

# *Simulation of Performance of Air Conditioning System using Multi-nets Artificial Neural Networks(MN-ANN)*

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**Abstract**— Usually, the air conditioning systems have to be compelled to maintain temperature among an exact fascinating vary. Specially, the temperature distribution isn't spatially uniform. Having sensors put in at mounted and restricted locations cannot react to the quickly variable space conditions thanks to transient and non-stationary human behavior. This paper has a tendency to use Multi-nets Artificial Neural Networks (MN-ANN) to work out and conclude the precise or close to cooling needed for the space, supported the amount of person's gift within the space. So, with the help of typical temperature range of persons within the space, we'll able to conclude what quantity temperature we've to present to cooling or heating the space. The operation is uncontrolled and should be manually turned on and off. Typically it will cause high usage of electricity that successively raises the electricity bill once the user forgot to change it off. So in order to avoid such problems automatic controlling of air conditioning systems can be used. In this paper, the simulation of performance of air conditioning systems using MN-ANN is performed. The simulation is done using Matlab R2018a.

**Keywords**—Air Conditioning Systems, Multi-nets Artificial Neural Networks (MN-ANN), Matlab, Heating, Cooling.

## I. INTRODUCTION

### A. Development of Air Conditioning Technology

The world is fully nowadays occupied by trendy and comfort life and so each individuals prefer air conditioners for their sophisticated life. Most of the developed and developing countries use air conditioners which results in lot of energy consumption which also results in large area occupancv. Our main motivation is to reduce this large energy absorption in most of the residential and industrial areas which may result in a noise free environment.

Usage of Solar energy resource can be considered as a new energy efficient method to reduce energy consumption in various places. Because solar energy is directly obtained from the sun and so it doesn't need any other sources. In a centralized AC, variable speed pumps can be used for energy consumption. Energy efficiency of an AC can be implemented

by using a feedback controller for AC. Similarly for a multi-unit ACs, fuzzy logic is used to enhance its efficiency and to reduce the energy consumption. Similarly Multi-nets Artificial Neural Networks can also be used to increase the efficiency and to reduce energy aborption.

ACs progress include efficiency, inventive technology, energy consumption and the most important one is human comfort zone. The types of ACs are window type, split type, fixed frequency and convertible frequency and all the above types have been introduced in the earlier days. Later smart type has been introduced for human comfort zone. In order to satisfy the customers and to reduce the noise coming from AC, in 1990s window type has been converted to split type and later split type became popular among the consumes because of its advantages. Till then fixed frequency has been used but after that because of high oil price and demand for energy consumption, the control of compressors has been done by convertible frequency instead of fixed frequency. Thus there occurs a drastic change in ACs in the previous days. Then later smart type has been developed for the same purpose that is for the comfort for humans.

After the introduction of mobile phones, tablets, cloud computing the air conditioners have become smart air conditioners. Since it can adjust the room temperature based on human presence, human temperature and so on. Due to the advancement in technology, the control of air conditioners are becoming smarter and smarter day by day. There occurs a less energy consumption and energy conservation. With the outside temperature and with the persons count or the number of persons entering in the room also the smart air conditioners can work. Not only with the mobile phones, with the help of smart watches also it has been able to control the ACs from anywhere in and around our place. Smart technology appears as a very effective and valuable place in our society. Not only it helps us to live in a comfort zone, it also results in an energy conservative technology which is a very good advantage of using smart technology.

## II. MULTI-NETS ARTIFICIAL NEURAL NETWORKS

Using multiple neural networks, the errors can reduce or minimize irrespective of multiple networks. Since number of networks are used, the errors of all the networks can be combined and averaged to minimize or reduce the overall errors. So that it will result in a better accuracy and efficiency. While using Artificial Neural Network (ANN), there will be only one network so it will not be able to approximate complicated functions since ANN classifiers consists of only one network function. They cannot be able to represent multiple views since they are having only one network. While using single ANN, they are not able to bear the burden or complexity of the network since they have been trained with a single network function. But in the case of MN-ANN, they can able to treat with all the functions since they have a number of networks and most important is that their administration view is being split to all the network functions in an equal manner. So that they play a very important role.

The benefits of neural networks are that they're non-linear, adjustable and self-learning, and are sensible at associations and comparisons. They will be strong against interference and might simply be enforced on hardware. It also can approximate any nonlinear perform, do data processing and be fault-tolerant. So it provides a brand new thanks to solve the speech recognition that could be a complicated pattern classification drawback. Nowadays neural networks became associate knowledge domain field involving: engineering science, engineering, arithmetic, physics, psychology, and linguistics. For various recognition systems the wants, the planning and implementation strategies are typically similar. Fig.1, explains a fully connected multi-layer neural network which is also called as a Multi-layer Perceptron.

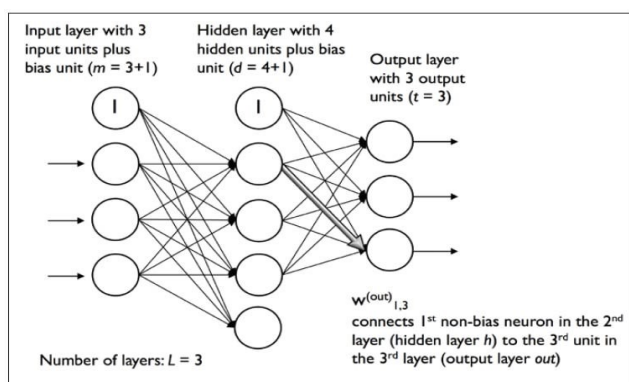


Fig.1 Multi layer Neural Network (Multi-layer Perceptron)

### A. Various methods for combining Neural Networks

Methods for combining multiple networks can be divided into the following approaches:

#### 1) Simple Averaging and Weighted Averaging:

From the heading itself it says that this type shows the output of combining all the multiple networks outputs that too in two different types one is simple averaging and the other one is weighted averaging. In the first type, all the networks functions output are been averaged to get the final output. The second one shows the output of averaging all the networks functions output. All these can be done by using Multiple Linear Regression (MLR) and Principal Component Regression (PCR).

#### 2) Non-linear Combining Methods:

Non-linear combining methods include Dempster-Shafers belief based method, combining using rank based information, voting, order statistic and Tumer and Ghosh methods.

#### 3) Supra Bayesian:

This method is opposite to linear combination type. The idea used in this type is that the people themselves are considered as a big dataset. That is the opinions or ideas of people themselves are taken for training and it is been trained for further process.

#### 4) Stacked Generalization:

In this type all the networks with their weights are been joined together which varies from a set of level 0 to level 1 is been used. It is been trained to produce the appropriate output. Since the weights are been used, so that the features can be extracted in a proper way.

Other strategies of combination square measure selective combination of networks. The target behind selective combination is to cut back the quantity of shared failure once combining the networks. There square measure heaps of strategies on the way to choose correct networks for combination. In selective combos, networks with abundant larger coaching and testing errors square measure excluded from forming stacked networks. Therefore the statistic modeling accuracy is improved by implementing the multiple combos of the neural networks.

### B. Combination of Networks

The combinations of networks used in MN-ANN are Elman back propagation, radial basis and Perceptron. This is due to the following reasons:

#### 1) Elman back propagation network

It is known as recurrent network. It is having its own backup memory in order to process the sequence of inputs.

Since it has a powerful backup memory it can able to handle the past relevant information in the internal states. Moreover it has some additional feedback connection so that it can able to recognize and generate temporal and spatial patterns.

### 2) Radial basis network

It consists of a 2 layer feed forward networks, since it is a feed forward network. So that both the training and testing function are very accurate and fast. So that it results in a better generalization capability, noiseless with strong tolerance to noise with better efficiency and accuracy when compared with all the other combining networks. Here Gaussian functions are used in radial basis networks in most of the times.

### 3) Perceptron

Here Multilayer Perceptron (MLP) is used. MLP is known as supervised network because it requires a required output in order to train and test. The main aim of this type is that it maps the input to the output in a correct or a proper way. It does not uses feed forward type since it uses back propagation type. Since it uses a back propagation type, the error can be fed back and it can be minimized and the weights of the functions can be adjusted to get the desired output.

## III. EXPERIMENTAL EVALUATION

### A. Description

Here the simulation of the performance of air conditioning systems is done in Matlab R2018a. Initially, in a home environment 25 persons were allowed to go one by one. The program is thereby set, when a person is set to move, it is indicated by 1 and if there is no entry it is indicated by 0.

Here neural networks are used as a machine learning technique in order to find the overall accuracy. Since in a single neural network the accuracy will not be in a predicted way so it has been involved in for multiple networks that is multi-nets artificial neural networks. In this type three combination of networks have been used.

Since 25 persons are considered, these 25 persons are divided into 5 classes. Each class consists of five persons such as class A, class B, class C, class D, class E. All these five classes are been trained with the above three neural networks individually. After training, they are also been tested to get the desired output.

Similarly the temperature may vary between adult and child, adult may accompany a child or may not. A sample data is given below in Table I. This table describes the sample data for a count of 5. Similar to this, a data sheet is created for 25 persons. But the thing is that it requires to create a database

for varying temperature such as it may start from 97 degree Celsius and it may go upto 103 degree Celsius. These temperature varying must be done for both adults and children. Similar to this sample data, in Matlab using created excel sheet database for 25 persons, which includes both adult and children. Since the full data cannot be established with this limited space, only 5 sample data has been shown in Table I.

Sometimes the adults may come with the children, then there occurs temperature for both the adult and children. So that it is required to find out the average temperature for both which will be easy for us to find out output AC temperature. Since in neural networks 5 classes are taken, where each class consists of 5 persons (i.e.,5 count). And the temperature will also be varying for all the 5 classes. All the 5 classes utilizes all the three neural networks which gives us number of hidden neurons, weights, bias and average accuracy.

The below table II gives the output by using the various neural networks. This output table also shows the sample output for the sample data given in table I. That is, here only class A output is shown in table II. The remaining classes also been trained and tested. In that table, all the trials include the classes used in this experiment. The neural network functions include newpr, newelm, newff and newrb which are perceptron, elman back propagation network, feed forward and radial basis network accordingly. Finally all the classes output is been combined and the average accuracy is been calculated.

TABLE I SAMPLE DATA(Class A which includes only 5 count)

Adult(temp)	Child (temp)	Average Temperature	Count
98.1	0	98.1	1
100.9	99.1	100	2
97.9	96.1	97	3
98.3	96.5	97.4	4
99.1	97.3	98.2	5

TABLE II PERFORMANCE MEASURES USING VARIOUS NETWORK FUNCTIONS (for the above sample data which includes only class A)

Trial No.	Network functions	No. of hidden neurons	Weights	Bias	Average accuracy (%)
1.	newpr	15	-1.3996	-	70
	newff	20	-11.1995	4.4006	
	newlm	30	-0.1078	- 0.2955 0.1555	
2.	newrb	10	0.1456	0.8326	73
	newpr	15	6.9994	-	
	newff	25	1.4006	1.1993 7.2321	
3.	newrb	20	0.1456	0.8326	79.5
	newp	-	0	0	
	newcf	40	-8.3987	0.5011	
4.	newlm	10	-0.1594	-	72
	newrb	20	0.1456	0.5242	
	newp	-	0	0.8326 0	
5.	newlm	50	-0.0408	-	79.5
	newrb	100	0.1456	0.1852	
	newp	-	0.000630	0.8326 0.0183	

#### IV CONCLUSION

In this report, one of the most important machine learning techniques Neural Networks (NN) is been discussed. Multi nets neural networks is nothing but the neural networks with various functions. Since various networks can be used just to improve the percentage of accuracy. Actually neural networks are the existing approach but the use of various network functions is an extended version and tried in an innovative way. So in general, the overall accuracy for all the 5 classes gives us 75.4% which is considered to be an important one. But in near future, it is in process to propose a stream based

machine learning approach to control the air conditioner according to the number of persons present in the room.

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