Forest	FastText	73.98	74.25	75.21	74.25
25	Random Forest	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	87.01	87.01	87.15	87.01
25	Random Forest	TF-IDF (analyzer = 'word' , n_gram=(1,2))	83.73	83.99	83.81	83.99
25	Support Vector Machine	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	86.27	86.00	87.06	86.00
25	Support Vector Machine	Bag of Words (analyzer = 'word' , n_gram=(1,2))	83.88	83.62	84.82	83.62
25	Support Vector Machine	FastText	84.47	84.33	85.02	84.33
25	Support Vector Machine	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	89.66	89.16	89.32	89.16
25	Support Vector Machine	TF-IDF (analyzer = 'word' , n_gram=(1,2))	87.22	87.03	87.79	87.03
25	XGBoost	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	87.13	87.13	87.19	87.13
25	XGBoost	Bag of Words (analyzer = 'word' , n_gram=(1,2))	85.79	85.81	85.96	85.81
25	XGBoost	FastText	78.59	78.51	79.06	78.51
25	XGBoost	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	87.84	87.77	88.00	87.77
25	XGBoost	TF-IDF (analyzer = 'word' , n_gram=(1,2))	86.29	86.36	86.38	86.36

Fig. 11. 80-20% Train / Test results

When we set the Training-Test stage as 66 or 34, the SVM algorithm stands out with a success of 88.73% with TF-IDF 3-6 character n-grams. The results obtained with the character

n-grams of the SVM classifier in 25 class problems with different trial stages stand out in Fig.12.

Class	Classifier	Tokenizer	F1-Score	Recall	Precision	Accuracy
25	Multinomial Naive Bayes	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	78.22	79.85	81.98	79.84
25	Multinomial Naive Bayes	Bag of Words (analyzer = 'word' , n_gram=(1,2))	75.17	76.83	80.74	76.83
25	Multinomial Naive Bayes	FastText	61.38	59.87	67.56	59.87
25	Multinomial Naive Bayes	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	70.01	72.52	75.28	72.52
25	Multinomial Naive Bayes	TF-IDF (analyzer = 'word' , n_gram=(1,2))	69.49	71.89	79.56	71.89
25	Random Forest	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	85.24	85.36	85.27	85.36
25	Random Forest	Bag of Words (analyzer = 'word' , n_gram=(1,2))	81.88	82.40	81.78	82.40
25	Random Forest	FastText	72.95	73.32	74.13	73.32
25	Random Forest	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	86.61	86.62	86.64	86.62
25	Random Forest	TF-IDF (analyzer = 'word' , n_gram=(1,2))	83.66	83.96	83.70	83.96
25	Support Vector Machine	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	85.95	85.60	86.90	85.60
25	Support Vector Machine	Bag of Words (analyzer = 'word' , n_gram=(1,2))	83.48	83.17	84.51	83.17
25	Support Vector Machine	FastText	84.20	83.97	84.91	83.97
25	Support Vector Machine	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	88.89	88.73	89.27	88.73
25	Support Vector Machine	TF-IDF (analyzer = 'word' , n_gram=(1,2))	87.15	86.96	87.82	86.96
25	XGBoost	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	86.99	86.95	87.10	86.95
25	XGBoost	Bag of Words (analyzer = 'word' , n_gram=(1,2))	85.70	85.71	85.87	85.71
25	XGBoost	FastText	79.80	79.75	80.19	79.75
25	XGBoost	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	87.59	87.56	87.71	87.56
25	XGBoost	TF-IDF (analyzer = 'word' , n_gram=(1,2))	85.91	85.99	86.01	85.99

Fig. 12. 66-34% Train / Test results

C. *Results for the 50 Classes*

The number of samples we have for the 50 Classes ranges from 295 to 7533. There is a decrease in the results obtained due to the differences in the number of samples and confusion.

With the cross matching method SVM classifier, TF-IDF 3-6 character n-gram has achieved 81.34% success. As the classes increased, there was a serious decrease in many approaches in the achievements due to both the complexity and the data difference between the classes in Fig.13.

Class	Classifier	Tokenizer	Accuracy(Mean)
50	Multinomial Naive Bayes	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	72.02
50	Multinomial Naive Bayes	Bag of Words (analyzer = 'word' , n_gram=(1,2))	67.01
50	Multinomial Naive Bayes	FastText	51.55
50	Multinomial Naive Bayes	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	62.12
50	Multinomial Naive Bayes	TF-IDF (analyzer = 'word' , n_gram=(1,2))	61.24
50	Random Forest	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	77.56
50	Random Forest	Bag of Words (analyzer = 'word' , n_gram=(1,2))	73.59
50	Random Forest	FastText	62.31
50	Random Forest	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	78.41
50	Random Forest	TF-IDF (analyzer = 'word' , n_gram=(1,2))	75.05
50	Support Vector Machine	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	78.65
50	Support Vector Machine	Bag of Words (analyzer = 'word' , n_gram=(1,2))	74.40
50	Support Vector Machine	FastText	76.38
50	Support Vector Machine	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	81.34
50	Support Vector Machine	TF-IDF (analyzer = 'word' , n_gram=(1,2))	76.54
50	XGBoost	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	79.30
50	XGBoost	Bag of Words (analyzer = 'word' , n_gram=(1,2))	78.18
50	XGBoost	FastText	68.58
50	XGBoost	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	79.53
50	XGBoost	TF-IDF (analyzer = 'word' , n_gram=(1,2))	77.80

Fig. 13. Cross match results for 50 classes

When we divided the training-test phase into 80 to 20, SVM algorithm TF-IDF achieved 82.69% success with 3-6 character n-grams in Fig. 14.

Class	Classifier	Tokenizer	F1-Score	Recall	Precision	Accuracy
50	Multinomial Naive Bayes	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	71.17	72.99	76.17	72.99
50	Multinomial Naive Bayes	Bag of Words (analyzer = 'word' , n_gram=(1,2))	74.18	75.38	74.36	75.38
50	Multinomial Naive Bayes	FastText	53.93	54.04	62.51	54.04
50	Multinomial Naive Bayes	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	57.09	62.09	66.40	62.09
50	Multinomial Naive Bayes	TF-IDF (analyzer = 'word' , n_gram=(1,2))	57.37	62.11	70.11	62.11
50	Random Forest	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	78.57	79.15	78.80	79.15
50	Random Forest	Bag of Words (analyzer = 'word' , n_gram=(1,2))	74.18	75.38	74.36	75.38
50	Random Forest	FastText	64.05	65.91	66.12	65.91
50	Random Forest	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	79.39	80.01	79.93	80.01
50	Random Forest	TF-IDF (analyzer = 'word' , n_gram=(1,2))	75.84	76.99	76.47	76.99
50	Support Vector Machine	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	80.05	79.91	81.31	79.91
50	Support Vector Machine	Bag of Words (analyzer = 'word' , n_gram=(1,2))	77.16	77.28	78.84	77.28
50	Support Vector Machine	FastText	79.37	77.86	77.51	77.86
50	Support Vector Machine	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	82.69	82.85	83.45	82.69
50	Support Vector Machine	TF-IDF (analyzer = 'word' , n_gram=(1,2))	79.71	79.94	81.42	79.94
50	XGBoost	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	80.59	80.69	80.72	80.69
50	XGBoost	Bag of Words (analyzer = 'word' , n_gram=(1,2))	79.61	79.81	79.96	79.81
50	XGBoost	FastText	69.47	69.95	70.24	69.95
50	XGBoost	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	80.44	80.71	80.72	80.71
50	XGBoost	TF-IDF (analyzer = 'word' , n_gram=(1,2))	79.20	79.62	79.44	79.62

Fig. 14. 80-20% Train / Test results

When we set the training-test stage as 66 to 34, SVM algorithm TF-IDF achieved 82.38% success with 3-6 character n-grams. According to the results, the SVM algorithm stands out with character n-grams in our 50-class problem in Fig.15.

Class	Classifier	Tokenizer	F1-Score	Recall	Precision	Accuracy
50	Multinomial Naive Bayes	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	70.77	72.78	75.76	72.78
50	Multinomial Naive Bayes	Bag of Words (analyzer = 'word' , n_gram=(1,2))	64.33	67.53	73.65	67.53
50	Multinomial Naive Bayes	FastText	53.90	54.00	62.68	54.00
50	Multinomial Naive Bayes	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	55.77	60.97	66.11	60.97
50	Multinomial Naive Bayes	TF-IDF (analyzer = 'word' , n_gram=(1,2))	56.27	61.10	69.10	61.10
50	Random Forest	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	78.63	79.30	79.06	79.30
50	Random Forest	Bag of Words (analyzer = 'word' , n_gram=(1,2))	74.18	75.54	74.63	75.54
50	Random Forest	FastText	63.24	65.12	65.67	65.12
50	Random Forest	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	79.24	79.82	79.77	79.82
50	Random Forest	TF-IDF (analyzer = 'word' , n_gram=(1,2))	75.49	76.66	76.03	76.66
50	Support Vector Machine	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	80.08	79.94	81.49	79.94
50	Support Vector Machine	Bag of Words (analyzer = 'word' , n_gram=(1,2))	76.57	76.79	78.45	76.79
50	Support Vector Machine	FastText	76.69	77.08	79.03	77.08
50	Support Vector Machine	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	82.31	82.38	83.16	82.38
50	Support Vector Machine	TF-IDF (analyzer = 'word' , n_gram=(1,2))	79.22	79.39	81.19	79.39
50	XGBoost	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	80.79	80.92	80.93	80.92
50	XGBoost	Bag of Words (analyzer = 'word' , n_gram=(1,2))	79.47	79.63	79.88	79.62
50	XGBoost	FastText	70.33	70.84	71.45	70.84
50	XGBoost	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	80.52	80.69	80.73	80.69
50	XGBoost	TF-IDF (analyzer = 'word' , n_gram=(1,2))	78.88	79.29	79.05	79.29

Fig. 15. 66-34% Train / Test results

D. *Results for 102 Classes*

The range of samples we have for the 102 Classes ranges from 42 to 7533. Our main goal is to strengthen the prediction in this category.

With the cross matching method SVM classifier, TF-IDF 3-6 character n-gram has achieved a success of 76.06% in Fig.16.

Class	Classifier	Tokenizer	Accuracy(Mean)
102	Multinomial Naive Bayes	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	66.36
102	Multinomial Naive Bayes	Bag of Words (analyzer = 'word' , n_gram=(1,2))	61.52
102	Multinomial Naive Bayes	FastText	44.73
102	Multinomial Naive Bayes	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	55.26
102	Multinomial Naive Bayes	TF-IDF (analyzer = 'word' , n_gram=(1,2))	54.55
102	Random Forest	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	72.48
102	Random Forest	Bag of Words (analyzer = 'word' , n_gram=(1,2))	68.36
102	Random Forest	FastText	57.21
102	Random Forest	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	73.00
102	Random Forest	TF-IDF (analyzer = 'word' , n_gram=(1,2))	69.61
102	Support Vector Machine	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	74.03
102	Support Vector Machine	Bag of Words (analyzer = 'word' , n_gram=(1,2))	69.27
102	Support Vector Machine	FastText	71.20
102	Support Vector Machine	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	76.06
102	Support Vector Machine	TF-IDF (analyzer = 'word' , n_gram=(1,2))	69.28
102	XGBoost	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	73.32
102	XGBoost	Bag of Words (analyzer = 'word' , n_gram=(1,2))	72.58
102	XGBoost	FastText	50.40
102	XGBoost	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	72.89
102	XGBoost	TF-IDF (analyzer = 'word' , n_gram=(1,2))	71.70

Fig. 16. Cross match results for 102 classes

In the 102-class estimations determined as 80 to 20 in the training and testing phase, the SVM algorithm was at the forefront with 78.25% as in other comparisons in Fig.17.

Class	Classifier	Tokenizer	F1-Score	Recall	Precision	Accuracy
102	Multinomial Naive Bayes	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	63.86	67.50	68.21	67.50
102	Multinomial Naive Bayes	Bag of Words (analyzer = 'word' , n_gram=(1,2))	57.92	62.63	65.66	62.63
102	Multinomial Naive Bayes	FastText	47.72	47.30	56.38	47.30
102	Multinomial Naive Bayes	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	49.83	56.14	57.3	56.14
102	Multinomial Naive Bayes	TF-IDF (analyzer = 'word' , n_gram=(1,2))	50.16	56.22	59.36	56.22
102	Random Forest	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	73.04	74.44	73.57	74.44
102	Random Forest	Bag of Words (analyzer = 'word' , n_gram=(1,2))	68.74	71.01	69.20	71.01
102	Random Forest	FastText	57.43	60.07	59.58	60.07
102	Random Forest	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	73.99	75.14	74.31	75.14
102	Random Forest	TF-IDF (analyzer = 'word' , n_gram=(1,2))	69.70	71.56	69.90	71.56
102	Support Vector Machine	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	75.44	76.09	76.85	76.09
102	Support Vector Machine	Bag of Words (analyzer = 'word' , n_gram=(1,2))	71.22	72.49	72.89	72.49
102	Support Vector Machine	FastText	71.15	72.85	72.87	72.85
102	Support Vector Machine	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	77.62	78.25	78.30	78.25
102	Support Vector Machine	TF-IDF (analyzer = 'word' , n_gram=(1,2))	72.73	73.79	74.66	73.79
102	XGBoost	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	75.12	75.58	75.06	75.58
102	XGBoost	Bag of Words (analyzer = 'word' , n_gram=(1,2))	74.59	75.34	74.58	75.34
102	XGBoost	FastText	57.84	59.06	58.10	59.06
102	XGBoost	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	74.36	74.80	74.41	74.80
102	XGBoost	TF-IDF (analyzer = 'word' , n_gram=(1,2))	72.98	73.92	72.73	73.92

Fig. 17. 80-20% Train / Test results for 102 classes

Finally, SVM achieved a success of 77.47% with the TF-IDF character n-grams during the 66 to 34 training and testing phase. The experiments conducted show the importance of

character n-grams in Fig.18. Each of the tried classifiers has achieved better results with character n-grams.

Class	Classifier	Tokenizer	F1-Score	Recall	Precision	Accuracy
102	Multinomial Naive Bayes	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	62.87	66.84	68.74	66.84
102	Multinomial Naive Bayes	Bag of Words (analyzer = 'word' , n_gram=(1,2))	57.31	62.09	66.13	62.09
102	Multinomial Naive Bayes	FastText	47.66	47.31	57.14	47.31
102	Multinomial Naive Bayes	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	49.02	55.26	56.08	55.26
102	Multinomial Naive Bayes	TF-IDF (analyzer = 'word' , n_gram=(1,2))	49.46	55.48	60.75	55.48
102	Random Forest	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	72.43	74.05	72.82	74.05
102	Random Forest	Bag of Words (analyzer = 'word' , n_gram=(1,2))	67.87	70.36	68.15	70.36
102	Random Forest	FastText	56.64	59.51	58.52	59.51
102	Random Forest	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	73.65	74.83	74.25	74.83
102	Random Forest	TF-IDF (analyzer = 'word' , n_gram=(1,2))	69.43	71.38	69.55	71.38
102	Support Vector Machine	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	74.43	75.17	76.28	75.17
102	Support Vector Machine	Bag of Words (analyzer = 'word' , n_gram=(1,2))	70.35	71.75	72.72	71.75
102	Support Vector Machine	FastText	71.14	72.07	72.76	72.07
102	Support Vector Machine	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	76.79	77.47	77.86	77.47
102	Support Vector Machine	TF-IDF (analyzer = 'word' , n_gram=(1,2))	72.48	73.38	74.32	73.38
102	XGBoost	Bag of Words (analyzer = 'char_wb' , n_gram=(3,6))	74.64	75.14	74.54	75.14
102	XGBoost	Bag of Words (analyzer = 'word' , n_gram=(1,2))	74.15	74.79	74.11	74.79
102	XGBoost	FastText	55.87	57.03	56.16	57.03
102	XGBoost	TF-IDF (analyzer = 'char_wb' , n_gram=(3,6))	73.93	74.39	73.93	74.39
102	XGBoost	TF-IDF (analyzer = 'word' , n_gram=(1,2))	72.72	73.58	72.51	73.57

Fig. 18. 66-34% Train / Test results for 102 classes

When we examine the obtained results, it was observed that the data set not equally divided into classes and the groups with a low number of data had a low prediction. For this reason, in future studies, the addition of data from the "Change of Authority" class and trials will be made with data manipulation techniques. Apart from that, more information about data will be obtained during studies such as NER (Named Entity Recognition) and urgency case. These analyzes have been thought to yield higher accuracy results. With the BERT model [7], the percentage of success achieved will be increased by strengthening the package and deep learning model with a pre-trained Turkish word vector.

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Developing an Identification Application for Overdress Products Using Convolutional Neural Networks

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***Abstract*— The variety of products in e-commerce makes it difficult for users to make quick and easy decisions and find the products they are interested in. To support users in such search and decision-making processes, the classification of products is usually made using text-based labels so far. In text-based product classification, however, it is difficult to accurately label all products manually. Therefore, there is a need for a new and more practical classification system to provide users with products they are looking for. This study aims to automatically categorize and extract various features from overdress product visuals by using Convolutional Neural Networks (CNNs). Particularly, visual data of three overdress products, including dress shirts, t-shirts, and sweatshirts has been utilized for training the classification model. The visual data has been obtained from Trendyol's own product data warehouse and consists of 11030 products photographed from different angles. By using the 80-20% splits of training/testing data, various measures such as confusion matrix, precision, recall, and F-score have been used to evaluate the performance of the CNN-based model. The results show that the proposed model provides satisfying performance in categorizing the overdress products and extracting various features from their visuals. The analysis of these products with categories and extracted features will be of great benefit in terms of the suggestion system and better recognition of the customers who purchase the product.**

Keywords—convolutional neural network, object detection, image segmentation, e-commerce, classification

I. INTRODUCTION

The variety of products in e-commerce makes it difficult for users to make quick and easy decisions and find the products they are interested in. To support users in such search and decision-making processes, the classification of products is usually made using text-based labels so far. Many companies, for example, enter the products and their characteristics into the database manually. In text-based product classification, however, it is difficult to label all products accurately and consistently. For this reason, since the error rate caused by the manual insertion is high and each product is often entered with only one or few features, the time between the search for the product by the customer and the finding can last long from time to time.

With the increase in the number of products and business partners day-by-day, it becomes difficult to keep customer satisfaction high. Therefore, there is a need for a new and more practical classification system to provide users with products they are looking for. One such system is based on artificial intelligence technologies that can automatically categorize and extract various features from products according to their characteristics to help the customers find the product they are looking for quickly and comfortably.

Some related works have already been conducted in the literature for automatically categorizing objects in images. Badrinarayanan et al. [1] proposed SegnNet, a deep fully convolutional neural network architecture for semantic pixel-wise segmentation. Chen et al. [2] presented a deep contour-aware network that integrates multi-level contextual features to accurately segment glands from histology images. Wang et al. [3] developed an interactive image segmentation method based on diffusive likelihood and perceptual learning. Ren et al. [4] proposed a fully convolutional Region Proposal Network that shares full-image convolutional features with the detection network and simultaneously predicts object bounds and objectness scores at each position. Krizhevsky et al. [5] trained a large, deep convolutional neural network to classify the 1.2 million high-resolution images in the ImageNet LSVRC-2010 contest into the 1000 different classes. Girschick et al. [6] proposed a simple and scalable object detection algorithm combining two key insights, namely (a) the application of high-capacity convolutional neural networks to bottom-up region proposals to localize and segment objects and (b) training of large CNNs when labeled training data is scarce.

All these previous studies, however, mainly focused on segmenting, or categorizing objects in images, rather than extracting and labeling the object characteristics. In this context, the object segmentation of the product visual should be performed first, and then the image should be labeled according to its extracted properties. Object segmentation can be explained as finding the place of the product in the image (i.e., finding the rectangle surrounding the product) and multi-labeling can be described as determining the properties of the product.

This study aims to automatically categorize and extract various features from overdress product visuals by using Convolutional Neural Networks (CNNs). Particularly, visual data of three overdress products, including dress shirts, t-shirts, and sweatshirts has been utilized for training the classification model. The visual data has been obtained from Trendyol's own product data warehouse and consists of 11030 products photographed from different angles. By using the 80-20% splits of training/testing data, various measures such as confusion matrix, precision, recall, and F-score have been used to evaluate the performance of the CNN-based model.

The rest of the paper is organized as follows. Section II introduces the details of image segmentation and classification models. Section III describes the model training and evaluation methodology. Section IV presents the results and discussion. Finally, Section V concludes the paper along with possible future works.

II. Image Segmentation and Classification

This section describes two neural network models for performing image segmentation and classification.

The utilized ground truth visual data consists of product images taken from Trendyol's own product data warehouse. The product range consists of 11030 products, including dress shirts, t-shirts, and sweatshirts photographed at different angles. There are three sub-categories in the dress shirt category: sleeveless, short sleeve, and long sleeve dress shirts. Similarly, there are four sub-categories in the t-shirt category: strappy, sleeveless, short sleeve, and long sleeve t-shirts. Finally, there are four sub-categories in the sweatshirt category: crew neck, high collar, hooded, and round neck sweatshirts. With an open-source segmentation tool, precise reference data was obtained in approximately 11030 images, as illustrated in Figure 1.

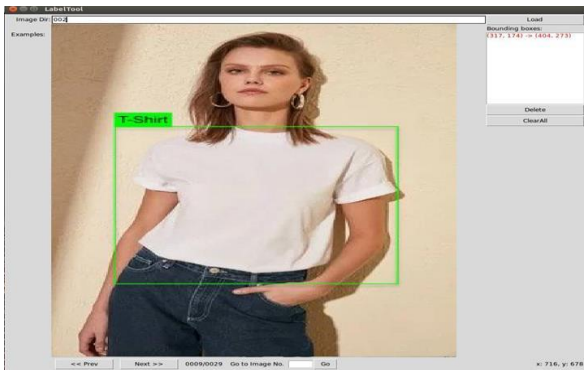

Fig. 1. Segmenting a product from visual

The "You Only Look Once" (YOLO) algorithm [7] was used for the segmentation process. The main reason for choosing this algorithm is that it is open-source, and its accuracy and performance are more efficient than other alternative algorithms. For the image classification process, the VGG-16 artificial neural network [8] was preferred due to its simple, implementable architecture and homogeneous topology.

The YOLO-based and VGG-16-based models, used for image segmentation and classification, respectively, were added to each other by the end-to-end insertion method. The YOLO network's output is the coordinates of the framed objects and the class to which the object in the frame belongs. Since VGG-16 was observed to be better than the YOLO network in terms of classification performance, it was used only in the image segmentation of the YOLO network and in determining the categories of objects with the highest hierarchy. After identifying the objects' categories, the area taken into the frame was brought to the input sizes accepted by the VGG-16 network with the "padding" method, and the training was carried out to yield the properties of the object as output. Figure 2 illustrates an example of image segmentation and classification using YOLO-based and VGG-16-based models, respectively.

Original Image | Frame coordinates and category information of the object found by YOLO | Image to be input to the VGG-16 network (the framed area is cut off)

YOLO: Category → t-shirt, VGG-16: Property → short sleeve,
Product: Short sleeve t-shirt

Fig. 2. Example of overdress segmentation and classification

III. Model Training and Evaluation

The YOLO-based segmentation and VGG-16-based classification models were coded using the Python programming language. Models were trained using Tesla P100-PCIE GPU accelerators. Python libraries such as Tensorflow, Pytorch, and Torch were utilized in the models. Furthermore, technologies such as Jupyter notebook and docker have also been applied during model development.

The training data was created by passing through various transformation steps, including random resized crop, random rotation, color jitter, random horizontal flip, and normalization. Some transformation steps used to create the training data are illustrated in Figure 3.

Fig. 3. Some transformation steps used to create the training data

The data set whose categories were previously defined was divided into 2 groups as 80% control group and 20% test group. Precision, recall, and f1-score metrics were used for the performance measurement of the model. Precision is used to define the number of relevant items selected (i.e., the ratio of true positives (tp) to all predicted positives ($tp + fp$)). Recall is used to define the number of relevant items retrieved by the supervised model (the ratio of true positives (tp) to all actual positives $tp + fn$). The f1-score measures the accuracy of both precision and recall metrics. A good classification algorithm should maximize both precision and recall simultaneously. Hence, the $f1$-score is also considered to be an evaluation metric. The equations of precision, recall, and f1-score are given in (1), (2), and (3), respectively.

$$precision = \frac{tp}{tp+fp} \quad (1)$$

$$recall = \frac{tp}{tp+fn} \quad (2)$$

$$f1-score = 2 \cdot \frac{1}{\frac{1}{recall}+\frac{1}{precision}} = 2 \cdot \frac{precision*recall}{precision+recall} \quad (3)$$

The output of the developed classification model is the probability of belonging to each product category, as illustrated in Figure 4.

Fig. 4. Output of the overdress classification model

IV. Results and Discussion

This section presents the results and discussion of all models for classifying dress shirts, t-shirts, and sweatshirts, as well as their properties.

A. Dress Shirts

The confusion matrix results for dress shirt products with different sleeve types are given in Table I. The models' results for classifying the sleeve type of dress shirt products are shown in Table II.

TABLE I. Results of Confusion Matrix for Dress Shirt Products with Different Sleeve Types

	sleeveless	short sleeve	long sleeve
sleeveless	58	4	4
short sleeve	5	578	21
long sleeve	1	46	546

TABLE II. Results of The Models for Classifying the Sleeve Type of Dress Shirt Products

	precision	recall	f1-score
sleeveless	0.906	0.879	0.892
short sleeve	0.920	0.957	0.938
long sleeve	0.956	0.921	0.938

According to the confusion matrix results, it is observed that overall, out of 1263 actual dress shirt sleeve types, the classifier predicted 1182 sleeve types correctly, and only 81 sleeve types were misclassified.

When the dress shirt models' precision values are compared, the best result is obtained by the long sleeve dress shirt model with 0.956 precision value. The sleeveless dress shirt model occupies the second place, whereas the short sleeve dress shirt model yields the relatively lowest precision value. The best performing long sleeve dress shirt model produces 5.23% and 3.77% higher precision values compared to that of sleeveless and short sleeve dress shirt models.

When the dress shirt models' recall values are compared, the best result is obtained by the short dress shirt model with 0.957 recall value. In contrast, the sleeveless dress shirt models, ranked at the second place, outperform the long sleeve dress shirt models. The best performing short sleeve dress shirt model produces 8.15% and 3.76% higher recall values compared to that of sleeveless and long sleeve dress shirt models.

When the dress shirt models' f1-scores are compared, it is seen that the short and long dress shirt models obtain the same best result with 0.938 f1-score. The sleeveless dress shirt model has a relatively higher f1-score with 0.892. The best performing short and long dress shirt models produce 4.90% higher f1-scores compared to that of sleeveless dress shirt model.

B. T-Shirts

The confusion matrix results for t-shirt products with different sleeve types are given in Table III. The results of the models for classifying the sleeve type of t-shirt products are shown in Table IV.

TABLE III. Results of Confusion Matrix for T-Shirt Products with Different Sleeve Types

	strappy	sleeveless	short sleeve	long sleeve
strappy	483	69	40	20
sleeveless	29	481	12	8
short sleeve	74	16	479	17
long sleeve	13	4	12	542

TABLE IV. Results of The Models for Classifying the Sleeve Type of T-Shirt Products

	precision	recall	f1-score
strappy	0.806	0.789	0.798
sleeveless	0.844	0.908	0.875
short sleeve	0.882	0.817	0.849
long sleeve	0.923	0.949	0.936

According to the confusion matrix results, it is observed that overall, out of 2299 actual t-shirt sleeve types, the classifier predicted 1985 sleeve types correctly and only 314 sleeve types were misclassified.

When the t-shirt models' precision values are compared, it is seen that the long sleeve t-shirt model obtains the best result with 0.923 precision value. The rest of the models' ranking leading from the highest to the lowest precision values is short sleeve, sleeveless, and strappy t-shirt models. The best performing long sleeve t-shirt model produces 12.68%, 8.56%, and 4.44% higher precision values compared to that of strappy, sleeveless, and short sleeve t-shirt models.

When the t-shirt models' recall values are compared, it is seen that the long sleeve t-shirt model again obtains the best result with 0.949 recall value. The rest of the models' ranking leading from the highest to the lowest recall values is sleeveless, short sleeve, and strappy t-shirt models. The best performing long sleeve t-shirt model produces 16.86%, 13.91%, and 4.32% higher recall values compared to that of strappy, short sleeve, and sleeveless t-shirt models.

When the t-shirt models' f1-scores are compared, it is seen that the long sleeve t-shirt model obtains the best result with 0.936 f1-score. The rest of the models' ranking leading from the highest to the lowest f1-scores is sleeveless, short sleeve,

and strappy t-shirt models. The best performing the long sleeve t-shirt model produces 14.74%, 9.29%, and 6.52% lower f1-scores compared to that of sleeveless, short sleeve, and long sleeve t-shirt models.

C. Sweatshirts

The confusion matrix results for sweatshirt products with different collar types are given in Table V. The results of the models for classifying the collar type of sweatshirt products are shown in Table VI.

TABLE V. RESULTS OF CONFUSION MATRIX FOR SWEATSHIRT PRODUCTS WITH DIFFERENT COLLAR TYPES

	crew neck	high collar	hooded	round neck
crew neck	561	5	26	22
high collar	10	142	16	4
hooded	2	8	550	10
round neck	14	1	16	585

TABLE VI. RESULTS OF THE MODELS FOR CLASSIFYING THE COLLAR TYPE OF SWEATSHIRT PRODUCTS

	precision	recall	f1-score
crew neck	0.956	0.914	0.934
high collar	0.910	0.826	0.866
hooded	0.905	0.965	0.934
round neck	0.942	0.950	0.946

According to the confusion matrix results, it is observed that overall, out of 1972 actual sweatshirt collar types, the classifier predicted 1838 collar types correctly, and only 134 collar types were misclassified.

When the sweatshirt models' precision values are compared, the best result is obtained by the crew neck sweatshirt model with 0.956 precision value. The rest of the models' ranking leading from the highest to the lowest precision values is round neck, high collar, and hooded sweatshirt models. The best performing the crew neck sweatshirt model produces 4.81%, 5.33%, and 1.46% higher precision values compared to that of high collar, hooded, and round neck sweatshirt models.

When the sweatshirt models' recall values are compared, the best result is obtained by the hooded sweatshirt model with 0.965 recall value. The rest of the models' ranking leading from the highest to the lowest recall values is round neck, crew neck, and high collar sweatshirt models. The best performing the hooded sweatshirt model produces 5.28%, 14.40%, and 1.55% higher recall values compared to that of crew neck, high collar, and round neck sweatshirt models.

When the sweatshirt models' f1-scores are compared, it is seen that the round neck sweatshirt model obtains the best result with 0.946 f1-score. The rest of the models' ranking leading from the highest to the lowest f1-scores is crew neck/hooded and high collar sweatshirt models. The best performing round neck sweatshirt model produces 1.27%, 8.46%, and 1.27% higher f1-scores compared to that of crew neck, high collar, and hooded sweatshirt models.

V. CONCLUSION AND FUTURE WORK

The purpose of the study was to match the correct semantic words (i.e., classes) that describe the overdress product by looking at its visual content. In this context, it is necessary to perform the object segmentation from the product visual and then label object according to its features. Object localization can be explained as finding the product's place in the image, and multi-labeling can be described as determining the product's properties. For this purpose, visuals of various dress shirts, t-shirts, and sweatshirts were collected. The segmentation models have been developed, and the visuals needed for the labeling process have been transferred to the database. Precision, recall, and f1-score metrics have been used for the performance measurement of the model. The probability of belonging to the overdress product classes, which is passed as input to the proposed CNN-based model, is calculated and matched to the class with the highest probability.

This is an initial study for categorizing and extracting features from a limited number of overdress product visuals. A broader range of fashion products can be considered in future work, including sportswear, shoes & bags, watches & accessories, cosmetics, and home & life product categories to generalize the promising potential of the proposed classification models.

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Forecasting Arrivals To a Call Center Using Supervised Machine Learning

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***Abstract*— Call center managers have to deal with multiple operational decision-making tasks. One of the most important and critical tasks is to determine the weekly staffing levels to ensure customer satisfaction and meeting their needs while minimizing service costs. In order to generate the weekly schedule of the staff, one needs to know in advance call counts that will arrive to the call center, which in turn requires intelligent forecasting models to be developed. In this paper, we develop Multilayer Perceptron (MLP)-based and Support Vector Machines (SVM)-based forecasting models to predict call counts within acceptable error rates. The dataset includes call counts that arrived to the call center from January 1st, 2018, to December 30th, 2020, on an hourly basis. Weekly, bi-weekly, tri-weekly, and monthly forecasts have been produced on daily as well as hourly periods. Mean Absolute Percentage Error (MAPE) has been utilized to assess the performance of all forecasting models. The results show that MLP-based forecasting models outperform SVM-based forecasting models and daily forecasts yield lower MAPEs than that of hourly forecasts. We can conclude that MLP-based forecasting models can be effectively used for predicting the call arrivals of a call center.**

Keywords—machine learning, regression, forecasting, call center

I. INTRODUCTION

A call center is a place from which calls are made or received in large numbers. Call centers serve as contact points in which communication from and to customers is enabled and efficiently organized. Communication is performed primarily based on telephony but can also occur via email, fax, Internet, or letter on both sides. Call centers aim to conduct service-oriented and efficient dialogues between companies and their customers and optimize the economy using the most modern telecommunication technology [1].

A call center is firmly integrated into the process of companies' organization. For the high communicative requirements, enough appropriately trained and motivated staff must be employed who are committed to customer-oriented behavior. Determining the optimum number of staff to achieve the set targets directly affects the company's profitability and customer satisfaction. Thus, capacity planning is one of the essential areas for call center performance. Capacity planning is done according to the workload. One of the most significant inputs to the workload is the number of call arrivals. Call arrival indicates the number of calls a call center receives. The call count forecast is mainly exploited to schedule the staff. Companies are interested in the short-term forecast to handle the unforeseen and optimize the staff schedule, and in the long-term forecast to hire or assign staff to other tasks. For these reasons, companies need to make an accurate forecast of the number of call arrivals [2].

In the last few years, numerous methods have been used to forecast call arrivals in a call center. Channouf and L'Ecuyer [3] forecasted the number of call arrivals by developing a normal copula model for the call center's arrival process. Kim et al. [4] forecasted peak call arrivals of rural electric cooperatives call center. They used Gaussian copula for capturing the dependence between non-normal distributions. Millán–Ruiz and Hidalgo [5] tried to forecast the number of call arrivals using artificial neural networks. Bastianin et al. [6] offered a strategy based on flexible loss function, statistical test, and economic measure of performance for selecting a model in call centers. Jalal et al. [7] forecasted the number of call arrivals by using a prediction model based on the Elman and nonlinear autoregressive network with exogenous inputs neural network and a back-propagation algorithm. Mohammed [8] proposed a personalized call prediction method that encodes agent skill information as the prior knowledge for call prediction and distribution. Moazeni and Andrade [9] used a data-driven approach to predict customer's call arrival in multichannel customer support centers. Li et al. [10] used a simulation-based machine learning framework to evaluate call centers' performance with heterogeneous servers and multiple types of demand. Barrow and Kourentzes [11] used artificial neural networks to forecast the number of call arrivals. Baldon [12] used time-series statistical and machine learning methods to forecast call volume in a call center. Li et al. [13] presented a simulation-based machine learning framework to evaluate the performance of call centers. Yamamato and Hatayama [14] forecasted call center arrivals at a call center using a dynamic linear model. Ballouch et al. [15] MLP-based and Long-Short Term Memory (LSTM)-based models combined with time lags to forecast the number of call arrivals in a call center.

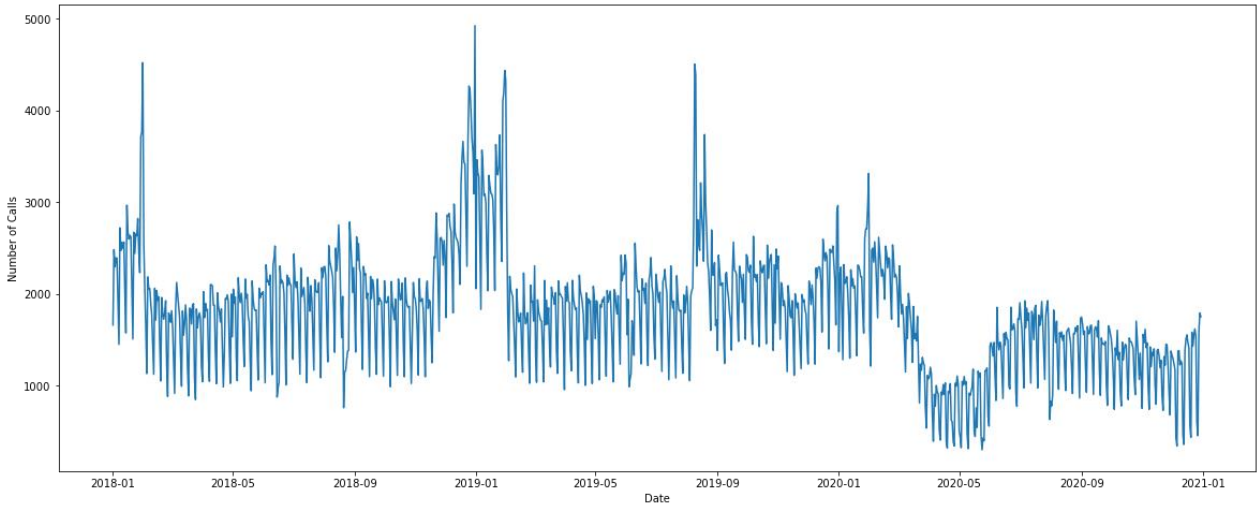

Fig. 1. Number of calls on daily basis

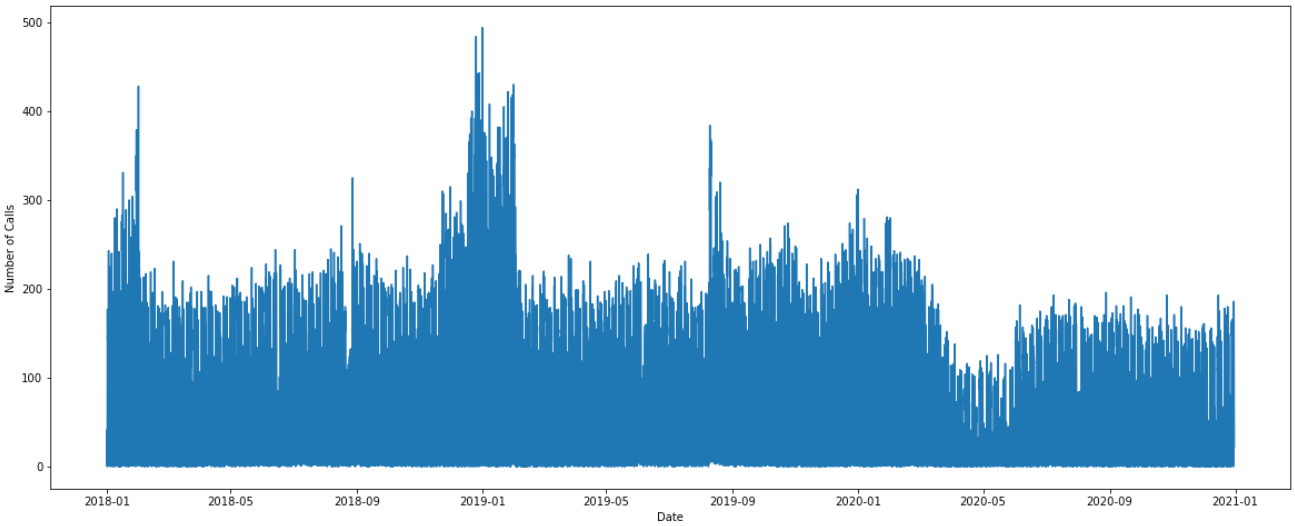

Fig. 2. Number of calls on hourly basis

In this study, we propose new supervised MLP-based and SVM-based forecasting models to predict call arrivals in call centers. Differently from the rest of studies in literature, we use a minimal number of easily obtainable predictors of expected call arrivals, including the year, month, monthday, weekday, and hour.

This paper is structured as follows. Section II describes the dataset and methodology. Section III presents the results and discussion. Section IV concludes the paper along with possible future research directions.

II. Dataset Generation and Methodology

In this study, we utilized a data set collected in hourly time intervals and obtained from Comdata in Turkey. The dataset includes call counts that arrived to the call center from January 1st, 2018, to December 30th, 2020, on an hourly basis. Figure 1 and Figure 2 illustrate the number of calls on daily and hourly basis, respectively.

Weekly, bi-weekly, tri-weekly, and monthly forecasts have been produced on daily as well as hourly periods. For daily period forecasts, the predictor variables are year, month, monthday, and weekday, whereas for hourly period forecasts, the predictor variables are year, month, hour, and weekday. In both cases, the target variable is the number of call arrivals. Mean Absolute Percentage Error (MAPE), the formula of which is shown in Eq. 1, has been utilized to assess the performance of all forecasting models.

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\frac{|A_t - F_t|}{A_t}, \qquad (1)$$

In Eq. 1, n is the number of forecasts, A_t is the actual value, and F_t is the forecasted value. For model validation, random percent splits of training and testing data (i.e., 50-50%, 60-40%, 70-30%, and 80-20%) have been used. Only random percent splits of training and testing data leading to the lowest MAPEs are reported in this study.

III. Results and Discussion

Table I through Table IV show the results of MLP-based and SVM-based models for weekly, bi-weekly, tri-weekly, and monthly forecasts using daily as well as hourly period data. MLP-related and SVM-related parameters that produced the lowest MAPEs are also given.

TABLE I. MAPES OF MLP-BASED MODELS FOR DAILY FORECASTS

Train Percent	Hidden Layer Size	Number of Neurons in the Hidden Layers	Epoch	Number of Forecasts	MAPE
90%	3	200, 200, 100	100	7 (weekly)	3.63
80%	2	300, 300	500	14 (bi-weekly)	4.95
70%	2	500, 100	100	21 (tri-weekly)	5.44
70%	2	400, 200	200	30 (monthly)	5.80

TABLE II. MAPES OF MLP-BASED MODELS FOR HOURLY FORECASTS

Train Percent	Hidden Layer Size	Number of Neurons in the Hidden Layers	Epoch	Number of Forecasts	MAPE
70%	2	512, 512	100	168 (weekly)	8.04
70%	2	128, 128	70	336 (bi-weekly)	8.66
50%	5	512, 512, 512, 512, 512	100	504 (tri-weekly)	8.86
50%	2	128, 128	100	720 (monthly)	9.57

TABLE III. MAPES OF SVM-BASED MODELS FOR DAILY FORECASTS

Train Percent	Epsilon	C	Gamma	Number of Forecasts	MAPE
100%	0.00008	2^{-2}	1.00	7 (weekly)	5.73
100%	0.0001	2^{-2}	Scale[1]	14 (bi-weekly)	5.77
100%	0.002	2^{-2}	Scale	21 (tri-weekly)	5.66
70%	0.004	2^{-2}	Scale	30 (monthly)	7.98

TABLE IV. MAPES OF SVM-BASED MODELS FOR HOURLY FORECASTS

Train Percent	Epsilon	C	Gamma	Number of Forecasts	MAPE
80%	0.002	2^{1}	Scale	168 (weekly)	11.05
70%	0.0009	2^{2}	Scale	336 (bi-weekly)	11.33
80%	0.025	2^{2}	0.05	504 (tri-weekly)	10.93
60%	0.02	2^{-2}	0.80	720 (monthly)	10.88

- The results show that MLP-based models outperform SVM-based models, independent of whether the models are built using hourly or daily period data. Particularly, MLP-based models produce 20.50% and 21.16% lower MAPE values on average than SVM-based models using daily and hourly period data, respectively.
- When the results of all weekly, bi-weekly, tri-weekly, and monthly forecasts using daily period data are compared, it is seen that the MLP-based weekly forecast model exhibits the best performance with a MAPE value of 3.63%. In contrast, the worst performance is obtained by the SVM-based tri-weekly forecast model with a MAPE value of 7.98%.
- When the results of weekly, bi-weekly, tri-weekly, and monthly forecasts using hourly period data are compared, it is seen that the MLP-based weekly forecast model shows the best performance with a MAPE value of 8.04%. The worst performance is obtained by the SVM-based bi-weekly forecast model with a MAPE value of 11.33%.
- Daily forecasts yield lower MAPE values than that of hourly forecasts, independent of whether MLP or SVM has been used to build the models. Particularly, daily forecast models produce 43.32% lower MAPE value on average compared to that of hourly forecast models.

IV. CONCLUSION AND FUTURE WORK

In this study, we proposed MLP-based and SVM-based models for forecasting the number of call arrivals in call centers. The dataset was created by including call counts that arrived to the call center of Comdata in Turkey from January 1st, 2018, to December 30th, 2020, on an hourly basis. Weekly, bi-weekly, tri-weekly, and monthly forecasts have been produced on daily and hourly periods. MAPE has been utilized to assess the performance of the forecasting models. Models' generalization errors were evaluated by using various random percent splits of training and testing data. The results show that MLP-based models are superior to SVM-based models and daily forecasts produce lower MAPE values than that of hourly forecasts. We can conclude that MLP-based forecasting models can be effectively used for predicting the call arrivals of a call center.

As future research direction, another study may be conducted to build new forecasting models based on deep learning, autoregressive moving average (ARMA), and Holt-Winters to investigate whether the accuracy of forecasts achieved in this study can further be improved. Another interesting future research direction would be to extend the existing forecasting models to predict different call types simultaneously, such as call counts related to receiving information about products, campaigns, and solutions to technical problems. Finally, quarterly and yearly call arrival forecasting models can be developed to enable long-term capacity planning in call centers.

ACKNOWLEDGMENT

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Transformation of Made in China Perception in Turkey: An Evaluation Based on Sentiment Analysis

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***Abstract*—Large companies of Chinese origin has increased their share significantly in the Turkish consumer electronics market. It is an undeniable fact that such products, which were evaluated with the label "Made in China" not so long ago, became such an important actor in the consumer electronics market in a short time. In this context, in order to answer to the question of "what's done right" by such companies, our study, which was prepared in order to systematically evaluate the comments made by consumers about such products, is intended to present an integrated approach with machine learning-based topical modeling and emotional analysis based on artificial neural networks. In this study, more than 500,000 comments from brand communities of Xiaomi brand, one of the largest phone manufacturers of China, were preprocessed with text mining approaches, and then these comments were categorized with machine learning-based topic modeling approaches in 7 dimensions from the literature review. In the last stage, in order to understand the change over the years and the position of the brand in the market, emotion analysis was performed with the TurkishBERT algorithm, which is based on artificial neural networks, and the results were evaluated. It was observed that the companies adopted approaches that prioritize the brand rather than the country image by keeping the product features high and the prices low, and then developed in dimensions such as competitiveness, supply chain, and country image. It is also predicted that the results of the study provide valuable clues to the point of breaking the "Made in Turkey" perception of Turkish consumers.**

Keywords—Brand Communities, Made in China, Machine Learning, Sentiment Analysis, TurkishBERT

I. Introduction And Literature Review

The effect of a product's country origin image on consumer purchasing decision has been one of the most studied topics in marketing literature for many years. In this context, it has been the subject of many academic studies over the years on the perception of products originating in China, which encompasses a significant part of global production [1, 2]. Since the perception of the country of origin is an issue associated with the economic and technological development levels of the countries, the perception of the products produced in China is considered negative, while the developments in recent years seem to have changed this perception and it is seen that some brands of Chinese origin have gained a significant share in the market where they are located. These brands break the negative perception arising from the country's image and play a leading role both for their own market and for other Chinese brands. They are also examples showing how the perception of the country of origin image has changed from negative to positive over time. From this point of view, how this negative perception is broken and what the key steps in this process can be will be very valuable for other countries and brands suffering from similar problems.

Contemporary marketing research reveals that brands are the emerging corporate key assets [3]. Louro and Cunha (2001), discussing the approaches to brand management of businesses, categorized four paradigms of brand management (product, projective, adaptive, and relational paradigm). Based on the approach of this study, Quinton (2013) suggests that the latest paradigm in brand management is the community brand management paradigm within the framework of changes in focus over time. The community brings together brand management and the stakeholders of the brand.

It is the nature of human beings as a social entity that consumers create a community because of their curiosity or love for a particular brand. While initially homogeneous small community groups were formed on the basis of family or blood ties to survive and find food, they later expanded to form heterogeneous communities by coming together within the framework of shared value systems and interpersonal trust. Individuals of such traditional communities based on family and geography are usually born into the community. Therefore, it is not a choice or voluntary participation. However, within these communities, there are also subcultures or social communities formed by individuals in line with their common interests and needs. The main factor that distinguishes them from family or residential communities is voluntary participation. Brand communities, which are a special form of consumption communities, connect brands and society within the framework of individual interests and needs [5, 6]. The phenomenon that holds this community together is the consumption practice of a particular brand [7].

Muniz and O'Guinn (2001) define the concept of brand community as "a community that is not geographically connected to each other, based on a structured set of social relationships between fans of a brand". This definition extends the traditional consumer-brand relationship to the consumer-brand-consumer trio. However, it is stated that this approach ignores many stakeholders related to the brand [8]. Because brand communities are the network of relationships that the customer is in. This network includes the relationships between the customer and the brand, the customer and the business, the customer and the product in use, and other customers [9]. The development of information and communication technologies has given brand communities an important new ability to cross country borders and share a common identity. Brand communities, called online brand communities, were born in a virtual environment where members' interaction is primarily via the Internet [10].

The main difference between traditional brand communities and online brand communities is that online communities use platforms in a virtual environment that do not require physical gathering [5]. Consumption-related online communities are networks of people who interact online, based on shared enthusiasm and knowledge for a particular consumption activity or group of related activities [11]. However, this does not change the fact that they are brand communities [10].

Online brand communities essentially represent word-of-mouth (WOM) networks where individuals interested in a brand or product category connect with like-minded people and interact to gain information such as purchase advice, usage experience, complaints [11]. Traditionally, word-of-mouth communication refers to "the transfer of information between someone who has no commercial expectation (communicator) and someone who wants to get information about a product, service or brand" [12]. This form of communication is still the most trusted advertising type by consumers with a rate of 83% [13]. This form of communication is found by consumers to be more reliable and credible than the marketing communication made by the brands themselves [14].

The development of information and communication technologies, consumers' sharing their knowledge and experiences about the products they consume on virtual platforms in a way that can be accessed by many individuals and institutions globally is called electronic word-of-mouth communication (eWOM) [15]. Although they are similar to each other, WOM affects a limited environment [16]. eWOM is transforming into a method of obtaining information that is getting stronger due to the fact that it provides access to a faster and wider audience [17]. Text, visuals, or audios shared on online platforms are accessible for years as long as they are not deleted by the user or the platform. This gives the eWOM the opportunity to talk to all individuals who have access to sharing for a very long time.

The main output of communication in online brand communities is forum messages, which type of a user-generated document, created by the user in a very sharing approach [18]. These messages contain valuable information about the hidden and valuable data they contain, about brands and their competitors [19, 20]. By systematically evaluating this information with various informatics methods, businesses can achieve important benefits such as gaining an idea about the product and/or brand image, developing the marketing strategy by understanding the customer better, and updating the production processes by identifying the potential problems in their products [21]. One of the most analyzed part of these data in recent years to achieve these benefits is the analysis of customer emotions. This process, called Sentiment Analysis, is automatic and semi-automatic extraction of emotions in text with various machine learning and text mining algorithms.

Sentiment analysis is a special technique that allows different levels of inference regarding the content being examined. However, the ability of this technique to summarize in very large data sets may not be sufficient on its own. In this context, it is very important to evaluate the data sets by classifying them into various categories with topical modeling tools in order to increase their generalization capabilities. This study, it is aimed to analyze in detail the form posts of the brand community belonging to the brand Xiaomi, which plays an important role in breaking the "Made in China" perception, with text mining approaches such as topical modeling and sentiment analysis, and to try to determine the steps that cause the negative perception to break.

II. Sentiment Analysis

For businesses, analyzing and interpreting consumer behavior is always among the priority research topics. The main data source of this research is questionnaires, interviews, and focus group studies until recent years. However, especially in parallel with the increase in the use of social media in recent years, the research trend regarding the use of classical methods has undergone a transformation. As a natural consequence of this transformation, extracting the comments shared by the users on a voluntary basis has been moved to the center of the research processes, and processes such as emotion analysis that manage this process semi-automatically came to the fore.

Sentiment Analysis (SA) is the process of extracting human behaviors, emotions, and beliefs in text, sound, and images shared by the user in a semiautomatic and automated way[22]. In parallel with the increase in access to opinionated documents over the years and studies in natural language processing, SA has become one of the basic methods preferred by researchers in the second half of the 2000s [20, 23, 24].

Sentiment analysis is performed at various levels depending on the type of data source examined. Document-level analyzes to focus on evaluating the emotion score of all downloaded content holistically [19, 20, 23, 25]. For this reason, it will not be very convenient to analyze very long documents in this way. With the limited number of characters they contain, social media data is the most frequently preferred data set for sentiment analysis at the document level.

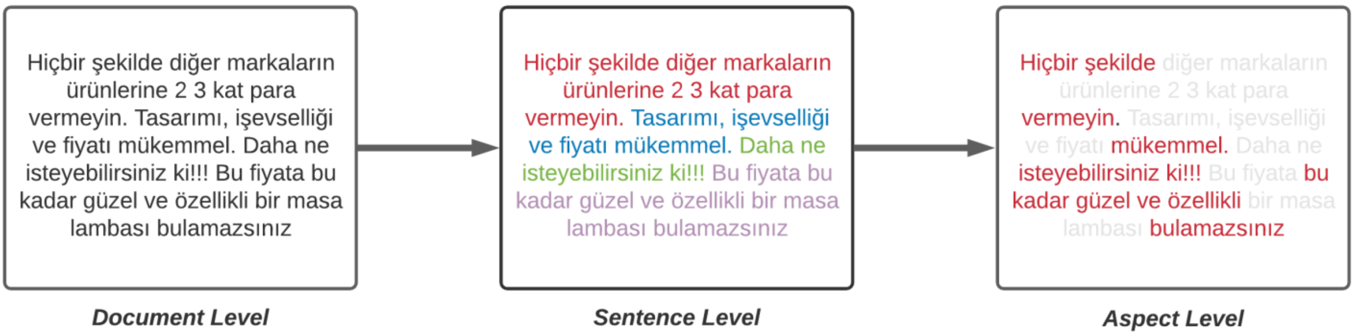


Fig. 1. Sentiment Analysis Levels

In sentence level analyzes, very long documents are first divided into sentences and the analyzes are carried out in this way. The emotional polarity and scores of each sentence are made separately [25]. Forum messages are suitable for sentence-level sentiment analysis due to their long content. Especially at the aspect level, emotion words are found in the sentence and document and their targets and related entities are determined and analyzes. In this way, different feelings about different entities in the same document or sentence can be separated. It can also be named Fine-Grained SA from time to time [19].

Although the sentiment analysis process is structural and generally an important process that provides valuable feedback to researchers, it has some important limitations. The texts subject to sentiment analysis include sarcastic expressions and irony, a differentiated use depending on the research domain, the lack of an appropriate emotion dictionary, the ability to analyze complex sentence structures, noisy data, and negativity prefixes directly affect the performance of the analysis (20, 22, 23, 25, 26, 27, 28]. Another challenge is related to the structure of the Turkish language. Although the rich formal structure of Turkish, which is a member of the additive language family, is an important factor that reduces the performance of the DA process [27], it can be said that this problem has been brought under control to some extent, especially with the libraries added to the python software language in recent years. However, especially the tokenizing and part of speech tagging processes are a field in need of improvement in Turkish natural language processing studies [21]. The Turkish version of the BERT (Bidirectional Encoder Representations from Transformers) algorithm, which is an advanced version of natural language processing algorithms based on deep learning, has come to the fore as a reference model for studies in the field in recent years.

III. METHOD OF THE STUDY

Sentiment analysis is the process of semi-automatic processing of mostly textual raw data and transforming it into valuable, usable, and useful information. The success of the process, which is carried out with systematic and serial steps, is directly dependent on the correct and appropriate performance of the activities in each step

The sentiment analysis process can include different steps depending on the size of the data source, the format and density of the data, the area of interest, and the analyst's preference. In this context, it may not be appropriate to mention a generally accepted process. In this study, a method is shown in Figure 2, which includes topical modeling processes, was preferred in order to increase the generalization and representation ability.

A. Data Gathering

In SA processes, data should be extracted from documents containing emotion. In this context, forum sites, e-commerce sites comment sections, and social media posts are the most important data sources. The process of extracting data from these sources requires the application of a special method called scrapping. The brand community comments of the Chinese company Xiaomi (or Mi for short), which is the subject of this study, have been handled by scraping from one of Turkey's leading IT site forums.

During the scraping process, it is important to systematically understand the map of the site and identify the elements of the openly shared comments. After the map (can also be called topic titles or subject hierarchy) is determined, scraping is performed with an automatic method using this determined structure. During scraping, only the necessary elements (such as date, text) should be selected. In the process of scraping with Python software language, the request, BeautifulSoup, and pandas libraries will be used to request data on the site, process the received data, and keep the processed data, respectively. As a result of these transactions, 183,982 were downloaded together with the comment dates.

B. Data Preprocessing

The most important and relatively time-consuming process of data and text mining is the process of preprocessing, along with obtaining data from the overshot. Errors to be made within these processes are called "systematic errors" and have a direct negative effect on the analysis results. In this sense, it can be said that a correctly constructed preprocessing process is decisive for analysis performances.

The first preprocessing process in the study is the translation of emojis that are in the data set and express emotion directly into sentences through a dictionary. Afterward, the very long comments were divided into sentences and parsed. In this way, it is aimed to increase the analysis performed through the data that will allow making sentence-level DA. The data has increased to 645.505 lines with its new version. After the preprocessing processes, the following steps were carried out.

- Changing uppercase letters to lowercase letters
- Clearing special characters and symbols
- Cleaning links
- Clearing punctuation marks

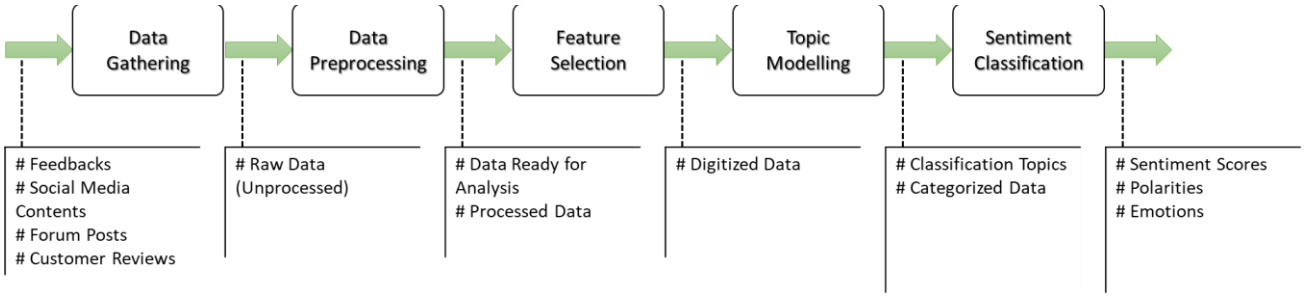


Fig. 2. The sentiment analysis process used in the study

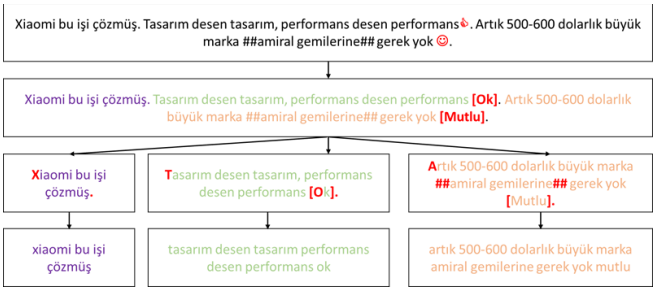
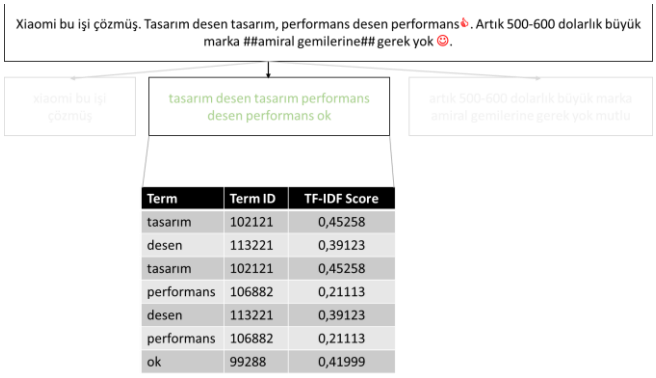


Fig. 3. An example of text preprocessing processes

All these preprocessing stages are exemplified in Figure 3. As a result of these operations, some repetitions are seen in the data set. These repetitions take place in the order of citation while responding to a previous message. With a final process, the messages were cleared and a total of 504.680 lines of clean and ready-to-analyze data set were sent to the next stage, for digitization.

C. Feature Extraction and Selection

As a result of the preprocessing processes, clean and ready-to-analyze data were obtained. However, this data set must be digitized in order to perform the sentiment and topic analysis. At this stage, which is also called feature extraction and selection, the most frequently used TF-IDF (Term Frequency-Inverse Document Frequency) algorithm was selected and the text data was transformed into numerical expressions with the sklearn library as illustrated in Figure 4.



Term	Term ID	TF-IDF Score
tasarım	102121	0,45258
desen	113221	0,39123
tasarım	102121	0,45258
performans	106882	0,21113
desen	113221	0,39123
performans	106882	0,21113
ok	99288	0,41999

Fig. 4. Example TF-IDF conversion

D. Topic Modelling

The biggest benefit of word-of-mouth communication in online brand communities is that consumers can access their comments about brands without any commercial concerns. Meaningful information is produced with the help of the shares and data on the behavior of consumers in the community. Consumers are classified according to many different criteria according to their behavior [14], by whom the posts are made [29], the usefulness of the sharing [31]. These classifications offer important benefits in terms of increasing generalization and representation capability, especially in analysis processes.

TABLE I. TOPICS DETERMINED BY TEXT MINING AND LITERATURE ANALYSIS

	TM	[1]	[2]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]
T1. Brand Trust			✓		✓	✓	✓	✓	✓	✓		✓
Warranty	✓				✓	✓				✓		
Brand Development	✓											
Entering large e-commerce sites	✓											
Fake Products	✓											
After-sales service					✓							
T2. Country of Origin					✓	✓	✓				✓	
Ethical, economic, and cultural problems				✓							✓	
Large companies prefer production in China	✓				✓						✓	
T3. Product Quality		✓		✓	✓		✓	✓		✓		
Design and Aesthetic		✓				✓		✓	✓		✓	✓
Hardware (Technical specifications, performance)	✓	✓								✓	✓	✓
Software (Interface, Language Support)	✓	✓								✓	✓	✓
Software and Hardware Problems	✓	✓									✓	
Using new technology and solutions								✓	✓	✓	✓	

	TM	[1]	[2]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]
T4. Pricing	✓	✓				✓		✓		✓		✓
T5. Supply Chain Abilities				✓								
Product stays at customs, customs costs	✓											
Delays, unsuccessful deliveries	✓											✓
Packaging issues								✓				✓
T6. Legal Issues												
IMEI (passport) Registration	✓											
International warranty, parallel import	✓											
T7. Competitiveness	✓											
Increasing Competition, Comparisons with Firms	✓											
Unfair competition, entry into the TR market	✓				✓							
Secondary product launch	✓											

* TM: Text Mining, * Numbers in all square brackets correspond to a reference.

After the topics are determined, all comments should be assigned according to these topics. In this sense, it is aimed to use machine learning approaches for this process that cannot be done manually. For this purpose, 2750 data sets were taken with the stratified sampling method (stratified as time) and coded into 7 categories in Table 1. In this coding, each line (sentence) is assigned to more than one category in some cases depending on its content. In order to achieve higher learning success in the multi-labeled data set, each column is separately estimated and combined. In Table 2, the prediction model performance for each category is given for 6 different machine learning methods.

When the table is examined, the most successful prediction model was selected for random forest estimation and the entire data set was coded with this estimation method. In the predictions, 0.80 was chosen as the threshold value in the binary coding stage and each line exceeding this value was assigned to the relevant category. As a result of this process, 90,343 records were assigned to at least one category, while the remaining records were assumed not to be related to the specified categories. 90,364 boats, the categories of which were coded, were transferred to the emotion classification stage.

TABLE II. MACHİNE LEARNİNG ALGORİTHMS PERFORMANCE FOR TOPİC MODELİNG

	Brand Trust	Country Image	Product Quality	Pricing	Supply Chain Abilities	Legal Issues	Competitiveness	Average
Naive Bayes	74,73	85,86	79,73	77,95	89,59	83,32	79,27	**81,49**
Logistic Regression	80,82	91,77	83,68	85,09	91,14	89	83,59	**86,44**
Decision Trees	79,91	94,68	82,27	86,86	94,73	93,86	82,95	**87,89**
Random Forest	**84,23**	**96,59**	**86,73**	87,82	95,14	**94,82**	**87,68**	**90,43**
Gradient Boosting	83,45	96,27	85,14	**89**	**96,09**	94,68	87,27	**90,27**
XGBoost	82,82	96,36	85,05	88,82	95,77	94,32	87	**90,02**

E. Sentiment Classification

Sentiment classification describes the process of assigning each comment to the positive or negative class (polarity). This assignment can be done on a dictionary basis or with natural language processing algorithms with the help of machine learning approaches. DA studies in the Turkish language have made significant progress in recent years with TurkishBERT, the Turkish version of the BERT algorithm.

As a working principle, BERT synthesizes the relationship by analyzing the sentences bidirectionally from right to left and left to right, and uses the transformer model, which is a feed-forward artificial neural network variant, for transformation (learning). In this process, it can process large amounts of data in an acceptable manner in parallel with its high functional architecture.

For this purpose, TurkishBERT was chosen for emotion classification (emotion scoring) in this study. 90,343 records from the previous step are positively and negatively coded with this algorithm.

IV. FINDINGS

The aim of the study is to investigate the reasons behind how the perception of "Made in China" has been surpassed over the years. In this sense, sentiment analysis was chosen as the main tool and messages received from an online brand community forum were evaluated within this scope.

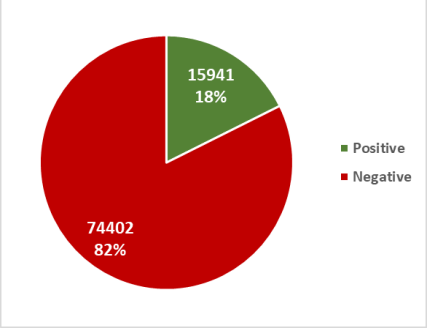


Fig. 5. Sentiment analysis polarity results

According to the first analysis results made with the TurkishBERT model, it is seen that 82% of 90,343 data consists of negative comments and 18% of them are positive comments. The BERT model assigns data to positive and negative categories with binary classification. The emotion distribution of the comments is given in Figure 5.

The positive distribution of comments in brand communities can be expected to be higher. However, it is thought that two situations affect this distribution, especially in the platform, which is open to general messaging. In the first case, the presence of negative expressions used in comparison with other brands creates an important problem for the analysis made at the sentence level. Fine-grained analysis may be required to resolve such situations. However, in this case, the determination of the emotional target and the affected entity arises as an important problem. Another situation is that the forum, which is open to public use, is thought to be commented with the negative perception of "made in china" over the years.

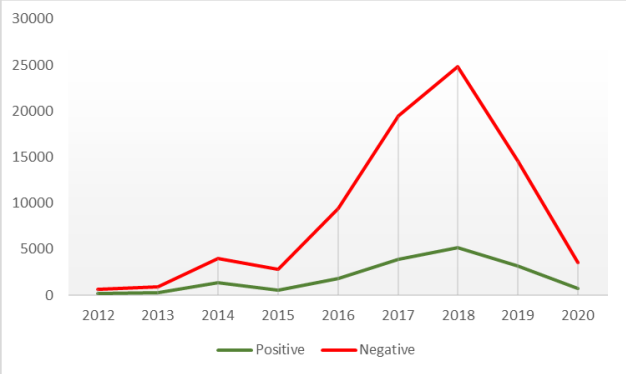


Fig. 6. Polarity distribution on a yearly basis

In the study examining the messages between 2012 and 2020, when the amount and polarity of the comments over the years are examined, it is seen in Figure 5 that the increasing message trend that started in 2016 peaked in 2018. The reason for this can be explained by the fact that the company officially entered the Turkish market in 2018, based on the rumors that the company will give Turkey distributorship in 2017.

When Figure 5 is examined, while the activity of the brand community increased between 2016-18, the negative situation in the comments is striking. This situation can be explained in two ways: the first is that the prices have swelled as a result of the increase in taxes on phones brought from abroad, and the price/performance priority users, which form the basis of the brand community, are disturbed by this situation. Secondly, Xiaomi, who founded/created the virtual brand community, is the complaints of new consumers whose expectations could not be fully met as a result of the proportional decrease of brand consumers, which can be described as “experts”, within the community.

In order to make sense of the analyzes in more detail, the comments were classified into 7 different categories with the topical modeling technique. When Table 3 is examined, it is seen that most of the comments are on the product quality (features). However, most of these comments, on an 8-year average, 87% of them were coded as negative. When the table is examined, it is seen that the positive rate in the tweets posted about brand reliability with the most comments is above the average. On the other hand, comments on supply chain capabilities seem to have a high rate of positivity, but the total number is low.

TABLE III. POSITIVE COMMENT RATIOS OF SENTIMENT ANALYSIS RESULTS BY TOPICS

	Positive		Negative		Total
Brand Trust	5376	26,47	14939	73,54	20315
Country Image	551	13,7	3471	86,31	4022
Product Quality	6013	12,76	41137	87,25	47150
Pricing	783	17,98	3572	82,03	4355
Supply Chain Abilities	504	32,13	1065	67,88	1569
Legal Issues	2076	20,82	7899	79,19	9975
Competitiveness	1803	18,3	8053	81,71	9856

Although Table 3 offers an important clue in terms of generalization, since the focus is on the change in the perception of Chinese goods over the years, the analyzes are re-evaluated in Table 4 by adding the time dimension. The table shows important clues about the transformation of this perception you are examined.

TABLE IV. POSITIVE COMMENT RATIOS OF SENTIMENT ANALYSIS RESULTS BY TOPICS FROM 2012 TO 2020

	Brand Trust	Country Image	Product Quality	Pricing	Supply Chain Abilities	Legal Issues	Competitiveness
2012	0,3107	0,1739	0,2600	0,1900	0,3243	0,2375	0,1852
2013	0,2632	0,1918	0,1583	0,1795	0,2809	0,2410	0,1667
2014	0,3349	0,2012	0,1698	0,1898	0,3568	0,2559	0,2569
2015	0,2599	0,0941	0,1262	0,1600	0,3137	0,1572	0,2000
2016	0,2719	0,1164	0,1244	0,1751	0,3060	0,1700	0,1704
2017	0,2538	0,1468	0,1204	0,1921	0,3396	0,2085	0,1791
2018	0,2657	0,1252	0,1275	0,1815	0,2900	0,2190	0,1824
2019	0,2579	0,1495	0,1328	0,1607	0,2149	0,2060	0,1744
2020	0,2500	0,0935	0,1100	0,2444	0,1458	0,1983	0,1659

When the table is examined, it is seen that 4 heels stand out between 2012 and 2015. It can be said that supply chain capability and legal issues are related to bringing products from abroad. It is seen that it is important for the brand to settle in the country market, as it is easier to bring products during international shopping between those dates, the customs fee is low and the legal registration fee is low. In the same years, it is seen that the comments on product quality and brand reliability were positive, well above the average. The fact that the comments about the country of origin were more positive in the first years played a role in breaking this perception. Based on all these findings, it is very important to have a strong brand that produces quality and reliable products in eliminating the negative image of a country. Here, the Xiaomi brand undertakes a very important mission for the Chinese market in the world.

When the transformation in recent years is examined, it is seen that the supply chain and legal issues are not partially discussed with the company entering the country market, and it has declined in terms of both the number of tweets and the positivity. It is seen that the product quality started to be questioned continuously in 2016 after the perception was broken. In the tweets of 2020, the reason behind the positive peak of pricing, which is in a general downward trend, can be explained as the rapid rise of the dollar and the increase of the scissors between the top models of the big brands and the Xiaomi brand once again.

In evaluations, the radar chart in Figure 6 has been prepared in order to evaluate the positive comment situation between 2012 (sending the forum message for the first time) and 2020 in the axis of topics.

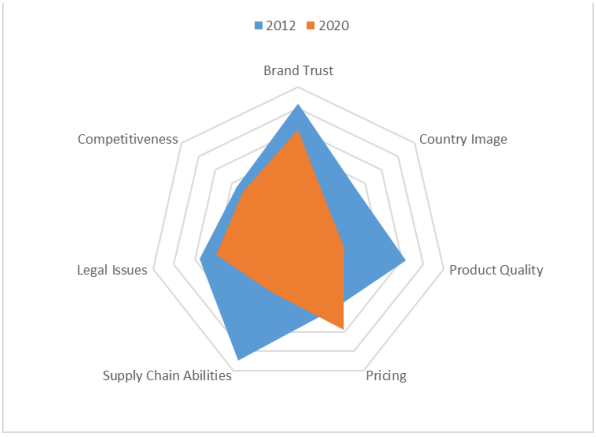


Fig. 7. Comparison of positive sentiment scores for 2012 and 2020

When the chart is analyzed, it is seen that positive comments are at the forefront in 2012, excluding the price category. From this point of view, it is predicted that significant advantages can be achieved in entering the market with a properly designed brand community and a strong brand.

V. Conclusion

The expression "Made in China" has been regarded as a taboo and an important element that determines purchasing behavior over the years. However, especially in recent years, it's been observed that consumers prefer this type of product more easily. From this point of view, it can be said that the negative perception of "Made in China" is somewhat broken. For other countries that are exposed to this type of negative perception (for example, the perception of Turkish goods in electronics), it is important to evaluate the reasons behind this perception. This study, prepared according to this situation, aims to analyze the situation in detail in the axis of brand communities and determining topics.

The forum messages contain different topics and positive/negative statements about them. These expressions, called emotion polarity, need to be analyzed somehow and the results made sense. Sentiment analysis is the preferred basic analysis method in this process study. In addition, it has been supported with machine learning-based topical modeling approaches in order to increase the generalization and representation capability of the method.

As a result of the study, the presence of a strong brand is very important in breaking the negative country image. In addition, the acceptance of this brand is a very important tool in online brand communities. It is seen that they are very valuable in the establishment of the brand in terms of product quality and legal issues. In addition to all these, it is useful to design social media fiction and stories such as "Xiaomi was founded by the engineers who left the Apple factory" in order to build trust in the brand. Price/performance emphasis should not be considered as a primary priority, although the price is a very important element. it can be much more important.

Although the study provides important results, it contains some limitations. These constraints are briefly listed below.

- The data set subject to the study contains plain forum messages and was taken from a single site.
- Sentence level sentiment analysis was preferred in the study.
- Machine learning has been performed in a supervised manner and the success of the coding directly depends on the evaluation of the encoder.

It is recommended to researchers who can work in this field to expand this study on forum messages, especially with social media data, and to reduce the level of emotion analysis from sentence to feature (target) level. In addition, it is thought that the level of performance can be increased with much more comprehensive machine learning sets.

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Social Media Big Data Analytics to Identify Covid-19 Symptoms

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***Abstract*—Social media is a digital platform where many people share their feelings and thoughts. The voluntary posts of those many people are an essential source of information for researchers. Studies in many different fields such as economy, marketing, social events, politics, disaster management have benefited from big unstructured data in social media. Detecting epidemic diseases such as influenza is another area where social media posts are used. In this study, the detectability of the symptoms of Covid-19 disease was researched by analyzing social media data. A data set consisting of over 15 million tweets shared on Twitter in Turkish containing keywords related to Covid-19 was analyzed. Tweets containing words about known symptoms of Covid-19 such as fever, cough, or sore throat were filtered in the data set. After these tweets are cleared of unnecessary phrases, they have been analyzed with data mining software. The Binary term occurrences (BTO) of the words in the tweets have been calculated. An association analysis has been made with the Frequent-pattern (Fp)-growth algorithm depending on these frequencies. As a result of the analysis, common and relatively rare COVID-19 symptoms in Turkey and their relationship have been found. Interesting relations between rare (such as nausea) and common symptoms (such as headaches) are revealed.**

Keywords—Social Media, Twitter, Text Association Analysis, Covid-19, Symptoms, Fp-growth, Binary Term Occurrence

I. INTRODUCTION

Social media are platforms where people share their feelings, thoughts and experiences and communicate with others. The posts made by millions of users on social media are considered an essential source of data in many scientific studies. Collecting and analyzing a large amount of unstructured data in social media for a specific purpose in order to obtain helpful information is referred to as social media analytics [1]. In order to emphasize the amount of data, in this study, the method has been named social media big data analytics [2].

Social media big data analytics have been used to obtain important information in the fight against pandemics such as Covid-19. In this context, there are studies that make use of social media big data for purposes such as to detect the symptoms of the epidemic disease [3], [4]; to understand the public's thoughts about the epidemic, the issues they worry about, their needs, expectations, demands from the administrators [5], [6], [7], [8], [9], [10], [11], [12]; estimating where the virus spreads, its rate of spread and the number of future cases [13], [14], [15].

This study aims to identify Covid-19 patients' symptoms in Turkey. For this purpose, the Turkish tweets written about the Covid-19 outbreak collected and analyzed. All tweets that mention the Covid-19 virus in Turkish were collected via Twitter API starting from March 10, 2020. The first date in Turkey Covid-19 emerged. The collected tweets were analyzed using RapidMiner data mining software. As a result of the analysis, the symptoms related to Covid-19 and their frequency were tried to be determined. In addition, the relationship between symptoms has been searched out.

II. LITERATURE REVIEW

Only two studies [3], [4] conducted to detect Covid-19 symptoms using social media data could be identified. In the first study, Sarker et al. [3] identified people who reported on Twitter that they caught Covid-19 and analyzed the symptoms these people reported in their tweets. First, they collected tweets containing covid, covid19, covid-19, coronavirus, and corona. In the collected tweets, they filtered the words positive, negative, test, tested and those containing at least one personal pronoun (I, my, us, we, and me) to find people who described themselves as patients. The authors of the article manually reviewed the tweets and profiles to identify true self-reports. They detected 203 COVID-19-positive Twitter users. Then, they collected all these users' past tweets from February 1, 2020. Again, they manually reviewed all the tweets from these users to identify each actual symptom expressed. Finally, 203 Covid19 positive users who reported 1002 symptoms had identified. As a result of the research, the most frequently reported symptoms were identified as fever/pyrexia (66.1%), cough (57.9%), body ache/pain (42.7%), fatigue (42.1%), headache (37.4%), and dyspnea (36.3%). Also, they claim that mild symptoms, such as anosmia (loss of smell) (28.7%) and ageusia (loss of smell) (28.1%), were frequently reported on Twitter, but not in early clinical studies. However, loss of smell and taste is indicated as Covid-19 symptoms now [16], [17]. Still, this study showed that social media could be a valuable data source for rare symptom detection.

A similar study [4] was conducted to detect symptoms related to Covid-19, experiences with access to tests and recovery processes. For this purpose, 72 million tweets containing the words "Covid19", "corona", "coronavirus", "coronavid19" were collected from Twitter. Among these tweets, 4,492,954 tweets containing "diagnosed," "pneumonia," "fever," "test," "testing kit," "sharing," "symptoms," "isolating," "cough," "ER ", And" emergency room" have been filtered. An unsupervised machine learning approach called the biterm topic model (BTM) was used to determine the topic clusters in these tweets. The tweets are divided into topic clusters containing conversations about symptoms, tests, and recovery process based on the words in their content. 35,786 tweets in BTM subject clusters were manually examined, and 3465 tweets containing experiences related to Covid-19 symptoms were determined. By geographically analyzing these tweets, they tried to determine in which regions of the United States, Covid-19 disease is

more prevalent and whether patients have problems accessing tests and hospitals.

The literature shows that Twitter is useful because it contains information on public health and that epidemic diseases can be monitored. Symptoms can be determined by collecting this Twitter data. However, the number of tweets analyzed in current symptom identification studies is minimal. Besides, manual methods were used to analyze the tweets. Also, any study about detecting the rare and common symptoms of Covid-19 diseases In Turkey could not be found. This study aims to fill this gap in the literature. For this purpose, Covid-19 related Turkish Twitter data collected and analyzed fully automated with data mining methods, identification of common and uncommon symptoms of the Covid-19 was made.

III. METHODOLOGY

To identify Covid-19 symptoms that Turkish people experienced, related tweets collected and analyzed. RapidMiner software was used for data collection and analysis. RapidMiner [18] is data mining software developed for text mining, machine learning, and business analytics that provides a free license for academic research [19].

A. Data Collection

The most widely used social media platform as a data source for Covid-19 epidemic research is Twitter [20], [15], [7], [5], [3], [4]. Therefore, in this study, data related to the epidemic was collected and analyzed from Twitter. At first, keywords related to the Covid-19 that used in Turkey were determined. These words are "Kovid", "Covid", "corona" and "corona". The tweets containing at least one of these words has collected by the RapidMiner "Search Twitter" operator.

Tweet collection process started March 10, 2020. This is the date the first Covid-19 case had been seen in Turkey's. The amount of the collected tweets until November 2020 has been published on the data sharing website to be used in different studies [21]. In this study, tweets until April 13, 2021, were used. Using the "id number" specific to each tweet, duplicate tweets were eliminated with the "Remove Duplicates" operator. After the duplicate tweets were cleaned, 15,754,802 unique tweets written in Turkish about Covid-19 that posted between March 10, 2020, and April 13, 2021 were obtained.

B. Data Filtering and Cleaning

First, the approach of Sarker et al. [3] is used. Tweets containing Turkish terms (positive, I am, I am caught, corona, am corona) used by individuals diagnosed with Covid-19 while announcing their illnesses on Twitter were filtered. 117,277 different users sent 206,254 different tweets containing these terms were identified. As a result of the content and association analysis, it was seen that most of these tweets did not contain symptoms related terms. Due to the character limitation on Twitter, it is normal for the person to share the experienced symptoms before or after the tweet stating that he or she is Covid-19. Therefore, it is necessary to collect all the tweets of these 117,277 users and extract the symptoms from them and analyze them. Sarker et al. [3] performed these procedures for only 200 users. They also made a manual evaluation of the collected tweets. Manual evaluation is not possible for this study. Also, the number of users is very high. The necessary hardware and time resources for collecting all tweets of 117,277 Twitter users and extracting and analyzing the tweets expressing symptoms among them are insufficient for this study. Therefore, as a different approach, tweets containing symptom terms were filtered, as did Mackey et al. [4].

Among the collected tweets, only those specifying common symptoms related to Covid-19 were filtered with the "Filter Examples" operator. Known common symptoms are Fever, Cough, Dyspnea (shortness of breath), Body ache, Fatigue, Headache (headache), Ageusia (loss of taste) and anosmia (loss of smell) [3]. Stems of the symptoms related terms are used to filter out the tweets that mention these symptoms. Thus, tweets including the derived words are included.

For example, tweets containing all words starting with "**ateş**" (fever) were selected for the fever symptom. So, tweets containing phrases such as "**ateş**im var" (I have a fever) are also included. However, since the term "**Tat**" (Taste) is used at the beginning of the term "**Tat**il" (Holiday), the tweets where only "**Tat**" (Taste) is used as it is (without any suffixes) are filtered.

In order to determine the frequency of symptoms more accurately, it is more appropriate to consider the original tweets that mention the symptoms. For this reason, Retweets are deleted by using the "RT" expression at the beginning of the Retweets with the "Filter Examples" operator.

Turkish prepositions and pronouns, punctuation marks and numbers found in most of the tweets have been removed from the tweet's content with the operator "Replace". Also, expressions consisting of a single character with the "Filter Tokens" operator and Html codes with the "Extract Content" operator were cleared. The "transform cases" operator is used to make the whole text lower case. In this way, it is known that clearing out unnecessary expressions increases the success of analysis [22], [23].

As a result of the filtering and cleaning processes, 87,635 tweets shared by 59,260 different people were obtained. It is aimed to analyze the content of these tweets and to detect common and rare symptoms. For content analysis with RapidMiner, the texts in the content of the tweets are transformed into words with the "Tokenize" operator [24]. The frequency list of the words seen in at least 0.1% of the tweets has been extracted with the "Process Documents from Data" and "Tokenize" operator. In addition, frequency lists of two words (bigrams) and triple word groups (trigram) were created with the "Generate n-Grams" operator to extract consecutive words used together in tweets. By interpreting the term frequencies obtained from these processes, inferences were made about the content of the tweets and the symptoms specified in the tweets.

C. Content and Association Analysis

Association analysis is used to measure the strength of co-occurrence of symptoms words in a Tweets dataset. fp-growth, the most commonly used association algorithm [25], was used for the analysis. The support and confidence percentage are taken into account in determining whether the frequency of using two words together can be converted into an association rule [25].

Support percentage is the ratio of the number of tweets in which two words are used together to the total number of tweets. The support rate gives an idea of whether a rule should be ignored or not. Relationship rules with meagre support rates should not be taken into account. A low support rate may

mean that the association is random. However, because the number of tweets in Twitter social media analysis is high, even relationships with low support rates can provide critical information for research.

The confidence percentage is an important measure that shows the reliability of the association between the premise (antecedent) and the conclusion (consequent) word. It is calculated by the ratio of the number of tweets in which two words appear together to the number of tweets where the premise word appears.

Firstly, for the relationship analysis with the operator "Process Documents from Data", Binary term occurrences (BTO) vectors created for each tweet. BTO is a value that takes one if a word is included in a tweet and zero if not. Then, association analysis was performed with the FP-Growth algorithm. "FP-Growth" and "Create Association Rules" operators were used for these analyzes. Analyzes were made with various support and confidence rates. As a result, it was seen that keeping the support rate low would give the best result so that rare symptoms could also be included in the analysis, and the minimum support rate was determined as 0.5%. The confidence rate was set as 20% to see all relations between symptoms, even if they are weak.

IV. FINDINGS

Twelve different symptoms associated with Covid-19 stated by the Republic of Turkey Ministry of Health [16] and the US Centers for Disease Control and Prevention [17], has been compiled. Using the word roots (stems) of these symptoms, the words in the frequency list were filtered, and a separate table was created for each symptom. Single (unigrams), double (bigrams) and triple (trigram) terms in the created tables were examined. Irrelevant words that have the same stem as the words used to express the symptom were identified. According to the results of the examination, the words deemed necessary were reduced to their roots. Replace Tokens operator is used for this process.

For example, headache can be expressed by using the words "baş" (head) and "ağrı" (ache) separately in Turkish. In the Tweet dataset, bigrams and trigram terms were examined to understand whether the word "baş" (head) means headache. In all of the word groups, "baş" (head) and a Turkish word expressing pain "ağrı, dönmesi, şiddetli" (pain, dizziness, severe) were found together. Therefore, it has been concluded that the frequency of the word "baş" (head) can represent headache. At this point, it should be reminded that all tweets in the Twitter data set have at least one of the Covid-19 and symptoms related term.

Since Turkish is an agglutinative language, it has been observed that the word "**baş**" (head) can be used with different suffixes such as "**baş**ım, **baş**ımın" (my head, of my head), and sometimes without a Turkish letter, like "**bas**im, **bas**" (my head, head). After making sure that they all express the same symptom, all words starting with the stem "**baş**" (head) have been converted to the word "**baş**" (head).

On the other hand, looking at the word "**koku**" (smell) and its suffixes used to express the smell loss symptom, it is seen that the same stem is used for different words, such as "**koku**şmuş, **koku**yor" (stinking, it smells). For this reason, the stemming process has not been performed for the "**koku**" (smell) term. A similar inspection was made for the other ten symptoms. The necessary words were reduced to their roots (stemming) and gathered under a single word.

As a result, 12 different Covid-19 symptoms frequency in analyzed tweets are calculated and shown in Table I. Since each tweet is accepted as a separate document for the analysis, Document Occurrences expresses the number of times the related symptom was mentioned in the tweets. Because more than one symptom can be expressed in a tweet, the total frequency of symptoms is greater than the number of analyzed tweets (87,635).

TABLE I. COVID-19 SYMPTOMS OCCURRENCE RATE

Symptom	Document Occurrences	Document Occurrences Rate
Fever or chills	23.422	19,5%
Shortness of breath	19.775	16,4%
Headache	18.686	15,5%
Cough	16.658	13,8%
Loss of taste	8.271	6,9%
Sore throat	8.123	6,7%
Loss of smell	7.090	5,9%
Fatigue	6.971	5,8%
Muscle or body aches	4.730	3,9%
Nausea or vomiting	3.298	2,7%
Congestion or runny nose	2.825	2,3%
Diarrhea	533	0,4%
Total	**120.382**	**100,0%**

The occurrence rate of symptoms in tweets gives an idea about the incidence in Turkey. As a matter of fact, the 59,260 users sharing these tweets is a large enough sample. Table 1 is shown that chills Fever, Shortness of breath, Headache and Cough had been identified as the most common symptoms seen in Turkey. Loss of taste, Sore throat, Loss of smell, Fatigue symptoms are among the general symptoms, although they are relatively less common. Muscle or body aches, Congestion or runny nose, nausea or vomiting, Diarrhea are the rarest symptoms. This distribution is visualized in Fig. 1.

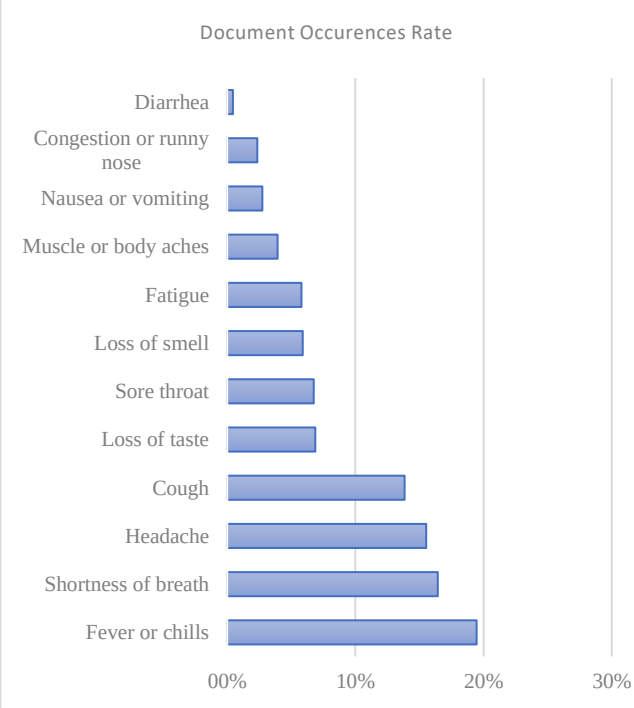

Fig. 1 Symptoms Occurences Graph

In addition to the search for existing symptoms, the word frequency list was examined to detect rare symptoms [26]. However, symptoms that are stated to be rare, other than those listed above, have not been detected. However, although not a symptom of corona disease, terms related to psychology was identified in 1284 of the tweets containing terms related to corona and symptoms. When the tweets containing these terms were examined, it was seen that some stated that their psychology was impaired due to the epidemic. Also, there have been those who stated that (s)he showed corona symptoms such as cough for no reason. They called it "psychological corona".

To understand the relationship between the symptoms, association analysis performed using the fp-growth algorithm. In the frequency list, the total number of single (unigrams), double (bigrams), and triple (trigram) words seen in at least 0.1% of 87,635 tweets is 2990. The first association analyzes were made for all of these terms in the frequency list. In the analysis results, 2647 different association rules, including irrelevant word and term relationships, were seen. Unrelated term associations with symptoms made it difficult to reveal the relationship between symptoms, which was the main research subject. Therefore, the association analysis was repeated with words expressing only the symptoms. Thus, 126 different rules of the association have been identified between symptoms. All of these relationship rules are given in the Appendix. Among these relationships, those deemed important are given in Table II.

TABLE I SYMPTOMS ASSOCIATION RULES SUMMARY

No	Premises	Conclusion	Support	Confidence
126	fever, joint	ache	0,01	0,94
89	ache, nausea	head, stomach	0,01	0,56
60	nausea	ache, head, stomach	0,01	0,38
47	stomach	ache, head, nausea	0,01	0,33
105	ache, taste	smell	0,01	0,71
32	joint	ache, fever	0,01	0,29
100	ache, smell	taste	0,01	0,68
92	head, smell	taste	0,01	0,58
73	taste	smell	0,04	0,45
85	smell	taste	0,04	0,54
6	head, throat	ache, fever	0,00	0,21
74	ache, nose	throat	0,01	0,45
66	ache, cough	throat	0,01	0,40
35	fatigue	ache, head	0,01	0,29
7	fatigue	throat	0,01	0,21
5	nose	throat	0,01	0,21
95	muscle	ache	0,01	0,64
58	fever, breath	cough	0,00	0,38
94	body	ache	0,01	0,60
3	throat	ache, head	0,02	0,20
46	fever, fatigue	head	0,00	0,33
67	cough, fatigue	fever	0,00	0,42
49	breath, cough	fever	0,00	0,35

In Table 2, it is seen that headache and nausea generally occur together, and nausea accompanies the headache. There is also a relationship between fever and joint pain. It is understood that the loss of smell and taste generally occurs together. The relationship between fever, headache and sore throat is also significant. Also, it was observed that there is a relationship between cough and sore throat, fatigue and headache. It has been found that breathing problems and cough usually coexist. Breathing problems and cough are accompanied by fever.

An association analysis graph was generated to visualize the relationship between symptoms. Association rules with a confidence rate higher than 65% are shown in Figure 2 in the Appendix. Since the analyzed tweets and terms are in Turkish, the symptoms on the chart are also in Turkish. The symptoms were foreground and most of the association rules were filtered to make the graph more understandable.

The association analysis graph shows that "ache" is at the centre of the symptoms. The terms closest to the centre are the words "nausea", "stomach", "head". It was deduced from this that the symptoms of headache and nausea coexisted. In addition, there is a relationship between the terms "fever, joint, muscle, throat, nose, weakness" with ache. There is also a relationship between ache and the words smell and taste (smell and taste). It is seen that the terms smell and taste (smell and taste) are generally used together.

From these association analyzes, it was inferred that fever usually occurs with throat, joint and muscle pains/ache together. Also, it was concluded that pains/ache might be accompanied by congestion or runny nose and fatigue; headache and nausea often occur together; It has been concluded that the loss of smell and taste generally occurs together. Although nausea is known as a rare symptom, it is usually expressed together with a headache. Although the number of people who mention nausea is relatively small, it occurs with headache, which is one of the most common symptoms. So this relationship between headache and nausea shows that nausea is an important symptom of Covid-19.

V. CONCLUSION

Social media seems to be an essential source of data in the fight against the Covid-19 Pandemic. In this study, Twitter social media data was used to determine the Covid-19 patients' symptoms in Turkey. It is seen that the findings obtained are compatible with the data of health institutions [16], [17]**.** As a result of this study, common and relatively rare Covid-19 symptoms in Turkey and the relationship between them have been found. Interesting relations between rare (such as nausea) and common symptoms (such as headaches) are revealed.

The tweets used in this study contain the symptoms of the individuals and news and information messages about the symptoms. For the analysis to give more accurate results, it will be useful to consider the tweets of people who only state that they are Covid-19. Therefore, in future studies, it is necessary to identify people who have Covid-19, collect all their tweets and try to find the symptoms they have stated in their tweets. Besides, it can be investigated whether the symptoms change with the mutation of the virus. For this, tweets can be divided into periods, for example, months, and separate analyzes can be made for each month/period. Changes in symptoms can be seen by comparing the analysis results of periods.

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APPENDIX

TABLE II. SYMPTOMS ASSOCIATION RULE LIST

No	Premises	Conclusion	Support	Confidence
1	throat	fever	0,02	0,20
2	throat	cough	0,02	0,20
3	throat	ache, head	0,02	0,20
4	nose	fever	0,01	0,21
5	nose	throat	0,01	0,21
6	head, throat	ache, fever	0,00	0,21
7	fatigue	throat	0,01	0,21
8	muscle	breath	0,00	0,22
9	head, throat	cough	0,00	0,22
10	throat	head	0,02	0,22
11	muscle	ache, head	0,00	0,23
12	head	fever	0,04	0,23
13	ache, head, throat	fever	0,00	0,23
14	fever, throat	ache, head	0,00	0,23
15	nose	cough	0,01	0,24
16	ache, throat	head	0,02	0,24
17	cough, throat	head	0,00	0,24
18	head, throat	fever	0,00	0,25
19	ache, fever	cough	0,01	0,25
20	ache, fever, head	throat	0,00	0,26
21	nose	head	0,01	0,26
22	ache	throat	0,07	0,26
23	fever, cough	head	0,01	0,26
24	ache, fever, head	cough	0,00	0,27
25	muscle	fever	0,01	0,27
26	muscle	head	0,01	0,27
27	body	head	0,00	0,28
28	fever, throat	head	0,00	0,28
29	cough, throat	fever	0,00	0,28
30	fever, throat	cough	0,00	0,28
31	fatigue	cough	0,01	0,28
32	joint	ache, fever	0,01	0,29
33	head, cough	fever	0,01	0,29
34	ache, fatigue	fever	0,01	0,29
35	fatigue	ache, head	0,01	0,29
36	fever, cough	ache	0,01	0,29
37	ache, joint	fever	0,01	0,30
38	fever, fatigue	cough	0,00	0,30
39	joint	fever	0,01	0,31
40	joint	ache, head	0,01	0,31
41	body	fever	0,00	0,31
42	joint	head	0,01	0,32
43	nausea	fever	0,00	0,32
44	ache, joint	head	0,01	0,32
45	ache, fever, throat	head	0,00	0,32
46	fever, fatigue	head	0,00	0,33
47	stomach	ache, head, nausea	0,01	0,33
48	ache, fatigue	throat	0,01	0,34
49	breath, cough	fever	0,00	0,35
50	ache, fever	throat	0,01	0,35
51	head, fatigue	fever	0,00	0,35
52	ache, muscle	head	0,00	0,36
53	fatigue	head	0,01	0,36
54	head, cough	ache	0,01	0,37
55	stomach	head, nausea	0,01	0,37
56	nose	ache	0,01	0,37
57	fever, head	ache	0,02	0,38
58	fever, breath	cough	0,00	0,38
59	ache	head	0,11	0,38
60	nausea	ache, head, stomach	0,01	0,38
61	ache, cough	fever	0,01	0,38
62	ache, breath	head	0,00	0,39
63	fatigue	fever	0,01	0,39
64	cough, fatigue	ache	0,00	0,40
65	ache, head, cough	fever	0,00	0,40
66	ache, cough	throat	0,01	0,40
67	cough, fatigue	fever	0,00	0,42
68	stomach	ache, head	0,01	0,42
69	nausea	head, stomach	0,01	0,43
70	ache, fever	head	0,02	0,43
71	ache, cough	head	0,01	0,44
72	fever, fatigue	ache	0,01	0,44
73	taste	smell	0,04	0,45
74	ache, nose	throat	0,01	0,45
75	ache, fever, cough	head	0,00	0,45
76	nausea	ache, head	0,01	0,46
77	ache, stomach	head, nausea	0,01	0,46
78	stomach	head	0,01	0,47
79	stomach	ache, nausea	0,01	0,47
80	stomach, nausea	ache, head	0,01	0,49
81	ache, nose	head	0,01	0,49
82	ache, fatigue	head	0,01	0,50
83	fever, head, cough	ache	0,00	0,51
84	nausea	head	0,01	0,52
85	smell	taste	0,04	0,54
86	nausea	ache, stomach	0,01	0,54
87	stomach, nausea	head	0,01	0,55
88	cough, throat	ache	0,01	0,56
89	ache, nausea	head, stomach	0,01	0,56
90	ache, stomach	head	0,01	0,58
91	fatigue	ache	0,02	0,58
92	head, smell	taste	0,01	0,58
93	head	ache	0,11	0,58
94	body	ache	0,01	0,60
95	muscle	ache	0,01	0,64
96	ache, stomach	nausea	0,01	0,66
97	head, taste	smell	0,01	0,68
98	ache, nausea	head	0,01	0,68
99	nausea	ache	0,01	0,68
100	ache, smell	taste	0,01	0,68
101	stomach	nausea	0,01	0,68
102	stomach, nausea	ache	0,01	0,69
103	ache, stomach, nausea	head	0,01	0,70
104	head, stomach	ache, nausea	0,01	0,71
105	ache, taste	smell	0,01	0,71
106	head, nose	ache	0,01	0,72
107	stomach	ache	0,01	0,72
108	head, nausea	ache, stomach	0,01	0,73
109	fever, throat	ache	0,01	0,73
110	nausea	stomach	0,01	0,78
111	head, stomach	nausea	0,01	0,79
112	ache, head, stomach	nausea	0,01	0,80
113	ache, nausea	stomach	0,01	0,80
114	head, fatigue	ache	0,01	0,80
115	head, nausea	stomach	0,01	0,81
116	throat, nose	ache	0,01	0,82
117	ache, head, nausea	stomach	0,01	0,83
118	throat	ache	0,07	0,84
119	fever, head, throat	ache	0,00	0,85
120	head, muscle	ache	0,00	0,85
121	head, nausea	ache	0,01	0,88
122	head, stomach	ache	0,01	0,89
123	head, stomach, nausea	ache	0,01	0,89
124	head, throat	ache	0,02	0,90
125	throat, fatigue	ache	0,01	0,91
126	fever, joint	ache	0,01	0,94

Fig 2. Symptoms Association Graph

AI Technologies in Social Work and Overcoming Injustice Caused by AI-based Decision Support Systems through Social Work

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***Abstract*— Decisions, judgments, and risk-taking in the states of uncertainty are everyday activities of life, and decision making is at the core of all professional activities. There is also emerging interest in the potential of Artificial Intelligence (AI) technologies to facilitate human decision making. Social work will be impacted by these rapidly expanding AI technologies as every profession. AI-based decision support systems (DSS) may make incorrect recommendations which perpetuate the social prejudices that disadvantage its users. The history of social work is linked with the struggle to help the most vulnerable members of society and there will be more need to the advocate role of social workers as technology advances by AI. This review article has two purposes: The first one is to provide some insights into examples of AI-based technologies used in social work and the second one is to define the role of social workers to overcome the potential injustice caused by AI-based DSS.**

Keywords*— *social work, artificial intelligence, decision-making, decision support systems.

I. INTRODUCTION

Decision is defined in dictionaries as a choice or judgment made by people on something after thinking about several possibilities. This definition does not include the computerized or Artificial Intelligence (AI) driven systems that decide on an action because eventually the human is responsible for decisions even taken by the support of such systems. There are three approaches to decision-making in theory: The first one, rational-analytical approach, supports the rationality where decisions are based on facts. In the second intuitive-emotional approach, instincts and past experiences guide the decision-makers. In the third political-behavioral approach, the decision makers are usually subject to pressure from others around them [1].

Decision-making is crucial for almost all professions but making decisions in social work impacts the vulnerable people which highlights the importance of the decision-making process of social workers. Klein and Bloom take the strengths of objective and empirical methods of rational decision-making mechanisms and they emphasized the importance of combining it with an intuitive application model for social workers. According to this concept which they call "Wisdom of Experience", social workers create a personal and value-oriented information system by using the experiences of the phenomenon in question and scientific knowledge [2]. Ventimiglia et al. evaluated the attitudes of the participants in the decision-making process in their survey with 222 undergraduate social workers. Although social workers tend to make decisions in pragmatic ways, research results demonstrated that the majority is open to decision making using their experience [3]. Collins and Daly observed social workers working with children and families and social workers working with elderly and disabled people for six consecutive days in their study examining how social workers make decisions. In addition to their observations, the researchers conducted nine in-depth interviews and conducted two bilateral meetings to understand group dynamics. At the end of the study, it was seen that social workers used their experience in decision-making processes regarding the facts to come to a conclusion when there is multi-source evidence. In cases where the necessary evidence to reach a conclusion is not presented, it has been observed that social workers rely on their previous experience, theoretical knowledge, professional judgment and interpretation of ambiguous signs [4]. There is a huge interest in AI-driven Decision Support Systems (DSS) which can arrange and sort large amounts of data by training on the data and facilitate human decision-making. Liedgren et al. concludes in their scoping review that a DSS not only gives support to social workers during the investigation process, but also gives an opportunity to freely make autonomous decisions [5].

This review article has two parts: The first part consists of some examples of AI technologies used in social work which are from both grey literature and published articles. The second part gives insights into how social workers can apply social work perspective for overcoming the potential injustice caused by AI-driven DSS.

II. AI TECHNOLOGIES USED IN SOCIAL WORK

Recent developments in AI technologies have impact on many fields from transportation to security, from manufacturing to advertising but there are still some areas where AI has potential to have impact on social good and social work is one of those areas.

AI-driven predictive systems evaluate risk and prioritize social services for the most in need. Reyes et al. [6] worked on a prediction system for the City of Cincinati where blight is a problem starting in a neighborhood but then spreads fast and people become homeless and unemployed. In their research, they are taking the preventative route and looking at the past 10 years of data to predict which neighborhoods will be next subject to blight. Inspectors and social workers can then be sent to those houses before blight to warn people.

AI is also used to assist in spreading health related information among large populations. For example, there

are more than 500.000 homeless youth in California [7] and they are at a greater risk of being infected with HIV [8]. A group of social workers worked on to create a "Smart Kiosk" to address this public health epidemic. These kiosks provide free rapid HIV tests, condoms, and feminine hygiene products. The researchers were able to provide places to deploy the kiosks using artificial intelligence, thus not only make it more accessible to the target youth, but also utilizes to reach and serve more people experiencing homelessness [9]. Many shelters implement social work intervention programs to prevent homeless youth from HIV infection through peer leaders who are taught strategies about HIV prevention measures and they inform the homeless youth within their social network. AI is used by a group of researchers from USC Center for AI in Society to reach these peer leaders by designing an adaptive software program called HEALER which recommends intervention attendees to homeless shelter officials. These researchers use similar algorithmic social network predictions for substance use prevention interventions in homeless youth and suicide prevention interventions for college students [10].

Columbia University School of Social Work has researched gang violence in Chicago by developing an AI-driven app which allows them to take in content from the social media that they can leverage in real time to inform their violence-intervention work. When they first started this research, the algorithms were unable to accurately interpret off-line context, which may lead to dangerous assumptions. They hired young people who were involved in gangs before as domain experts for contextualizing social media data to overcome this challenge. In their interdisciplinary study, they integrated knowledge of social work with production of algorithms by data science and training of qualitative annotators [11]. A similar AI-driven app was developed in Turkey by Vodafone Turkey called "Red Line", which was used to detect the words and phrases of violence and negative gender stereotypes on the texts of the Turkish newspaper Hurriyet website and on the scenarios of Turkish TV serials. It can be said that the project created awareness, attitude and behavior change regarding the use of sexist language in the target audience, so artificial intelligence technology has an important role in solving the social problem [12].

An interdisciplinary team from University of Texas School of Social Work designed and implemented a pilot study with elderly people living in residential care. Researchers integrated AI-driven social robotics and theatre to improve the psychological well-being of the participants. Their study results showed that depression and loneliness scares of the participants decreased significantly [13]. Another robotics study with elderly people was funded as an Erasmus project in Italy. The researchers of the Robot-Era Project implemented an advanced robotics systems in real-life scenarios for the elderly participants. They tested 6 robotic services with 35 participants to accomplish everyday life tasks including shopping, garbage collection, reminding, communication, indoor and outdoor walking support services. The results of the study showed that their system has the potential to be a socially acceptable provider of robotic services [14].

Child abuse is another significant and challenging area of social work because the victims are usually reluctant to disclose their abuse. There are also researches of AI-based predictive risk analysis on this sensitive topic. Researchers from the University of Auckland used data from welfare systems to train an algorithm to identify the risk of child abuse in New Zealand. They managed to develop a predictive risk modelling with 76% accuracy [15]. Researchers from the University of Twente developed an AI-based decision support system to support social workers to identify the risk of maltreatment of the children under care in Australia. Their tool was over 90% accurate [16].

Utilizing AI technologies for social good or addressing social problems through AI-driven tools emerges day by day and social workers need to ethically engage with the power and challenges of these emerging AI technologies.

III. Overcoming Injustice Caused by AI-based Decision Support Systems through Social Work

The main challenge of AI-based systems is trust. If an AI-based system offers you the wrong advertisement on your website, it will not cause a big problem but if the AI system led to misdiagnoses or erroneous treatment suggestions, this could be fatal and can breach the trust of doctors. According to Propublica news, COMPAS, the AI-driven tool used in the US to guide sentencing by predicting the likelihood of a criminal offending was racially biased. The system predicts that black defendants pose a higher risk than white defendants [17]. Another news from the Reuters states that Amazon's AI hiring tool discriminated based on gender. The trained algorithm preferred male candidates and eliminated CVs including the word "women's" as in "women's chess club captain" [18]. There are several similar examples demonstrating biases of algorithms that can result in injustice such as ethnic origins, skin color, gender, age or disabilities .[19], [20], [21].

Social work profession has a commitment to respect for persons, equal opportunity and meeting needs of the clients. How social workers might practice in the context of cases of injustice question has the answer on knowledge, skills, value base of the profession and the advocacy role of the social worker. The National Association of Social Workers (NASW), the major professional organization which regulates important aspects of social work professional life, actively promotes the knowledge base of the profession: "Social workers should critically examine and keep current with emerging knowledge relevant to social work and fully use evaluation and research evidence in their professional practice" [22]. Connecting knowledge, skills and value base of social work with new technologies in AI science, more accurate studies can come out for social good.

However, in cases of injustice caused by AI-based decision support systems social workers will be ready to show the way to claim the rights because social work profession has the advocacy role for the most disadvantaged people in society who are unable to find a voice on their own for injustice [23]. Combatting social injustice through advocacy activities is a basic function of the profession declared by the Council on Social Work Education (CSWE) and NASW [24], [25]. Schneider and Lester [26] defines social work advocacy as "the exclusive and mutual representation of a client or a cause in a forum, attempting to systematically influence decision-making in an unjust or unresponsive system." The advocacy role is one that social work has taken from the legal discipline and is actively used.

The purpose of this role is not to humiliate any institution or organization, but to protect and defend the rights of clients in order to ensure social justice [27]. Advocacy in the social work profession differs from other professions that assume an advocacy role because of its emphasis on the environment surrounding the individual as well as the individual [28]. Basic competencies to be demonstrated by a social worker in the advocacy process of an injustice caused by an AI-driven DSS might be being a good listener, being able to reflect back, building on others' strengths, gathering information from many sources, moving discussions to solutions and acting in ethical ways to achieve client goals.

IV. CONCLUSION

Decision support systems are potentially the most exciting use of technology and artificial intelligence. As shown in the first part of this study, AI is used in many social work areas, including but not limited to child protection, prevention of violence, health related interventions, issues of homelessness and elderly people. Artificial intelligence has the potential to enable social workers to increase success rates in aid, protection and prevention by comparing hundreds of variables especially in social investigation files and to calculate the risks rapidly and prevent the delay between decision and intervention.

It is obvious that the world is going to continue to use big data sets to automate important decisions. Therefore, there must be more research on the limits of using big data and algorithms and the corresponding regulations and laws with an interdisciplinary perspective and the social work profession is a must among those disciplines to encode ethical principles. Data scientists and social workers need to collaborate to avoid biases, mislabeling and other negative results and thus it will be easier to develop more accurate AI-based decision support systems. In cases of injustice caused by AI-driven systems, social workers can develop strategies to advocate the victims.

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Prediction of Biochemical Oxygen Demand (BOD5) in Wastewater Treatment Plant Based on Fuzzy Rough Set Theory and Machine Learning: An Industrial Case Study

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***Abstract*—Biochemical oxygen demand (BOD5), an essential parameter in water quality management, is very difficult to measure, and it takes longer times (5 days) to obtain results compared to other parameters. In this study, a hybrid model, including fuzzy rough set theory, SMOTER, and machine learning algorithm, was developed in order to predict BOD5 in a wastewater treatment plant in Sakarya, Turkey. The values measured in the laboratory environment for nine parameters of influent wastewater including chemical oxygen demand (COD), total suspended solids (TSS), ph, ammonium nitrogen (NH4-N), nitrate nitrogen (NO3-N), nitrite nitrogen (NO2-N), total nitrogen (TN), total phosphorus (TP) and biochemical oxygen demand (BOD5) belonging to the samples collected from the wastewater treatment plant during 2019-2020 were used. A fuzzy rough set theory-based feature selection algorithm and SMOTER method have been applied to increase the performance of the models, while an instance selection algorithm based on fuzzy rough set has been applied to eliminate unnecessary or noisy instances. The performances of machine learning regression algorithms were compared on the dataset obtained. Comparative results show that fuzzy rough set-based feature selection and instance selection algorithms, and especially SMOTER methods increase the performance of machine learning algorithms. Among the machine learning algorithms, the Boosted Decision Tree Regression algorithm, one of the ensemble machine learning algorithms, is the algorithm that shows the best prediction performance with a R2 value of 0.9718.**

Keywords—wastewater treatment plant, fuzzy rough set theory, machine learning, SMOTER, instance selection, feature selection

I. INTRODUCTION

The ecological system is adversely affected due to the tremendous growth of population and the rapid technological developments in the world, the water resources, which are the most important part of the ecological system, are rapidly polluted and the amount of wastewater is increasing. Physical, chemical, biological and advanced biological treatment processes are applied to the wastewater in order not to affect the water resources in the environments where wastewater generated for different reasons is discharged from the negative factors caused by wastewater. Wastewater treatment is a very complicated process that can be affected by a variety of chemical, physical and microbiological factors, and improper operation can lead to serious environmental and public health problems. Because wastes that can reach water resources can cause various diseases in humans and can spread these diseases quickly. Wastewater treatment should be carried out with systems that can increase the efficiency of treatment through engineering studies by carefully using the water quality parameters measured in the laboratory in order to restore the water used in every phase of life to the nature.

In wastewater treatment plants where bacterial-based biological methods are used in purification of wastewater, the water pollution loads (such as TN, TP, COD, BOD5 and TSS parameters) and oxygen balance affect the biological life cycle in the facility and are very important in controlling the amount of bacteria to be protected. In sudden rises in pollution parameters values at the entrance of the facility, bacteria that provide biodegradation begin to die in the cases where the operator does not intervene or improperly intervenes. Therefore, treatment cannot be carried out as the biological balance will be disrupted. Among the laboratory parameters, the analysis of BOD5, which is of great importance for the operation of treatment plant, and obtaining the results take a long time such as five (5) days. Late analysis of biological oxygen demand can delay the decisions and measures to be taken during the operation of the facility and can negatively affect the productivity. This situation leads to an increase in operational costs as well as operational management difficulties. Therefore, in order to eliminate this problem, many studies have been carried out to predict the BOD5 parameter more quickly with machine learning methods by using other parameter results that can be measured in a shorter time in the laboratory environment or can be obtained online through sensors. While some studies have developed models with artificial neural network [1-9], some of them used multivariate adaptive regression splines [10] or multi-linear regression [11].

In the machine learning modeling process, the quality of input data has a significant effect on the performance of algorithms [12]. For this reason, many methods have been developed for data preprocessing processes such as dealing with missing data, feature selection, instance selection and dataset balancing. Too many features can adversely affect the accuracy of algorithms [13]. The purpose of feature selection is to eliminate unnecessary or noisy attributes from a data set to increase the performance of models by making them faster and more accurate. Apart from irrelevant features, isolated and inconsistent samples also have a negative impact on the performance of prediction algorithms. Instance selection is a process in which a subset of samples is selected before machine learning algorithms are trained in regression and

classification problems. It aims to increase the quality of the dataset by removing unnecessary or noisy samples while preserving consistent samples in a preprocessing step. In these ways, these techniques improve the accuracy and performance of the prediction algorithms and shortens their running times. The rough set theory proposed by Pawlak in 1982 [14] is a mathematical tool developed from classical set theory to deal with uncertainty and information uncertainty. In the rough set theory, a lower and upper approximation of a concept is found according to the binary indiscernibility relation and hidden patterns are discovered. It can be used for feature selection, data reduction, decision rule extraction, and pattern extraction [15]. Fuzzy Rough Set Theory combines the concepts of uncertainty and indistinguishability expressed by fuzzy sets introduced by Zadeh in 1965 [16] and the Rough Set Theory. While Rough Set Theory can process qualitative (discrete) data, Fuzzy Rough Sets enables to analyze continuous features without applying discretization to data. Taken in this context, Fuzzy Rough Set is a powerful machine learning tool that offers many approaches for a range of tasks, including attribute selection and instance selection. The target variable in many real world datasets used in classification and regression studies may have highly unbalanced distributions [17]. In case the dataset obtained from the wastewater treatment plant, where water quality parameters, especially BOD5, are of vital importance, are unbalanced, the rarely encountered target values may be values that need to be determined and taken measures quickly. The rarity of some values in the training data set causes predictive modeling techniques to not learn these values adequately and creates serious problems. The SMOTER method has been developed by Torgo et al. [18] to deal with unbalanced datasets in regression problems.

When the literature on biological oxygen demand estimation is examined, no studies applying Fuzzy Rough Set and SMOTER methods have been encountered. In this study, a hybrid model including Fuzzy Rough Set approaches, SMOTER method and machine learning regression algorithms is proposed in order to estimate the BOD5 parameter based on other water quality parameters. A real industrial data has been studied for the proposed approach. Fuzzy-Rough QuickReduct Algorithm for feature selection, Fuzzy-Rough Instance Selection Algorithm (FRIS-1) for instance selection and SMOTER method for balancing the data were applied after missing data cleaning and normalization processes were applied on the dataset. On the dataset obtained, machine learning regression algorithms including Linear Regression, Bayesian Linear Regression, Artificial Neural Network and ensemble machine learning regression algorithms namely Boosted Decision Tree Regression and Decision Forest Regression were trained and their performances were compared over various performance criteria. The rest of this paper is organized as follows: The methods used in the study are explained in Section 2. Section 3 describes the methodology and implementation and prensents experimental results. Finally, the conclusions are discussed in Section 4.

II. METHODS

A. Fuzzy-Rough QuickReduct Algorithm

The Fuzzy QuickReduct algorithm developed by Jensen and Shen in 2002 [19] was used for feature selection in this study. For the purpose of feature selection, assume that (X, C U {d}) is a decision system non-empty sets of instances and conditional attributes that can be represented by X = {x1, .., xn} and C = { α1,…, αn}, respectively. d is a decision attribute and d ∉ A. Values of all features can be either quantitative or discrete. In the Fuzzy-rough QuickReduct algorithm given in Table I, we start with an empty set and add the best candidate attribute that increases the degree of dependency until a consistent state is reached. The degree of dependency is an evaluation measure in feature selection methods and shows the dependence of selected attributes on output. γB represents degree of dependency of d on B and B is a fuzzy decision superreduct to degree α if $\gamma B \geqslant \alpha$, and a fuzzy decision reduct to degree α if moreover for all $B^* \subset B$, $\gamma B^* < \alpha$. For more details about the fuzzy-rough QUICKREDUCT algorithm [20-22] can be analyzed. For the purpose of calculation of degree of dependency many variants of lower and upper approximations were developed such as, OWA [21], VQRS [23], implicator/ t-norm approach [20], SFRS [24], FVPRS [25], RFRS [26].

TABLE I. FUZZY-ROUGH QUICKREDUCT ALGORITHM (∧ ∈]0, 1]) [20]

Input C – All conditional attributes
d – All decision attributes
Output B – Selected attributes subset
Method
(1) B ←{}
(2) do
(3) T ← B
(4) foreach α ∈ (C-B)
(5) if $\gamma_{B\cup\{\alpha\}} > \gamma_T$
(6) T ← B ∪{α}
(7) B ← T
(8) until $\gamma_B \geq \alpha$
(9) return B

B. Fuzzy-Rough Instance Selection (FRIS-1) Algorithm

In this study, FRIS-1 algorithm, one of the Fuzzy-Rough Instance Selection (FRIS) Algorithms proposed by Jensen and Cornelis [27], was used as the instance selection method. The purpose of the Fuzzy-Rough Instance Selection algorithms is to eliminate samples that cause conflict with other samples identified by the fuzzy positive region. Positive region membership is used to determine the samples to be retained in the dataset and the data to be removed from the dataset. For this purpose, the relationships between the instances are calculated and the membership degree of each instance in the fuzzy positive region is evaluated. If the degree of membership is below a predetermined threshold, the sample is removed [28]. FRIS-1 algorithm is given in Table II. The algorithm accepts the data set that is intended to be reduced expressed as K, the fuzzy similarity measure parameter indicated by α and the threshold parameter τ as input. Every object x in the K dataset has a degree of membership to the positive region. If this degree of membership is lower than the threshold, it means there is uncertainty and the sample is removed. In this way, selected samples, denoted by Z, are obtained as output [27].

TABLE II. FRIS-1 ALGORITHM [27]

FRIS-1 (K, α, τ)
Input K – set of instances to be reduced
α – granularity parameter
τ – threshold
Output Z – set of selected instances
FRIS-1 Algorithm
(1) Z ← K

(2) For each x ∈ K

(3) if $(POS_A^{\alpha,K}(x) < \tau$

(4) return Z

C. SMOTER Method

SMOTER method is based on the SMOTE method which was developed by Chawla et al. [29] in 2002 for classification problems with datasets with unbalanced class distribution. For the purpose of dealing with the problem of unbalanced domains in regression tasks, the algorithm was presented by Torgo et al. (2013) [18]. SMOTER Algorithm is shown in Table III. To balance the dataset in this method, new instances are syntheticly generated from rare extreme samples by the use of the nearest neighbors of these instances, while under-sampling is applied in the most frequent cases randomly. In the generation of synthetic samples, two instances from the rare cases are used and an interpolation strategy is applied to the attributes of these two cases. The target variable value of new instance is obtained by the calculation of weighted average of the target variable values of these two samples.

TABLE III. SMOTER ALGORITHM [18]

SMOTER (U, Y, τ, os, us, k, ϕ(Y))

Input U – A dataset with a set of instances
Y – The target (dependent) continuous variable
τ – Threshold for relevance on dependent variable values
os, us– Percentages of over and undersampling
k – The number of neighbours for synthetic instance generation
ϕ(Y) – The relevance function

Output newU – a new modified dataset

Method

(1) rLow ← $\{\langle X, Y\rangle \in U: \phi(Y) > \tau \wedge Y < \bar{Y}\}$ // $\bar{Y}$: the median of the target variable Y

(2) synthInstancesLow ← GENSYNTHCASES(rLow, %os, k) //generation of synthetic instances for rLow

(3) rHigh ← $\{\langle X, Y\rangle \in U: \phi(Y) > \tau \wedge Y > \bar{Y}\}$

(4) synthInstancesHigh ← GENSYNTHCASES(rHigh, %os, k) //generation of synthetic instances for rHigh

(5) synthInstances ← synthInstancesLow ∪ synthInstancesHigh

(6) kNorm ← %us of | synthInstances|

(7) normInstances ← sample of kNorm instances ∈ U \ { rLow ∪ rHigh} // application of undersampling

(8) newU ← synthInstances ∪ normInstances

(9) return newU

The user provides a relevance threshold and a relevance function to determine normal and rare instances. The relevance function refers to user preferences regarding the importance assigned to the target variable range. To obtain the relevance function automatically, some methods are suggested by Ribeiro [30].

D. Machine Learning Algorithms

Machine learning, which is a sub-field of artificial intelligence, is a set of algorithms and techniques that give computers the ability to learn on large amounts of data in order to extract hidden patterns from data and generate useful information [31, 32]. There are four basic categories according to the learning process: supervised, unsupervised, semi-supervised and reinforced learning [32]. In the supervised machine learning process, learning is structured with data with certain input and output, and then a model is trained to generate appropriate predictions for response to new input data [33]. Regression techniques, one of the types of supervised machine learning, aim to predict response variables with continuous values [34]. In this study, machine learning regression algorithms including Linear Regression, Bayesian Linear Regression, Artificial Neural Network and ensemble machine learning regression algorithms namely Boosted Decision Tree Regression and Decision Forest Regression were used for the purpose of BOD5 prediction.

Linear Regression (LR) method tries to fit a line by establishing a linear relationship between variables in the form of a function. While generating the regression line (equation), the aim is to ensure the most appropriate fit to the data during the training and to minimize the errors. For this, methods such as Ordinary Least Squares method that tries to minimize the squares of errors are used. If the dependent variable in the linear regression model is assumed to be Y, a linear equation is created for the relationship between Y and independent variables expressed by X1, X2,…,Xn. This equation is the regression equation for the dependent variable Y desired to be predicted and it is expressed as in Equation 1 [35]. In the equation, b1, b2,…,bn values represent the regression coefficients and ε is the error term.

$$Y = b_0 + b_1X_1 + b_2X_2 + \cdots + b_nX_n + \varepsilon \quad (1)$$

Bayesian Linear Regression (BLR) is the extended of the linear regression technique with the Bayesian approach. In this method, linear regression is supplemented with additional information in the form of the previous probability distribution [36]. While linear regression provides a single estimates of regression model parameters, BLR also determines a probability distribution of these parameters. This advantage makes BLR more powerful and widely used [37]. It is useful in machine learning applications where there is difficulty in making decisions due to the inability to obtain sufficient data.

Artificial Neural Network (ANN) is one of the most efficient machine learning algorithms that was developed by simulating the working structure of nervous system and capable of learning nonlinear and very complicated relationships in the dataset. The basic unit of ANN are nodes called neurons that are interconnected by weighted connections. These nodes are grouped to form layers, namely input layer, hidden layer, and output layer. Each neuron receives its input values from the nodes of the previous layer. It calculates the weighted sum of these values and then applies an activation function. It sends its output as an input to the neuron in the next layer in the network [37, 38]. Through the algorithm, successful results are obtained in regression problems where a more traditional regression model does not fit a solution [39].

Boosted Decision Tree Regression (BDTR), builds an ensemble of regression decision trees utilizing the gradient boosting method. In this method, every tree is dependent on trees before it and it realizes the learning process by fitting the residual of these trees. At each step, error is measured and a predefined loss function is used for correction of it in the next step. Thus, each regression tree is built step by step. Final model is the ensemble of weaker regression tree models [40].

Decision Forest Regression (DFR) algorithm is an ensemble method by the use of multiple regression decision trees similar to the BDTR. The main difference between the

two ensemble machine learning methods is that while boosted decision tree regression uses gradient boosting method, DFR utilizes bagging approach [34]. In decision forest algorithm, every decision tree is constructed independently of each other. For each decision tree, a different subset of data from the original data set is used. The prediction result of each tree is in the form of a Gaussian distribution. Finally, the learning results of all decision trees are integrated by applying aggregation [34, 41, 42].

III. METHODOLOGY AND IMPLEMENTATION

The application flow chart of the proposed model for the BOD5 estimation study in the wastewater treatment plant is given in Fig. 1. In the first stage, data were collected and the missing data were cleaned for machine learning studies. Then the data were normalized and Dataset1 was obtained. In the second stage, in order to eliminate redundant and irrelevant attributes the Fuzzy QuickReduct Algorithm was applied to the obtained data and the attribute selection was realized. Thus Dataset2 was obtained. In the third stage, inconsistent and noisy samples were removed from the dataset by applying Fuzzy-Rough Instance Selection Algorithm for Dataset3. In the fourth stage, Dataset4 was obtained by applying the SMOTER algorithm to balance the dataset. Finally, in each dataset generated, regression algorithms were trained and tested, and the performances of the obtained models were compared according to perfromance evaluation criteria.

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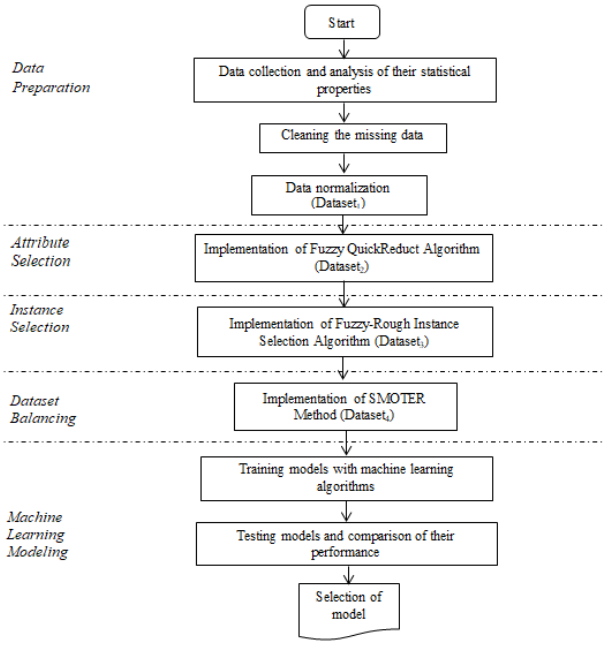

Fig. 1. *Implementation flow chart of the proposed model*

A. Study Area and Data Collection

This study was carried out on the data obtained from Karaman Wastewater Treatment Plant in Sakarya, Turkey. The wastewater treatment plant in Fig. 2, located in the center of Sakarya, was put into operation in 2003 and is large enough to serve an equivalent population of 1,000,000 people. The wastewater treatment plant, established in the Karaman district of Adapazarı town, was established on an area of 296,000 m2 and has a capacity of 198,800 m3 / day. Domestic wastewater from Adapazarı, Erenler, Serdivan, Arifiye and Sapanca towns of Sakarya City is treated in the facility.

Fig. 2. *Karaman Wastewater Treatment Plant*

The data used within the scope of the study consists of 177 samples obtained from the inlet pool of the wastewater treatment plant between the years 2019-2020. The values for eight inputs (COD, TSS, ph, NH4-N, NO3-N, NO2-N, TN, TP) and one output (BOD5) parameter of each sample were measured in the laboratory environment. Because 18 samples had missing attribute values, these 18 samples were deleted and the study was continued with 159 instances. Descriptive statistics of the dataset are shown in Table IV. The values of mean (Xmean), median (Xmed), minimum (Xmin), maximum (Xmax), standard deviation (Sx), skewness coefficient (Csx) and kurtosis coefficient (Ck) are given in the table, respectively.

TABLE IV. DESCRIPTIVE STATISTICS OF KARAMAN WASTEWATER TREATMENT PLANT ANALYSIS DATASET

Parameter	X_{mean}	X_{med}	X_{min}	X_{max}	S_x	C_{sx}	C_k
COD	356.5849	334	47	970	167.0476	1.0914	1.6675
TSS	263.9152	236	13	926	140.6228	1.2003	2.7049
ph	7.3482	7.37	6.52	8.1	0.3041	-0.0822	-0.2411
NH_4-N	15.8743	14,1	3.30	39.3	6.3139	0.6913	0.3936
NO_3-N	0.7238	0.38	0	10.67	1.2092	4.9243	33.2545
NO_2-N	0.1350	0.06	0	1.71	0.2071	3.9872	23.1642
TN	32.4513	31.81	3.36	66	10.6637	0.2750	0.5387
TP	6.8518	6.3	0.01	24.99	3.6882	1.3396	3.8979
BOD_5	113.2642	110	14	300	52.5264	0.8918	1.3227

As can be seen in Table IV, the experimental dataset consists of attributes with numerical values in many different scales. This situation can potentially add errors to the experiment during modeling or negatively affect the performance of machine learning algorithms. In order to transform the values into a common scale between 0-1, MinMax normalization process was applied to the input variables using Equation 2. In this way, Dataset1 was generated.

$$\tilde{X}^{i} = \frac{X^{i} - X_{\min}}{X_{\max} - X_{\min}} \tag{2}$$

where is the value of the feature, is the scaled feature value, Xmin and Xmax are the minimum and maximum value of the dataset, respectively.

B. Attribute Selection with Fuzzy QuickReduct Algorithm

In this study, Fuzzy QuickReduct Algorithm was used for fuzzy rough set-based feature selection in order to obtain an optimal subset dataset by removing redundant and irrelevant attributes from the dataset. For the implementation of the Fuzzy QuickReduct Algorithm, the 'RoughSets' package developed by Rıza et al. in 2015 [43] for R programming language was utilized. The 'RoughSets' package is a software package that includes algorithm applications based on rough sets and fuzzy rough sets theory. By the agency of methods in the package, applications such as basic concepts, discretization, instance (data) selection, feature selection, rule induction and prediction / classification can be realized. Fuzzy QuickReduct Algorithm steps were performed in RStudio program by the use of FS.quickreduct.FRST() function. The 'RoughSets' package must be loaded into the R Studio environment with the install.packages("RoughSets") line of code before the function can be implemented. The package is then activated with the library(RoughSets) code. The codes developed in the RStudio program for the application of fuzzy rough set based feature selection on the analyzed dataset are as follows.

```
install.packages("RoughSets")

library(RoughSets)

dataset1 <- SF.read.DecisionTable (file.choose(), decision.attr = 9, sep=",")

colnames(dataset1) <- c("COD", "TSS", "ph", "NH4-N", " NO3-N ", " NO2-N", " TN", "TP", "BOD5")

control <- list(alpha = 0.9, q.some = c(0.1, 0.6), q.most = c(0.2, 1), type.aggregation = c("t.tnorm", "lukasiewicz"))

attsel <- FS.quickreduct.FRST(dataset1, type.method = "vqrs", type.QR = "fuzzy.QR", control = control)

dataset2<- SF.applyDecTable(dataset1, attsel)
```

In the implementation, the vaguely quantified rough sets (VQRS) approach developed by Cornelis and Jensen [20] in 2008 was used as a method for defining lower and upper approximations. A real number representing a threshold value between 0 and 1, or the stopping criterion 'alpha' was determined as 0.9. Some quantitators (q.some), which are a pair of numerical values for the alpha and beta parameter of the VQRS, were set at 0.1 and 0.6, and the most quantitative (q.most) were set at 0.2 and 1. The "lukasiewicz" t-norm was used for type of aggregation. Dataset with nine features, namely COD, TSS, ph, NH4-N, NO3-N, NO2-N, TN, TP, BOD5 obtained from the wastewater treatment plant (Dataset1) was reduced to 4 attributes by the application of the Fuzzy QuickReduct Algorithm and the Dataset2 was obtained. The attributes in Dataset2 are COD, NO2-N, TN and BOD5, respectively.

C. Implementation of Fuzzy-Rough Instance Selection Algorithm

In this stage of the study, Fuzzy-Rough Instance Selection (FRIS-1) Algorithm was used to eliminate noisy, unnecessary or inconsistent samples while preserving the consistent instances in the Dataset2. For the implementation of the algorithm, the 'RoughSets' package was used through the RStudio program as in the fuzzy rough set based feature selection application. Fuzzy-rough instance selection algorithm steps were performed through the IS.FRIS.FRST() function. RStudio codes developed for instance selection are as follows.

```
res.1 <- IS.FRIS.FRST(decision.table = dataset2, control = list(threshold.tau = 0.9, alpha = 0.8, type.aggregation = c("t.tnorm", "lukasiewicz"), t.implicator = "lukasiewicz"))

dataset3<- SF.applyDecTable(dataset2, res.1)
```

The threshold.tau seen in codes is a threshold value that determines whether an object can be removed. If it is lower than the threshold value, the object can be removed [43]. alpha is a granularity parameter of the fuzzy similarity measure with positive values. In this study, threshold.tau value was determined as 0.9 and alpha value as 0.8. The "lukasiewicz" t-norm was used for type of aggregation as in the fuzzy rough set based feature selection application. Dataset3 was obtained by eliminating 5 samples with the application of the algorithm.

D. Balancing Data Set with SMOTER Method

In this study, the SMOTER method was applied to reduce the imbalance problem between rare target variable cases and the most frequently encountered values. In order to apply the method steps, the 'UBL' package developed by Branco et al. [44] for the R programming language in 2016 was utilized. The package presents a set of functions in order to achieve better prediction performance in cost sensitive-problems and costs / benefits tasks for use in regression and classification studies. It includes resampling approaches that direct the original dataset according to user preferences [27]. SMOTER algorithm can be implemented in open source R environment with the help of SmoteRegress() function. install.packages("UBL") command is used to install the 'UBL' package into the R Studio environment, and library(UBL) is used to activate the package. The code block required for the implementation of the SmoteR algorithm in the R Studio environment is as follows.

```
install.packages("UBL")

library(UBL)

dataset4<- SmoteRegress(BOD5~., dataset3, dist = "HEOM", C.perc=list(1.5,2.5))
```

In the implementation of the SMOTER algorithm, for the nearest neighbors computation, HEOM distance metric, which can deal with both nominal and numeric features, was used. The number of neighbors used to generate new synthetic samples was set at 5. The relevance function was set as auto, and the relevance threshold value was determined as 0.5. According to the algorithm, a case above this value is considered to belong to the rare "class". The C.perc parameter controls the amount of over-sampling and under-sampling to be applied to each class specified by the threshold. This list has been determined as 1.5 and 2.5, because over-sampling was applied. With the application of SMOTER algorithm, Dataset4 with 244 samples was obtained.

E. Development of Models with Machine Learning Algorithms

Training and testing of regression models with machine learning algorithms for BOD5 prediction was carried out on the Microsoft Azure Machine Learning Studio environment. For the development of models, the dataset is randomly divided into two parts, a training dataset and a test dataset. While 70% of the dataset was selected to be used for training, 30% was used for testing. The machine learning algorithms

used in this study are Boosted Decision Tree Regression, Decision Forest Regression, Artificial Neural Network, Linear Regression and Bayesian Linear Regression.

Among the machine learning algorithms used, the parameters of Boosted Decision Tree Regression, Decision Forest Regression and Artificial Neural Network algorithms were determined with the entire grid option using the "Tune Model Hyperparameters" module in Azure Machine Learning Studio. With the entire grid option, the module tries all different possible combinations of values for parameters on a grid predefined by the system and determines the best learning parameters. In models created with the Boosted Decision Tree Regression algorithm, the maximum number of leaves per tree is 8, the minimum number of samples per leaf node is 1, the learning rate is 0.1 and the total number of decision trees to create in the ensemble is 500.

The parameters of the Decision Forest Regression algorithm were determined as follows: the minimum number of samples per leaf node was 1, the number of random splits per node was 128, the maximum depth of decision trees was 16, and the total number of decision trees to create in the ensemble was 32. The structure of the Artificial Neural Network consists of three layers: an input layer, a hidden layer and an output layer. While the number of neurons in the hidden layer was determined as 100, the learning rate was 0.1. Mean squared error (SquarredError) function was used as the loss function. The number of learning iterations was determined as 80.

For Linear Regression model, Ordinary Least Squares method was used as a solution method to measure the error and construct the regression line. The L2 regularization weight, which is used to solve the overfitting problem of the model, was determined as 0.001. In the Bayesian Linear Regression Algorithm, the regularization weight constant, which represents the ratio of weight sensitivity before noise precision, is determined as 1.

F. Comparison of Models

The performances of the models trained with machine learning algorithms were evaluated according to six different performance criteria using Equations 3-8: mean absolute error (MAE), root mean squarred error (RMSE), relative absolute error (RAE), relative squared error (RSE), mean absolute percentage error (MAPE) and coefficient of determination (R2) [45-46].

$$MAE = \frac{1}{N}\sum_{i=1}^{N}|(Y_i - \bar{Y}_i)| \quad (3)$$

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(\hat{Y}_i - Y_i\right)^2} \quad (4)$$

$$RAE = \frac{\sum_{i=1}^{N}|\hat{Y}_i - Y_i|}{\sum_{i=1}^{N}|\bar{Y} - Y_i|^2} \quad (5)$$

$$RSE = \frac{\sum_{i=1}^{N}(\hat{Y}_i - Y_i)^2}{\sum_{i=1}^{N}(\bar{Y} - Y_i)^2} \quad (6)$$

$$MAPE = \frac{100}{N}\sum_{i=1}^{N}\frac{|(Y_i - \bar{Y}_i)|}{Y_i} \quad (7)$$

$$R^2 = \left(\frac{\sum_{i=1}^{N}(Y_i - \bar{Y}_i) - \sum_{i=1}^{N}(\hat{Y}_i - \bar{Y}_i)}{\sqrt{\sum_{i=1}^{N}(Y_i - \bar{Y}_i)^2}\sqrt{\sum_{i=1}^{N}(\hat{Y}_i - \bar{\hat{Y}}_i)^2}}\right)^2 \quad (8)$$

where Y_i and $\hat{Y}_i$ are the observed and predicted values, respectively. $\bar{Y}_i$ and $\bar{\hat{Y}}_i$ are the mean of observed and predicted values, respectively. N denotes the sample number of test dataset.

The results of performance indices of all models for prediction BOD_5 are given in the Table V. While BDTR, BLR, DFR, LR, NN models were generated by applying regression algorithms on $Dataset_1$ (with only normalization process), FQR-BDTR, FQR-BLR, FQR-DFR, FQR-LR, FQR-NN models created by applying machine learning algorithms on $Dataset_2$ (with Fuzzy QuickReduct Algorithm). On the other hand, FRIS-FQR-BDTR, FRIS-FQR-BLR, FRIS-FQR-DFR, FRIS-FQR-LR, FRIS-FQR-NN represent models trained on $Dataset_3$ (with Fuzzy QuickReduct Algorithm and Fuzzy Rough Instance Selection Algorithm) and SmoteR-FRIS-FQR-BDTR, SmoteR-FRIS-FQR-BLR, SmoteR-FRIS-FQR-DFR, SmoteR-FRIS-FQR-LR, SmoteR-FRIS-FQR-NN models were developed by applying regression algorithm on $Dataset_4$ (with Fuzzy QuickReduct Algorithm, Fuzzy Rough Instance Selection Algorithm and SMOTER method).

TABLE V. THE TEST PERFORMANCE METRICS OF THE MODELS IN PREDICTION OF BOD5

Model	*MAE*	*RMSE*	*RAE*	*RSE*	*MAPE*	R^2
Dataset1						
BDTR	15.2502	22.1727	0.3574	0.1759	13.4319	0.8243
BLR	12.3419	15.3622	0.2892	0.0843	13.1943	0.9157
DFR	14.2150	19.4747	0.3331	0.1355	14.0144	0.8645
LR	11.8244	16.1916	0.2771	0.0937	10.3500	0.9063
NN	14.0929	17.1634	0.3302	0.1053	17.3687	0.8947
Dataset2						
FQR-BDTR	13.5861	17.4401	0.3184	0.1087	13.0753	0.8913
FQR-BLR	11.8875	15.6277	0.2786	0.0873	12.9596	0.9127
FQR-DFR	13.5034	18.5302	0.3164	0.1227	13.0772	0.8773
FQR-LR	11.2170	15.7105	0.2629	0.0882	9.7931	0.9118
FQR-NN	12.9919	17.3056	0.3044	0.1070	14.7307	0.8930
Dataset3						
FRIS-FQR- BDTR	9.9787	15.8763	0.2591	0.0958	12.4711	0.9042
FRIS-FQR-BLR	12.5824	17.0097	0.3267	0.1099	14.4665	0.8900
FRIS-FQR-DFR	9.5523	13.1917	0.2480	0.0661	11.9367	0.9339
FRIS-FQR-LR	9.1604	12.7161	0.2379	0.0614	9.9686	0.9386
FRIS-FQR-NN	11.0402	14.7156	0.2867	0.0823	12.1712	0.9177
Dataset4						
SmoteR-FRIS-FQR-BDTR	7.0002	9.3212	0.1586	0.0282	6.0753	0.9718
SmoteR-FRIS-FQR-BLR	9.4302	12.6620	0.2137	0.0520	9.2604	0.9480
SmoteR-FRIS-FQR-DFR	7.6177	11.1255	0.1726	0.0402	6.8533	0.9598
SmoteR-FRIS-FQR-LR	8.6714	11.8501	0.1965	0.0456	7.6351	0.9544
SmoteR-FRIS-FQR-NN	9.9170	13.0296	0.2247	0.0551	9.6762	0.9450

From the figures given in Table V, it is apparent that when the algorithms are trained on Dataset1, which is obtained by applying only the normalization process, the LR model has the lowest value for MAE, RAE and MAPE, and the BLR model has the lowest value for RMSE and RSE. The highest value for R2 was reached with the BLR model. The LR algorithm, which shows the best performance according to the MAPE results, achieved prediction performance with 10.35% error. It is seen that the prediction performance of almost all

algorithms is increased by applying the Fuzzy QuickReduct Algorithm to the dataset. Only the RMSE and RSE values of the BLR and NN algorithms increased, and the value of R2 decreased slightly. In the next stage, it was observed that the prediction performance of the models, except for the BLR algorithm, increased more than Dataset2 through the FRIS-1 algorithm applied for instance selection. While the R2 value decreased in the BLR algorithm, there was a slight increase in the values of MAE, RMSE, RAE, RSE, MAPE, although there was a decrease in all other algorithms. With the balancing of the data using the SMOTER method, significant decreases were observed in the MAE, RMSE, RAE, RSE, MAPE values of all models, while the R2 values increased. According to the results of performance criteria, while Linear Regression Algorithm shows the best performance among all algorithms on Dataset1, Dataset2 and Dataset3, Boosted Decision Tree Regression Algorithm has the best predictive power on Dataset4. Hybrid usage of machine learning algorithms with Fuzzy QuickReduct Algorithm, Fuzzy Rough Instance Selection Algorithm and especially SMOTER method has provided a significant increase in the performances of the models at every stage. SMOTER-FRIS-FQR-BDTR model, which gives the best performance, has a prediction performance with 6.0753% MAPE value and 0.9718 R2 value.

IV. CONCLUSION

In this paper, a hybrid model based on fuzzy rough set theory, SMOTER and machine learning algorithms was developed to estimate the Biological Oxygen Demand water quality parameter that can be measured for 5 (five) days in a laboratory environment. Firstly, data on COD, TSS, ph, NH4-N, NO3-N, NO2-N, TN, TP and BOD5 parameters were collected from the wastewater treatment plant. The missing data was then cleared and the input parameters were normalized. Secondly, for the purpose of identify significant features and to eliminate the dispensable attributes, Fuzzy QuickReduct Algorithm was implemented. In the third stage, the fuzzy rough instance selection algorithm was applied to examine whether the noisy and inconsistent data in the dataset affects the performance of machine learning algorithms. In the fourth step, the SMOTER method was applied to reduce the imbalance problem between the rare target variable cases and the most frequently encountered values. For regression, machine learning algorithms, Linear Regression, Bayesian Linear Regression, Artificial Neural Network, Boosted Decision Tree Regression, Decision Forest Regression were trained on each dataset obtained. As a result of the evaluation of the models, it was observed that there was an increase in the performance of the algorithms thanks to each step applied in this study. The best machine learning model was found by SMOTER-FRIS-FQR-BDTR model with 6.0753% MAPE value.

With the use of the developed model, it is predicted that wastewater treatment plants can save both time and cost in terms of BOD5 parameter. This study showed that fuzzy rough set approaches and SMOTER technique are important preprocessing tools to improve machine learning algorithms performances in the context of BOD5 prediction. Despite the contributions, this study has some limitations. In this study, only one feature selection algorithm named Fuzzy QuickReduct Algorithm and one instance selection algorithm namely FRIS-1 were implemented. Future research should therefore concentrate on the investigation of effects of different feature selection and instance selection algorithms based on rough sets and fuzzy rough sets.

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Classification of Power Quality Disturbances in a Grid-Connected PV System using Discrete Wavelet Transform and Feedforward Neural Networks

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***Abstract*— Reliability of a distributed generation (DG) system is required to provide a robust grid connection and operation of a power system. Power quality disturbances (PQDs) are highly effective in the reliable operation of a grid-connected photovoltaic (GCPV) system. For this reason, fast and accurate classification of PQDs in a GCPV system is a significant issue. In this study, an intelligent method based on discrete wavelet transform (DWT) and feed-forward neural network (FFNN) is proposed to classify PQDs in a GCPV system. The nominal voltage signals and PQDs were performed to DWT decomposition, then the energy and entropy values of the detail coefficients are calculated in the proposed method. The determined features constituted the inputs of the multilayer FFNN. At the last stage, PQDs were classified using the SoftMax activation function. The overall performance of the proposed method was examined with different training percentages to examine the effect of data distribution on the results in the multilayer FFNN structure, which is strengthened with the scaled conjugate gradient (SCG) algorithm. The test results show that the proposed method has 99.91% accuracy in classifying PQDs, and is suitable for DG system applications.**

Keywords—discrete wavelet transform, neural networks, power quality disturbances, event classification

I. INTRODUCTION

Power systems undergo a rapid and significant change with the developing technologies in parallel with the increasing energy demand. Environmental problems caused by fossil resources and high fuel costs, together with climate change, have led countries and investors to renewable energy resources (RESs). Among the RESs, solar energy has sustained growth due to development in grid integration technologies, decreasing photovoltaic (PV) panels production costs, subventions from the governments, etc. Therefore, the integration of grid-connected photovoltaic GCPV systems, whose number is rapidly increasing, and its effects on power quality (PQ) have become an important issue [1].

Fig. 1 shows the general schematic of a GCPV system [2]. This model consisted of PV array, inverter, filter, load, and grid connection modules. In the model, the output of the PV panels is connected to the H-bridge inverter. The inverter control system provides maximum power point tracking, current, and voltage regulation to be achieved and synchronized with the grid. The inverter output is filtered, it is connected to the grid via a circuit breaker (CB), and there is a local load at the point on common coupling PCC.

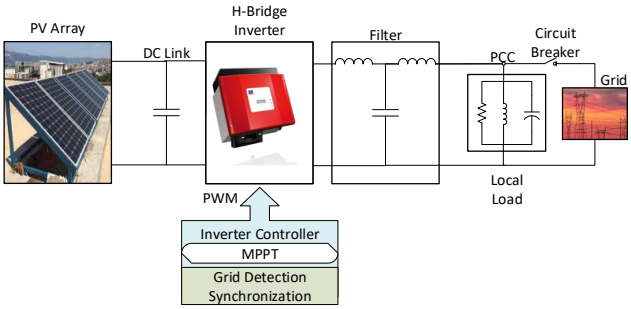

Fig. 1. General schematic of a GCPV system

PQ parameters are a set of limits that allow equipment to operate as intended without significant performance and life expectancy loss [3]. A problem that leads to deviation from the ideal waveform is called the power quality disturbance (PQD). PQDs are classified as current and voltage harmonics, voltage sag/swell/interruption, impulsive and oscillatory transients, spikes, notches, flickers [4]. Particularly in systems with distributed generators (DGs) such as GCPV systems, PQDs must be classified accurately to ensure the sustainability and reliability of the power flow. Besides, PQ parameters should be taken into consideration in power system planning and operation.

Neural network (NN)-based and signal processing (SP)-based methods used in PQDs detection and classification are given in Fig. 2 [5]. NN-based methods for classifying PQDs are back propagation-neural network (BPNN), probabilistic neural networks (PNN), radial basis function networks (RBFN), and wavelet neural networks (WNN). A classifier is an algorithm that takes raw data or extracted feature data as input and makes decisions about the normal operating state of the system. Artificial neural network (ANN)-based approaches are used in Reference [6, 7] for fault and event detection in PV systems and wind turbines (WTs). Adaptive probabilistic neural networks (APNNs) and PNNs have been used to classify power quality events in Reference [8]. SP-based methods for feature extraction and detection are Fourier transform (FT)- based techniques, Hilbert-Huang transform (HHT)-based technique, S-transform (ST)-based technique, and wavelet transform (WT)-based techniques [9]. WT-based techniques have advantages over other SP-based methods to locally investigate sudden changes and discontinuities in high-level derivatives [10]. In the proposed method for island mode detection, events in wind turbine systems have been determined by utilizing the discrete wavelet transform (DWT)

technique's ability to analyze both the frequency and the time domain [11].

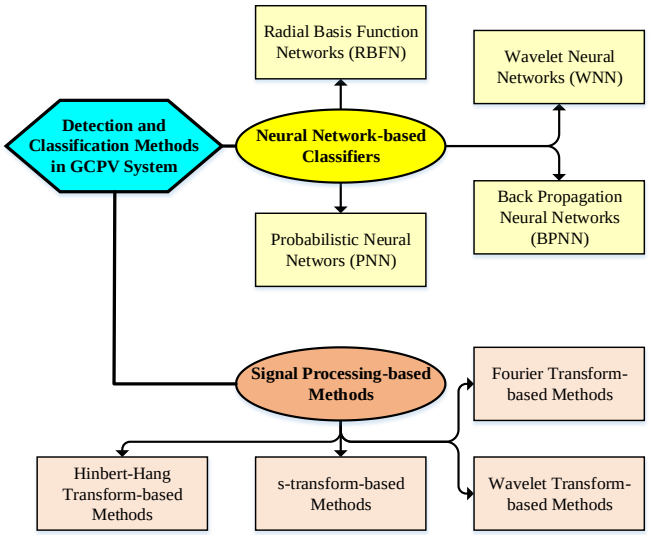

Fig. 2. Detection and classification methods in GCPV systems

In this study, a new hybrid DWT and feed-forward neural network (FNNN)-based method proposed to classify PQDs in the GCPV system connected distribution grid. The DWT decomposition was used to feature extraction of the PQD voltage signal at PCC, and these events' energy and entropy values were obtained. Then, determined features constituted the inputs of the multilayer FFNN. At the last stage, PQDs were classified using the SoftMax activation function. The overall performance of the proposed method was examined with different training percentages to examine the effect of data distribution on the results—the FFNN-based classifier structure, which is strengthened with the scaled conjugate gradient (SCG) algorithm. The overall recognition test accuracy for the PQDs is 95.7% for the proposed hybrid method. DWT-FFNN hybrid method produces reliable and readily usable results in the classification of PQDs in the DG system applications.

II. Theoretical Background

DWT decomposition was applied to the voltage signal obtained from PCC, and detail coefficients were calculated in the proposed method. Then, the feature matrix was determined by calculating the energy and entropy values of the coefficients at each level. The event signal was classified with the FFNN classifier using the obtained feature matrix in the last stage.

A. Discrete Wavelet Transform Theorem

DWT decomposition method, which is frequently used in pattern recognition, classification, and event detection applications, is a method that is capable of processing data at different scales and resolutions. In Equation (1), a mathematical expression is given for the DWT decomposition process, which is especially suitable for real-time applications.

$$DWT(s,b) = 2^{-s/2} \int f(t)\psi(2^{-s}t - b)dt \qquad (1)$$

Where (ψ(x)) is the scalable main wavelet, b is the shifting factor, and s is the scaling factor. Filter banks are used for the decomposition process in DWT applications. The multi-resolution analysis (MRA) method, which is one of the widely used methods for DWT, involves passing a signal through a series of high and low pass filters to examine the different frequency band responses [12]. Low-frequency information of the signal is analyzed by obtaining approximation coefficients (A_n). In contrast, low frequency is obtained with detail coefficients (D_n) Three-level decomposition using MRA has shown in Fig. 2.

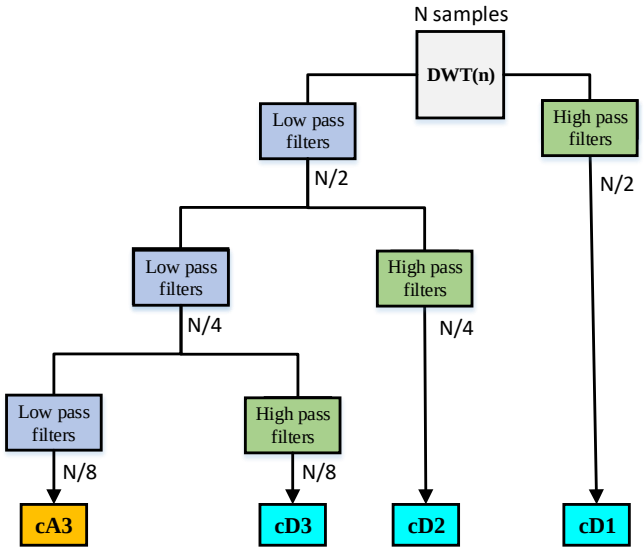

Fig. 3. Filter outputs for three-level decomposition using MRA

B. Feature Extraction

The statistical parameters have been used for the feature extraction. The feature matrix was created by calculating the energy (E) and entropy (En) values of the detail coefficients at each level.

The energy feature extraction technique is applied to DWT coefficients of the PQD signal. The detail coefficients' energy is given by

$$E_i = \sum_{j=1}^{N} \left(|D_{ij}|^2 \right) \qquad (2)$$

Where $i=1, 2, \ldots, l$ represents the number of DWT decomposition at level l, and N is the number of coefficients for each level.

Entropy is a unit of measure that expresses the irregularity of the elements in the data with real numbers. The detail coefficients' entropy is calculated in Equation (3).

$$En_i = -\sum_{j=1}^{N} \{ D_{ij}^2 \log(D_{ij}^2) \} \qquad (3)$$

In the proposed feature extraction method, DWT coefficients are provided by an 8-level decomposition received signals from the PCC. The energy and entropy values of the obtained detail coefficients (D_1, D_2, ... D_8) are calculated. The result is a feature vector consisting of 16 elements. Energy and entropy features are normalized using the min-max normalization technique. The feature vector is given as follows:

$$F = [E_1\ E_2\ E_3\ \ldots\ E_8, En_1\ En_2\ En_3\ \ldots\ En_8] \qquad (4)$$

C. Multiclass Classifier using FFNN

The combination of cells called neurons forms artificial neural networks (ANNs) structures. A neuron has a layer with inputs, weights, summation function, activation function, and output layer. In the neuron, the input values $(x_1, x_2, x_3, \dots, x_i)$, are multiplied by the weight coefficients $(w_{1j}, w_{2j}, w_{3j}, \dots, w_{ij})$ and subjected to the summation process with the addition of bias value *(b)*. The total result is passed through an activation function, and the output $(y_i = f(\sum_i w_{ij} x_i + b_j))$ is obtained. Developing a multilayer feed-forward neural network (FFNN) model generally involves selecting input and output variables, data normalization, determining the number of layers / the number of neurons, and selecting the activation function.

The most common method used in the training process is the gradient descent algorithm. Since the Scaled conjugate gradient (SCG) backpropagation algorithm searches in the conjugate direction, it is an improved method that converges faster than the gradient descent algorithm [13]. In this algorithm, the step size is readjusted at each iteration, and it gains an adaptive structure. It has been determined by the tests that the SCG training algorithm is a fast backpropagation training algorithm for PQD classification. SCG training algorithm was chosen in this study because of the need to make real-time event classification very quickly in GCPV systems.

III. Power Quality Disturbances

The schematic view of the studied PV-based test system has shown in Fig. 4. These loads generate PQDs such as sags, swells, transients, harmonics, and flickers. PQD classes generated with different scenarios performed on the test system are given in Table 1.

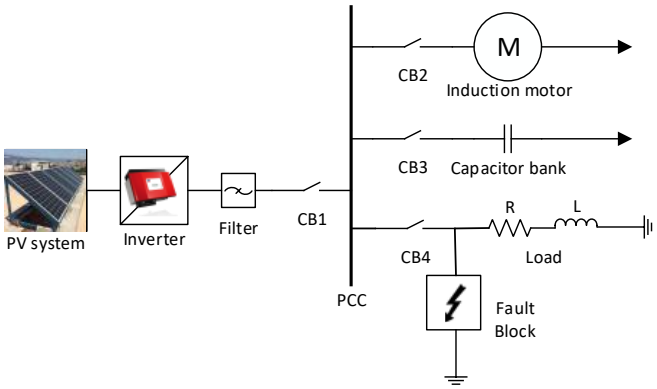

Fig. 4. Studied test system

TABLE I. Generated Power Quality Disturbances

Class	PQD Signals
C1	Nominal signal
C2	Voltage sag
C3	Voltage swell
C4	Transient
C5	Harmonic
C6	Flicker

PQDs were received at PCC with a sampling frequency of 10 kHz. The duration of each event signal is 0.2 seconds. The operating frequency has been selected as 50 Hz. A total of 6000 samples were used for training, testing, and validation, with 1000 samples from each class. While generating the data set, it was aimed to provide sufficient data for all conditions to the neural network. These data were shared at different rates among training, validation, and test data sets, and the relationship between the highest accuracy rate and data distribution was examined.

IV. Proposed DWT-FFNN Method for Classification

The proposed application procedure is shown in Fig. 5.

1) The voltage signal is received from the PCC at a sampling frequency of 10 kHz. After pre-processing this signal, 8-level decomposition is performed using the db4.
2) Each level coefficient's entropy and energy are calculated, and a feature dataset is created with these values calculated for all levels.
3) Construct the FFNN framework based on PQD problems.
4) Feature dataset (6 types of the sample as input) used to train the FFNN. In the model, training was carried out with the SCG backpropagation algorithm. Cross-entropy was used as a performance criterion. Optimal parameters are acquired after the training process using a validation check.
5) After training, the process uses the proposed model to test the testing samples. Softmax was used at the network outputs, and events were classified.

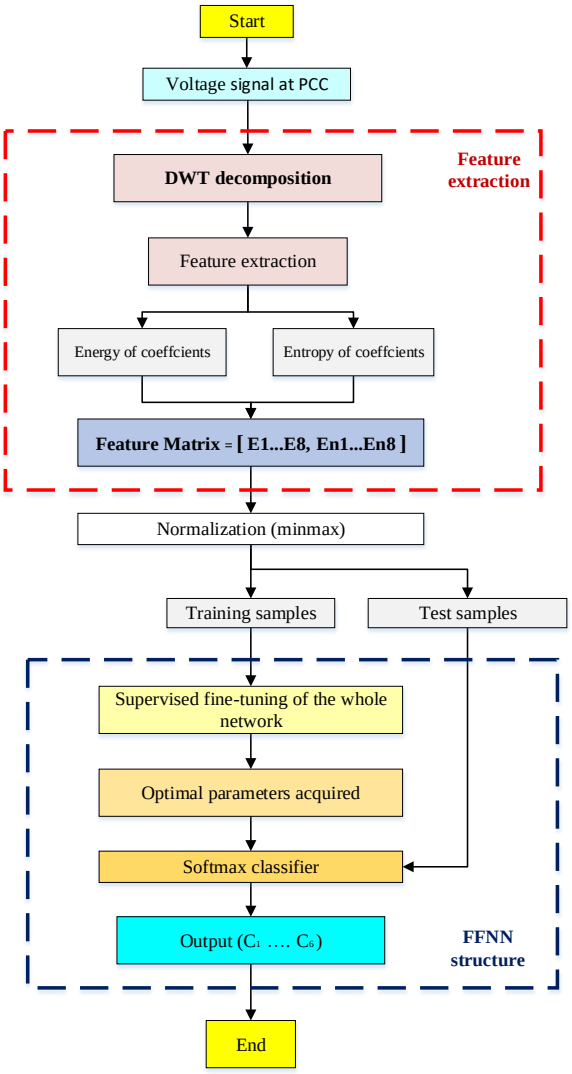

Fig. 5. Proposed method

V. RESULTS

In the network modelled in MATLAB environment, validation confirmation parameter (net.trainParam.max_fail) was selected as 20. Model training is stopped when the maximum number of validations is reached. The learning rate was chosen as 0.01 (net.trainParam.lr = 0.01). Learning ratio increase / decrease ratios were selected as 1.05 and 0.7, respectively (net.trainParam.lr_inc = 1.05; net.trainParam .lr_dec = 0.7). The momentum constant is taken as 0.9 (net.trainParam.mc = 0.9).

The change of model performance by iteration is given in Fig. 6. The best validation performance is 0.0010171 at epoch 1549.

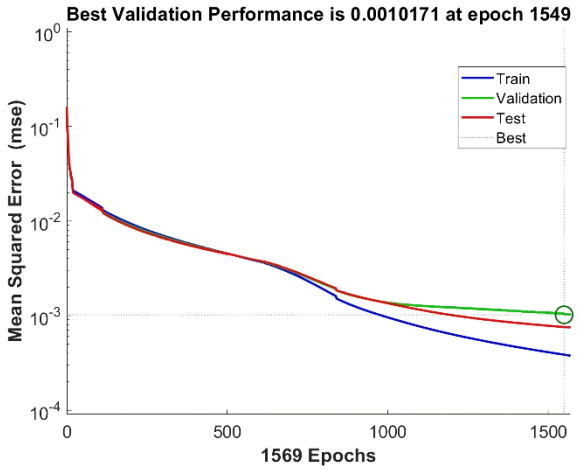

Fig. 6. Validation performance according to the number of iterations

Error histogram for test, validation, and training data set is given in Fig. 7.

Fig. 7. Error histogram

Performance was examined with different training percentages to examine the effect of data distribution on the results. The accuracy rate was highest when the data was divided into 70% training, 15% validation, and 15% test data. The accuracy rate in the test confusion matrix is 99.9%. Even in C2 (voltage sag), where the accuracy rate was 99.3%, 143 outputs were predicted correctly, while the erroneous prediction samples were limited to only 1. Test and general confusion matrix are shown in Fig. 8 and Fig. 9, respectively.

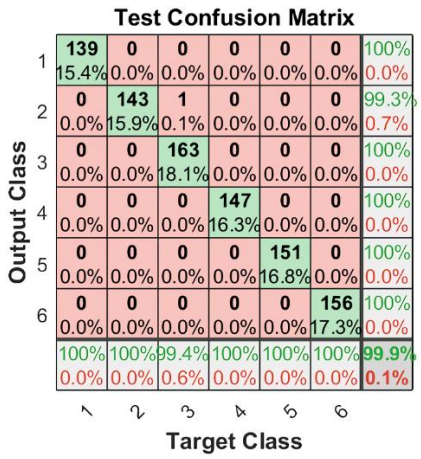

Fig. 8. Test confusion matrix

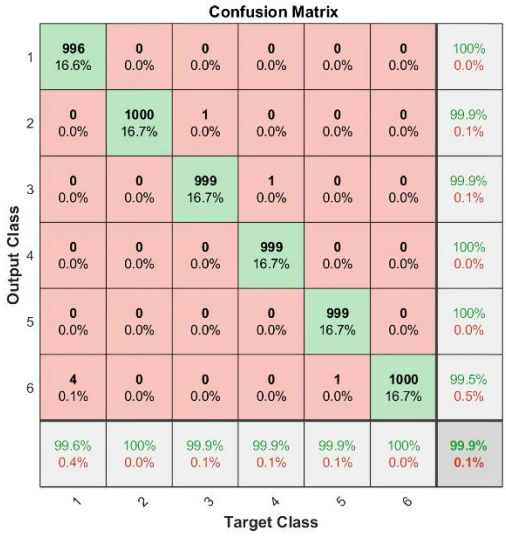

Fig. 9. Confusion matrix

VI. CONCLUSION

In this study, a new hybrid, DWT-based feature extraction method using an FFNN is proposed to classify PQDs in the grid-connected PV systems. The hybrid DWT and FFNN-based algorithm start with receiving the voltage signal at PCC. The nominal voltage signals and PQDs were performed to DWT decomposition, then the energy and entropy values of the detail coefficients are calculated. Then, determined features constituted the inputs of the FFNN. At the last stage, PQDs were classified using the SoftMax activation function. The test results show that the proposed method has 99.91% accuracy. As a result, the DWT and FFNN-based methods are most suitable to classify PQDs in PV-based microgrids.

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Determining Biomarkers Associations with Polymerase Chain Reaction (PCR) by Factor Analysis and Artificial Neural Networks

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***Abstract*—The use of PCR tests is an important part of the fight against COVID-19 disease. Several factors may contribute to inconsistent PCR test results. This arises a need for validation where and when it is crucial. This validation can be provided by artificial intelligence (AI) methods for precision. It is considered that with the help of biomarkers, a complementary evaluation can be realized using an artificial neural network. For an increased certainty and for initial determination of optimum number of biomarkers, dataset should be populated with a wide variety of biomarkers with enough data. In the study, some biomarkers have shown relevancy with PCR test results. Determined biomarkers have been used to train an artificial neural network (ANN). The study proposes a method for selection of biomarkers and the use of these biomarkers for PCR test validation with the support of an ANN. This method can be adapted to other diseases as well.**

Keywords—artificial neural network, PCR, COVID-19

I. INTRODUCTION

The COVID-19 pandemic has forced the world of science for interdisciplinary studies, following the shock of its unique features understood. Although the coronavirus is known since 1965 and SARS and MERS disease variations are known and studied, the fact of lack of a developed vaccine and/or effective drugs for treatment has caught the world off guard. The worsening situation by increasing number of cases and deaths has alarmed the world of science and the review of the known and unknown regarding coronavirus and such diseases has been initiated. The world of medicine focused on antiviral drugs and drugs for symptomatic treatment of COVID-19 as it has shown similarities with influenza and pneumonia in addition to first steps of vaccine development. Depending on increasing amount of statistics data, precautions have been planned. The widespread use of the computer science branch of the natural sciences for analysis and analytics has been delayed due to the limited data provided. Gathering of clear and enough data is crucial for data analysis and data analytics application because of the sensitivity of medicine field. In this study, data for 105 cases has been approved and analyzed and the data analytics approach under development has been evaluated regarding Polymerase Chain Reaction (PCR) and blood-test results. This case study is still under investigation. Literature review section presents references to research to date that have been used to evaluate the information required for development of medicine-specific data analytics. Design and method section explains the approach that is being developed. Research findings and discussion section discusses proposed approach and explanation of obtained results so far. Conclusion and recommendations section provides information implemented from interpreted results and suggestions for further studies.

II. LITERATURE REVIEW

It is possible to differentiate COVID-19 and other diseases using specific biomarkers [1]. The unnecessary PCR SARS-COV-2 PCR tests and possible false-negative results can be avoided via faster resulting with an improved range of tests [2]. In order to overcome the risk of false-negative tests, it is possible to decide to re-test patients based on specific biomarkers [3]. False positive and negative results can cloud important estimations for wider population [4]. Machine learning has some limitations and weaknesses as well as their strengths [5]. To strengthen estimations, a larger variety of biomarkers can be used to prioritize patients for PCR tests and/or for validation of PCR test results [6]. There is a large unexplained heterogeneity in false negative PCR tests due to risk of bias and applicability [7].

III. DESIGN AND METHOD

In the study, methods of defining biomarker associations with PCR results have been evaluated. Moreover, factor analysis (FA) showed promising results as its output with less and the most relevant biomarkers to represent a latent variable can be trained more successfully than human-selected biomarkers for ANN training. The ANN has a hidden layer with 10 neurons.

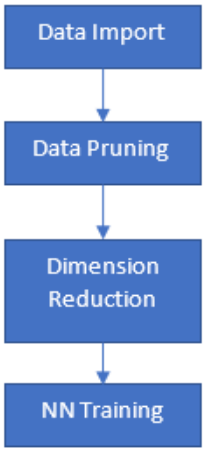

Fig. 1. Steps of Analysis

A. Data Pruning

Some data fields in the dataset that have unacceptable number of missing values were discarded. Following manual selection of the data fields that were considered relevant with PCR test results and that may produce objective results, rows with missing values were also removed. Some fields subject to ambiguity have been removed. An example for removed fields is body temperature. Patients might have taken drugs with antipyretic effects and this may lead to an incorrect evaluation due to inconsistency with other relevant data at the time of analysis. Missing values in data rows can be filled with values based on some assumptions such as column averages. However, this type of imputation may lead to loss of information and data inconsistency that may cause misleading increased weights regarding other data fields.

B. Dimension Reduction

There are 86 data fields as columns regarding 150 patients in the dataset. These fields include various data in addition to biomarkers. As the goal of this study, only biomarkers have been chosen. Factor analysis was applied to 24 data fields consist of biomarkers data to reduce the dimension. The latent variable that includes the PCR test result was selected for further analysis. White blood cell count (WBC), neutrophil count (NEU), lymphocyte count (LYM), lactate dehydrogenase (LDH) and C-reactive protein (CRP) data fields were in the latent variable.

TABLE I. CORRELATION MATRIX

	WBC	***NEU***	***LYM***	***LDH***	***CRP***	***PCR***
WBC	1,00	0,97	0,26	0,29	0,30	-0,33
NEU	0,97	1,00	0,06	0,31	0,34	-0,33
LYM	0,26	0,06	1,00	-0,01	-0,20	-0,05
LDH	0,29	0,31	-0,01	1,00	0,21	-0,15
CRP	0,30	0,34	-0,20	0,21	1,00	-0,17
PCR	-0,33	-0,33	-0,05	-0,15	-0,17	1,00

C. Neural Network Training

The number of data fields has been reduced from 24 to 6. This helped training process of the ANN with 10 neurons in its hidden layer.

The ANN has been set to mean square error (MSE) to be used as the error function. Due to lack of sufficient amount of data, training has been performed with 80% of total data and 20% has been reserved for testing, without validation.

The purpose of ANN training was to simulate selected biomarkers to probe specific cases for confirmation or validation. The expected output is a value between 0 and 1 where 1 means PCR-positive. The output layer was not forced to output a binary value based on a specific threshold to show data uncertainty just in case.

The ANN has shown a 76.19% success for test values that are not used in training set. The MSE value for the test was 0.2381. It is considered that dataset includes false negatives due to PCR test timing or other unknown factors. A deep learning ANN and clustering of dataset have been planned for a more comprehensive analyze and decision support as a future work.

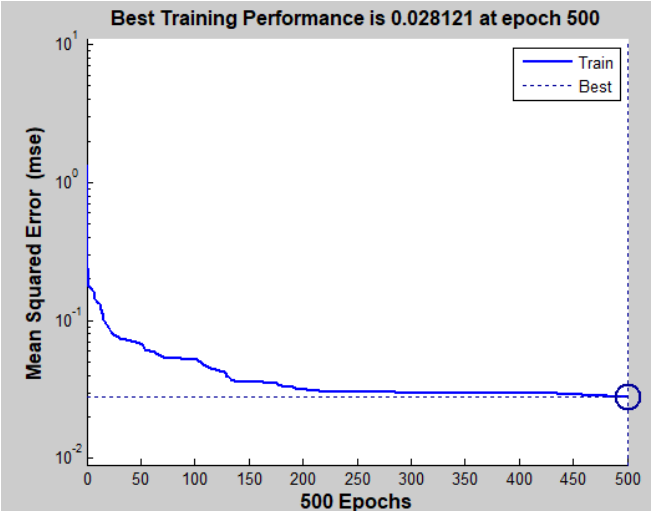

Fig. 2. MSE change during training.

As seen in Fig. 2, the ANN has shown adequate performance with the training partition of the dataset. Fig. 3 shows the structure of the ANN.

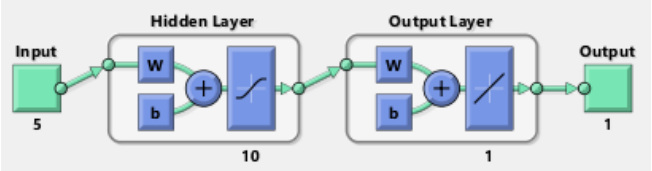

Fig. 3. ANN Architecture

IV. RESEARCH FINDINGS AND DISCUSSION

The study has shown that togetherness of WBC, NEU, LYM, LDH and CRP levels in blood samples has a significant relevance with COVID-19 PCR test results, more than other biomarkers. In other words, these biomarkers are candidates for PCR result prediction. Also, these biomarkers may show potential differential diagnosis of COVID-19 as in [1].

The most difficult step of the study is about deciding on the biomarkers to analyze and gathering sufficient patient data for PCR evaluation. After filtering out patient data with missing values, 105 patients' data was approved for further analysis. To focus on biomarkers, some of data was needed to be omitted from the analyze. Changes in number of data fields can cause slight to significant variation in results. This fact is thought to have an impact on research focus. With sufficient data, the factors underlying positive and negative PCR results can be organized and revealed depending on a specific research goal.

Removal of data rows with missing values is an important step before conducting an analysis. Nevertheless, with further work, data imputation may become more accurate by not assuming the missing values as random [8]. Thereby, novel ways of data imputation specific to biomarkers can be developed.

None of the biomarkers displays a strong and direct correlation to PCR test results. However, togetherness of determined biomarkers displays a relevancy that points to a more complicated one. This indicates the need for more extensive research using a larger data set and a deep learning ANN.

V. CONCLUSION AND RECOMMENDATIONS

In this study, it is not claimed to detect positive or negative Covid-19 cases using only these biomarkers. Generated results should be considered as confirmation and/or necessity of a testing. These biomarkers show significant relationship with COVID-19 PCR results, compared to other biomarkers in the dataset. The results show consistency with studies in the field.

Fields determined to be relevant with PCR and their values can be used to train an ANN for simulating PCR test results as in this study. A wider range of biomarkers should be tested and evaluated for better prediction assistance. The study shows that the use of a range of biomarkers selected from a comprehensive dataset can be more helpful for differential diagnosis of diseases with the support of an ANN.

As mentioned in design and method, regular or spontaneous drug use before the analysis may lead to data inconsistency and misleading results. Nevertheless, the inclusion of these information in addition to an extended number of data fields may also provide benefits regarding necessary factors for successful PCR and similar tests. This requires a strict integration with the healthcare system and a detailed procedure about gathering of initial and crucial data regarding such pandemics. Protection of personal data is another part of such integration and should be planned accordingly.

Proposed approach is a good example of interdisciplinary study as it strongly encourages medicine and computer science collaboration. It is also a promising method for evaluation of different diseases subject to medical research, in addition to COVID-19.

Regarding COVID-19 researches using artificial intelligence, the global problem is about gathering quality and adequate data. Therefore, obtained results in hundreds of researches go unnoticed or become obsolete or invalid due to mutations of the virus in time. Thus, to develop a robust detection or confirmation system, supplying and analyzing of sufficient data on time is crucial. A carefully designed generalized method is thought to be immune to mutations when a wide variety of data fields and enough data are provided.

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People's Perspectives Related to Studies Vaccine for the Covid-19

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***Abstract*—Vaccines, defined by the World Health Organization as practice that reduces the risk of getting sick by working with the body's natural defenses to provide protection, and immunization are a success story of global health and development saved millions of lives each year. The importance of vaccines, which are critical in humanity's history, were noticed once again with Covid-19, thought to have emerged for the first time in December 2019. As vaccines are frequently discussed among people, their importance is understood more; anti-vaccination ideas are also increasing. Especially the news published and the way they present this news can directly affect people's perspectives on vaccines. In this study, people's perspectives on vaccination in the pandemic process caused by covid-19 will be evaluated in general. In addition, from the beginning of 2020 to today, people's views on vaccination studies for Covid-19, which affects the whole world, will be evaluated. These perspectives will be investigated whether they change when determining the differentiation of people's vaccine approach, this reason of difference and how new developments occurring during the pandemic period affect people will be searched. While measuring people's perspectives on vaccine studies, necessary pre-processing steps will be applied to the data acquired using an open-source programming language. Once the step of cleaning data, sentiment analysis will be used to measure people's perspectives through this clean data. It is planned to apply sentiment analysis processes with the Turkish-Bert model, trained with a large data set. Through this model, positive/negative evaluations of individuals about the vaccine can be classified.**

Keywords—Covid-19, Vaccine, Immunization, Anti-Vaccination, Sentiment Analysis, Machine Learning

I. INTRODUCTION

Infectious diseases, which have an undeniable place in human history, are diseases caused by microorganisms such as bacteria, viruses, fungi, or parasites that enter the body in various ways. These infectious diseases, which can be transmitted through direct contact, indirect contact, spoiled food, or exposure to chemical or radioactive substances, have turned into epidemics with severe consequences in human history. Examples of these devastating epidemics in human history are Covid-19, which is still affected these days, and black plague, smallpox, cholera, Spanish flu, HIV / AIDS, SARS, swine flu, and ebola. Covid-19, the last of these infectious diseases that emerged in different centuries and still maintaining its effects, is an infectious disease that appeared with a new type of coronavirus (SARS-CoV-2). Coronaviruses, first described by Tyrell and Bynoe in 1966 based on patients suffering from the common cold [2], are enveloped, positive single-stranded RNA viruses that affect humans as well as a wide variety of animals [1]. The covid-19 disease that is the last such of these viruses and declared a pandemic situation in 2020 caused by the SARS-CoV-2 virus is thought to have passed from an animal to human in Wuhan, China the last months of 2019. Covid-19 is a disease with high infectiousness and affects the elderly population primarily, and being able to infect without symptoms brings on the disease to be more dangerous in spreading. However, the emergence and continuing of new mutations can cause anxiety among people and changes in the treatments administered.

Taken precautions by countries against Covid-19, which affects the whole world, differ from each other. Depending on measures taken dissimilar against the spread of the epidemic and population, the number of deaths varies among countries.

According to the information obtained from the coronavirus statistics of the Ministry of Health, there are 4,591,416 cases and 38,011 deaths in Turkey on April 25, 2021 [3]. With these numbers, Turkey is the third country with the highest number of cases in Europe after France and Russia; in terms of death numbers, it is the 9th country after the United Kingdom, Italy, Russia, France, Germany, Spain, Poland, and Ukraine. As of 25 April 2021, there are 4,401,109 cases and 127,385 deaths in the UK, 3,949,517 cases and 119,021 deaths in Italy, 4,699,988 cases and 106,108 deaths in Russia, 5,432,085 cases and 102,046 deaths in France, 3,291,293 cases and 81,610 deaths in Germany, 3,468,617 cases and 77,591 deaths in Spain, 2,751,632 cases and 65,222 deaths in Poland, 2,071,142 cases and 12,841 deaths in Ukraine. Apart from this table in Europe, considering April 25, 2021, the United States has the highest number of cases and deaths, with 32,070,058 cases and 571,471 deaths worldwide [4].

With the increase of the epidemic, the fear of getting the virus, the loss of loved ones, including concerns about vaccine safety, isolation processes, social changes and distances, loneliness, and financial issues have raised during the Covid-19 pandemic [5][6]. Although the measures are taken to bring under control these negative situations led by Covid-19 and to keep the epidemic under control differ between countries, vaccination is the leading measure that can be taken against epidemic diseases. However, the development of the vaccine, an account of the epidemic, takes time. Failure to fully keep down the outbreak during the vaccine development process increases people's concerns. These concerns can give rise to the emergence and progress of insecurity in the vaccine. Furthermore, it becomes understandable to hesitate about vaccination against Covid-19 taking into account new illness, unusually this kind of fast-developing vaccine process, people's distrust of some science and healthcare professionals [7][8][20].

Despite the acceptance of vaccines, individuals who refuse vaccination services or not being vaccinated are called vaccine anti-vaxxer. Though many observers believe that the anti-vaccination movement and concerns over vaccination are something new, concerns about vaccination began shortly after introducing the smallpox vaccine and have continued unabated ever since [9]. The anti-vaccination movement has started in Turkey, especially in the last eleven years [11]. Anti-vaccination movements that continue to be effective today catch up with social media platforms, and anti-vaccination movements proceed on social media applications. According to the report published by the Center for Countering Digital Hate (CCDH), approximately 31 million people follow anti-vaxxer groups on Facebook, and 17 million people subscribe to similar accounts on YouTube. The report also stated that social media accounts managed by anti-vaxxer have increased up to 7-8 million boosts in followers as of 2019 [24]. These actions taken on social media can be directly reflected in real life. There is a significant rate of people showing their reluctance not to be Covid-19 vaccinated [10].

Considering the sensitivity in emotional situations that emerged during the pandemic period, it can be inferred that the vaccine news more affects people during the pandemic period. To attenuate vaccine hesitation and corroborate vaccine trust, evidence-based communication strategies play a crucial role [10].

Considering the importance of communication strategies and the effectiveness of social media on anti-vaccination movements, Twitter, one of the social media platforms, was chosen as the data source. It was investigated how vaccination news affects people. With this study about the vaccines developed against Covid-19, which caused the announcement of a pandemic by the World Health Organization in March 2020, the changes in people's perspectives and their sensitivity to the emerging news will be examined. At the end of the study, it will explore whether the news affects people's opinions and, if it is determined, which type of news has a high effect. In such severe periods, however, it will be examined how sensitive people are to the news. All tweets collected containing the words ("vaccine" etc.) and ("covid," "covid19", "covid-19", "covid_19" etc.) from Twitter, one of the social networking sites, to complete the study. While collecting data, it paid regard to a lot of important vaccine news regarding Turkey and the world during the pandemic period. To achieve this study, sentiment analysis is one of the most widely used and well-working data analyses obtained through Twitter.

Sentiment analysis, which is one of the widely used methods when analyzing people's emotions, opinions, beliefs, behaviors, etc. [12], can be performed with text data and audio and visual data [13]. The increase in the use of social media has enhanced the number of anti-vaccine movements and optional posts on these platforms. It can be inferred that the use of sentiment analysis has increased due to people sharing a lot of information about themselves voluntarily. In particular, comments expressed as multimodal emotions and used to infer emotions in different data types other than text such as pictures, videos, and music have come to the fore with their increase in recent years [14][21].

Sentiment analysis, which occurs from the concepts of emotion, emotion goal, entity, and polarity, is generally seen as subheadings of natural language processing and semantic science. However, it can be stated that it is not a subheading but an independent notion that supports these two notions [15][22]. Sentiment analysis, commonly used to determine people's emotions, can be classified as positive, negative, and neutral, or only positive and negative while being analyzed. This classification process, made with sentiment analysis, can be performed by more than one method. Machine learning approach, rule-based approach, and dictionary-based approach [16] can be given as examples of frequently used approaches.

- **Machine Learning Approach**: In this approach, supervised and unsupervised learning methods can be used. The algorithm is trained with some inputs having outputs to use a supervised learning method, and thus a model is created. After that, this trained model can be run on inputs with unknown output [16]. However, it is not necessary to label the data beforehand in case of the unsupervised learning method. There are many different algorithms used in the machine learning approach. It can be given as an example of commonly used algorithms Support Vector Machine (SVM), N-gram Sentiment Analysis, Naive Bayes Method, Maximum Entropy Classifier, and K-NN.
- **Rule-Based Approach**: In general, rule-based sentiment analysis, which consists of 3 stages in the form of learning the feature extraction rule, extraction of opinion sentences, and determining the direction of opinion, is an approach that can extract product features or opinion sentences for a specific product feature of interest, and uses a classification algorithm to discover effective and rules automatically [23].
- **Dictionary-Based Approach**: In this method, the sentiment analysis dictionary containing the words and sentiment scores of the phrase is used. The word in the text is matched with its equivalent in the sentiment analysis dictionary. On the contrary, this approach doesn't need to pre-process data in machine learning methods and train a classifier [17][18].

Sentiment analysis approaches and data types that analysis can be applied to may differ, as mentioned above.

II. RESEARCH DESIGN

People encounter various news in every period of their lives. Although some of this news is followed consciously, people may be exposed to some news. The impact of news can also affect individuals at different levels depending on the period. In other words, the news that couldn't affect people in their usual time can affect in unusual time exceedingly. In times when people can be more sensitive to news, it should be made in a way that news will not lead to negative consequences. This study is conducted to investigate all these possible situation.

In this study, the vaccine news that emerged during the pandemic period that people may be more sensitive to the news will be examined. At the end of this study, where text type data will be used as a data set source, it will be researched which news types affect people more. The study also aims to provide decision support for the news platforms and officials on what kind of sharing can prevent people from panicking in serious situations such as epidemics. The methods followed and their order to conclude the study are shown in Figure 1.

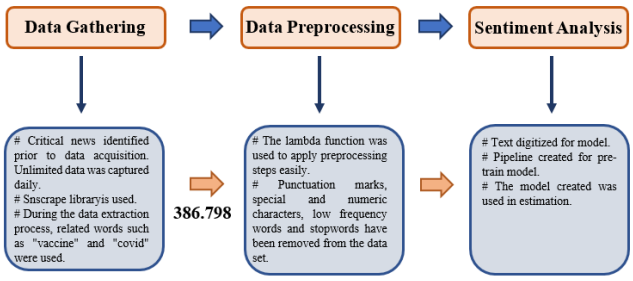

Fig. 1. Process of Study

A. *Data Gathering*

The increase in using social media has allowed people to carry their activities to social platforms. By sharing personally via social media, people can reach various purposes through these platforms. As mentioned in the study, one of these aims is to conduct and develop anti-vaccine movements through social media applications. Since social media has a significant impact on anti-vaccine movements, Twitter, one of the social media applications, was preferred as the dataset source in this study as in many other issues. Twitter is also one of the most preferred social media platforms for sentiment analysis.

The process of obtaining data from Twitter has been determined according to the relevant words and dates. In general, the data set was created by pulling all tweets with the relevant words from 01.12.2019, when the first Covid-19 case occurred, to 19.04.2021. Related words are ("vaccine" or etc.) and ("covid" or "covid19" or "covid-19" or "covid_19"). In other words, for a tweet to be received, it must contain both one of the words "vaccine" etc. and one of the words "covid", "covid19", "covid-19" or "covid_19". With all this combination, 386.798 Turkish tweets were taken between the specified dates. Unlike the Twitter API, Snscrape, one of the Python libraries, was used while collecting the tweets. Besides being gathered Turkish tweets according to the specified words, important news about Covid-19 in terms of Turkey and the world was also taken to investigate the importance of the news in the study.

The based headlines are as follows:

- The first Covid-19 case in the world was seen
- The first case was seen in Turkey.
- The first volunteer application of the Covid-19 vaccine in the world was made to Jennifer Haller.
- He talked about the first Covid-19 vaccine, and the vaccine studies continued.
- Jennifer Haller, the first Covid-19 vaccine, shared the effects of the vaccine.
- The first volunteer application in the Covid-19 vaccine was performed in Turkey.
- In domestic vaccine studies, the human trial phase was started.

  An agreement was made with China on vaccines.
- The first vaccine in the world was given to 90-year-old Margaret Keenan in England.
- An agreement was made with Germany on vaccines.
- For the first time, Chinese vaccines were introduced in Turkey.
- German vaccines were introduced in Turkey for the first time, and local vaccination studies entered the WHO list.
- Minister Varank was a local vaccine.

Since the data source in the study is tweets shared in Turkish, news that could affect Turkey's agenda, particularly during the pandemic period, were determined. While choosing the headlines, the news with striking and first situations was chosen.

B. *Data Preprocessing*

In data analysis, the data pre-processing step is crucial for the results to be accurate and meaningful. Pre-processing steps, which differ according to the type of data, can be applied in a standard way for text data, especially Twitter. One of the reasons it is common is that patterns that do not make sense or express emotion in the flow of sentences can be easily detected. Person and status tagging with "#" and "@" in the sentence can be given as an example of easily detectable characters.

The following pre-processing steps have been applied to the data taken from Twitter for the relevant date ranges.

Steps of Data Preprocessing:

1. Converting all tweets to lowercase letters (In this way, case-sensitivity was prevented),
2. Clearing frequently seen marks in tweet data such as http / @ / # / gt,
3. Cleaning punctuation and numeric expressions,
4. Removing numeric expressions,
5. Removing Turkish stopwords from the data (stopwords words were cleared using the NLTK library. For example, I wonder, but, actually, few, some, maybe, etc.)
6. Deleting lesser words in the data and determining and cleaning the words that need to be removed are specific to the data.

An example of the status of the data before and after the pre-processing steps can be found in Table 1.

TABLE I. BEFORE AND AFTER DATA PREPROCESSING

text	text
bu büyük ilaç şirketleri komplosuna girmek ist...	ilaç şirketleri komplosuna girmek istemiyorum ...
bir kaç aya kalmayacak corona virüsü aşısı bul...	kaç aya kalmayacak corona virüsü aşısı bulunul...
Koronavirüs için "Tedbirlerimiz koronadan güçl...	koronavirüs tedbirlerimiz koronadan güçlü slog...
Çocuğuna aşı yaptırmayan, aşıyı safsata gören,...	çocuğuna aşı yaptırmayan aşıyı safsata gören b...
La oğlum paniğe gerek yok. \nDomuz gribi için ...	la oğlum paniğe gerek domuz gribi aşı olmamışt...

C. *Sentiment Analysis*

The analysis method used to classify positive, negative, and in some cases, neutral emotional states in texts are called sentiment analysis. Thanks to this analysis, people's emotional situations can be measured quickly for different subjects and fields of study. Sentiment analysis can be performed manually by tagging the emotions of the texts by people, by processing keywords and assigning sentiment scores to the words, using different methods, such as using natural language processing

methods that enable the discovery of patterns defined in terms of emotion and context to analyze words and extract their true meanings.

Based on natural language processing studies, tokenizing and part of speech tagging operations make the analysis process difficult due to the different sequences in the sentence structures of Turkish texts. This difficulty becomes even more prominent in social media messages, which are already formally problematic and noisy.

Turkish natural language processing studies have made significant progress with TurkishBERT, the Turkish version of the study named BERT (Bidirectional Encoder Representations from Transformers) managed by Google. The current version of the TurkishBert model, a ready-made model trained with a comprehensive data set and high hardware capacity, is a filtered and sentence-split version of the Turkish OSCAR corpus, a recent Wikipedia transcript, several OPUS corpuscles, and a remarkable corpus provided by Kemal Oflazer. The size of the educational corpus is 35GB. A ready-made model was used in the study, as it would benefit both in terms of time and resources.

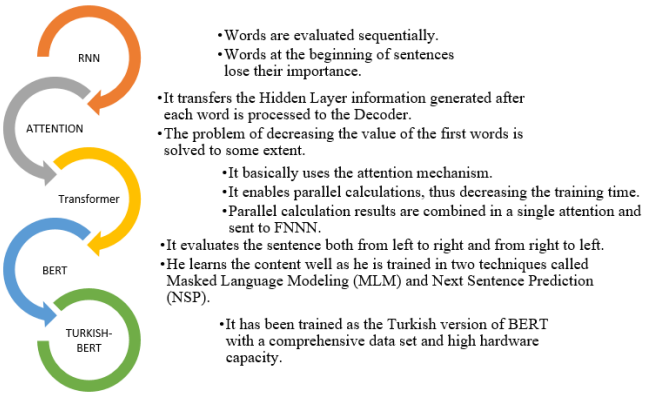

Fig. 2. Development Process of the BERT Model [19]

Python's transformers library was used for this pre-train model turned into a library and shared the way that open source. Through the Transformers library, BERT aims to search for the relationship between words in two ways by scanning sentences from right to left and left to right. In order for the relationship to be synthesized correctly in the scanning process, Feed Forward Neural Networks are used. In this learning process, large amounts of data can be processed in parallel and serial. At the same time, it uses two techniques called MLM (Masked Language Modeling) and NSP (Next Sentence Prediction). The MLM technique estimates what the masked word is in a trained environment without human tagging. While the relationship between the words in the sentences is emphasized in MLM, in the second technique, NSP, the relationship between the sentences is established. During the training, it is predicted whether the second sentence is a continuation of the first sentence in the pair of sentences [19]. The technical details of the BERT model development process are shown in Figure 2.

The python code of the pipeline created for the Turkish BERT pre-trained model is also shared in Table 2. It is worth noting that the data is included in the pipeline as a string. For this pre-train model, which was transformed into a library and shared open-source, python's transformers library was used. Thanks to the tokenizer function provided by this library, there is no need to separate the data into words. The tokenization function for the model through the pipeline is carried out through this library.

TABLE II. CREATING TURKISH BERT PRE-TRAIN MODEL

```
from transformers import AutoModelForSequenceClassification, AutoTokenizer, pipeline
model = AutoModelForSequenceClassification.from_pretrained("savasy/bert-base-turkish-sentiment-cased")
tokenizer = AutoTokenizer.from_pretrained("savasy/bert-base-turkish-sentiment-cased")
sa = pipeline("sentiment-analysis", tokenizer = tokenizer, model = model
sa = pipeline("sentiment-analysis", tokenizer = tokenizer, model = model)
df['text'] = df['text'].str.replace('\d','')
```

III. FINDINGS AND DISCUSSION

The fight against the Covid-19 disease, which has affected the whole world since December 2019, is continuing. Developments in the field of health to prevent the increase and spread of this infectious disease and all decisions taken in the political and economic area to minimize the bad influence on society have become a priority for whole communities worldwide. In this study, sentiment analysis had carried out on Turkish tweets by being based on all date ranges, when vital news emerged from the beginning of the coronavirus to today.

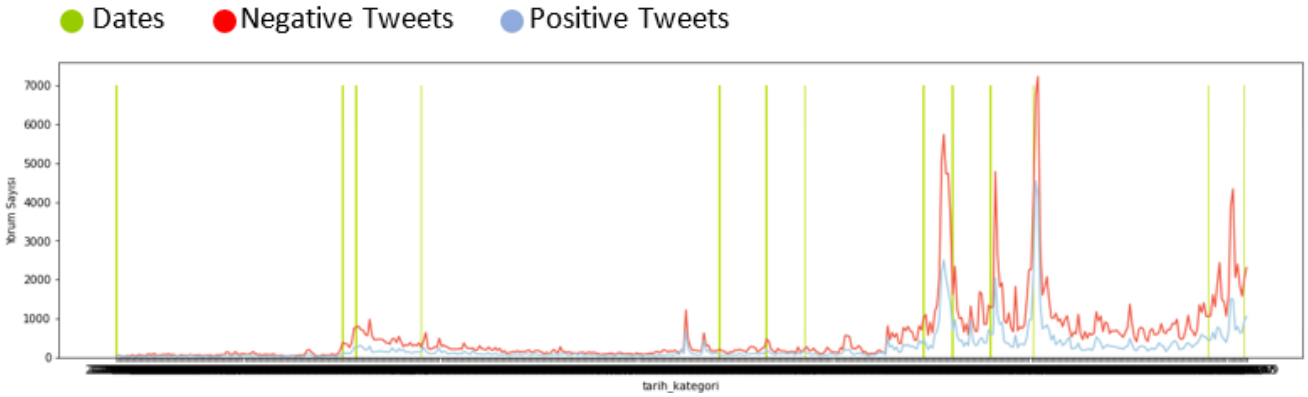

Fig. 3. Display of All Tweets Day-By-Day

The graphic in Figure 3 demonstrates the distribution of positive and negative moods of the tweets sent on a daily basis. The total number of tweets drawn for the relevant date ranges consists of 386.785 lines. 70% negatively and 30% positively of whole tweets have determined in total. The date 01.12.2019, taken as the start point, is when the first case was seen in the world. According to the time this study prepared, the latest news gotten date is 18.04.2021. In this end date has been vaccinated Minister Varank with the domestic vaccine. All tweets obtained and the interval between the determined dates are shown in Figure 3 on a day-by-day basis

In this chart, which is handled on a daily basis, it is seen that the number of negative tweets is always dominant. In fact, this is a typical situation since the subject discussed is a sensitive subject such as a disease. What is investigated and wondered here is whether there are sharp increases in mood after news dates separated by green lines. In general, it has been observed that news was shared before all the rises. Namely, it can be inferred that the rising points were derived from the news.

In addition to the line chart on a daily basis, the word cloud created by the terms in which people express their views most frequently over the total data is given in Figure 4.

Fig. 4. Word Cloud of All Data

In this study, in which the vaccine perspective was measured for the appropriate time intervals, the dominance of the word vaccine, as seen in Figure 4, is apparent. The health minister, who is at the forefront of this process and ensures that Covid-19 news reaches the citizens, has also come to the fore as a concept. At the same time, "anti-vaccine" is another of the most talked-about ideas. Since anti-vaccine movements have been active on social media for many years and vaccine studies have increased after Covid-19, posts with anti-vaccine content are thought to be among the most frequently repeated word groups during the pandemic process.

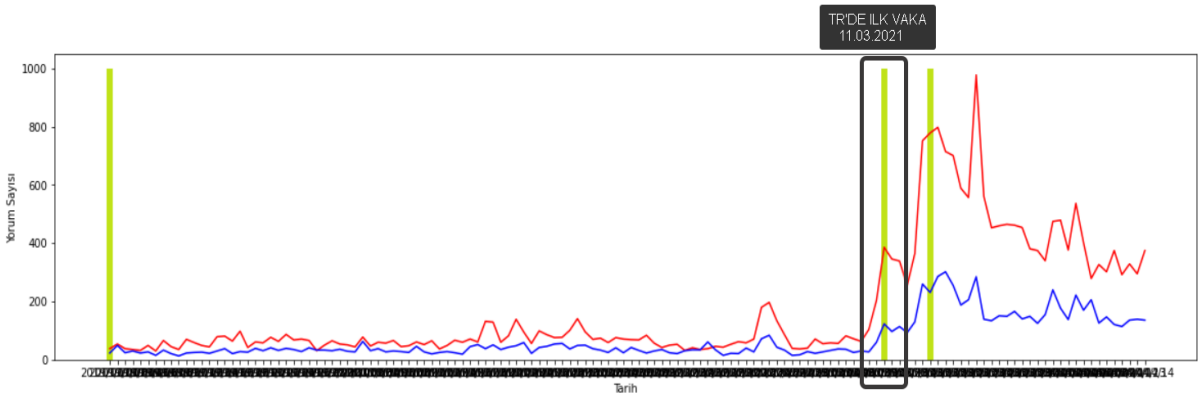

Fig. 5. The Date of the First Case in Turkey and the Increase of Related Tweets After

In the line chart made on the total data, there is an increase after almost every news. However, in specific time intervals are obvious they differ from one another. It has been found out that the growth seen after the first case in Turkey is one of the highest and first increases. This raise is shown in Figure 5.

Fig. 6. Word Cloud and Sentiment Scores (%) of Tweets Posted After the First Case

The first case in the world was seen on 01.12.2019, indicated by the first green line in Figure 5. Although Covid-19 started after this date, there was a tremendous increase in the number of tweets after the first case was seen in Turkey. The word cloud consisting of tweets posted after the first case and the average sentiment score of these tweets are given in Figure 6.

As seen in the word cloud after the first case in Turkey, the tweets posted generally include the vaccine issue. In addition, the concept of medication, which is within the same scope and quarantine words, also stands out. The significant concepts were similar in the word cloud that was for all times. This is because the concepts that can be a solution to the disease have remained popular since the first day. Besides, after the first case was seen, the word groups formed by "anti-vaxxer," etc., can be distinguished directly. Remarkably, people living in Turkey share the vaccine, developing vaccine and anti-vaxxer after the first case seen in their country. Relied on the word cloud in Figure 6, it can be seen that shortly after the first case was seen, some people started talking about anti-vaccine movements. However, people's tweets about finding a vaccine directly after the first case are noticed, and the word groups created by these tweets are also noteworthy. In other words, after the first case emerged, there is a contrast between people who are anti-vaxxer and people who want them to find the vaccine. Based on all the implications above, it can be said that the way the first news is shared puts people in a panic atmosphere.

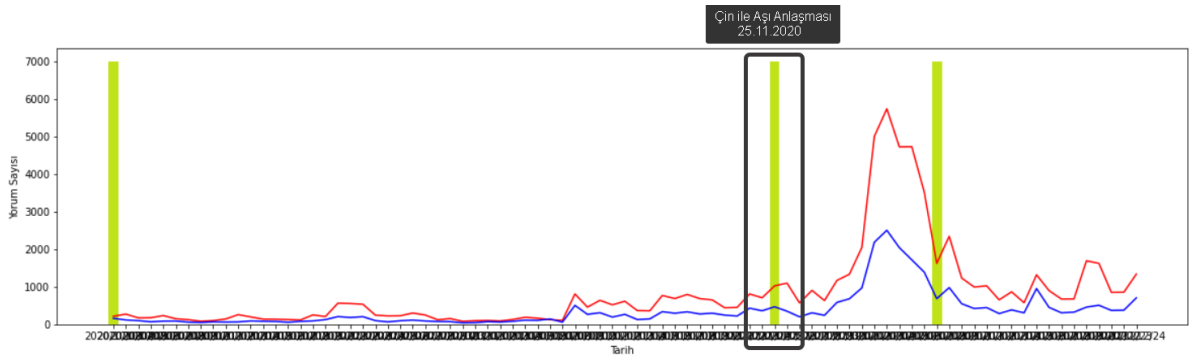

Fig. 7. Tweets Posted After the Vaccine Agreement with China

In the prepared line chart based on day, The second rise occurred after the vaccine agreement with China. Although different vaccination studies have reached the final stage, Turkey made its first agreement with China. Its impact is specified in Figure 7.

Fig. 8. Word Cloud and Sentiment Scores (%) of the Tweets Posted after the Agreement with China

The tweets posted after the vaccine agreement with China increased considerably after a short time. Word cloud and emotion distribution for this date range can also be found in Figure 8.

As can be found in Figure 8, it can realize that "Chinese vaccine" is among the most frequently mentioned word group in the word cloud. It was observed that the anti-vaxxer sharing, which emerged with the first case, continued. Also, the news on Bill Gates and vaccines, whether it has chips, lead to shared tweets about "I won't be vaccinated" and "vaccine with chips". Especially after encountering the word group "I won't be vaccinated", which is one of the expressions of anti-vaxxer, there was a need to examine the trend line of posts with the content of "I won't be vaccinated". The trend graph is shared in Figure 9.

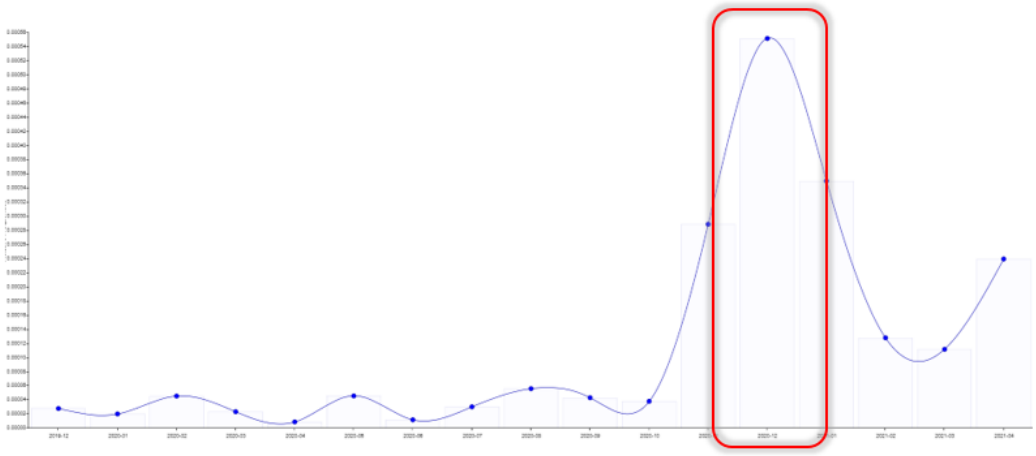

Fig. 9. Trendlines About "I won't vaccinated"

In Figure 9, the increase in the word group "I won't be vaccinated", which can be considered one of the most expressions about anti-vaxxer, shows that people were affected by the news of "vaccine with chip". applications, it has changed just 5% positively on sentiment score from previous peak news in Turkey to today. Starting from this, it can be inferred that the vaccine agreement with China and the news of the first voluntary vaccination implementation could not be made effectively enough and also said that emerging assumptions could not be controlled, how much these assumptions could affect people. The distribution of emotions of the tweets in the time period also supports this situation. ite this news, which emerged as hypotheticals, are not a convincing element by all people, it can be mentioned that they increase anti-vaccination movements on the general picture. Mentioned this circumstance is supported by the word tree graph shown in Figure 10 obtained from the tweets posted in the relevant period.

Fig. 10. The Word Tree Resulting from Shared Tweets

It has been mentioned before how sensitive people who are anti-vaxxer or not are to the news. In addition, voluntary

vaccination practices have been carried out in the world until this date, and the results of this have been shared with the whole world. However, it can be seen from the word cloud, trend graph, word tree graph, and sentiment scores that the results do not have a significant effect on anti-vaxxer.

Even though developed so quickly vaccine study and the performed voluntary applications, it has changed just 5% positively on sentiment score from previous peak news in Turkey to today. Starting from this, it can be inferred that the vaccine agreement with China and the news of the first voluntary vaccination implementation could not be made effectively enough and also said that emerging assumptions could not be controlled, how much these assumptions could affect people. The distribution of emotions of the tweets in the time period also supports this situation. After the Chinese vaccine deal and the resulting chip vaccine assumptions, tweets have 70% negative and 30% positive emotions.

In the graph containing the number of tweets daily, the first two peaks were the first date of the case in Turkey and the vaccine agreement with China. After this news, it was found that word-groups related to anti-vaxxers, availability of the vaccine, etc., were shared, and assumptions such as "chip vaccine" came to the agenda; it was determined how much people could be affected such the news. In recent history, when more concrete steps have been taken about the vaccine, other three different peak points have occurred after the news of "vaccine agreement with Germany", "application of Chinese vaccines in Turkey", and "application of German vaccines in Turkey". It is shown a graphic presentation of peak points, word clouds, and emotion scores regarding posted tweets in Figure 11, respectively.

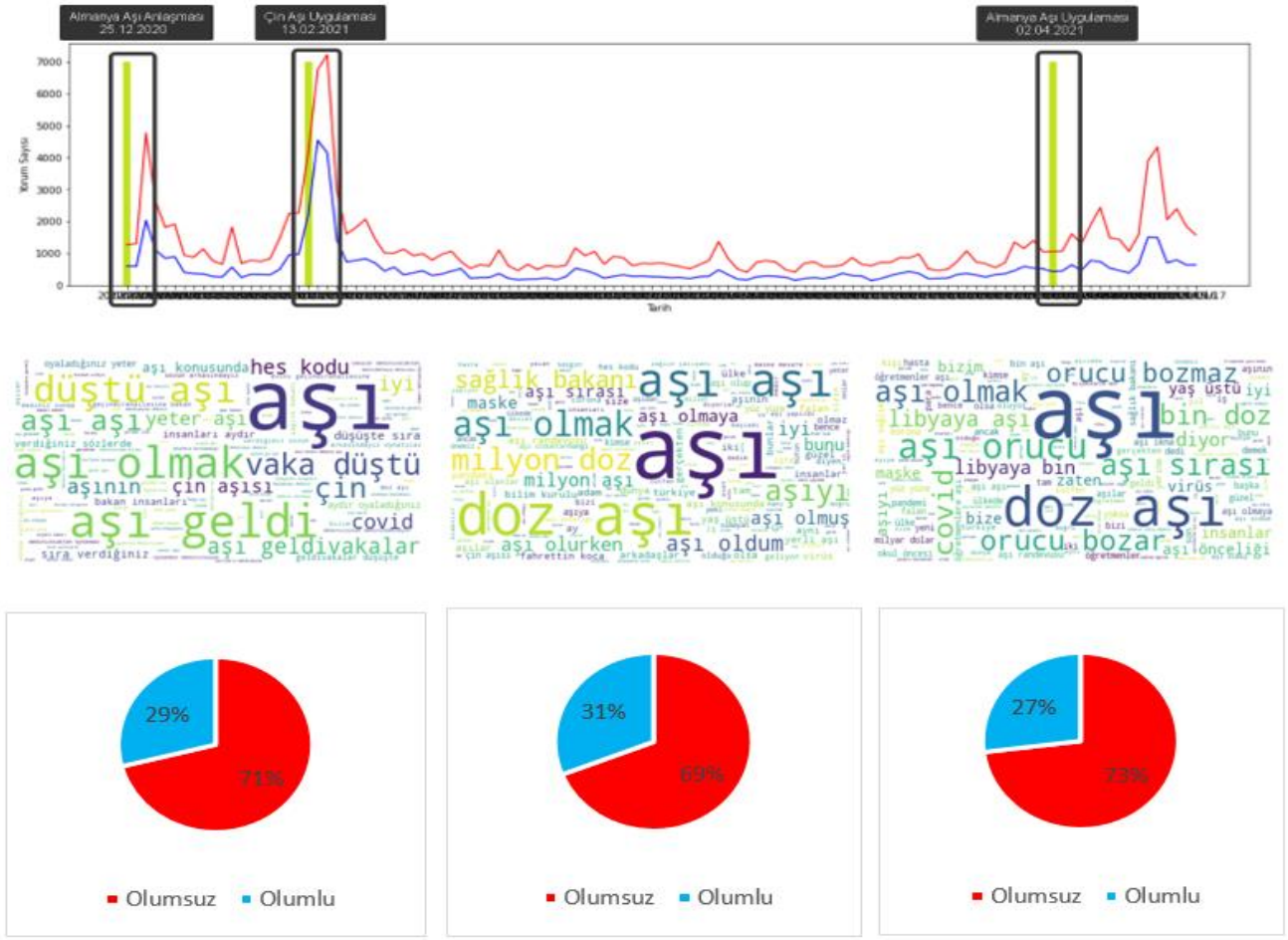

Fig. 11. The number of tweets, word clouds, and sentiment scores (%) after the news "vaccination agreement with Germany", "application of Chinese vaccines in Turkey" and "application of German vaccines in Turkey" respectively

The peak points formed after the vaccine agreement with Germany also include the volunteer application of the Chinese vaccine. For this reason, patterns such as "vaccine has arrived" are found in the word cloud containing the dates of the vaccination agreement with Germany. In other respects, the raises that occur after the Chinese vaccination application are pretty high. In this period, subjects about which age groups will be vaccinated too, etc., issues have been brought up and discussed. At the same time, evaluations of the people who had been vaccinated were followed closely. Finally, the effect of the approaching Ramadan can be seen in the rise that occurred after applying the German vaccine. The increasing stock of vaccines with the German vaccine and the decreasing age groups have led people to ask questions such as "does the vaccine break the fasting". In general, the remarkable point is that the word "anti-vaxxer" did not come to the fore in this interval, which can be assumed as a recent date.

By handling anti-vaxxer in Turkey that don't come to the fore after domestic voluntary and official vaccination applications, it can be inferred that the most effective method in preventing such anti-vaccination movements is applied demonstration.

As a result of all the news obtained, it is another point to be reached that some critical news has little effect in Turkey, while some news causes a hardly significant increase. Although it tries to explain why some news has a lesser impact than another with current period, it can be said that the news doesn't make effective enough. To observe the effects of the news more clearly, the date the news was made and the tweets posted within the next day were handled. The number of tweets posted within the first two days after all the news and news examined in the study is shown in Table 3.

TABLE III. NEWS CONTENT AND THE NUMBER OF TWEETS WITHDRAWN

No.	Dates	Detail of New	Number of Tweets Posted in the First Two Days After the News
1	01.12.2019	The first Covid-19 case in the world was seen.	163
2	11.03.2020	The first case was seen in Turkey.	952
3	17.03.2020	The first volunteer application of the Covid-19 vaccine in the world was made to Jennifer Haller.	2093
4	15.04.2020	He talked about the first Covid-19 vaccine, and the vaccine studies continued.	1073
5	26.08.2020	Jennifer Haller, the first Covid-19 vaccine, shared the effects of the vaccine.	512
6	16.09.2020	The first volunteer application in the Covid-19 vaccine was performed in Turkey.	1221
7	03.10.2020	In domestic vaccine studies, the human trial phase was started.	757
8	25.11.2020	An agreement was made with China on vaccines.	2933
9	08.12.2020	The first vaccine in the world was given to 90-year-old Margaret Keenan in England.	5622
10	25.12.2020	An agreement was made with Germany on vaccines.	3773
11	13.01.2021	For the first time, Chinese vaccines were introduced in Turkey.	17616
12	02.04.2020	German vaccines were introduced in Turkey for the first time, and local vaccination studies entered the WHO list.	3007
13	18.04.2020	Minister Varank was a local vaccine.	6301

Considering all the analyzed news and the peak points they created, it was determined that some news had minimal impact and some news had almost no effect. Some of this critical news determined for the Covid-19 process has little or no effect since the way the news is shared is not compelling enough. Especially the effects of the news that Jennifer Haller, the first Covid-19 vaccine, shared the impact of the vaccine and that the domestic vaccine studies started to be tested on humans are almost nonexistent. Another reason for the low impact of this news may occur the falling number of cases during the summer months and fewer restrictions on people. Nevertheless, the downward effect of two such

important news shows that the news could not be made effective enough. Also, those apart from the news mentioned in terms of peaking in the study haven't enough impact.

At first glance, although the news of the first vaccination in the world to 90-year-old Margaret Keenan in England seems to have a significant impact, it is thought that this effect stems from the assumptions of "vaccine with chip". This situation is demonstrated in detail in Figure 9 and later. In addition, in Table 3, the most significant increase occurred with the start of the Chinese vaccine application in Turkey. Still, the date when German vaccines were applied did not have a similar effect. Considering the news of vaccination agreements of these two countries -China and Germany-, although the opposite situation is striking, as mentioned after Figure 11, the reason for this difference may be the voluntary practices in Chinese vaccines at the time when German vaccines arrived. The news of the application of Chinese vaccines has a much more significant effect than all news, including the news of the application of German vaccines, which is thought to be because of the first vaccine application in Turkey, especially started with politicians. When this situation is taken into account, it can be said that the news that had the most impact during the pandemic period came about through practical initiatives, particularly on politicians. Nonetheless, based on all the findings, it can be stated that much important vaccination news can't be made sufficiently effective in the pandemic period when people might easily fall into panic. It is recommended that developments be made much more effectively than in other periods, significantly when cases are reduced, and people are less restricted.

IV. Conclusion

Pandemics are critical events that negatively reshape human history, and dealing with this situation has always been a priority. Drug and vaccine development studies stand out as the essential tools to cope with the pandemic. As a more practical approach due to its proactive nature, vaccination is always the first starting point. The same is true of the Covid 19 epidemic.

The development of vaccines in the fight against Covid 19 has taken place at an unprecedented speed in history. Parallel to the developments in the field of medicine, it was observed that the first vaccine was administered only one year after the first case appeared. In addition, instead of classical passive vaccines, fast-acting mRNA derivatives were focused on. With the speed of the process and its differentiation for the first time throughout human history, unexpected and severe side effects have spread rapidly among people. This has resulted in "anti-vaccine" campaigns. Politicians, states, and non-governmental organizations prefer to use media channels to cope with these campaigns' essential and vital effects. In this study, the success of these contents shared through media channels in managing the process has been evaluated. To evaluate this situation, sentiment analysis techniques were used to analyze large amounts of social media data automatically.

As a result of the study, it has been seen that although the prejudice, which is negative at the time of the first vaccine development and the preference for the Chinese vaccine, builds up very quickly, this situation is less felt in the future when the devastating effect of the pandemic increases. In addition, it has been observed that Turkish people tend to prefer the Chinese vaccine and the German vaccine, and SinoVac. It is thought that it is adequate to explain the situation accurately and informative, especially in the news on this subject.

Although significant results were obtained in the study, there are some limitations. The success of the study directly depends on the performance of the Turkish natural language processing algorithm. Although this algorithm produces good results, it is still thought to have an ongoing learning process. The data subject to the study was drawn with the help of specific keywords. Although it is believed that this situation does not pose a problem at the point of general representation, it can be said that the sample can be expanded.

There are certainly some opportunities for other researchers who want to work in the field. It can be considered that text categorization and summarization techniques can be included in the study to increase representation and summarization. It is also envisaged that this process can be enriched with machine learning techniques. Another field of research is the use of a hybrid approach, in which translations and dictionaries are preferred, which will increase Turkish natural language processing performance.

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An Application of Robotic Process Automation: The Social Leave Robot

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***Abstract*—The aim of this study is to provide the social leave part, which is one of the repetitive jobs of human resources, through a robotic process automation. The social leave robot has triggered by e-mail, parses the e-mail and understands which user has sent and what type of leave they want. The five leave types are defined in this study. The social leave robot decides whether the user can take these leave by accessing the database containing the user data. And, it also sends its decision to the user by e-mail. In this study, UiPath Studio tool is used to determine flow processes of the users and to ensure the collection and processing of data. The development process has implemented by using Visual Basic programming language. The social leave robot has the potential to save time and increase work efficiency in terms of human resources. It is thought that this study can contribute to the execution of different business processes.**

Keywords—*social leave robot, robotic process automation, work management, business process.*

I. INTRODUCTION

Robotic Process Automation (RPA) is an intelligent software robot technology that interacts within digital systems, imitates and integrates a human's actions to run a business process [1, 2, 3]. RPA robot has the potential to automate the repetitive tasks, rule based works and lower value jobs which are routine analysis and reports performed by company's employees [4]. RPA performs the automation tasks that include performing calculations, account management, financial planning and reporting, transactional tasks, human resources, updating employee information, customer service, etc. [5, 6, 7]. RPA technology uses the artificial intelligence and machine learning to improve overall workflows and business process [7]. RPA works on User Interface (UI) level elements to capture data and update applications, just like humans [8]. The level of decision making and communicating with other applications is much more advanced than traditional automation. It provides easy "Record" and "Play" automation method [9]. Customization and integration of its applications is easy, so the complexity is less than traditional automation. RPA provides better customer service and controlled workflow [7].

In this study, the social leave robot has a task that carries out employee leave informations. It evaluates the leave queries sent by the users by e-mail and returns a response to the users. The robot runs on five leave types which are annual leave, birthday leave, death leave, maternity leave and marriage leave. This study is organized as follows: Section 2 describes the method used in this study. Experimental study and its results are illustrated in Section 3. Evaluated of the results of this study and suggestions are given in the conclusions section.

II. METHODS

This work is implemented by using Visual Basic programming language in UiPath Studio tool [10]. UiPath is a RPA tool used to automate repetitive and rule based work tasks without human intervention. The tool has a simple drag and drop user interface. UiPath Studio offers the business user to build a software robot. It has the advantage for designing complex and large workflows [11].

In this study, the social leave robot uses Outlook webmail to manage the employee's leave process. The robot understands triggers and responses. The leave process executed by the social leave robot consists of 5 steps depicted in Figure 1.

The first step is the trigger process that starts the access the mail address. The content of the mail includes employee identity number (id), leave type, leave start and end dates. The second step is parsing process related to the structural part of the incoming mail. In this step, the robot parses the correct format e-mail according to its lines and assigns values in rows to variables for use where necessary. The third step includes learning process. The social leave robot learns the department of the employees according to the employee id obtained from the parsing part. In this work, employees' leave process is scanned for 6 different departments of employees which are human resources, finance, purchasing department, engineering, marketing and administrative affairs. The processing step which is the fourth step establishes the employees' leave request evaluation process. The employee transmits his/her employee id, leave type, leave start and end date information by e-mail. And, in the last step, the robot responds to the employee who sends this leave request by e-mail.

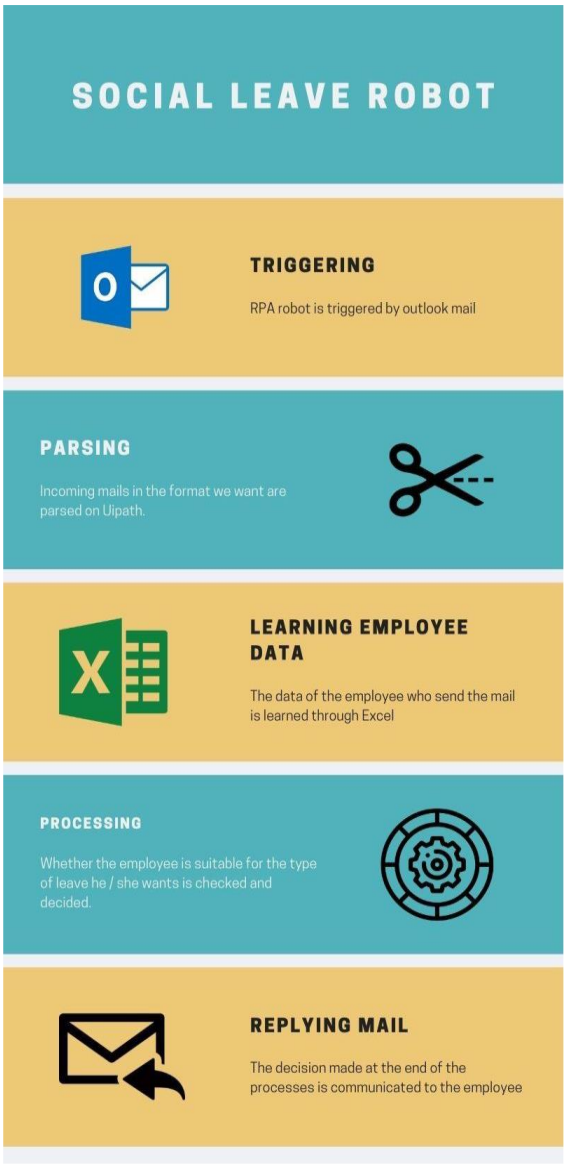

Fig. 1. The development process of the workflow

III. EXPERIMENTAL WORKS

The social leave robot behaves like a virtual worker. The robot responds to the employees' leave request information. The screenshot of the mail sent by the employee is given in Figure 2.

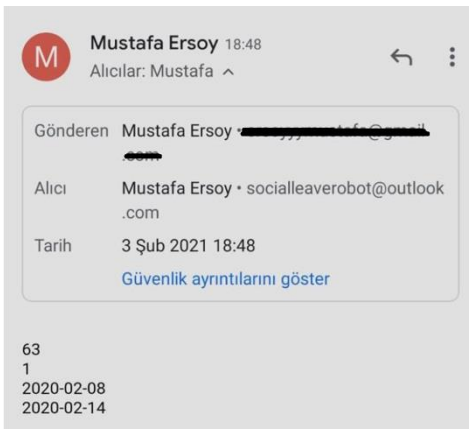

Fig. 2. E-mail of the employee's leave request sent to the robot.

The employee must indicate employee id, the type of leave, start and end dates of the leave in the e-mail. The social leave robot evaluates the leave request according to the rules of 5 different leave types. The leave type and the leave identity (id) are shown in the Table 1.

TABLE I. EMPLOYEE LEAVE TYPE

Leave type	Leave id
Annual leave	1
Birthday leave	2
Death leave	3
Maternity leave	4
Marriage leave	5

The social leave robot processes the annual leave request according to the flowchart shown in the Figure 3.

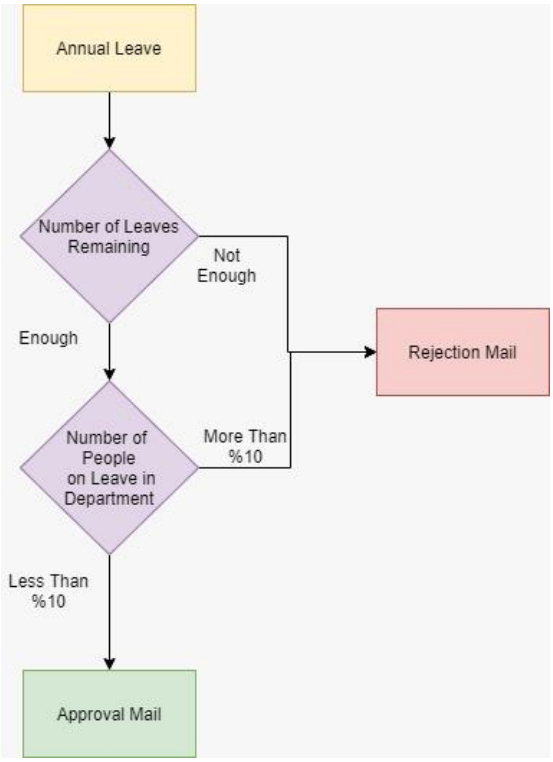

Fig. 3. The flowchart of the annual leave

The 7-day leave request of the employee id 63 in the mail shown in Figure 2 is the annual leave (annual leave id = 1). If the employee has sufficient leave days and more than 10% of the number of employees in the workplace is not on annual leave, the robot approves the leave.

The second type of leave is birthday leave. The employee gets 1 day off on his/her birthday. The flowchart of the birthday leave is shown in Figure 4.

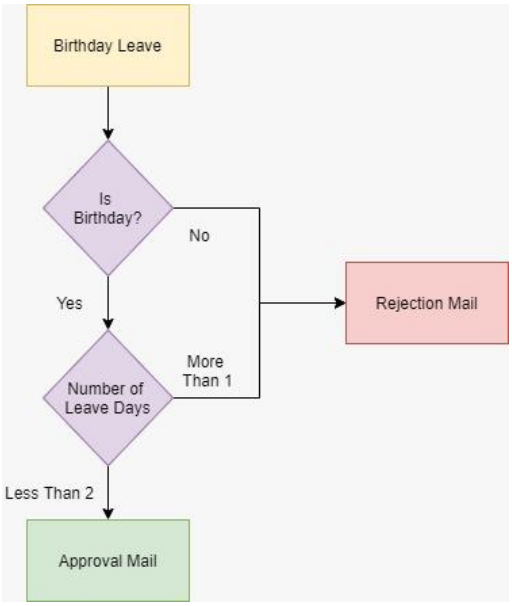

Fig. 4. The flowchart of the birthday leave

Death leave is accepted as a type of leave that the employee can request for the death of a first-degree family member such as mother, father, sibling and child. The death day is considered the starting day of leave. The flowchart of the death leave is shown in Figure 5.

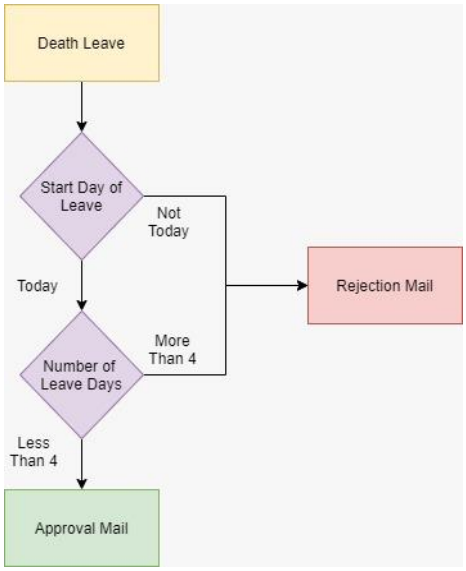

Fig. 5. The flowchart of the death leave

The maternity leave request is evaluated according to the gender of the employee. The mother can have this leave of up to 90 days. The father requests this leave of maximum 10 days. The flowchart of the maternity leave is shown in Figure 6.

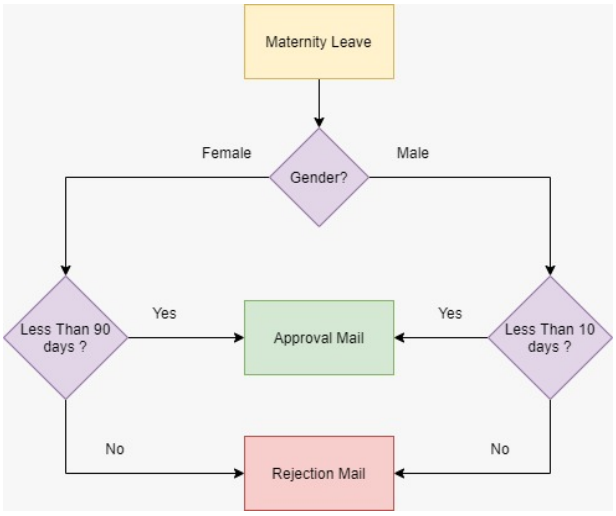

Fig. 6. The flowchart of the maternity leave

In the marriage leave, the social leave robot checks the marital status of the employee. The employee is given 5 days off for marriage. The flowchart of the marriage leave is shown in Figure 7.

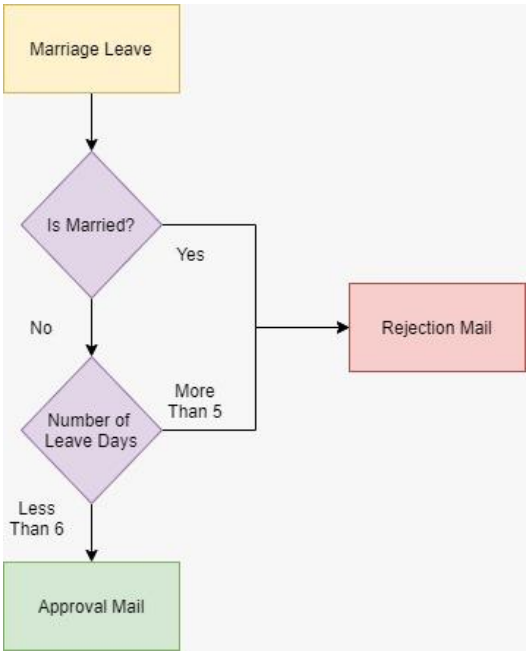

Fig. 7. The flowchart of the marriage leave

IV. CONCLUSIONS

In this study, rule-based workflows for each leave type are automatically performed by the robot. RPA increases employee creativity and productivity by enabling robots working on servers to do all kinds of repetitive tasks that can be converted to algorithms. The social leave robot runs the social leave department, which is one of the duties of human resources personnel. The robot's ability to perform repetitive tasks saves human resources extra time. This study includes a usable infrastructure for different business tasks. The social leave robot has a potential to be developed with a modular design.

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Comfort Parameter Estimation using Artificial Neural Network in Vehicle Powertrain System

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***Abstract*—Modeling and optimization for Vehicle powertrain system with high sensitive and multiple driving assumptions is one of the leading issues that Automotive industry strictly follow during system engineering phases. Specifically, Internal combustion engine needs more sensitive modeling based on vibration unlike to EV (Electric Vehicle) because of the explosion inside the engine pistons creating oscillations. Artificial Intelligence is one of the potential for Automotive technologies which also enables the mechanic system modeling more precise, clear and time and cost saving instead making experimental test load. In parallel, Artificial Neural Network (ANN) is the potential concept to consolidate with dynamic systems to make more precise parameter assumption with the support of wide experienced data pool. In this study, the vehicle with medium torque level produced by internal combustion engine is modeled via 1-D principle basis powertrain vibration behavior. After that, the modeled powertrain system is subjected to Design of Experiment (DOE) study using Latin Hypercube distribution which enables to have system behavior data in wide range which provides the data pool for ANN model. Obtained data pool from DOE including the stiffness and inertia values effecting Noise, Vibration, Harshness (NVH) is modeled with ANN structure in Python language. Trained ANN model, also called 'Digital Twin' of the system, is used to estimate comfort parameters in modeled powertrain system. According to results of the performed methodology, ANN adaptation considerably approaches to estimate best system parameters within acceptable limits. This methodology creates opportunity to estimate realized system model results in design phase instead to making too much several experimental study causing time and cost consuming.**

Keywords*—Artificial Neural Network, NVH, Latin Hypercube distribution, Digital Twin, Vehicle comfort, Double Mass Flywheel

I. INTRODUCTION

Vehicle comfort is one of the most important factor as well as driving safety and fuel consumption for driver and passengers. Noise, Vibration and Harshness (NVH) is the phenomena that establishes the base of vehicle comfort concept and classified with some specifications and limits which explains the targets of the vehicle comfort range. Double Mass Flywheel (DMF) is the product that has advantages in NVH behavior compared to Flywheel having single casting body. Oscillations occurred during the explosions in internal combustion engine should be damped to provide comfort and mechanical endurance in the vehicle. Figure 1 represents the model analyzed in this study.

Artificial Neural Network (ANN) represents the biological brain by making interacting with each artificial neurons and transmit the signals to the other in the physical models. In general, the information flow between the neurons can be provided just the signal can exceed the threshold value. Figure 2 shows the classical ANN model consists of; Input, Hidden and Output layers. Hidden layers represent the non-linear transformation section that strength the model consistency for the input values. Hidden layers strength the model estimation in case the more non-linear data exist in the pool.

Recently Artificial Intelligence (AI) studies have started to take place in engineering problem solving area both in system or design point of views. Artificial Neural Network models have one of the major possible area that representing the physical model of the real system. Nowadays 'Digital Twin' concept is leading virtual representative method for engineering systems that provides to make predict in behalf of the model behavior. ANN modeling is one of the methodology to create 'Digital Twin' for the physical models and provide physical prediction without using either real model or physical model so called 1-D model.

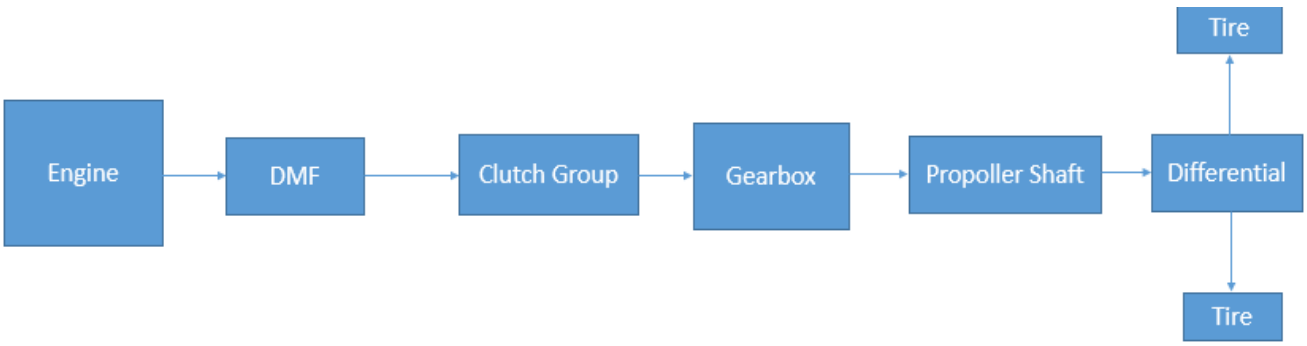

Fig. 1. Powertrain System Modeling using with Double Mass Flywheel (DMF)

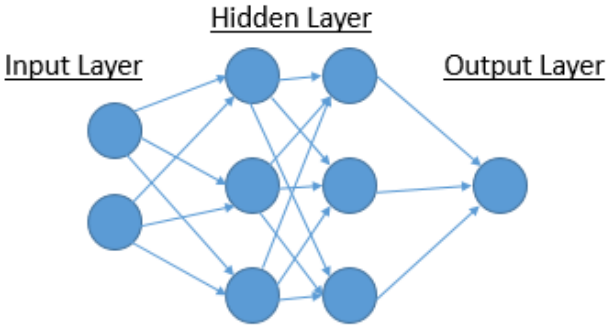

Fig. 2. Information Flow in ANN

Figure 3 explains the methodology followed in this study. The powertrain system using DMF was first modeled via 1-D model library in LMS AMESim. As next step, the system model was defined with parameter tolerances, and totally 100 experimental set was defined by using Latin Hypercube method in order to have more sensitive distribution that provides precise input for ANN model. As next step, the obtained results from 1-D model was transferred to ANN model, so that the model predict the estimated vibration value on the Gearbox based on the input data. This methodology enables to eliminate too many real vehicle testing and 1-D modeling by using 'Digital Twin' that making model predicting.

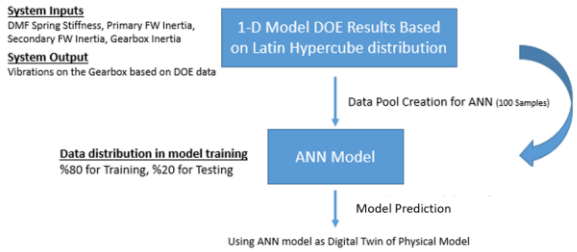

Fig. 3. General Flow Followed in the Study

II. VIRTUAL MODELING

This section explains the virtual modeling study of the real product. Virtual model, also called physical model, was created as 1-D model in AMESim programme. Figure 4 shows the modeled powertrain system. In this study, as system parameter totally 4 different values were taken into account. These parameters are in order; DMF spring stiffness (Nm/°), Primary Flywheel inertia (kg.m^2), Secondary Flywheel inertia (kg.m^2) and Gearbox inertia (kg.m^2). Based on these inputs, the output was defined as vibration (rad/s^2) value on the Gearbox of the modeled vehicle. Gearbox vibrations have high impact on NVH performance of the vehicle, because of the rattle noise tendencies in gear contacts. This sensitivity on gearbox vibrations composed the motivation during this study by using ANN model prediction. Table 1 shows the parameters within the tolerance values. The parameters were considered based on the real vehicle having medium range torque value.

TABLE I. SYSTEM PARAMETERS USİNG İN 1-D MODELİNG

System Parameters	*Min Value*	*Max Value*
Spring Stiffness (Nm / °)	40	60
Primary Flywheel (kg.m2)	0.1	0.2
Secondary Flywheel (kg.m2)	0.08	0.15
Gearbox Inertia (kg.m2)	0.8	1.5

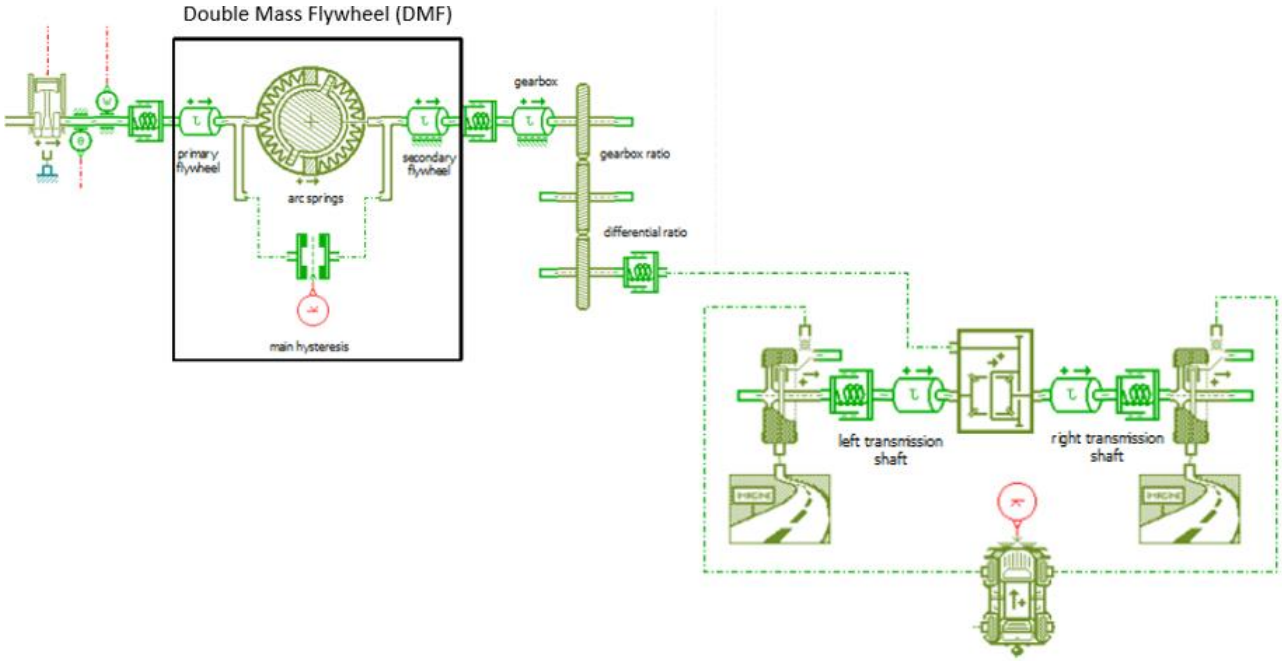

Fig. 4. AMESim 1-D Model with DMF

III. ARTIFICIAL NEURAL NETWORK MODELING

A. *Digital Twin Concept*

Digital twin represents the virtual twin of a physical model and can allow the make prediction based on the real or virtual model. In this study, in order to create base information data for 'Digital Twin', the virtual model was modeled as 1-D and DOE (Design of Experiment) study was performed by using Latin Hypercube distribution methodology. Figure 5 explains the 'Digital Twin' concept by comparable with real and virtual systems.

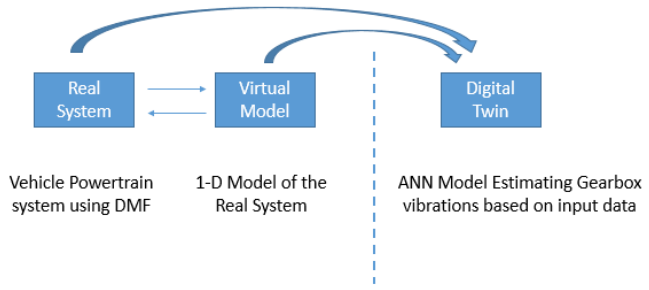

Fig. 5. Digital Twin Concept Followed in the Study

B. *Ann Modeling*

In this section the ANN modeling study is introduced and explained. Figure 6a shows the DOE data used in 1-D modeling as representative for first and last five values within the 100 samples. Figure 6b indicates Latin Hypercube distribution coefficients as sample for first and last five values as the base coefficients of the value in 6a. These data were sent to ANN model and enabled the model to get read it via 'Pandas' module.

	Spring Stiffness Nm/°	Primary FW Inertia kg.m²	Secondary FW Inertia kg.m²	Gearbox Inertia kg.m²
1	52,3	0,1535	0,12375	1,0345
2	43,3	0,1335	0,13075	1,1325
3	51,3	0,1835	0,13355	1,2235
4	40,5	0,1645	0,08315	0,8315
5	42,1	0,1815	0,09575	1,1255
96	48,5	0,1185	0,13005	1,2865
97	53,1	0,1025	0,14825	1,2725
98	55,9	0,1625	0,09155	1,1955
99	46,9	0,1275	0,09505	1,2795
100	45,3	0,1315	0,10205	1,4405

a) 1-D Modeling DOE parameters

1	[0.615	0.535	0.625	0.335]
2	[0.165	0.335	0.725	0.475]
3	[0.565	0.835	0.765	0.605]
4	[0.025	0.645	0.045	0.045]
5	[0.105	0.815	0.225	0.465]
96	[0.425	0.185	0.715	0.695]
97	[0.655	0.025	0.975	0.675]
98	[0.795	0.625	0.165	0.565]
99	[0.345	0.275	0.215	0.685]
100	[0.265	0.315	0.315	0.915]]

b) Latin Hypercube distrubition factors

Fig. 6. DOE Input Parameters distributed by Latin Hypercube Theory

Figure 7 shows the ANN model flow performed in the study. The obtained DOE results coming from the 1-D modeling first are being read by the model, than the model is randomly splitted into two groups. First group is used for training , and covers the 80% of the data. The remain 20% of are used for testing the performance of the trained data. Afterwards, the layer definition for the Artificial Neurons (AN) is done including hidden layers according to expected performance from the model. As next step, the optimizer and loss method definition take place. 'Adam' optimization methodology and 'Mean Squared Error' are selected , after that the model fit is provided and tested to provide model prediction at last step. Figure 8 shows the Python code of the ANN model used in this study. Keras ANN module library was used to make prediction based on powertrain system vibrations, and the 'Digital Twin' model was represented by Artificial Neurons . As activation function between the neurons 'Relu Activation Function' was used to provide interactions between the layers.

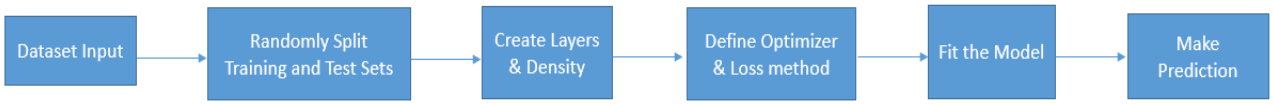

Fig. 7. ANN Model Flow

```
url = "C:\\Users\\User\\1.csv"
column_names = ['Spring stiffness', 'Primary FW', 'Secondary FW', 'Gearbox Inertia', 'Vibration']
df = pd.read_csv(url, names=column_names,
                 na_values='?', comment='\t',
                 sep=';', skipinitialspace=True)

dataset=df.values
dataset

X=df.drop(columns=['Vibration'])
Y=df[['Vibration']]

X=dataset [:,0:4]

Y=dataset [:,4]

X_train, X_val_and_test, Y_train, Y_val_and_test=train_test_split(X, Y, test_size=0.2)
X_val, X_test, Y_val, Y_test=train_test_split(X_val_and_test, Y_val_and_test, test_size=0.8)
print(X_train.shape, X_val.shape, X_test.shape, Y_train.shape, Y_val.shape, Y_test.shape)

model = keras.models.Sequential()

model.add(keras.layers.Dense(228, activation='relu', input_shape=(4,)))
model.add(keras.layers.Dense(228, activation='relu'))
model.add(keras.layers.Dense(228, activation='relu'))
model.add(keras.layers.Dense(228, activation='relu'))
model.add(keras.layers.Dense(228, activation='relu'))
model.add(keras.layers.Dense(1))

model.compile(optimizer='adam', loss='mean_squared_error')

model.fit(X, Y, epochs=1000, callbacks=[keras.callbacks.EarlyStopping(patience=3)])

print ("X is %.3f" %  x0)
print ("Y is %.3f" %  y0)
print ("F is %.3f" %  f0)
print ("F is %.3f" %  z0)

dataset = np.array([x0, y0, f0, z0])
print(model.predict(dataset.reshape(1,4), batch_size=1))

g=open("maximum_values.txt","a+")

g.writelines("Limit"+"_"+"_value="+'      '+str(x0)+' '+str(y0)+' '+str(f0)+' '+str(z0)+' '+str(model.predict(dataset.reshape(1,4), batch_size=1))+'\n')

g.close()
```

Fig. 8. Coded ANN Model for the Study

Table 2 explains the random try-out results for the defined model. In the table randomly selected three test sets are shown. After the random points are defined and found, the results are compared with the 1-D model. According to results predicted by ANN model and found by 1-D model, in average the results are found around 4.76% deviation. This deviation ratio can be considered in model predicting because the vibration of the vehicle is distributed non-linear during the operation ranges in the vehicle.

IV. CONCLUSIONS

This study makes the innovative approach to vehicle comfort modeling and parameter estimation by using ANN model, also represents the 'Digital Twin Concept'. The physical model of the powertrain system with internal combustion engine, also called virtual model, first set and run with DOE methodology based on Latin Hypercube distrubiton. Obtained data pool sent to ANN model to provide model predicting represents the Gearbox vibration. Gearbox vibration has major importance in NVH behavior, and predicting based on the system and design data provides the more consistency in engineering phases. According to model results, the vibration on the Gearbox is predicted around with 4.76% deviation. This results can be acceptable to make model prediction and considered as 'Digital Twin' of the physical model in vehicle engineering.

TABLE II. TRAİNED ANN MODEL RANDOM RESULTS VS. COMPARİSON WİTH 1-D MODELİNG

	System Parameters	***Value***	***ANN Result (Vibration)***	***1-D Results (Vibration)***	***Deviation (%) (Vibration)***
1st Random Trial	**Spring Stiffness** (Nm / °)	51.3			
	Primary Flywheel (kg.m2)	0.1835			
	Secondary Flywheel (kg.m2)	0.13355	290	280	3.5%
	Gearbox Inertia (kg.m2)	1.2235			
2nd Random Trial	**Spring Stiffness** (Nm / °)	54.3			
	Primary Flywheel (kg.m2)	0.1515			
	Secondary Flywheel (kg.m2)	0.12865	180	170	5.8%
	Gearbox Inertia (kg.m2)	1.2935			
3rd Random Trial	**Spring Stiffness** (Nm / °)	43.9			
	Primary Flywheel (kg.m2)	0.1155			
	Secondary Flywheel (kg.m2)	0.08875	310	295	5%
	Gearbox Inertia (kg.m2)	0.8455			

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Sleep Analysis Using Smart Wearable Devices

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***Abstract*—The demand for smart wearable devices has increased due to their competitive prices and accessibility. They have made significant contributions to healthcare services in terms of collecting and evaluating healthcare data. When it comes to monitoring the health status of individuals, wearable smart devices come to the rescue. It is possible to measure movement, heart rate, oximetry, respiration, body temperature, neural activity, EEG signals obtained from the head area, and other parameters with the sensors they have on them. Some devices also provide feedback services to the users on behavior or physical activities through various mobile applications via cloud-based servers. In this study, wearable devices that can record various signals during sleep and measure sleep quality are compared according to their diverse characteristics.**

Keywords—Sleep, EEG, Wearable Device, Sensors, IoT

I. INTRODUCTION

Polysomnography (PSG), which is based on the measurement of physiological signals collected from sensors connected to various parts of the body, is widely used in analyzing sleep and detecting sleep diseases. However, since the PSG system is expensive and its use requires expertise, it can only be used in hospitals or clinics in the presence of experts. Only 1 or 2 full-night PSG measurements of patients hospitalized in sleep clinics can be recorded [1]. This makes it difficult to analyze and track sleep over a long period. When analyzing sleep using PSG signals, sleep is staged according to the rules determined by the American Academy of Sleep Medicine (AASM). Accordingly, sleep is classified into two basic stages as Wake and Sleep (REM and Non-REM). The Non-REM phase consists of the N1, N2, and N3 phases [2].

Wearable devices offer advantages such as being easy to use in terms of sleep monitoring in the home environment, low cost, and can be used with other health products. However, it has not become widespread in medical use due to low accuracy and lack of transparency regarding data collection and analysis [3]. In recent years, the number of wearable health devices has increased rapidly with the effect of technological developments. These devices can collect large amounts of health-related data obtained from multiple channels with the help of different sensors they have on them, analyze this data and store them in cloud environments. The sleep data obtained from these devices, which are suitable for individual use, are valuable for sleep analysis. The offered stages of sleep with the help of wearable devices is different from the sleep stages preferred with PSG in a clinical environment. The stages labeled by these devices are wakefulness, light sleep, deep sleep, and REM stages [4].

Sleep is a neurophysiological process. EEG, which allows the investigation of the activity of the brain and is obtained with the help of electrodes placed on the head, is preferred to measure the electrical monitoring of brain wave activity. EEG signals can be used alone or together with other auxiliary signals [5]. Other signals are evaluated together with the EEG signal in detecting some stages of sleep or marking sleep disorders [6]. Therefore, in this paper, current wearable devices that can measure EEG signals and have a sleep monitoring system are included.

The paper is organized as follows: Section II gives the background about EEG signals, sleep monitoring, and sensors on the devices that help increase sleep quality. In the Section III, a review of those devices and literature studies are detailed. Finally, section IV concludes the paper.

II. THE SENSORS ON WEARABLE SLEEP TRACKERS

Most of the first-generation wearable sleep trackers had sensors that only detect motion. The next-generation devices have shrunk in size, their design has become more flexible, and they have multiple sensors. In addition to movement parameter, these devices can also measure heart rate, body temperature, Electroencephalogram (EEG), Electrooculogram (EOG), Electromyogram (EMG), oxygen saturation, skin conductance, snoring [7].

In EEG recordings taken in clinics and sleep centers, electrodes are fixed to certain parts of the head with special adhesives. Dry EEG headbands, on the other hand, were produced in a suitable way to record EEG in a home environment without the need for the adhesive to attach EEG sensors to the head [8]. EOG signals are used to detect horizontal and vertical eye movements obtained from various electrodes placed around the eye. By looking at eye movements together with EEG signals, especially REM or Non-REM phases of sleep can be easily distinguished [9]. Movement data is used to determine whether the person is awake or asleep and measured by an accelerometer. Accelerometers use a piezoelectric sensor that generates voltage in response to a motion [10]. Photo plethysmography (PPG) detects the heart rate from the volumetric changes of the blood circulation with the help of a light source and photodetector placed on the skin surface. Although the PPG signal is mainly used to detect the heart rate optically, it is also used clinically to measure oxygen saturation in the blood [11]. Heart rate and oxygen saturation are other data used to detect sleep stages or sleep-related disorders. At the same time, oxygen saturation levels in the blood are examined for respiratory events [12]. TABLE I shows the wearable devices and the sensors on them.

TABLE I. WEARABLE DEVICES AND SENSORS ON THEM

Manufacturer	Model	Form	Other parameters that can be measured with the device					
			MD	HR	O_2S	BT	EEG+EOG	Other Features
Dreem	Dreem2	Dry EEG Headband	Yes	Yes	Yes	----	EEG	Microphone input for breath control and snoring
InteraXon	Muse S	Dry EEG Headband	Yes	Yes	Yes	-----	EEG	Guided meditation with biofeedback
Philips	SmartSleep Deep Sleep	Dry EEG Headband	-----	-----	-----	-----	EEG	Acoustic stimuli to improve deep sleep quality
URGOnight	URGOnight	Dry EEG Headband	-----	-----	-----	-----	EEG	Sleep improvement program (shortening time to fall asleep and increasing sleep time)
Neuroon	Neuroon	Sleep Mask	Yes	Yes	Yes	Yes	EGG+EOG	Sleep improvement program and meditation
Entertech	Luuna	Sleep Mask	-----	-----	-----	-----	EEG	Sleep improvement program

All devices in TABLE I. can measure the EEG signal. On the table, MD represents motion detection, HR heart rate, O_2S oxygen saturation, and BT body temperature. It also includes other features of the device.

In this paper, methods of obtaining data from wearable smart devices, verification processes, usage areas will be examined and literature reviews of the devices will be presented. Future applications will be discussed as well.

III. OBTAINING DATA FROM WEARABLE DEVICES AND VERIFYING

Data collected from sensors in wearable devices is transferred to mobile applications via a wireless connection. The data produced by the mobile application is sent to a server in the cloud. Algorithms process and analyze data and produce a result. This result is shown to the user again through the mobile application. In Figure 1, the steps of data collection and evaluation from sensors in wearable devices are shown as a block diagram.

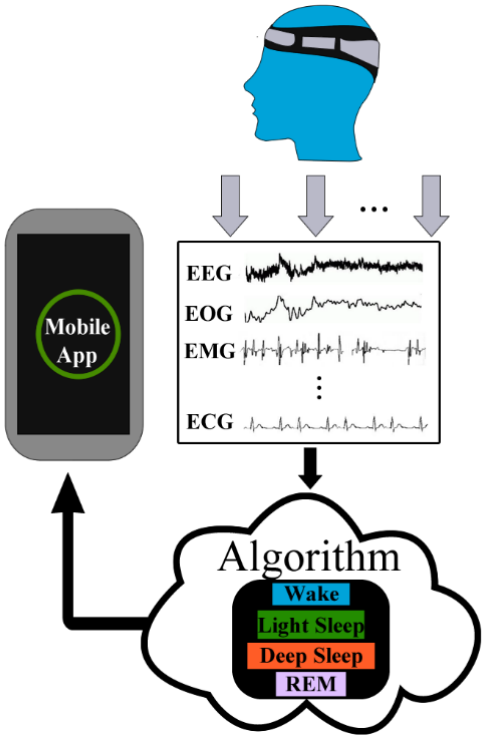

Fig. 1. Sleep device measurement.

The raw data collected from the sensors and the algorithms used to interpret them are not seen by the end-user, but it is possible to export this data [4]. Comparative validation studies of PSG signals obtained simultaneously with some of the wearable sleep trackers in the sleep clinic are present in the literature.

Data from the Dreem 2 dry EEG headband sensors are analyzed by an algorithm. At the same time, raw data can be exported. There is a microphone on the device to detect breathing irregularities and snoring. In addition, the evaluation algorithm of this device, unlike other headbands, stages sleep according to the AASM rules used in clinical PSG recordings [13]. Arnal et al. staged sleep according to AASM rules in a study they conducted with Dreem 2 concurrently with full night PSG recordings from 25 subjects in a sleep clinic. The accuracy of sleep scoring according to Dreem 2 and 5 distinct sleep experts is 83.5% ± 6.4 (F1 score: 83.8% ± 6.3) and 86.4% ± 8.0 (F1 score: 86.3% ± 7.4) respectively [14]. Chambo et al. employed a deep learning model called Dreem One Shot Event Detector (DOSED) to determine the locations and durations of 3 different features (k-complex, sleep spindle, and arousal) that they extracted from the raw EEG data obtained with Dreem 2. They tested their results on 4 different datasets and compared them with other studies in the literature [15].

The Muse S dry EEG headband is preferred for both sleep tracking and focusing. Various biofeedbacks can be collected for sleep and stress control in measurements carried out with the device [13]. There is no study in the literature for the Muse S headband, but there are studies for its previous version, the Muse 2 headband. The Muse 2 headband cannot analyze sleep and is only used to improve focusing performance. Przegalinska et al., in their research with 5 different participants selected over social media, measured the focus levels of the participants while listening to the lecture passively, using the EEG signals they obtained with the Muse 2 headband. They found that the EEG signal could not be obtained from the device very well outside the laboratory environment and the signal contained excessive noise [16]. Maddox et al studied the brain waves of expert surgeons to measure concentration and stress levels on a surgical simulator compared to other surgeons with novice or intermediate knowledge. The Muse 2 headband was used to track brain waves and concentration levels in a study involving 19 different surgeons from various branches [17].

SmartSleep Deep Sleep (SDS) is another dry EEG headband developed to improve sleep quality by tracking EEG signals. In addition, SDS generates acoustic stimuli through vibrations to improve deep sleep quality with the help of a sensor placed behind the ear [15]. In their study, Tononi et al. investigated the effects of SDS acoustic stimulations on 3 different subjects using EEG signals. Accordingly, by examining the EEG signals they obtained using the SDS headband, they proved that the acoustic stimulation feature increased the quality of deep sleep [18].

With the URGOnight neurofeedback sleep mask, it is promised to help users with a 2-hour increase in nighttime sleep and 40% faster falling asleep after 3 weeks of use. With the application, real-time feedback is provided on how to increase the duration of brain waves that will positively affect sleep [13]. Krepel et al., in their study with 37 participants with sleep problems, observed that the use of URGOnight increased the sleep quality of the participants. Accordingly, the sleep duration, which was 5.3 hours in the beginning, increased to 5.8 hours and then to 6.0 hours during the treatment, but the effect of the number of sessions on the sleep duration was not measured in the study [19].

Neuroon eye mask tracks sleep and detects the most suitable sleep pattern for the user. First, the best one is determined by monitoring the user's brain waves between different sleep patterns. Then, the cognitive level of the user is checked by performing several memory tests to measure the mental abilities of the user after sleep [13]. Liang et al. measured the reliability of wearable devices by comparing data from Neuroon and another wearable device with a device capable of clinical measurement. As a result of the study, it was found that the Neuroon sleep mask had good signal quality and accurately detected the total wakefulness data. However, it was observed that in experiments on a subject with a sleep disorder, it did not give the same results as clinical measurements [20].

IV. CONCLUSION

In the analysis of sleep, the EEG signal is mostly preferred to monitor the functions of the brain and to understand the events related to sleep. For this reason, devices that use the EEG signal to monitor sleep and improve sleep quality are finding more and more space in the consumer market day by day. When the literature studies are examined, it has been seen that the studies on these devices and their usage areas are insufficient. In particular, there are almost no peer-reviewed studies on the sensors in these devices and whether their use is necessary in the device. It is considered that there is a need for studies comparing the measurement results of these devices with the results of clinical measurements to make home sleep monitoring systems reliable.

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Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System

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***Abstract*— The major issue for the most popular countries globally has remained the ignorance of health and road accidents. In such critical health issues, it is auspicious as well as precious to save a life. The aim is to provide a Smart Patient Monitoring (SPM) system having basic parameters (Temperature Sensor, Echocardiographic (ECG) sensor, Pulse rate Sensor, Diabetes sensor, Camera, Oxygen Saturation (SO2) sensor, Blood Pressure sensor, and Spirometer sensor) in moving ambulance. In this research, an SPM system for an ambulance by using the Fuzzy Inference System (FIS) named "Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System (SPMAFIS)" is proposed to monitor the patients smartly and efficiently. The simulation results show that the proposed system gives promising results in terms of accuracy and miss rate.**

Keywords—ECG, FIS, SPMAFIS, IoMT, WBSN

I. INTRODUCTION

Advanced healthcare applications are required in current frameworks. With the exponential increments in population and innovation, the number of mishaps and diseases is likewise confidently growing. Therefore, the interest in some kinds of smart innovation in the medical field has become a requirement. Concerning the future advances and patterns, we propose a smart ambulance to be the up and coming age of innovation used to lessen the death rate caused by obstacles in travelling to the hospital for the patient [1].

The researchers discussed a novel methodology with a smart ambulance equipped with the IoT to develop the data to a fundamental focus or hospital where specialists can treat patients utilizing attendants or surgeons in the ambulance prepared through Wireless Body Sensor Network (WBSN) [2,3,4]. The Internet of Medical Things (IoMT) uses the IoT for medical and healthcare-related purposes, data collection and checkup for exploration, and checking. The IoMT has been referenced as "Brilliant Healthcare" as the innovation for making a digitized human services framework, associating accessible vital assets and social insurance administrations [5].

Improvements in computing frameworks have expanded traffic in numerous folds. In creating countries, vehicle use is expanding step by step with increments in the populace, producing additional traffic issues. To support crisis vehicles like fire motors, ambulances can react to changes comfortably means smart traffic control is required. The researchers proposed a traffic administration solution for ambulances utilizing sensors and GPS innovation [6]. The information got from the sensors is sent to allotted stations, where it is then prepared, and refreshed data is sent to the ambulance for traffic supervision [7].

Fuzzy logic is a multi-value form of logic in which any real number between 0 and 1 can be included in the real values of variables. The definition of partial truth, in which the meaning of truth is between entirely true and false, is used. Therefore, the real values of the variables can only be integer values 0 or 1 in Boolean logic.

The usage of IoT in human services adopts an essential job in supervising common illnesses and malady counteractive action and control. Remote checking is made likely through the association of ground-breaking remote measures. Furthermore, the availability permits wellbeing professionals to catch patient data and put on complex calculations in healthcare data investigation [8,9,10,11].

II. LITERATURE REVIEW

In [12], Healthcare monitoring systems aimed at uniting Artificial Intelligence (A.I.) technology. The recommended model was able for assembling verified operational data from patient's body then sent by GSM component to Azure IoT Hub wherever raw data transformed into linguistic portrayal, by the assistance of logically-based algorithm, that's trained in Fuzzy Based Inference System (FBIS) get the state of the patient [13].

In [14], the researchers introduced the Health-RAD approach for constant patient monitoring using a Wireless Body Sensor Network (WBSN). Health-RAD managed the patient's health regularly and identified an issue with dynamic symptoms scores. In [15], the developing number of patients and development in remote innovation has made the WBSN bang in the market. WBSN enabled its clients to become body sensor information and assets everywhere globally with the assistance of the Internet.

In [16], it was realized that Remote healthcare monitoring could be an answer to give an elective healthcare service that can lessen the measure of strain that the present medical services frameworks involvement in the regularly expanding interest for medical services administrations around the world. This research demonstrated a Fuzzy expert framework used to reason medical settings from a Body Area Network comprising a few sensors observing essential healthcare pointers [17,18,19].

In recent time, various research problems have been correlated by authorized surviving Evolutionary algorithms [20,21], Swarm Intelligence [22,23], Neural Network and Fuzzy Systems [24,25,26] and Deep, Extreme Machine Learning [27,28,29,30,31] that have recently been incorporated, yet additionally some new methodologies. This opened some other time for the researchers. The fundamental reason for the proposed SPMAFIS system is to save the patients who lose their lives due to the lack of medical resources in critical conditions. Such a kind of IoT enabled framework was the need of today that is auspicious and precious to save a life.

III. Proposed Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System

The hospital is an integral part of our lives, providing excellent medical facilities to patients suffering from various diseases. However, smart patient monitoring in ambulances requires significant activity in medical services and the number of innovations required. The proposed SPMAFIS system monitors the patient in a moving ambulance and creates interaction between the doctor by sending the necessary details of the patient to the hospital via IoT.

Figure 1 shows the proposed SPMAFIS approach, which relies on the four layers called Sensory Layer, Preprocessing Layer, Application Layer, and Performance Layer, respectively. The sensory layer includes various input parameters, such as Temperature, SO_2, Pulse rate, Diabetes, Camera, ECG, B.P. and Spirometer that receives patient values and transfers via IoT to a device known as a database. Due to wireless communication, the data which is received through IoT may contain missing or noisy data. So, it's called raw data. The next layer is the preprocessing layer. It is an important layer that handles the missing values using moving average and normalization to mitigate the noisy data. Finally, after preprocessing layer output of the preprocessing layer is sent to the prediction layer.

If the input parameter is relevant in the prediction layer, it passes through the fuzzification to change it into the fuzzy crisp inputs. Then, the crisp set of input data is assembled and transferred over to a fuzzy set using fuzzy linguistic variables, fuzzy semantic terms and membership functions in fuzzifier. In the subsequent stage, the fuzzy advances go through a Fuzzy Inference Engine (FIE). Fuzzy inference is the way toward figuring an offered input to output utilizing fuzzy logic, and after that, in de-fuzzifier, fuzzy set qualities are changed to a crisp set. It is normally required in fuzzy control frameworks. Finally, the crisp output value decides that either the patient's condition is Normal, Minor or Dangerous.

The input parameters range of the proposed SPMAFIS system is shown in Table I, and Table II show the Graphical and mathematical representations of proposed SPMAFIS I/O variables membership functions. The membership function of the proposed system gives curve output values between 0, 1 and also gives a scientific capacity that offers accurate estimations of information and output variables.

The output of the prediction layer will be sent to the performance layer to detect the patient's condition in terms of accuracy and miss rate. Then, it will move towards the critical patient condition detection point that either the patient's condition is serious or not. In the case of Yes, the patient will be treated as a priority Non-Preemptive, and in the case of No, the patient will be treated as FCFS, and after both conditions, either Yes or NO, it will update the data.

Figure 2 describes the flow of the proposed SPMAFIS system. First, the proposed system senses the input from the sensory layer and saves it in the database in raw form because noise added due to wireless communication. Then the raw data is sent to the preprocessing layer to mitigate noise using moving average and normalization. After preprocessing layer, the data is further sent to the prediction layer and so on.

TABLE I. Input Parameters of Proposed Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System

Factors	Normal	Minor/Avg	Severe
Temperature	90-100	99-104	103-106
SO_2	70-80	75-90	85-100
Pulse Rate	60-72	65-82	78-100
Diabetes	100-150	120-250	200-500
Camera	85-100	75-90	70-80
ECG	120-200	170-260	230-320
BP	80-120	100-200	180-300
Spirometer	50-60	55-80	75-100

A. Rule-Based

A basic part of FIS is I/O rules. FIS implementation based on I/O rules formed utilizing membership functions illustrated in Table II. The proposed SPMAFIS system I/O rules depend upon a FIS that has shown below.

B. Inference Engine of Proposed SPMAFIS

One of the centre parts of a FIS is the Inference Engine.

1. If (Camera is Normal) and (Spirometer is Normal) and (Diabetes is Normal) and (Blood-Pressure is Normal) and (Pulse-Rate is Normal) and (ECG is Normal) and (Temperature is Normal) and (Oxygen-Saturation is Normal) then (Hospital is Normal)
2. If (Camera is Normal) and (Spirometer is Normal) and (Diabetes is Normal) and (Blood-Pressure is Normal) and (Pulse-Rate is Normal) and (ECG is Normal) and (Temperature is Normal) and (Oxygen-Saturation is Minor) then (Hospital is Normal)
3. If (Camera is Normal) and (Spirometer is Normal) and (Diabetes is Normal) and (Blood-Pressure is Normal) and (Pulse-Rate is Normal) and (ECG is Normal) and (Temperature is

Normal) and (Oxygen-Saturation is Severe) then (Hospital is Normal)

6561. If (Camera is Severe) and (Spirometer is Severe) and (Diabetes is Severe) and (Blood-Pressure is Severe) and (Pulse-Rate is Severe) and (ECG is Severe) and (Temperature is Severe) and (Oxygen-Saturation is Severe) then (Hospital is Severe)

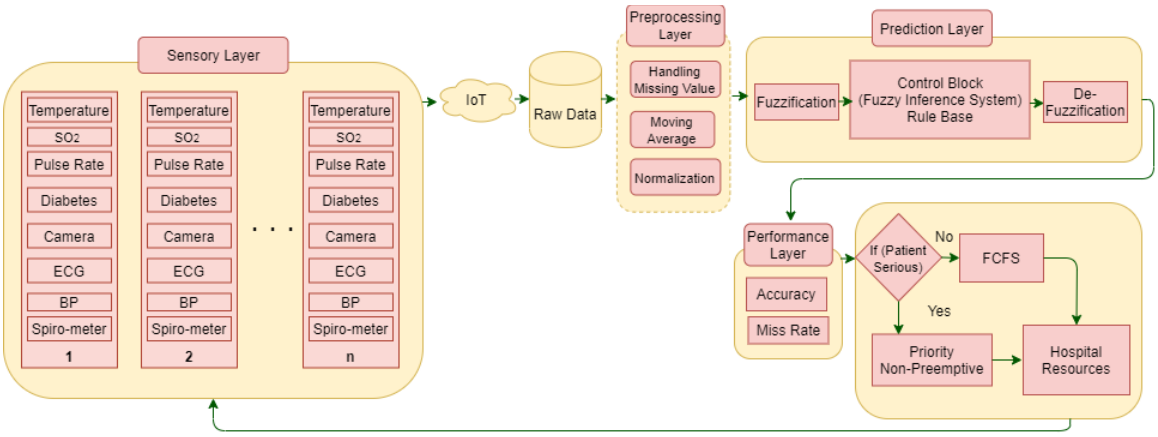


Fig. 1. Proposed Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System

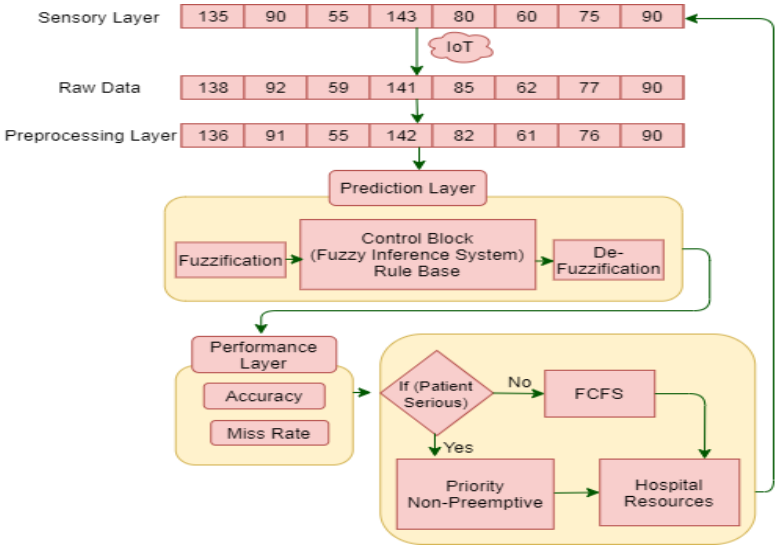
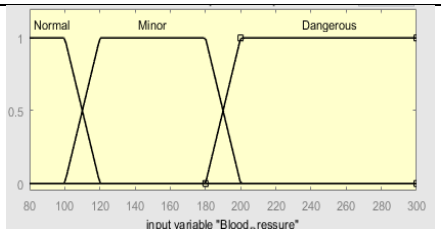
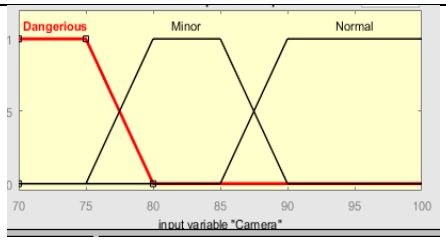
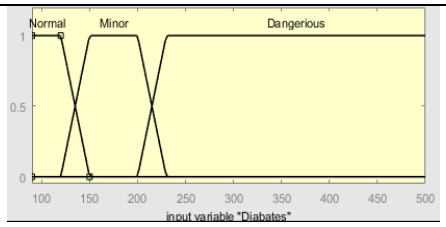
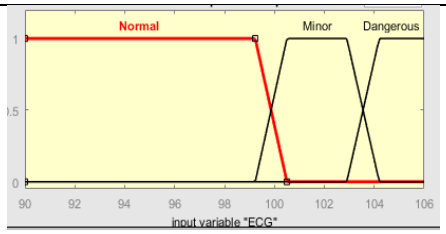
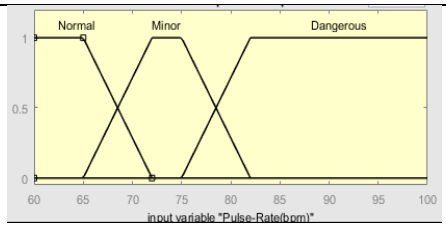
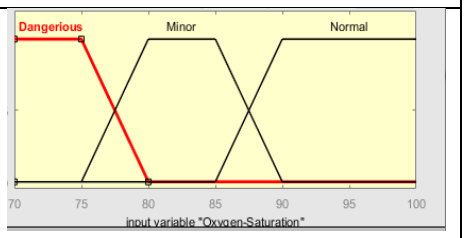
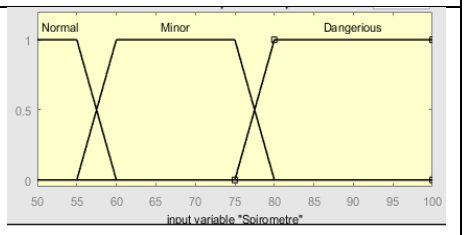
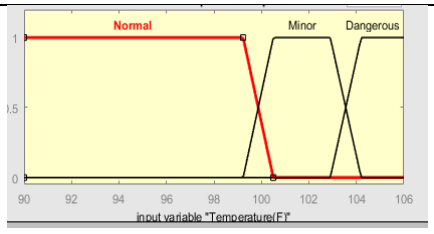
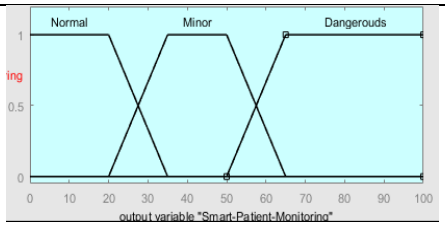


Fig. 2. Flowchart for Proposed Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System

TABLE II. GRAPHICAL & MATHEMATICAL REPRESENTATION OF MEMBERSHIP FUNCTIONS OF INPUT/OUTPUT VARIABLES OF PROPOSED SMART PATIENT MONITORING IN AMBULANCE EMPOWERED WITH FUZZY INFERENCE SYSTEM

Input/Output	Membership Functions	Graphical Representation of MF
BP= $\mu_{BP}(bp)$	$\mu_{BP_N}(bp) = \{\max(\min(1, \frac{120-a}{20}), 0)\}$ $\mu_{BP_M}(bp) = \{\max(\min(\frac{a-120}{20}, 1, \frac{200-a}{20}), 0)\}$ $\mu_{BP_D}(bp) = \{\max(\min(\frac{a-200}{20}, 1), 0)\}$	

Cam=$\mu_{Cam}(cam)$	$\mu_{Cam_D}(cam) = \{\max(\min(1, \frac{80-a}{5}), 0)\}$ $\mu_{Cam_M}(cam) = \{\max(\min(\frac{a-80}{5}, 1, \frac{90-a}{5}), 0)\}$ $\mu_{Cam_N}(cam) = \{\max(\min(\frac{a-90}{5}, 1), 0)\}$	
Db=$\mu_{Db}(db)$	$\mu_{Db_N}(db) = \{\max(\min(1, \frac{150-a}{25}), 0)\}$ $\mu_{Db_M}(db) = \{\max(\min(\frac{a-150}{25}, 1, \frac{225-a}{25}), 0)\}$ $\mu_{Db_D}(db) = \{\max(\min(\frac{a-225}{25}, 1), 0)\}$	
ECG =$\mu_{ECG}(ecg)$	$\mu_{ECG_N}(ecg) = \{\max(\min(1, \frac{101-a}{2}), 0)\}$ $\mu_{ECG_M}(ecg) = \{\max(\min(\frac{a-101}{2}, 1, \frac{104-a}{2}), 0)\}$ $\mu_{ECG_D}(ecg) = \{\max(\min(\frac{a-104}{2}, 1), 0)\}$	
P.R. =$\mu_{PR}(pr)$	$\mu_{PR_N}(pr) = \{\max(\min(1, \frac{72-a}{7}), 0)\}$ $\mu_{PR_M}(pr) = \{\max(\min(\frac{a-72}{7}, 1, \frac{82-a}{7}), 0)\}$ $\mu_{PR_D}(pr) = \{\max(\min(\frac{a-82}{7}, 1), 0)\}$	
SO_2 =$\mu_{SO_2}(so_2)$	$\mu_{SO_{2_D}}(so_2) = \{\max(\min(1, \frac{80-a}{5}), 0)\}$ $\mu_{SO_{2_M}}(so_2) = \{\max(\min(\frac{a-80}{5}, 1, \frac{90-a}{5}), 0)\}$ $\mu_{SO_{2_N}}(so_2) = \{\max(\min(\frac{a-90}{5}, 1), 0)\}$	
SM=$\mu_{SM}(sm)$	$\mu_{SM_N}(sm) = \{\max(\min(1, \frac{60-r}{5}), 0)\}$ $\mu_M(sm) = \{\max(\min(\frac{r-60}{5}, 1, \frac{80-r}{5}), 0)\}$ $\mu_{SM_D}(sm) = \{\max(\min(\frac{r-80}{5}, 1), 0)\}$	
T=$\mu_T(t)$	$\mu_{T_N}(t) = \{\max(\min(1, \frac{101-c}{3}), 0)\}$ $\mu_M(t) = \{\max(\min(\frac{c-101}{3}, 1, \frac{105-c}{3}), 0)\}$ $\mu_{T_D}(t) = \{\max(\min(\frac{c-105}{3}, 1), 0)\}$	

SPM=$\mu_{SPM}(spm)$	$\mu_{SPM_N}(spm) = \{\max(\min(1, \frac{35-O}{15}), 0)\}$ $\mu_{SPM_M}(spm) = \{\max(\min(\frac{O-35}{15}, 1, \frac{65-O}{15}), 0)\}$ $\mu_{SPM_D}(spm) = \{\max(\min(\frac{O-65}{15}, 1), 0)\}$	

C. *De-Fuzzifier*

One of the major FIS systems is De-fuzzifier. There are various sorts of De-Fuzzifier, and the centroid kind of De-Fuzzifier is utilized in the concerned article

IV. Simulation and Results of Proposed Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System

MATLAB R2017a tool is allocated for simulation results. MATLAB is furthermore used for demonstrating recreation, algorithm growth, prototyping, also various additional departments. MATLAB is an expert device for software strategy, data analysis, design, and calculation. For recreated results, eight data centres and one output aspect are used. At that time, results display output; there can be specific sets of output, for instance, temperature, SO_2, Pulse Rate, Diabetes, Camera, ECG, B.P., and Spirometer. In this paper, the proposed SPMAFIS system also recognized output and similarly proves the varied sorts of output like FCFS and Non-Preemptive Priority Scheduling algorithms. FIE creates lookup rules.

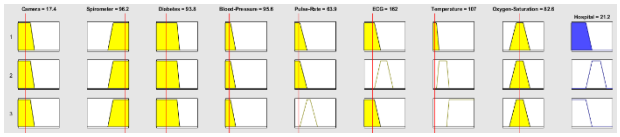


Fig. 3. Lookup Rules of Proposed Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System

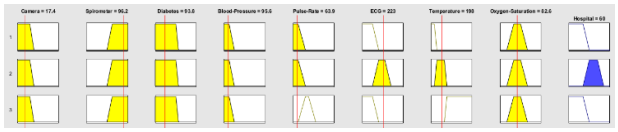


Fig. 4. Lookup Rules of Proposed Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System

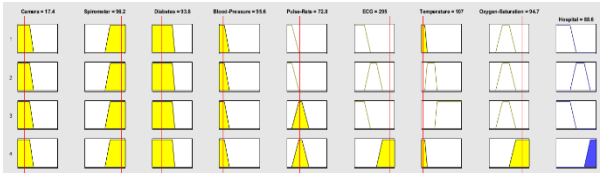


Fig. 5. Lookup Rules of Proposed Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System

Figure 3 illustrates that if the value of the Camera is Normal, Spirometer is Normal, Diabetes is Normal, Blood-Pressure is Normal, Pulse-Rate is Normal, ECG is Normal, Temperature is Normal, and Oxygen-Saturation is Minor then there in output proposed SPMAFIS is Normal. Figure 4 illustrates that if the value Camera is Normal, Spirometer is Normal, Diabetes is Normal, Blood-Pressure is Normal, Pulse-Rate is Normal, ECG is Minor, Temperature is Minor, and Oxygen-Saturation is Minor. There is output proposed SPMAFIS is Minor. Figure 5 illustrates that if the value of the Camera is Normal, Spirometer is Normal, Diabetes is Normal, Blood-Pressure is Normal, Pulse-Rate is Minor, ECG is Severe, Temperature is Normal, and Oxygen-Saturation is Normal. The output of the proposed SPMAFIS is Severe.

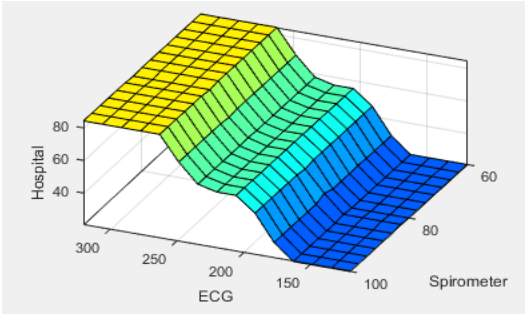


Fig. 6. Rule Surface for ECG and Spirometer of Proposed Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System

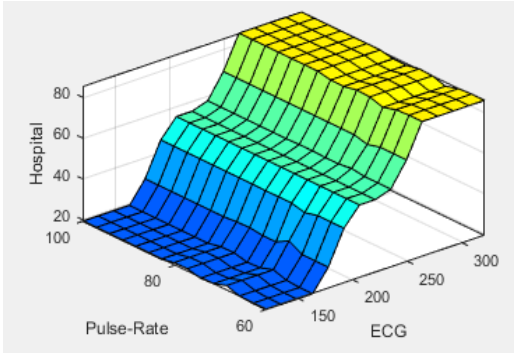


Fig. 7. Rule Surface for Pulse-Rate and ECG of Proposed Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System

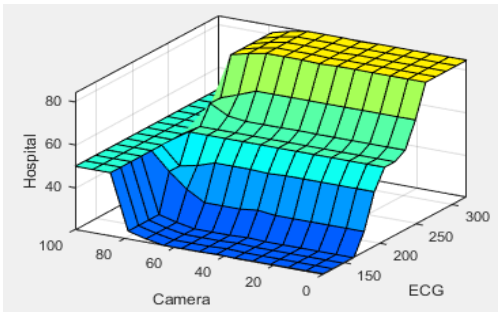


Fig. 8. Rule Surface for Camera and ECG of Proposed Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System

Figure 6 is illustrating the 3D look by dominating various input parameter estimations of ECG and Spirometer. Blue, Green and Yellow variation describe weightage Sever, Good and Best respectively. Figures 7 is illustrating the 3D look by dominating various input parameter estimations of Pulse-Rate and ECG. Blue, Green and Yellow variation describe

weightage Sever, Good and Best respectively. Finally, figure 8 illustrates the 3D look by dominating various input parameter estimations of Camera and ECG. Blue, Green and Yellow variation describe weightage Sever, Good and Best respectively.

V. CONCLUSION

In this paper, the proposed Smart Patient Monitoring in Ambulance empowered with Fuzzy Inference System generates messages after sensing the patient in case of a critical condition. By utilizing FIS, the system becomes more reliable and efficient. After the simulation, the results show that the proposed system gives a quick response to handle any patient's critical condition according to the given inputs. In the future, the vision could be improved by using A.I. to give real-time prescriptions to patients in an ambulance.

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Optimization of the Emergency Healthcare Facility Location: A Case Study in Tepebasi District, Eskisehir

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***Abstract*—Identification of the optimal location of facilities is one of the most important optimization issues that have been studied by both the practitioners and the scholars for years. In particular, the acceptable/reasonable location of facilities that directly affect the human life such as health centres, emergency response points, fire station or field hospitals after a disaster/earthquake is key for both human life and timely access to all demand points. Emergency measures and efficient use of resources are needed for some extraordinary situations in terms of public health in matters that require attention and dynamism such as epidemics. Nowadays, it has been observed that the COVID-19 outbreak has reached a serious third/fourth peak and some hospitals have been declared as pandemic hospitals. In this study, the locations of the new pandemic hospitals planned to be established in Eskisehir, Tepebasi district were tried to be determined and it was aimed to reach all the necessary points with an appropriate set covering model within the specified constraints.**

Keywords—set-covering problem, optimization, emergency healthcare facilities

I. INTRODUCTION

Identification of the optimal location of healthcare services is a very critical strategic decision in terms of ensuring uninterrupted continuity of public health services. Inadequate and poorly located service points can be very costly, especially in healthcare systems. It is very important to reach on time in emergency situations therefore, when the system is installed, the distance or response time should be strictly evaluated. Otherwise, serious human life losses such as injuries, coma and deaths associated with not arriving on time may occur.

Since the method of facility locations was introduced by Weber[2], various researches and applications have been carried out. In the 1960s, the first facility location model for health systems was proposed by the Hakimi [3], and then many innovative efforts by other researchers followed.

Determination of the appropriate health centre locations is often discussed in the literature with different types (hospital, emergency response point, humanitarian logistics, blood distribution bank, etc.). Considering how important human health/life is, health facilities to be established are expected to meet expectations in the best way. In this context, location models are effectively employed by researchers due to the mathematical model structure that provides successful and satisfactory results.

In the literature, under the topic of healthcare applications, set covering model, maximal covering model and P-median models are performed to specify the proper locations of the facilities. The major installation principles of the healthcare facilities are accepted as accessibility, adaptability, and availability [1]. Site-selection/location models are very functional and useful for disaster management and humanitarian logistics. The location models consider that the appropriate number of facilities have been opened and the service points include certain factors such as neighborhoods, number of the case, population ratio, distance, and the importance levels of the regions.

Various studies focusing on health facility locations are given in the literature[1], [4]–[7]. Afshari and Peng [8] classified healthcare services into three main groups: preventive, emergency, and health center services or other normal services. Hale and Moberg [9] modelled a deterministic set covering problem for location selection, Dekle et al. [10] developed a set covering model to respond demands in disaster zones. Hu et al. [11] provided a model to determine earthquake shelter location selection for the given area.

Recently, it has been observed that the COVID-19 epidemic has reached a serious peak level and some hospitals have been declared pandemic hospitals due to the inability to cope with the cases. There is an urgent need to bridge the gap in health systems to effectively fight against this serious disease/epidemic. After the World Health Organization declared the novel coronavirus a pandemic in early 2020, many outbreak charts have been created to show the recent progression of COVID-19 using various statistical data. When the numbers reach their highest value, it is called a peak. The importance of the peak point is to be able to see how the number of people in need of treatment at that point is met with the current health system capacity. If the number of patients needing treatment at the peak point is higher than the bed capacity in the country, some of these people may be deprived of health services or even lose their lives. For this reason, the peak point is tried to be pulled down with the measures taken. At this point, a complementary healthcare system is needed, and capacity building studies should be initiated. Accordingly, the most suitable health facility location should be determined within the framework of the determined restrictions/special expectations.

In this study, we aimed to establish a pandemic health facility in Eskisehir, which is one of the best and developed cities in urban planning in Turkey, and it was investigated with a set-covering model to provide the optimal location of new pandemic hospitals. The candidate sites to be established in Tepebasi district were selected and the most suitable positions were determined by using some specific determinants such as

population density of the neighborhoods, the number of potential patients and the elderly people.

According to literature reviews, it is the first study which focuses on location selection of a pandemic hospital considering the set-covering approach for Eskisehir case. In addition, conducting the study with real data (a real-life problem) can be presented as another contribution.

II. Background Information

In this section, the basic classical facility location model-set covering model- is presented. Set covering model is in the class of discrete facility location models which assume demands can be collected as a finite number of discrete positions.

A. The Set Covering Problem

The set covering model aims to minimize the number of elements that are required to cover all demand nodes or total fixed cost of open facilities by covering all demand points. The following formulation shows the classical set covering model:

$$x_j = \begin{cases} 1, if\ an\ emergency\ health\ facility\ is\ assigned\ to\ site\ j \\ 0, \quad o.w \end{cases}$$

$$min\ z = \sum_{j=1}^{n} x_j \qquad (1)$$

$$\text{s.t} \quad \sum_{j \in J} a_{ij} x_j \geq 1\ \forall_i\ i = 1, \dots, m \qquad (2)$$

$$x_j \in \{0,1\}\ j = 1, \dots, n$$

where a_{ij} is a 0-1 coefficient. The objective function (1) minimizes the number of facilities that are located, Constraint (2) provides that each demand point must be covered by at least one of the selected facilities within the distance limits. Constraints (3) show standard integrality conditions. In set covering problems, maximum distance or response time data can be utilized for identification of emergency health facility.

III. Application of the Model

Eskisehir is one of the important crossroads for transportation in Turkey, such as Ankara and Istanbul. Eskisehir municipality has Tepebasi and Odunpazari districts in city center. Tepebasi Municipality has ninety-one districts (Fig. 1) and according to statistics, the twenty-five most populous and most vulnerable districts were selected to identify suitable pandemic healthcare facilities. In order to obtain an optimal model, a set covering model was created using the relationships of neighbourhoods.

The main objective of Tepebasi Municipality is to create a healthy, sustainable and livable environment for all its citizens. Under this concept, in the pandemic periods the city policy makers aim to construct emergency service facilities to support Covid-19 patients effectively with considering the rate of disease spread. Because close contact, distance and hygiene conditions are very critical in combating this relentless disease. Therefore, it makes sense to establish emergency health centres in high and elderly population locations that are more vulnerable by evaluating risk factors.

IV. Results and Discussions

In this study, critical places were determined using the population ratio, the elderly population ratio and some serious disease statistics (weighted importance levels). All these factors are effective in reaching the hospital as soon as possible and being closer to the patients while determining the location of the hospital. The hospital should be established among the priority regions where this demographic and health information/statistic is high in the related districts in study.

According to the health data statistics, the neighbourhoods in Tepebasi district are as follows (Table 1):

$$min\ z = \sum_{j=1}^{25} x_j$$

$$\text{s.t}$$

$$x_3 + x_5 + x_6 \geq 1$$
$$x_6 + x_{11} \geq 1$$
$$x_1 + x_6 + x_{19} \geq 1$$
$$x_{10} + x_{11} + x_{20} + x_{21} \geq 1$$
$$x_1 + x_6 + x_{21} \geq 1$$
$$x_1 + x_2 + x_3 + x_5 + x_{11} + x_{21} \geq 1$$
$$x_{10} + x_{11} + x_{18} \geq 1$$
$$x_{12} + x_{13} + x_{14} + x_9 + x_{16} + x_{17} + x_{18} \geq 1$$
$$x_8 + x_{10} + x_{12} + x_{13} \geq 1$$
$$x_4 + x_7 + x_9 + x_{12} + x_{13} + x_{20} + x_{22} \geq 1$$
$$x_2 + x_4 + x_6 + x_7 \geq 1$$
$$x_8 + x_9 + x_{10} + x_{18} \geq 1$$
$$x_8 + x_9 + x_{10} + x_{14} + x_{22} \geq 1$$
$$x_8 + x_{13} + x_{17} + x_{25} \geq 1$$
$$x_{14} + x_{16} + x_{17} + x_{23} + x_{24} \geq 1$$
$$x_{15} + x_{17} \geq 1$$
$$x_8 + x_{14} + x_{15} + x_{16} \geq 1$$
$$x_7 + x_8 + x_{12} \geq 1$$
$$x_3 \geq 1$$
$$x_4 + x_{10} + x_{21} + x_{22} + x_{25} \geq 1$$
$$x_4 + x_5 + x_6 + x_{20} + x_{25} \geq 1$$
$$x_{13} + x_{14} + x_{10} + x_{20} + x_{25} \geq 1$$
$$x_{15} + x_{24} \geq 1$$
$$x_{15} + x_{23} \geq 1$$
$$x_{14} + x_{20} + x_{21} + x_{22} \geq 1$$
$$x_j \in \{0,1\}\ j = 1, \dots, 25$$

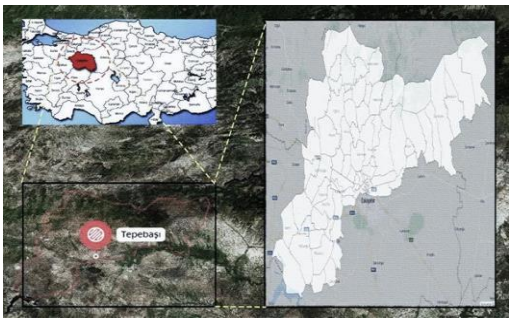

Fig. 1. The location of Tepebasi district, Eskişehir [12]

TABLE I. The Set-Covering Problem

Numbers	Districts	The Covered Points						
1	Çamlıca	6	3	5				
2	Şirintepe	11	6					
3	Batıkent	19	6	1				
4	Yenibağlar	21	20	10	11			
5	Ertuğrulgazi	21	6	1				
6	Uluönder	2	3	1	21	5	11	
7	Sütlüce	18	11	10				
8	Zafer	16	18	12	9	14	13	17
9	Fatih	10	13	12	8			
10	Bahçelievler	9	12	13	7	22	20	4
11	Yeşiltepe	2	7	4	6			
12	Kumlubel	8	18	9	10			
13	Tunalı	9	10	14	22	8		
14	Ömerağa	13	8	17	25			
15	Şeker	16	17	14	24	23		
16	Fevziçakmak	15	17					
17	Şarhöyük	14	8	16	15			
18	Esentepe	8	12	7				
19	Aşağı Söğütönü	3						
20	Eskibağlar	21	4	10	22	25		
21	Hoşnudiye	5	6	20	4	25		
22	Güllük	13	10	14	25	20		
23	Merkez Yeni	24	15					
24	Işıklar	23	15					
25	Cumhuriye	21	22	20	14			

The optimal solution of the model obtained using GAMS software is given in Table 2. According to the analysis results, the minimum number of health facilities is equal to seven and the identified pandemic healthcare facility locations are obtained as Batıkent, Uluönder, Bahçelievler, Kumlubel, Şeker, Şarhöyük, Güllük.

All facilities allocated to meet each specified district health needs (twenty-five subsets). The optimal set-covering plan regarding the minimum number of facilities has given a successful result (Fig. 2).

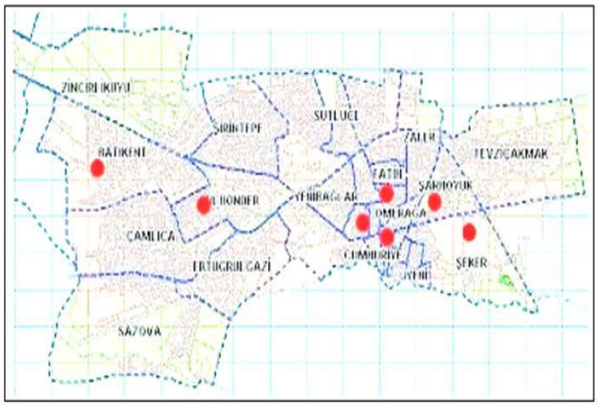

Fig. 2. The obtained model solutions

TABLE II. THE OBTAINED RESULTS

Numbers	Districts	The Covered Points						
3	Batikent	Çamlıca 1	Uluönder 6	Aşağı Söğütönü 19				
6	Uluönder	Çamlıca 1	Şirintepe 2	Batikent 3	Ertuğrulgazi 5	Yeşiltepe 11	Hoşnudiye 21	
10	Bahçelievler	Yenibağlar 4	Sütlüce 7	Fatih 9	Kumlubel 12	Tunalı 13	Eskibağlar 20	Güllük 22
12	Kumlubel	Zafer 8	Fatih 9	Bahçelievler 10	Esentepe 18			
15	Şeker	Ömeraga 14	Fevziçakmak 16	Şarhöyük 17	Merkez Yeni 23	Işıklar 24		
17	Şarhöyük	Zafer 8	Ömeraga 14	Şeker 15	Fevziçakmak 16			
22	Güllük	Batikent 3						

V. CONCLUSION

Since the emergence of COVID-19, many scientists and researchers have begun to seriously redefine and address different aspects of epidemiological models. However, there are few studies focusing on how this hot topic can be applied to emergency health facility location problems to address the deficiencies in health services.

In this paper, emergency pandemic healthcare facility location optimization model for Tepebasi district in Eskisehir, was investigated using set-covering modelling approach in a simple and practical way. The set-covering model discovers the minimum number (or cost) of resources needed to cover all demands within a particular time or distance. In this study, we aimed to allocate emergency healthcare facilities for pandemics in the determined locations, which is called as Pandemics hospitals, with covering twenty-five districts which are more vulnerable according to demographic data and health statistics. The obtained results are successful in terms of satisfying the decision makers and policy makers expectations.

For future studies, the model can be expanded to include more data on districts across Eskisehir and uncertainty can be considered for the new model using P-median and Maximal coverage modelling with scenario analysis. Depending on the size of the problem, some meta-heuristic methods or heuristic methods can be adapted to the location selection problem.

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Determination Of Enterprise Resource Planning Critical Success Factors At The Defense Industry

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***Abstract*—The defense industry, which has been the leading sector in terms of modern technology in the world in recent years, has been traded as a strategic product between states on a world scale with the increasing intensity of investigations and developments, and they affect the political pacts and policies of the countries to the same extent. According to global stiff competition in the worldwide defense industry, Turkey faced sanctions and restrictions exposed for decades. Particularly after the Cyprus Peace Operation, Turkey have made necessary conclusions and made the legislation to make national defense industry moves and has created a research and manufacturer institutions. Currently Turkey in all fields by the national defense industry has developed breakthrough projects, Turkish Armed Forces has met the needs of a high rate and the export of products and technologies to other countries also have met with increasing momentum.**

Since the development of Computer Technology, the modern world experienced that Information Technologies are used in many business areas. Among these technologies, Enterprise Resource Planning (ERP) systems are among the largest, most complex and most challenging information systems used by companies. With these applications, companies have integrated information systems that have been discrete in the past, and have increased the opportunities for better decision support and time management for managers and employees. However, while the defense industry sector is struggling with the budget overruns, adaptation problems and the Enterprise Resource Planning Systems that have not overcome the system integrations in the world, Turkish defense industry sector institutions carry out the installation of the Enterprise Resource Planning systems in a not-so-old time. With this study, "Determination of Critical Success Factors of ERP in the Defense Industry" was studied with the survey application of Turkish defense industry sector players, and the results and suggestions were evaluated.

***Keywords*—**

I. INTRODUCTION

Although the implementation of ERP systems in the defense industry of a country may seem irrelevant, taken together, they can become a force that can save millions of public money and take the defense industry sector to the next level.

Nowadays, most of the production-oriented organizations around the world have gained many benefits with the implementation of ERP systems. In its current form, ERP systems are the largest, most complex and most challenging information technology systems implemented by companies and represent a significant deviation from the personal and corporate information technology systems that were common in the past. Although it is observed that other sectors, besides production-oriented companies where ERP systems are used extensively, tend to be inclined towards ERP systems, it is considered that the potential of ERP systems is not fully understood by the service sector, and the main reason behind this is the lack of knowledge and understanding about the benefits of a ERP system to such organizations(1).

The Defense Industry Sector is one of the most up-to-date areas for transition to ERP systems. The potential of ERP systems in the defense industry was not considered until 2005. The main reason for this delay can be considered to be the lack of ERP benefits for the defense industry sector, where operations have serious deviations from normal manufacturing and service organizations. However, some leading ERP vendors have developed customized ERP systems to best fit the defense industry sectors(2). Along with these developments, defense organizations of many countries have chosen to implement ERP systems to assist in military operations, and especially in the control and management of logistics.

Designed specifically to serve the defense industry sector, ERP systems support the wide-ranging requirements of current military operations and aim to assist in all aspects of defense transformation projects, including strategy, operations, organization, change management and information technology. Defense industry focused ERP systems includes three areas of expertise; transformation of military enterprises, military information and communication technologies and defense outsourcing, and covers five objectives: ready-to-task and effective defense power, customer-oriented service opportunities, collaboration and secure operation capability, resource management and accounting, enabling affordability, monitoring and defense response management, steering, decision-making and correction of the operational cycle(3).

Today's defense industry organizations have strong ties with suppliers, service institutions, government agencies and customers. At the same time, ERP solutions offered to the defense industry help defense organizations and supporting defense institutions to connect with each other for real-time information. In addition, these systems provide centralized information, planning and resource capability across different services to support the effective management of projects involving effective joint operations and large-scale change transformation(4).

With the similarities gained with the experience with other sectors, a new idea has been triggered and many attempts have been made to implement a ERP system in the defense industry sector. As a result of these implementations, firstly the US Department of Defense initiated the largest ERP implementation project that connects all services, and many other countries have started to use the applications afterwards(5).

II. ENTERPRISE RESOURCE PLANNING SYSTEMS

Currently in globalized business market, the business departments of companies can be located in different countries. Therefore, in order for software to be accepted as a successful software, it must ensure coordination between business departments and share information with each other and provide important information for managers so that they can dominate all business functions.

A. Enterprise Resource Planning Systems and Features

The term ERP was used to refer to the improved material resource planning system in the early days. However, it is not possible to limit the ERP system to the term improved material resource planning system. Nowadays, it can be said that the ERP system refers to an institutional and managerial system that enables the flow of information between business stakeholders and other actors in the internal and external environment of public and private sector organizations, and helps to carry out planning, organization, management and coordination processes from a single source. In the early days, the definitions related to the term ERP system were created only to refer to a system used in the production departments of the enterprises. The fact that ERP systems have shown functional development over the years and their features that can be used in different business departments have also changed the conceptual definitions. Thus, the semantic expression of the term ERP systems has reached a semantic scope that includes all of the information systems that increase the productivity of the employees in the business processes of organizations and save time and cost(6). The conceptual definitions determined in relation to the Enterprise Resource Planning system are as follows; The term Enterprise Resource Planning systems is used to express the computer-based systems used for planning business processes(7). In another definition, it is stated that Enterprise Resource Planning systems are analytical business software with automation and integrated processes(8). As can be understood from this definition, it can be said that Enterprise Resource Planning systems are expressed as a software that helps to provide automation and organizational integration in business processes, and it can be said that their contributions to organizations that are users of these systems are emphasized.

B. Factors Affecting Success in Integration to Enterprise Resource Planning Systems

The nine factors that help to successfully integrate into Enterprise Resource Planning systems are described below.

- Top Management's Support to the Enterprise Resource Planning System,
- Successful Organizational Change Management,
- Understandability of Strategic Goals,
- Presence of Key Personnel,
- Having a Good Practice Team,
- Data Accuracy,
- Conducting a Comprehensive Applied Training on the System,
- Focus on Performance Measurement,
- Preparation of Application Guide,

C. Economic and Social Benefits of Enterprise Resource Planning Systems

There has been a lot of research on the benefits or savings achieved by implementing ERP systems in companies and institutions. Various research results regarding these benefits are shown in Table 1. (9)(10)(11).

TABLE I. BENEFITS AND SAVINGS ACHIEVED BY IMPLEMENTING ERP SYSTEMS

Benefit	Tipi	Benefit / Saving (%)
Inventory Reduction	Tangible	32-16
Personnel Reduction		27-12
Reduction of Cost of annually inputting information twice		50
IT Cost Reduction		8-14
Order Management Improvement		36-20
Transportation Logistics Cost Reduction		4-9
Cost Reduction		8-14
Revenue / Profit Increases		8-23
Procurement Cost Reduction		12
Shorten the Procurement Cycle	İntangible	80
Productivity Improvement		26-20
Financial Close Cycle Reduction		19-44
Cash Management Improvement		4-11
Maintenance Reduction		4-7
On Time Delivery		4-6
Monitoring Efficiency		23-28
Information Sharing Efficiency		53-40
Better Management Decisions		34-56
Strategic Competitive Advantage		45-55

Firms and institutions that implement ERP systems strive for the most basic benefits for themselves, and stock management and optimization of processes are at the top of them. ERP systems help companies and institutions to manage their stocks in an optimum way and to make huge financial savings from them. Sharing order status information between supply chain partners improves customer service quality, speeds up the payment cycle and saves costs. Delivery times, quality specifications, return status etc. Sharing data on performance metrics helps supply chain partners to identify and overcome bottlenecks in supply inventory optimization, including demand planning, and the benefits to optimized inventory management, increased profitability by avoiding discounts and obsolete losses, accurately forecasting demand and keeping excess inventory by redistributing. There is a lower working capital cost, better purchase ordering and better purchase management, and better space utilization in both warehouses and stores. At the same time, optimization of shipping processes and reduction of logistics cost saves significant operational costs for an organization(12).

III. DEFENSE INDUSTRY IN TURKEY AND THE WORLD

A. The State of the Defense Industry in the World

In the defense expenditures report published by the SİPRİ research organization on 15 March 2021, the expenditures made were discussed in many categories. The volume of international transfers of large weapons was 0.5% lower than in 2011-2015 and 12% higher than in 2006-2010(13).

Between 2016-2020, the top five arms exporters in the world were the United States, Russia, France, Germany and China, while the top five arms importers in the world between 2016-2020 were Saudi Arabia, India, Egypt, Australia and China.

B. The Defense Industry in Turkey

The foundation of the Turkish defense industry dates back to the rise of the Ottoman Empire, and the most important war tools and equipment of the era such as artillery and warships were produced entirely with local resources. The Turkish defense industry started to stay out of the technological developments in Europe since the 18th century and lost its effectiveness to a great extent during the First World War. For this reason, a serious infrastructure related to the defense industry was not taken over in the first years of the Republic, and the activities in this field were limited to a few production facilities established during the The Turkish War of Independence(14).

1964 during the Cyprus crisis, the defense equipment imported from allied countries used in accordance with the national interests of Turkey, therefore some allies including the USA tried to prevent and threaten with sanctions. For this reason, it has revealed the drawbacks of being absolutely dependent on other countries in meeting defense needs. This problem has formed the basis of ideas and policies for the establishment of a self-sufficient defense industry infrastructure(15).

Considering the Current Situation of the Turkish Defense Industry; As of the end of 2019, the Total Defense and Aerospace Sector Turnover, which includes all defense and aerospace sales of our defense companies and shows the size of the industry, reached $ 10.884 billion (16). Defense and aviation sector turnover between 2002-2019 is shown in Figure 1.

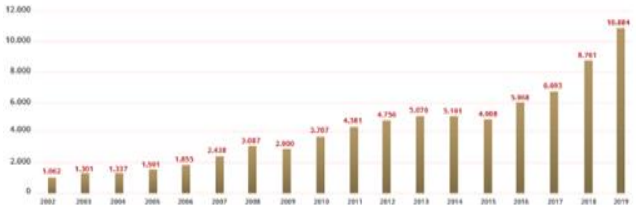

Fig. 1. Defense and aviation sector turnover between 2002-2019 (16)

While 66 defense projects were carried out with an external dependency rate of approximately 80% in 2002; Today, the number of projects has reached 762 with a localization rate of over 65%, While defense projects with a budget of approximately $ 5.5 billion were carried out in 2002, today a project volume of $ 55.8 billion has been reached. Considering the projects in the tender process, it is estimated that this amount will be over $ 60 billion(16).

Turkey, with a total of 1.926 billion dollars in arms exports to be realized between the years 2010 to 2020 has taken its place as 16th in the world. The export amounts in the mentioned years are as in Figure 2(17).

Rank 2010-2020	Rank 2009-2019	Supplier	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2010-2020
1	1	United States	8062	8940	9056	7485	9604	9937	9868	12070	9895	10788	9372	105078
2	2	Russia	6214	8676	8180	7919	5469	5922	6790	6088	6753	5226	3203	70440
3	3	France	870	1735	1029	1493	1656	2043	2088	2359	1784	3269	1995	20321
4	4	Germany	2666	1311	750	791	1790	1763	2506	1944	1070	978	1232	16802
5	5	China	1475	1271	1526	2067	1212	1780	2410	1438	1169	1472	760	16580
6	6	United Kingdom	1157	1055	929	1608	1651	1180	1393	1237	703	907	429	12248
7	7	Spain	262	1428	545	733	1051	1162	471	820	1025	989	1201	9686
8	9	Italy	538	963	741	861	672	676	618	791	535	321	806	7523
9	8	Israel	640	546	458	419	399	790	1464	1268	704	363	345	7395
10	10	Netherlands	370	546	858	374	631	461	471	1050	448	238	488	5936
11	11	Ukraine	485	570	1501	654	632	353	487	307	196	96	115	5396
12	12	South Korea	198	350	224	349	207	94	480	742	1056	693	827	5220
13	13	Sweden	660	696	477	386	339	179	265	80	155	172	286	3695
14	14	Switzerland	264	340	242	194	343	479	215	173	240	226	179	2897
15	15	Canada	237	317	266	183	189	337	110	70	115	211	200	2233
16	16	Turkey	72	86	143	156	168	252	236	167	264	240	141	1926

Fig. 2. Exports between 2010 and 2020 (17)

Turkey with a total of 7,606 billion dollars in import weapons which was carried out between the years 2010 to 2020 has taken its place as one in 11 in the world. The import amounts in the mentioned years are as in Figure 3 (17).

Rank 2010-2020	Rank 2009-2019	Recipient	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2010-2020
1	1	India	2911	3598	4392	5381	3347	3117	3003	2909	1485	3075	2799	36016
2	2	Saudi Arabia	1083	1222	1033	1614	2740	3377	2961	3931	3315	3419	2466	27160
3	3	China	981	1055	1571	1289	1077	1262	1139	1338	1962	1347	811	13831
4	4	Australia	1513	1557	867	245	906	1464	1026	1653	1557	1184	1658	13630
5	7	Egypt	686	630	281	673	420	1436	1690	2395	1677	1046	1311	12245
6	5	UAE	644	1235	1154	2306	768	1224	956	966	1196	691	432	11570
7	9	South Korea	1299	1570	1078	191	723	254	1058	1052	1100	1480	1317	11121
8	6	Pakistan	2205	1128	1014	1095	828	779	837	837	799	521	759	10802
9	8	Algeria	835	1125	661	362	620	898	2903	1128	1284	164	549	10527
10	10	United States	1091	1012	1207	791	590	513	451	516	380	866	687	8103
11	11	Turkey	485	780	1503	793	1524	438	328	428	487	754	86	7606

Fig. 3. Imports between 2010 and 2020 (17)

The personnel employment of the sector is at the level of 73,771 in total, with 25% engineers and 10% university graduates, as a sign of the intensity of technological production, design and development activities. Also; In addition to keeping the managerial staff and other employees relatively low, the ratio of operators / technicians (in the productive staff) close to half of the total employee indicates the importance given to productivity and efficiency(18).

IV. ENTERPRISE RESOURCE PLANNING SYSTEMS FOR THE DEFENSE INDUSTRY SECTOR

Defense organizations today are faced with new, asymmetric threats that cross international borders. Operations are carried out in a multinational environment where real-time information is very important, so more than ever before, the entire organization from the smallest unit to the factory needs trust in reliable, accurate and well-processed data.

The world's leading international ERP system vendors have focused on privatizing their ERP systems, which have a global market share, to meet the needs of the defense industry. In this case, by analyzing and evaluating defense ERP systems and features developed by the world's leading ERP vendors such as SAP, Oracle, Microsoft Dynamics and IFS, SAP has released a ERP system named "SAP - Defense and Security" built on the standard ERP System core(3), Oracle claims that all of the world's top ten global aerospace and defense companies rely on Oracle ERP applications to manage their programs, service maintenance, and compliance initiatives, achieving innovation and value chain excellence(19), Microsoft has developed a defense solution based on Microsoft Dynamics ERP System, which is based on Axapta ERP System technology. (20).

Nowadays, many applications of the ERP System are encountered in military organizations around the world. Aims to be achieved by the US Department of Defense (DoD) in

establishing ERP Systems are, Better Inventory Management, Better Financial Management and Auditability. To provide reduced cycle times, Integrated Personnel and Pay System (IPPS), Global Combat Support System (GCSS), Logistics Modernization Programme (LMP), Naval Air Systems (NAVAIR), Naval Supply Systems (NAVSUP), Space and Naval Warfare Systems (SPAWAR), Naval Sea Systems (NAVSEA), Expeditionary Combat Support System (ECSS) applications are used(21).

In addition to the establishment of ERP systems in the US Department of Defense (DoD), ERP systems have been completed in institutions affiliated to the defense ministries of other countries and have achieved partial success. Examples of these are the German Ministry of Defense, the Danish Ministry of Defense, the Israel Ministry of Defense, the New Zealand Ministry of Defense and the Norwegian Ministry of Defense(22).

V. Enterprise Resource Planning Systems For The Turkish Defense Industry Sector

Considering the technological level of the Turkish defense industry, research institutions and universities as of today, it has been evaluated that the sector players and the sector infrastructure have reached a certain maturity since the early 2000s, the strategy of giving priority to original and national products in meeting the needs of the Turkish Armed Forces has started to be implemented. This is primarily an original and national development that has made significant improvements in Land, Sea, Air, Unmanned Air, Land, Sea platforms, C4ISR, Weapon / Ammunition, Rocket / Missile, Training and Simulation, Space, War Support systems and Service systems since the 2000s, and the specified products were included in the Turkish Armed Forces inventory. The Turkish defense industry has become an important sector player and supplier in international markets by making serious investments in structural and intellectual knowledge.

When the performance data of the sector for 2019 are examined, there have been significant positive developments in almost all areas in turnover, foreign sales revenues, received orders, imports, product and technology development expenditures and employment. The sector's data for 2019 are as in Table 2(18).

TABLE II. 2019 Data of The Sector (18)

2019	
Turnover	10.884 Million USD
Foreign Sales Revenues	3.068 Million USD
Received Orders	10.671 Million USD
Imports	3.088 Million USD
Product And Technology Development Expenditures	1.672 Million USD
Employment	73.771 Person

Sales amounts based on technology segments of the sector are as follows; Land Platforms / Systems are seen to have the highest sales volume. Aviation (military and civilian) takes the second place. The turnover on the IT side has remained well below expectations. Considering that this technology segment occupies the largest slice in the World Defense Market, it is considered that the turnover of the works in the segment is included in the sales amounts related to the systems and platforms(18).

In this study, within the scope of the research on "Determination of Critical Success Factors of ERP in the Defense Industry", the results of face-to-face surveys for IDEF-2017 and IDEF-2019 Defense Industry Fairs and other public/private defense industry participants, which are considered as the major meeting point of the defense industry, were tried to be examined. Accordingly, with the participation of all sector participants, it is aimed to contribute to the determination of ERP Critical Success Factors in the Defense Industry by conducting 265 surveys and evaluating the results on the LimeSurvey, online statistical survey web application. Within the scope of the survey study, the duration of the participants' working at the institution was asked, and 65% of the participants stated that they were in the 1-10 year. With these data, it is evaluated that employment has been shaped accordingly, depending on the importance and development of the defense industry in the last 10 years. The working periods of the participants in the institution are as in Table 3.

TABLE III. Working Times of the Participants in the Institution

RESPONSE	***SCORE***	***RATE %***
1-5	64	24.15
5-10	112	42.26
10-15	41	25.47
>15	24	9.06
NO ANSWER	24	9.06

The positions of the participants in the institution were asked, and 60% of the participants stated that they were senior and middle level managers. It was evaluated that the survey study conducted with these data provided a more real perspective by answering by people who have ruled over of all fields. The positions of the participants in the institution are as in Table 4.

TABLE IV. Positions of the Participants in the Institution

RESPONSE	**SCORE**	**RATE %**
COORDİNATOR	47	17.74
GENERAL MANAGER	78	29.43
DIRECTOR / MANAGER	36	13.58
DEPARTMENT EMPLOYEE	68	25.66
NO ANSWER	36	13.58

The ERP applications used in the institutions of the participants were asked, and the ERP applications used are as in Table 5.

TABLE V. ERP applications used in participants' institutions

RESPONSE	**SCORE**	**RATE %**
SAP	65	24.53
ORACLE PEOPLESOFT	37	13.96
GLOBALSOFT	30	11.32
IAS-CANIAS	3	1.13
LOGO NETSIS	18	6.79
MICROSOFT	53	20.00
INTER GLOBAL SOLUTIONS	10	3.77
SAGE	10	3.77
IFS	11	4.15
OTHERS	2	0.75
NO ANSWER	26	9.81

It was asked how long the ERP applications used in the institutions of the participants have been used, and the results are presented in Table 6. It is understood that 65% of ERP applications used in institutions are between 1-3 years and that ERP applications are quite new in the defense industry sector.

TABLE VI. HOW LONG THE ERP APPLICATIONS USED IN THE INSTITUTIONS OF THE PARTICIPANTS HAVE BEEN USED

RESPONSE	SCORE	RATE %
6 month-1 year	37	13.96
1-2 year	96	36.23
2-3 year	66	24.91
>3 year	39	14.72
NO ANSWER	27	10.19

The Critical Success Factors used in the survey were selected from the article "A contingency fit model of critical success factors for software development projects" (23) published by Arthur Ahimbisibwe, Robert Y Cavana and Urs Daellenbach in 2015. In this study, 37 Critical Success Factors were identified from 148 different articles. The sample of the study consists of managers and / or related persons working in Defense Industry companies using ERP. With the representation of all 37 Critical Success Factors in which the questionnaire was processed / quoted, 4 demographic, 21 organizational factors, 14 team factors, 7 user factors, 12 project factors, 3 complementary factors and 12 success factors were asked, and totally 83 questions will be tried to be measured. Participants were asked to choose one of the answers of "Strongly Disagree-Strongly Agree" for the questions of the 5-point Likert type scale. The organizational factor, team factor, user factor and project factor and the survey results are shown in Table 7.

TABLE VII. ORGANİZATİONAL FACTOR, TEAM FACTOR, USER FACTOR AND PROJECT FACTOR AND SURVEY RESULTS (* VALUES ARE GİVEN İN%.)

	SURVEY QUESTIONS	STRONGLY AGREED*	AGREED *	HESİTANT *	DISAGREED *	STRONGLY DISAGREED *
1	The ERP system has a strong support from the company management	50.19	32.83	9.06	6.04	1.89
2	The success of the ERP system is due to the senior managers actively supporting	39.25	38.11	12.45	6.42	3.40
3	Organizational culture has a positive impact on performance	34.34	39.25	13.21	8.68	3.77
4	ERP has developed organizational learning	33.21	35.47	14.72	10.94	5.28
5	ERP project plan and progress is sufficient	30.57	32.08	19.62	12.45	4.91
6	ERP project work plans and the performance criterias attached to them are clearly defined	30.57	38.49	15.09	12.08	3.40
7	ERP project manager has an important role during an ERP installation	34.72	36.23	13.21	10.19	4.91
8	ERP project manager's leadership skills contributes positive support to on the project	35.47	34.34	13.58	12.08	4.53
9	ERP project is suitable for the company's mission and vision	34.72	33.96	15.47	10.57	4.53
10	Monitoring and control of ERP Project was carried out frequently	33.58	31.32	13.58	16.23	5.28
11	The existence of an effective control system in all of the business processes in the company has improved the quality of produced information	37.36	30.94	11.32	15.47	4.91
12	ERP project's cost, scope, quality and time balancing has been prepared in terms of good change management plan	36.98	30.19	13.21	14.34	4.91
13	Company's restructuring, introduction of new technologies, exchange of personnel, etc. in-company management factors of "change management" skills affects the quality of the produced information	66.42	24.53	3.02	3.02	1.89
14	ERP project's change / development convenience has helped company's change of management	55.47	29.43	5.28	2.64	1.89
15	Privatization/Needs changes are made on time in the organization processes	48.30	24.91	9.43	4.53	1.51
16	Establishing a good the infacstructure and supporting the existing operation in the installation of the ERP project is important	48.68	31.32	4.15	2.26	1.89
17	Adequate financial and other resources for the installation and use of the ERP project must be provided	45.66	30.57	6.04	2.64	3.02
18	Risks should be identified and a management plan including measures should be prepared during insallation of the ERP project	50.19	29.81	5.28	0.75	0.75
19	Quality plan of the ERP project is important for achieving a good chnge management	43.02	28.68	8.30	1.13	1.13
20	ERP project tasks and responsibilities should be clearly defined	42.64	27.92	7.55	0.38	1.13
21	ERP project goals must be clearly defined	42.26	26.79	7.92	0.38	1.13
22	ERP project team consisted of people that they know what the basic performance indicators are and their knowledge of individual contribution of ERP project	35.47	41.51	9.81	7.92	3.77
23	The work of ERP project team took place in the time specified in the instructions and contracts	31.32	39.62	11.32	11.32	4.15
24	ERP project increased communication throughout the organization	35.85	36.98	9.43	11.32	3.02
25	ERP project has contributed the development of coordination between the departments	38.87	34.34	11.32	9.81	3.40
26	ERP project team is composed of people who have enough knowledge	36.60	31.32	14.72	11.70	3.02
27	Necessary authority / trust. was given to the ERP project team	33.21	35.09	13.58	12.08	3.40
28	ERP project team is composed of people who are balanced or have more functional features	37.36	29.81	13.58	11.70	4.53
29	There are many experts in the ERP project team specialized in advanced technologies and methods related to ERP	33.58	30.94	14.34	13.21	5.66
30	The project team has sufficient expertise about the ERP project	33.58	30.57	12.45	14.34	6.04
31	ERP project team consists of people who have organizational knowledge and know how far positioning the target objectives of the project organization	41.51	28.68	12.83	8.30	4.53
32	ERP project team have the current software knowledge	35.85	32.83	12.08	9.81	3.02
33	There are software development experts in the ERP project team	39.62	27.55	14.34	7.17	3.40
34	The eliminationof ERP team shortcomings is critical to the achievement of the system	42.26	28.30	8.68	8.30	4.15

35	Success of suppliers in technical support, response time, accuracy of analysis methods and Project management is important for the installation of the ERP project	45.28	27.17	8.68	7.17	5.28
36	During ERP installation measures were taken to eliminate the difficulties faced by employees	49.81	25.66	11.32	10.19	1.51
37	Role distribution of employees became more effective by ERP Project	42.26	32.83	11.70	9.06	2.64
38	ERP system has high importance for employees	39.25	31.70	9.81	12.08	3.77
39	Employees have demonstrated support for using the ERP system	35.85	35.85	10.57	12.45	3.77
40	ERP trainings given to the employees are sufficient	35.09	30.94	13.96	12.83	5.66
41	The experience of employees is important for ERP Project success	38.49	35.09	10.94	9.43	4.15
42	The employees were subjected to severe training according to their ages, educations and experiences	33.96	30.94	12.08	12.83	7.92
43	Strategic measures have been taken for the presence of technological uncertainty in the ERP project installation	41.13	31.32	12.08	9.43	3.02
44	Proposals for alternative solutions are planned against defects that may occur during the ERP project installation	29.81	33.58	15.85	12.45	4.91
45	ERP software is up to date to cope with the requirements	30.57	36.23	13.96	12.83	3.77
46	Software development in the ERP project is planned by considering general long-term business plans of the company	28.68	33.58	16.60	12.45	5.28
47	Problems occured during the installation because of the complex structure of the ERP project	25.28	33.58	16.23	13.96	7.55
48	ERP project applicable threshold and end dates had been provided with realistic measurable data	25.66	34.72	16.98	12.45	7.17
49	Critical thresholdlevels in the installation of the ERP project has been verified and controlled	29.06	30.57	18.11	12.83	6.42
50	ERP project installation had been provided throughout the entire organization	29.43	31.32	15.09	13.96	6.04
51	Technical changes in the ERP project installation had been provided throughout the entire company	30.19	31.32	15.47	13.96	6.04
52	Implemantation schedule in the ERP project must be prepared realistically	32.83	31.70	13.96	12.45	6.42
53	Budget allocated to the ERP project must be planned with realistic data	34.34	34.34	11.70	10.94	6.04
54	Real-time process should be reported in the installation phase of ERP project	39.25	28.30	12.08	11.32	6.42

Complementary factor questions and the data results are presented in Table 8.

TABLE VIII. SURVEY RESULTS WİTH COMPLEMENTARY FACTOR QUESTİONS (* VALUES ARE GİVEN İN%.)

	SURVEY QUESTIONS	**UNDER BUTGED***	**EXACT BUDGET***	**%1-25 OVER BUTGED***	**%26-50 OVER BUTGED ***	**OVER %50 OF THE BUTGED ***
1	Was ERP project completed by determined budget?	24.53	35.09	20.00	7.55	5.66
		PREMATURELY *	**ON TİME ***	**DELAYED 0-6 MONTHS ***	**DELAYED 6-12 MONTHS ***	**DELAYED MORE THAN 1 YEAR ***
2	Was the ERP project completed at the determined time?	12.08	44.53	23.77	7.17	6.42
		WHOLE COMPANY İNCLUDİNG SUPPLİERS *	**WHOLE COMPANY ***	**75% OF THE COMPANY ***	**50% OF THE COMPANY ***	**25% OF THE COMPANY ***
3	Did ERP Project cover all the company?	18.11	37.74	24.91	12.45	2.64

Success factor questions and the data results are presented in Table 9.

TABLE IX. SUCCESS FACTOR QUESTİONS AND SURVEY RESULTS (* VALUES ARE GİVEN İN%.)

	SURVEY QUESTIONS	VERY GOOD*	GOOD*	INTERMEDİATE*	BAD*	VERY BAD*
1	Operability of ERP project	31.32	30.94	26.04	6.42	1.13
2	The information security ensured by ERP project	25.28	36.23	25.28	6.04	1.51
3	ERP project's eligibility to the company	22.64	35.85	29.06	6.04	1.89
4	Maintenance adequacy of ERP project	23.40	37.74	23.02	9.81	1.51
5	Information/data transfer capability of ERP project	27.55	38.11	19.25	7.92	2.26
6	The overall quality of the ERP project	30.19	40.00	17.36	6.79	1.51
7	Functional suitability of the ERP project	33.96	31.70	22.26	5.66	1.89
8	Confidence in the ERP project	28.30	37.36	19.25	8.30	2.26
9	Performance efficiency of the ERP project	27.55	37.74	20.75	7.92	1.89
10	User satisfaction of ERP Project	28.68	35.47	23.02	6.04	2.64
11	Satisfaction about ERP project team	31.32	33.96	21.13	6.04	3.02
12	Satisfaction of top management on ERP project	33.96	32.83	17.74	8.30	3.02

Considering the success factor results that constitute the final part of the ERP projects, the functionality of the ERP projects, the maintenance competence, knowledge / data transfer competence, general quality, functional suitability, trust, performance efficiency, user satisfaction, satisfaction with the project team and senior management satisfaction was seen at a good level, and it came to the fore as the field that needs to be developed within the scope of the suitability of the ERP project according to the institution.

When the ERP project was completed with the determined budget, it was understood that the projects of the sector companies were generally completed with the targeted budget and below, the ERP projects were completed at a specified time that could not exceed 6 months and that 75% of the institution was widely used.

In evaluating the results obtained, it can be said that in general, ERP installations of Defense Industry companies have been successfully implemented. When the factors that contribute to the evaluation of success are examined, ERP systems;

- Receives strong support from the company management,
- Institution restructuring, introduction of new technology, personnel change, etc. Management's "change management" skill in internal factors affects the quality of the information produced,
- The ease of change / development of the ERP project helped in the change management of the institution,
- It is important to establish a good infrastructure and support existing processes in the establishment of the ERP project,
- Risks should be identified in the establishment of the ERP project and a management plan containing measures should be prepared

It has been evaluated that its factors are highly effective and other factors contribute well.

VI. CONCLUSION

Considering the technological level that the Turkish defense industry has reached as of today, it has been evaluated that the sector players and the sector's infrastructure have reached a certain maturity since the early 2000s, and the strategy of giving priority to original and national products in meeting their needs has started to be implemented. Since the 2000s, the defense industry's Land, Sea, Air, Unmanned Air, Land, Sea platforms, C4ISR, Weapon / Ammunition, Rocket / Missile, Training and Simulation, Space, Combat Support systems and Service services have made very important developments. The products were included in the TAF inventory, and when the performance data of 2019 were examined, there were significant positive developments in almost all areas in terms of turnover, foreign sales revenues, imports, product and technology development expenditures and employment, but the expectations of the sector in the field of informatics were not met.

A lot of research has been done on the benefits or savings achieved by implementing ERP systems in companies and institutions. With the implementation of ERP systems, Reducing Inventory, Personnel, Information Input Cost, Information Technology Cost, Improving Order Management, Reducing Transportation Costs of Logistics, Increasing Income / Profit, Reducing Supply Cost, Shortening Supply Cycle, Improving Production, Reducing Financial Closing Cycle and provide Gains and Savings on Improving Cash Management, Reducing Maintenance Costs, Timely Delivery, Monitoring Efficiency, Efficiency of Information Sharing, Better Management Decisions and Strategic Competitive Advantage.

Many applications of ERP Systems are found today in military organizations around the world. However, institutions in the sector are struggling with budget overruns, compliance problems and ERP Systems that have not overcome their system integration. In Turkey, it is observed that both industry players to leap in recent years due to both to contribute to the solution of complex applications caught momentum in recent years in the implementation of ERP System.

In this study, the defense sector and expenditures in the world and in Turkey were provided and accordingly, it was aimed to evaluate the critical success factors affecting ERP applications in the defense industry. Accordingly, within the scope of the research on "Determination of Critical Success Factors in Defense Industry", 265 surveys were conducted with the participation of defense industry sector participants, and it was aimed to contribute to the determination of ERP Critical Success Factors in the Defense Industry and evaluate the results.

In the study, it was determined that 65% of the survey participants were in the sector in 1-10 years, 60% were senior and mid-level managers, 65% of the ERP applications used in their institutions were in use for 1-3 years and that the ERP applications installed were the most used applications in the world market. Considering the success factor results that constitute the final part of the ERP projects, it was generally seen as a good level of success, it was understood that the ERP projects were completed in the specified budget and at a specified time not exceeding 6 months, and it was understood that 75% and more of the institution was widely used.

In evaluating the results obtained, it can be said that the ERP installations of Defense Industry companies were applied successfully, but it is considered that the specified and measured factors are open to development and the factors that are effective in the installation need to be examined more carefully by the industry players.

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A New Path in Digital Era: Integration of Artificial Intelligence to Translation Studies

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The ever-changing description of life and the growth speed of communication throughout the world has come to the fore with the touch of technology undoubtedly. The steps taken in the technology field paved the way for new and unique milestones for information-sharing technologies and eventually for interaction between languages. The rapidly-globalized world has created a huge demand for a rapid interaction between languages, creating a remarkable demand on translators. The globalization speed of the world brought the idea of combining technology and translation studies together to reach successful translations through translation machines to meet the demand. Yet, the outcomes of basic machine translation systems alone were not successful enough to cover the needs of translation business. At this point, the idea of integrating Artificial Intelligence (AI) into computer-based translation software has evaluated to be a solution for this dilemma. This article evaluates three of current AI-integrated translation softwares in agreement with some predetermined criterion. It is concluded at the end of this paper that, the present features of AI integrated into those pre-chosen translation software are not sufficient enough to meet the needs of the translation business.

Keywords—Translation, Translation Studies, Artificial Intelligence, Machine Translation, Translation Software

I. INTRODUCTION AND BACKGROUND OF THE STUDY

Technology comes to the fore as one of the most significant issues of today' world. It is a concept that affects many fields of life, such as education, media and health. The globalization speed of the world and the developments in the field of technology benefit from each other in numerous different points. Eventually, technology becomes a tool that lays the basis of communication in such a globalized world. Especially after the end of 20th century, which is the birth date of many significant technological breakthroughs, the rapid growth rate of the globalization brought various different cultures, ways of life, countries and people closer to each other. The boundaries all over the world has become transparent, causing the differences between people, countries and cultures vanish in time. The sharing and borrowing processes between distant and different parts of the world have created common features in such a globalized world. Conclusively, language has become an inseparable part of this process, since all the forementioned sharing and borrowing processes have language as the very foundation.

While a fast-globalized world needed a practical and swift way to transfer knowledge and to communicate, the touch of technology upon the process was inevitable. Since the first days of the humankind on the earth itself, communication has always been a significant issue, and it has gained more and more importance over time. Different ages had different needs, and current means of communications have developed by adapting them to current needs. Once upon a time, humankind has been communicating through smoke, yet, after the emergence of the first basic computers in the 1980s, the way to the invention of the world wide web was set forth. After that day the differences between cultures, people and countries has started to become invisible. Over time, the need to share and borrow has increased, and that was the time when the idea of inventing a tool to mock and imitate the perceiving ability and way of functioning of the human brain itself. Nevertheless, it has not been easy as it has sounded.

II. INVENTION OF THE ARTIFICIAL INTELLIGENCE

A. First Steps towards a Technological Miracle

The basics of Artificial Intelligence (AI) dates back to the 1950s and 1960s, in other words, the invention of the internet itself. The military issues popular that times thanks to the Cold War period after World War II, were laid the groundwork for the invention of the internet, the tool that may be the most inextricable part of the daily lives of the present day. The basic need of protection has forced two powerful countries to agree upon a common solution. Obtaining the nuclear power would make a country to dominate the world, as a result, a demand for a tool to keep the both sides, the United States of America and the Soviet Union, has emerged. Paul Baran has become the creator of the ultimate solution. He has worked on a communication system and designed a mesh network based on high levels of link redundancy and a digital communications technology called packed switching (Hafner & Lyon, 1996, p.51). His idea was revolutionary at that time, yet, it could not be turned into reality thanks to a couple of different reasons.

Furthermore, the means of communications present that day were not enough to enable a fast sharing process all over the world. This has created the urge to find unique ways to solve this problem. Donald Davies has brought the idea of using the digital switches to allow an interactive time-shared computing all over the world. Yet, it was not possible since the current switching technology of the telephone system of that times was not enough to allow that idea to become real (Haftner & Lyon, 1996, p.66). Basicly, he aimed to benefit from the packet switching technology to create a communications system all over the world. This was followed by the launch of Sputnik satellite in 1957. The United States side countered this step by the foundation of Advanced Research Projects Agency (ARPA). The idea of a 'resource-sharing network, ARPANET, has emerged therein 1966 (Naughton, 1999, p.84). Afterwards, the University of Hawaii has created a system named ALOHA, which uses radio to share information. In time, ARPANET has become a tool to serve research purposes, instead of serving the military and defense aims. (Naughton, 2016, p. 8-11). After this point, the steps towards the invention of the world wide web have been taken. Tim Berners-Lee's main aim was to establish a tool to authorize locating, publishing and

retrieving documents and reach them from every part of the world, does not matter how far they are (Berners-Lee, 2000,

p. 30-32). His establishment of World Wide Web, also known today as WWW, has become a milestone, and has become the first steps towards the internet used in the present day.

After a means of world wide sharing has become real, the new aim was to create a tool to act as the human brain itself. This idea was the groundwork of the invention of the Artificial Intelligence. Difference Engine, proposed by Charles Babbage, which was used to produce mathematical tables automatically could be regarded as the ancient versions of the current computers. Analog computing machines has come after that, yet, the most significant turning point was at Cambridge University, Turing invented the principle of the modern computer in 1963. Since one of the fields he was interested in was Artificial Intelligence, he has worked on his Automatic Computing Engine (Copeland, 2017). These milestones all created the basis for the invention of modern computers and eventually, Artificial Intelligence.

B. The Need for a Fast Communication Process

Since the first days of mankind on the earth, one of the main needs to be met was communication. As the time passes, this need has become more and more significant and eventually this issue has been touched upon by technology. While the barriers and boundaries between the countries, cultures and people all over the world has started to become invisible, the issue of language has been brought into the fore since it was one of the most significant obstacles in a rapid information sharing and communication process. A deep and extended knowledge of two languages was fundamental to enable a sharing process between two cultures, nevertheless, the number of educated and qualified translators was limited. In addition, the demand for an efficient communication process was increasing rapidly while the number of skillful translators was rising nonchalantly.

In a globalized communication process, translation is an inseparable step. Yet, a professional and true translation required a professional translator. Hence, a translator should be a qualified and proficient. Erton and Tanbi (2016, p.38) evidently pronounces that "As of mid-20th century, the functional study of languages has continued to attract many, bringing about more investigation into semantics, pragmatics, style and text-related issues in languages…", in other words, an extended knowledge and efficient use of languages were critical in a professional translation process. Since language is a multi-dimensional tool to create communication between two different cultures, individuals or countries, not only a grammar and vocabulary knowledge is enough, but also an adequate skill to read between the lines and perceiving cultural elements is a text are also required to transfer the message correctly.

The increasing demand for a correct translation in a globalized world and the limited number of professional translators were steered the route towards the emergence of some computer-assisted translation programs. Yet, they were not efficient since they were not able to perceive all the dimensions of the languages, and were mostly limited to a word-to-word translation style. Artificial Intelligence has regarded to be a quick fix for this problem. The concept itself was expected to act as a professional translator, perceiving and working upon the details of the language, as well as

producing true translations. Brown and Yule (1983, p.1) clearly declared that "The analysis of discourse is, necessarily, the analysis of language in use… While some linguists may concentrate on determining the formal properties of language, the discourse analyst is committed to an investigation of what that language is used for". Just as a professional translator, Artificial Intelligence was expected to perform a deeper analysis than producing a superficial target product. The main question at this point is, even though AI may perform this, some text types and concepts may not be suitable enough to be analyzed deeply since AI do not carry all of the features of human brain such as the human conception and perception. Those two features has become the toughest challenges for the AI, in the translation process. However, it is a tool that can be trained and open for changes and updates that may be developed in future.

III. TRANSLATION STUDIES AND MODERN DAY TECHNOLOGIES

The forementioned demand for a rapid communication in such a globalized world has become the propulsive force to bring translation studies and modern day technologies together. While the most significant step in this process has become the computer itself, its integration with the language has enriched the process more. Türkmen (2019) affirms apparently that the transformations in societies thanks to the globalization and developments in the field of technology raised the demand of different cultures to communicate with each other, creating a greater need of translation between different languages (p. 20), yet, this process has to be rapid but impeccable.

The Computer-Assisted Language Learning has symbolized a new turning point in this process, however this was just a helper at the classroom as Gündüz (2005) summarizes, and did not reflect human perception and cognition wholly. They just acted as simple helpers, and needed to be controlled by a professional. Meantime, the internet itself has become a vital part of daily lives, as it is stated by Lloyd (2005), "Both society and technology are changing and their relationship leads to drastic evolution in the way technology is used to communicate" (p. 32). Inevitably, while the individuals and cultures have become closer and the borders between countries has become invisible, the internet has become the main source of this exchange of cultures, languages and knowledge.

This quick exchanging process inevitably required a quick, impeccable and professional translation process. The pressure to produce such translation products is directly connected to the translators themselves. The accurate translations of them would help ease this burden, however, the education and training of a professional translator takes a significant amount of time since an extended knowledge of at least two languages is required. Technology itself has regarded to be a solution to this struggle, and it was expected to produce flawless translations like a professional translator, paving the way to the creation of modern translation machines. Eventually, developing translation software programs has become popular to overcome the language barrier between cultures, countries and individuals. While a professional translator would take a long time to translate impeccably, those software programs would be a shortcut for perfect translations.

Efficient solutions for language barrier was a long-time need in the world in different contexts and means. As Lloyd

(2005) declares "During WWI and WWII, news took weeks to filter through to the general public, and it was usually produced in print, or maybe the radio" (p. 33). Therefore, NATO and European Union have worked on a solution, and SYSTRAN has come to the fore. As it is stated in the article titled 'SYSTRAN – A Machine Translation Pioneer', in the web-page SYSTRAN, it was basically a software program developed for military aims during the Cold War period. The desire to gain a victory has laid the basis for a new path in the field of translation studies. The main aim was to allow a quick translation to get ahead of the other party, yet, the machine translation produced needed proofreading, and it would take more time, and eventually caused a loss of money according to the ALPAC reports (Automatic Language Processing Advisory Committee) (Arthern, 1979, p.77). Even though the system was enough to decode simple sentences and structures, it was devoid of a total human perception to understand cultural and contextual aspects of the source text.

TAUM METEO (Traduction Automatique de l'Université de Monteral) followed SYSTRAN, however, it was a tool to translate weather reports to save time, and it was quite successful in translating simple sentence structures. Nagao (1989) clearly stated that TAUM METEO was efficient in simple structures, and phrases within definite topics and concepts in weather reports (p. 31). Nevertheless, this system also could not reflect the human perception, and was not able to perceive a more complex text as a whole. The products of such systems required a human translator to carry out a post-editing process, and this process also had different challenges. Schairer (1996) declares, "Input language that is sufficiently limited to permit computer-aided translation is unacceptably restrictive to the authors and the post editing of even pre-edited material takes almost as long as manual translation" (p. 96). In other words, the products of such translation programs were mostly limited to word-to-word translation, and could not transmit the desired message since they failed to mock the human perception and cognition wholly. This resulted in a post-editing process by a professional translator, causing a loss of money and time. As a consequence, a need for a solution to overcome such challenges has emerged.

To present a solution, the European Community suggested the creation of EUROTRA. It aimed to obtain better translations, and reduce the problems faced while translating a text, and in the post-translation process. EUROTRA aimed to present a different point of view to break the language barrier, "… the architecture of a multilingual MT system of this system has to be different from that of a system designed for translation between languages" (Durand and Bennet et. al., 1991, p. 104). In other words, the ability to read between the lines, and understanding culture-specific items and perceiving the text as a whole together with its different dimensions have gained significance. As Maegaard and Perschke states "That is, the general EUROTRA methodology contains a move from transfer method towards an interlingual method" (1991, p. 76). Namely, EUROTRA was a new dimension in the path of obtaining more professional translations through translation softwares after SYSTRAN and TAUM METEO.

It is evident that those programs were mostly limited with word-to-word translation, which was not effective in complex sentence structures and texts. If the source text should be perceived multi-dimensionally and the lines should be evaluated for multiple meanings, those programs could not meet the demand. In such cases, a professional proofreading process had to be carried out for any left out features of the source text, resulting in a waste of time and money. Such challenges accelerated the thought of integrating Artificial Intelligence into this kind of software programs, regarding that it would mimick human perception and cognition in the process of perceiving and understanding the text to produce flawless translation products, and minimize the challenges faced in the post-translation processes.

IV. THE TURNING POINT: THE INTEGRATION OF ARTIFICIAL INTELLIGENCE INTO TRANSLATION STUDIES

A globalized and more integrated world required unusual solutions for unusual struggles. A new world order brought together new challenges, since the limited manners of communication have transformed into more modern and rapid ways. Apart from physical and political maps, boundaries between cultrues and countries has almost become invisible, and information sharing technologies have evolved accordingly. Language and the aim of conveying the messages accurately have created the basis of these new and unique means of communication processes. Inevitably, these ways have been coming into the fore hand in hand with the technological developments.

The struggles occurred while the world rapidly globalized created the demand for a younger generation solution. A tool, a means to replace human brain and its ability to perceive was needed and the birth of Artificial Intelligence has become the milestone at this point. Winston (1993) clearly declares that "Artificial Intelligence can help us to solve difficult, real-world problems, creating new opportunities in business, engineering, and many other application areas" (p. 14). It has soon to become a tool to be used in many different parts of daily lives and professional branches. From simple household appliances to the complex tools used in operation rooms at the hospitals, it has become an inseparable tool in the lives of mankind. Today, it performs more than perfectly if it has faced clear-cut rules just as in a chess game, yet, a language is a way more complex concept than a game.

When AI and languages has brought together, the main and maybe the most significant question has become whether AI could imitate human perception, since it is a feature critical for understanding and perceiving. In other words, the production of a flawless translation is connected with linguistics, anthropology, psychology and philosophy. Erton (2017) claims that "Competence can be accepted as a kind of subconscious schemata that exists within the minds of individuals. It is a kind of underlying organizational pattern, a structure, a conceptual framework that enables the self to carry out her everyday actions" (p. 1579). To put it in another way, it can be viewed as a common accumulation of information between individuals which enables an easier way of interpretation of understood and perceived contexts and messages. As a result, Artificial Intelligence is regarded to stand for human mind itself and its competence in transmitting the messages from a language to another flawlessly.

In addition, this field has also ties with psychology, pragmalinguistics, and core linguistics as it is stated by Fodor and Garret "both linguistic and psychological models are model of competence" (p. 138). In other words, as a human translator naturally does, the translating process is more than searching for the exact word in the target language, and it is tied to a correct perception of cultural and contextual elements in the source text. To emphasize, Türkmen (2019) puts forward that the translator as a concept can be explained as a tool to act as a bridge between signs, languages and cultures and to enable a message in a language fully understandable in another (p.19). The AI is expected to mimick how the human brain itself perceives the text as a whole and reads between the lines, and to have a competent way of mocking it through a pragmatic perception, while taking sociolinguistic variables into consideration.

From time to time, reading between the lines and uncovering hidden messages and concepts are not easy even for a professional human translator, yet, the AI is has been expected to mock this ability of human brain. As Erton (2017) states, "The task of pragmatics in this sense is not easy. For the language user, pragmatics has to incorporate and mirror the personal, sociocultural, psychological and even geographical aspects of language." (p. 167). While analyzing the text, the AI was expected to follow the same way of pragmatic approach to produce an impeccable translation product, evaluating the source text together with its every extralinguistic elements.

Modern times had modern requirements, and the integration of translation studies and technology was inevitable since language is one of the most vital elements of the communication process of the present day. This urgency has created the basis of the invention of computer- assisted translation machines. SDL Trados (Software and Documentation Localization Trados) and CAT (Computer- Assisted Translation) has become significant tools to remove the heavy demand of translation off of the translators, yet, they were not quite effective while working on complex sentence structures and texts. Unfortunately, they were limited with simple structures and text types. Nevertheless, they were quite efficient in saving time, they could keep the sentences of the translator in memory, getting rid of the need of translating the same sentence structures again and again. This limited nature of those tools required a fresh update, in other words, the integration of Artificial Intelligence was expected to be a groundbreaker.

The process of communication is initiated with the language acquisition with all of its aspects, linguistic and extralinguistic. Yet, there might be differences even in the same language. To put it into another way, the people who speak the same language might face difficulties while trying to understand each other due to various dialects and micro- cultural features. Respectively, transmitting a message impeccably from one language from another in a short time period becomes a significant matter which becomes a considerable responsibility for the translators themselves. Instead of depending on statistical manner of operating of the ancient computer-assisted translation machines, Artificial Intelligence has been regarded as the ultimate solution to obtain flawless and more natural translation

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.products. These elements accelerated the studies of

significant companies such as Google, Microsoft and DeepL, to integrate AI into computer-assisted translation tools.

V. CONCLUSION

The developments in technology, the need of communication between cultures, nations and countries has created a quite exceptional need; the integration of technology and language, translation studies in the end. The communication process between various cultures and languages has become significant over time, as a result, conveying a message correctly from a language has turned out to be crucial. In the end, this created a great responsibility for the professional translators, since a professional translation process takes more time and effort than it is thought. Yet, the education and training of a professional translator have also takes a great deal of time. The developments and breakthroughs in the field of technology have paved the way for the emergence of the Artificial Intelligence, and it has saved the situation in the translation field. Together with the invention of Artificial Intelligence, the translation business made a clean break.

Translation process creates a translation product, which aims to convey the messages in the source text correctly to the target text with all of its different dimensions. Since the main aim of Artificial Intelligence is to mock the human brain as a whole, it is expected to function as the human brain naturally does, and to perceive and figure out a text with its cultural, social and pragmatic features and different layers. Significant companies such as Google, Microsoft and DeepL has created AI-integrated software programs to meet this demand. Google has created Google Translate, which depends on a neural machine translation system, in order to produce human-like translation products. Its main working principle counts on an end-to-end artificial neural network, which has the ability of learning while translating. Once an online dictionary, DeepL has established a system that can evaluate and learn from the translations through AI. The accumulation of knowledge provided by the rich online dictionary it is based on allowed it to create better, less erroneous and faster translations. Microsoft followed these achievements with its Microsoft Translator. Its new system has the ability to deal with complex and longer sentence structures, thanks to AI.

It is evident that transmission of messages between two different languages and cultures is a more complex process than it sounds. Seeing that language and its culture are inseparable, and those are layered concepts, the process of communication is also embellished with those elements. The professional education allows a human translator to detect, perceive, understand and convey those elements from one language to another. As a result, Artificial Intelligence is regarded to perform just as the same as a human translator. Nevertheless, it does not meet the expectations perfectly, it is inadequate to perceive the desired message due to the cultural, contextual, and extralinguistic features of the source text. Those details requires a thorough analysis and understanding in order to transmit the message accurately. The underlying meanings should be found out, studied in detail, and then translated correctly. Since the written or the verbal text is adorned with sociological, psychological, and contextual elements,

Artificial Intelligence remains incapable in finding those out and translating them morphologically, syntactically and semantically, resulting in inadequate translation products. In other words, it does not meet the requirements at the surface level grammatically.

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