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A METHOD FOR FORECASTING WEATHER CONDITION BY USING ARTIFICIAL NEURAL NETWORK ALGORITHM

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Abstract

This article presents a method to forecast and make decision on weather condition. In most of the cities around the world, people try to decide on leisure activities on their spare time but weather condition would not be suitable for them. By this fact, we suggest a solution to solve this problem with ANN. Therefore, users of our proposed method can organize their daily life in accordance with weather condition. Artificial Neural Network (ANN) is one of the popular research subjects in computer science, thus, this paper aims to familiarize the reader with ANN. In our proposed method, at first, people can organize weather condition, and then the program suggest whether the time is suitable for them or not on chosen hour of day. In ANN, we discuss about neuron that have relation with performance. Mean Square Error (MSE) is the key issue for the performance of our method. At the end, the simulation results show that relation between Neuron and MSE is applicable for daily usage.

Key Words:

ANN, Neural Networks, Weather Conditions

1. INTRODUCTION

Nowadays, weather forecasting is one of the popular applications in daily life. A process of weather forecasting is valuable only if it can be used to make decisions that yield attractive benefits to the users [1], [2]. Therefore, people want to be aware of weather climatic conditions after doing something especially in metropolitan cities like Istanbul, because people spend most of their daily time in traffic. At this point of view, weather condition is one of the main causes for traffic to be high or low. On the other hand, people sometimes go on a trip to a city that they have never been but do not know any information about climate conditions of there. Then they probably check weather temperature, precipitation and so on from global weather forecasting websites. Thereby, it can be concluded that a kind of events in our daily life such as shopping, picnic, sport are directly related to the weather condition. These events would be done in different weather conditions; for example, when the weather is rainy, going picnic is not an excellent choice but going shopping maybe is suitable.

When we examine the related data mining literature, it can be concluded that most of the weather forecasting applications only show us general weather condition in terms of temperature, humidity, perception, and wind. But in our study we want to separate these conditions according to personal manners. In our method, we tried to use diverse criteria in terms of seasons because of the different leisure activities of the seasons. For instance, shopping activity has different structures in winter and in summer. As we assume a year constitutes 365 days and 4 seasons. In addition, we chose Istanbul for testing our model. This city is marine city (Marmara Sea) and has latitude of 40.75000, longitude of 29.00000. Because of its geographical position, there would appear different seasonal weather conditions around this city. Due to this fact, there are 35 weather observation centers located all around the city. We chose 5 station (Sariyer, Istanbul Bölge, Fatih, Florya, Eyüp) district and we applied our method to the data about this district. We gathered data from National Weather and Climate Organization of Turkey (MGM).

In this study, we propagate our method on Artificial Neural Networks (ANN) algorithm. ANN was inspired by human brain neural systems. In addition, the reason of our decision is that ANN is based on 'prediction' by smartly 'analyzing' the trend from an already existing voluminous historical set of data [3]. Human brain learns initially using the previous work then gives the command. For instance, when our hand get close to heater, a suitable command from our brain send to hands neuron that you must be away from heater. Our brain uses previous trains in these kinds of actions. In the computer execution, a system can train and decide next actions according to trains. Thus, artificial intelligence is a computer program designed to acquire information in a way like the human brain. Artificial intelligence, a compound of neural networks, was developed as a result of research on cognitive talent and machinery design [4]. The history of artificial intelligence dates back to Aristo. It is known that Aristo worked on the algorithm of thinking and discussed its difficulties. In a modern sense, artificial intelligence was introduced to the scientific world when the first computer was invented in the 1940s and Alan Turing developed the first software [5].

In our study, for neural network applications, a common Neural Network Fitting Tool GUI "nntool" was used. This tool is available in MATLAB (R2014a) and is used to carry out the analysis on the weather data using Artificial Feed-Forward Neural Network with back-propagation principles [6].

This paper effort to show the applicability of ANN and make decision that user can customize it by self-needs based on 5 Weather Stations for three years (2014, 2015, 2016). Our paper is organized as follows: the second section presents the concepts of ANN, the third section explains training processes and discussion about the results. The last section indicates conclusion and future study recommendations.

2. LITERATURE REVIEW

Artificial Neural Networks (ANN), also called neuro computing, connectionism, or parallel distributed processing (PDP), provide an alternative approach to be applied to problems where the algorithmic and symbolic approaches are not well suited [7]. The human nervous system consists of billions of neurons of various types and lengths relevant to their location in the body [8]. In biological neuron there are dendrites, cell body

and axon that their task are send and receive signal from other neurons and do some works as brain instruction. ANN is inspired by the way biological nervous system.

Another definition is given by Haykin [9] as a neural network is a massively parallel distributed processor that has a natural propensity for storing experiential knowledge and making it available for use. It resembles the brain in two respects:

- Knowledge is acquired by the network through a learning process.
- Interneuron connection strengths known as synaptic weights are used to store the knowledge.

In 1958, Rosenblatt introduced the mechanics of the single artificial neuron and introduced the 'Perceptron' to solve problems in the area of character recognition [10] in artificial neuron there are input and output, that neuron receives inputs and combines them in a special way. Perceptron means a computer model or computerized machine devised to represent or simulate the ability of the brain to recognize and discriminate. The perceptron algorithm was invented in 1957 at the Cornell Aeronautical Laboratory by Frank Rosenblatt, [11] funded by the United States Office of Naval Research [12].

The perceptron can be trained on a set of examples using a special learning rule [10] perceptron has three layers with a middle layer known as the link layer. The system can learn inputs then impose random output.

Simple ANN consist of three layers of input, output and processing. Each layer has group of neuron cells that associated with all neurons in other layers. However, neurons of each layer are unrelated of same layer neuron. Each neuron can be non-linear function so the result is a neural network which is formed from the union of these neurons, could be a nonlinear system is quite complex.

Neural networks offer a number of advantages, including requiring less formal statistical training, ability to implicitly detect complex nonlinear relationships between dependent and independent variables, ability to detect all possible interactions between predictor variables, and the availability of multiple training algorithms. Disadvantages include its "black box" nature, greater computational burden, proneness to overfitting, and the empirical nature of model development [13].

Some of the well-known types of neural networks are Competitive Learning [15] [16], the Boltzmann Machine [17], and the Hopfield Network [18], the Kohonen network [19], the Adaptive Resonance Theory (ART) [20] and back propagation neural networks [21]. Although there are many other variations of neural networks, the back propagation network and its variants, as a subset of multilayer feed forward networks, are currently the most widely used networks in applications [13].

The Fig.1. demonstrates a neural network. Each of the processing units takes many inputs and generates an output that is a nonlinear function of the weighted sum of the inputs. The weights assigned to each of the inputs are obtained during a training process (often back-propagation) in which outputs generated by the nets are compared with target outputs. The answers you want the network to produce are compared with generated outputs, and the deviation between them is used as feedback to adjust weights [13].

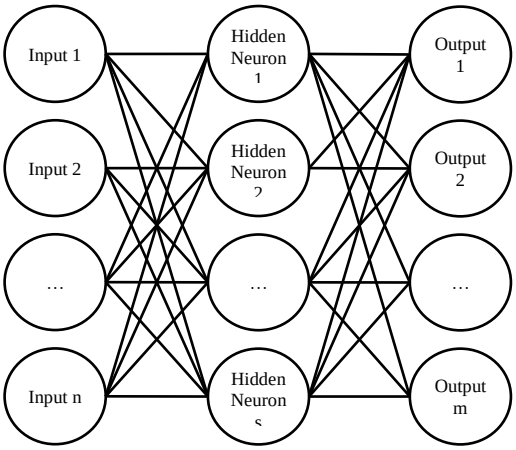

Fig.1. A Neural Network Model

3. METHODOLOGY

In this section, our methodology is described briefly. We assume that the person wants to decide and go shopping but intends to customize weather conditions. For example, some people like shopping in rainy days, so s/he can customize weather conditions with a precipitation of 55mm and temperature between 5 and 9°C. As another example, a group of friends want to play football on hot weather so they would customize weather condition in related features. In addition, most of the families go picnic with special weather condition, or a group of mature women want to have trip with special weather condition and so on. In this decade, there are more and more weather condition system that predict but our goal is to allow people customize weather condition with their demand.

As mentioned above a coach of football team want to practice his team in very dry weather so they must state demands in terms of high humidity rate, and be aware in which day and hour they would practice. One of our system's benefits is that person can know hourly condition with demands.

At the first step, we use some instance values for decision function. Weather features are important respectively (e.g. time (hour), temperature, precipitation, wind power, humidity, snow etc.). These features in every hour and stations recorded. We get weather data of year 2015 (12 month, every day, and every 24hour) from MGM. As the first example, we assumed that a person want to go shopping with weather conditions and priority which are mentioned in Table.1.

Table.1. Shopping weather Condition

Weather condition	Rate
Hour(time)	Between 7am and 15pm
Temperature	Between 4°C, 12°C
Precipitation	0mm
Humidity	< 60%
Wind power	13msec
Snow	0mm

According Fig.2, shopping flowchart start from time, for instance, the person want to go shopping between 7am and 15pm

so this is the first criteria, then temperature is other criteria to person so, the temperature must between 4 and 9ºC, precipitation, humidity, wind power and snow are other criteria for that person. After all, this is a model that produce by a person, and then our system must to suggest suitable options. These options selected from our 3 years weather condition. In the next section, we will discuss about this results. In other try, we assume a group of friends wants to play football under weather conditions listed in Table.2. In this example, time and humidity have high priority so they must customize these items at the first row.

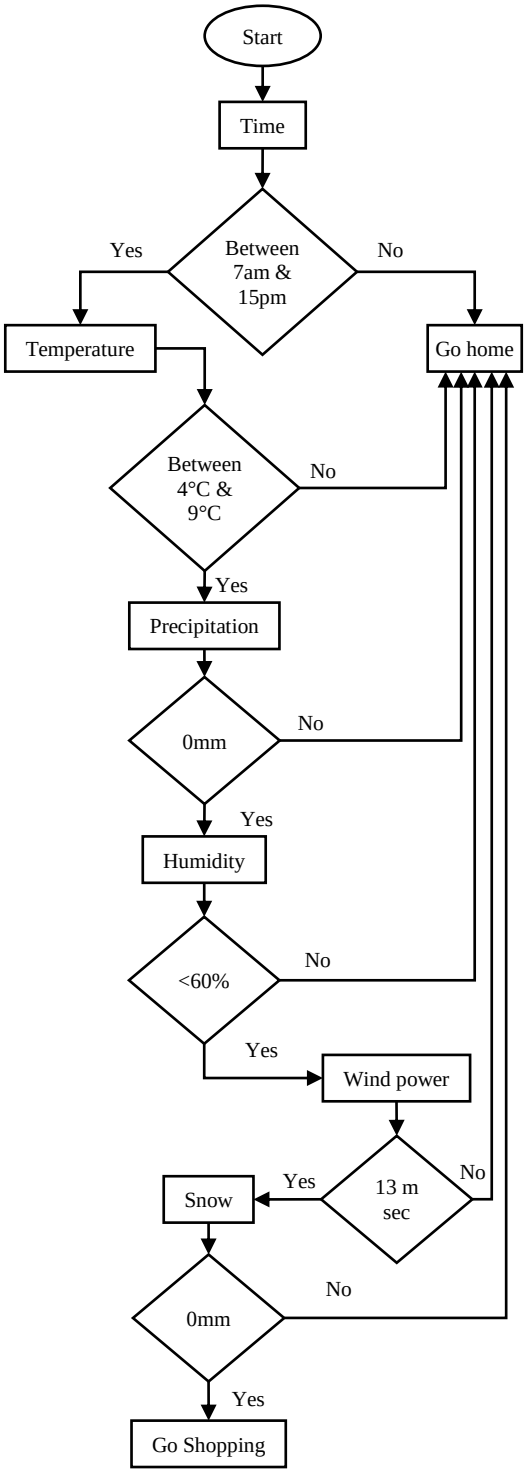

Fig.2. Shopping Flowchart

As mentioned in the shopping flowchart section there are same criteria's in sport flowchart (Fig.3), but time and humidity have higher priority than other criteria, this is clear in in flowchart the initial rules have higher priority, in this example, after time, humidity must be less than 80%, temperature must between 6 and 14ºC. This model suitable for sport group.

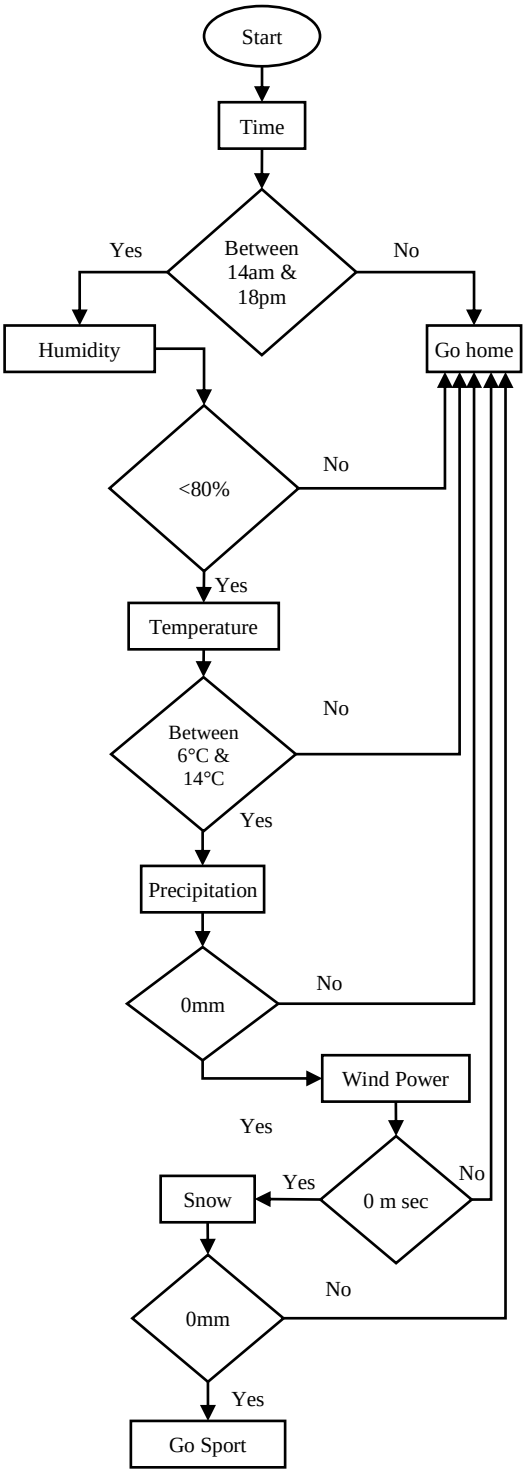

Fig.3. Sport Flowchart

Table.2. Shopping weather Condition

Weather condition	Rate
Hour (time)	Between 14pm, 18pm
Humidity	>80%
Temperature	Between 6°C, 14°C
Precipitation	0mm
Wind power	0msec
Snow	0mm

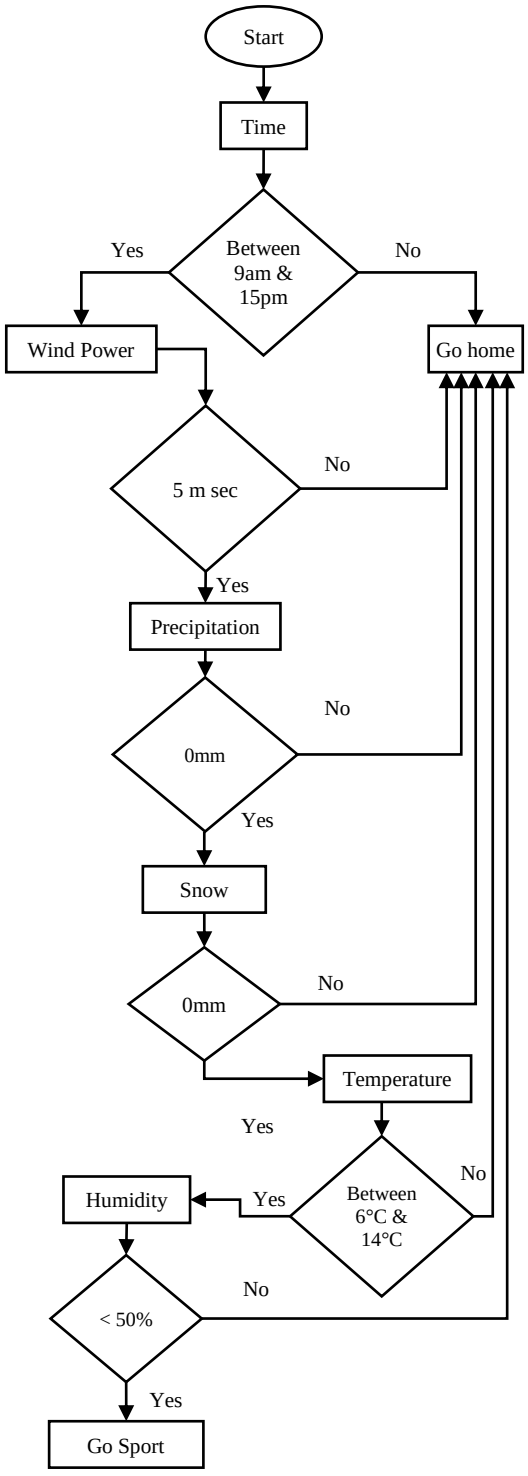

Fig.4. Picnic Flowchart

Table.3. Picnic Weather Condition

Weather condition	Rate
Hour(time)	Between 9am, 15pm
Wind power	5msec
Precipitation	0mm
Snow	0mm
Temperature	Between 6°C, 14°C
Humidity	<50%

In the third situation (Fig.4), going picnic is case study. Thus, wind power, rain and snow have high priority. It means the person want to go picnic according weather conditions listed in Table.3.

Picnic flowchart express that, time and wind power have higher priority than others, like other examples this flowchart gives us a model that we use in our neural networks simulation system.

3.1 NNTOOL AND NEURAL NETWORK EXECUTION

Neural networks are good at fitting functions and recognizing patterns. In fact, there is proof that a simple neural network can fit any practical function [14]. We used the neural network fitting tool GUI available in MATLAB 2014a. On the weather decision, function using artificial Feed-Forward Neural Network with back-propagation principles [6].

After this we will discuss about how to increase performance, or how increasing the number of neurons and hidden layers does.

3.2 DATASETS

As mentioned before, we gathered data from MGM [20] about many stations that we choose year 2014, 2015, 2016 and 5 stations around "SARIYER" district. (Sariyer, Istanbul Bölge, Fatih, Florya, Eyüp). The input dataset consists of Eq.(1):

365 day * 24 hour * 3 Year * 5 Station = 131400 Record

Each record presents, day of year, station id, year, month, day, Time (hour), Temperature, Precipitation, Wind power, Humidity, snow.

3.3 NEURAL NETWORK MODEL

Generally, feed forward with back propagation network should have three layers; input layers, hidden layers, output layers. Experimentation is necessary in order to select the numbers of hidden layers. There are some training algorithms and we selected the Levenberg-Marquardt algorithm. At the end of iterations, results are examined based on Mean Square Error (MSE) calculation. This number is a measure of the quality of an estimator, it should be non-negative, and values closer to zero means better findings [6], [14]. In the training process, there are a set of input data and the corresponding target output - good or bad - this result related to person customized weather condition. Obtained Output reflects the expected behavior of the system. Then the obtained output is compared with the target output. In our simulation, Transfer Function of Hidden Layers (TANSIG) is used and there appeared five hidden layers. The results are shown in Table.4.

In Table.4, Istanbul Bölge in 2016 with 50 Neurons/Layer for Shopping, Istanbul Bölge in 2016 with 50 Neurons/Layer for

Sport, Istanbul Bölge in 2016 with 20 Neurons/Layer for Picnic, respectively have 0.087, 1.3, 1.3 MSE. We find out our model in this stations have very close predict to target. From other hand, we can say our method has less error in those stations. Because MSE value is very close zero. In contradiction, FLORYA in 2015 with 20 Neurons or layer for Shopping, Sariyer in 2015 with 20 Neurons/Layer for Sport, Florya in 2015 with 50 Neurons/Layer for Picnic have very far predict to target.

Table.1. Results

	Neurons/Layer = 20			**Neurons/Layer = 50**		
Shopping						
Station Name	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**
	MSE	**MSE**	**MSE**	**MSE**	**MSE**	**MSE**
Sariyer	15.2	16.8	12.3	11.3	13.2	9.3
Istanbul Bölge	8.6	4.2	2.3	4.3	1.4	.087
Fatih	6.4	15.3	13.2	2.5	9.5	11.2
Florya	13.2	17.7	14.2	11.6	14.2	10.3
Eyüp	12.2	15.5	11.2	9.1	11.7	4.6
Sport						
Station Name	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**
	MSE	**MSE**	**MSE**	**MSE**	**MSE**	**MSE**
Sariyer	14.3	17.2	11.7	11.8	11.4	8.7
Istanbul Bölge	13.3	3.5	2.2	8.4	2.6	1.3
Fatih	7.3	12.2	11.4	6.4	9.6	7.6
Florya	12.3	16.2	15.6	11.4	9.4	10.1
Eyüp	11.5	11.6	12.7	6.8	7.6	6.8
Picnic						
Station Name	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**
	MSE	**MSE**	**MSE**	**MSE**	**MSE**	**MSE**
Sariyer	13.9	11.2	9.4	9.3	16.8	12.3
Istanbul Bölge	12.9	2.6	1.3	8.6	4.2	2.3
Fatih	8.2	14.2	9.7	6.4	15.3	13.2
Florya	11.2	11.9	11.3	13.2	17.7	14.2
Eyüp	11.8	7.4	9.7	12.2	15.5	11.2

4. CONCLUSION

The main goal of this article to get suggestion according to weather condition via ANN, so after simulation in Matlab 2015a, we can say about that our Neural Network can predict near 91% that it make us happy. In this article the MSE is performance for us, MSE values closer to zero are better. We must mention that the MSE value has inverse relationship with input values and neuron numbers; it means if the number of input values and neuron numbers increases, MSE decreases and performance will be good.

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