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A REVIEW ON APPLICATIONS OF ANN FOR DEMAND FORECASTING

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ABSTRACT
An organization should be able to make the right decisions depending on demand information to increase the competitive advantage in a constantly fluctuating business environment. Therefore, predicting the demand quantity for the coming period becomes very crucial. Artificial intelligence forecasting techniques have been receiving much attention recently as these are able to solve problems that are hardly solved by the use of traditional methods. As a new tool, artificial neural network has been used in demand forecasting systems or for smoothing as data pre-processors and classifying noisy data to match the relationships between non-linear functions. The objective of the paper is to review the various literatures where ANN has been used as a tool for forecasting demand.

KEYWORDS: Artificial Neural Network, Demand Forecasting.

INTRODUCTION
A supply chain always has a dynamic system involving the continuous flow of information, product between different stages (Chopra & Meindl, 2001). Every Supply chain process has following three important stages; supply, production, and distribution include manufacturer and suppliers and customers themselves. The flow of information, knowledge or resources between these entities is always important to maximize the overall profitability.

Forecasting, as a part of the supply management, directly affects both quantity and delivery. Forecasts of usage, supply, market conditions, technology, prices, and so on, are always important to make good decisions (Leernders, Fearon, Flynn, & Johnson, 2002). Forecasting the expected demand for a certain period of time with one or more products is one of the most crucial targets in an enterprise. It is unavoidable to be able to know or predict the future demand as close to reality as possible. Although there is need for accurate forecasting to enhance the competitive advantage, there is no standard approach. There are many forecasting techniques that can be classified into four main groups: (1) Qualitative methods which rely on human judgment and opinion to make a forecast. (2) Time-series methods which use historical data to make a forecast. (3) Causal methods assume that the demand forecast is very much correlated with certain factors e.g., the state of the economy, interest rate. (4) Simulation methods that imitate the consumer choices which give rise to demand to arrive at a forecast (Chopra & Meindl, 2001).

ARTIFICIAL NEURAL NETWORK
Artificial neural network is a powerful tool which is popularly used for solving a wide variety of problems in engineering, especially in some areas where the relationship between input and output is non-linear. An ANN can be used as a data-processing model which works in same way as the human biological neural system. Similar to the human brain, ANN learns from examples. The model is trained with a given set of data and then it is validated with the help of independent data. Whenever a new dataset is made available to an ANN, it learns to improve its performance. This results in predictive ability of model.

Neural networks do not require the use of complex mathematically representations, computer models, and costly physical models. Its abilities of computing, self-learning, self-adapting, nonlinear mapping and fine error correction make it suitable for solving number of real-world problems. It has been successfully used in various areas such as pattern recognition, mapping, image processing, data classification and various manufacturing applications.

The aim of neural networks is to mimic the human ability to adapt to changing circumstances. As the human brain is a highly complex and interconnected network of neurons, components of ANN model are prepared with a direct analogy to the biological neuron and hence are termed as Artificial Neuron.

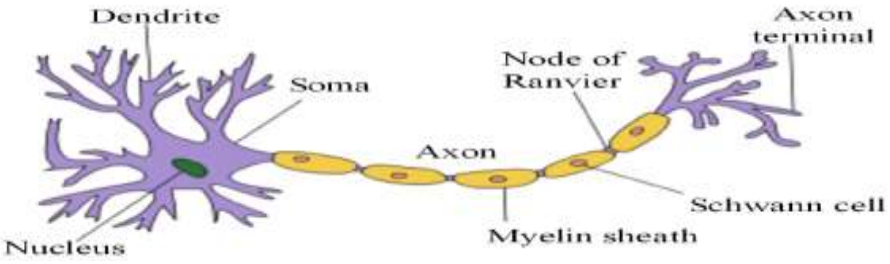

Fig. 1.1 Structure of Biological Neuron

A biological neuron consists of synapses, dendrites, the cell body and the axon as shown in fig 1.1. ANN model consists of many nodes, i.e. processing units similar to the neurons in the human brain. Each node has node function assigned to it which along with a set of local parameters determines the output. The nodes process the information and pass it on only if it is considered important. The links possess an associated weight which is multiplied along with incoming information. The output is obtained by applying activation function to the net output. Figure 1.2 shows the principle of how an artificial neuron works using a basic ANN model.

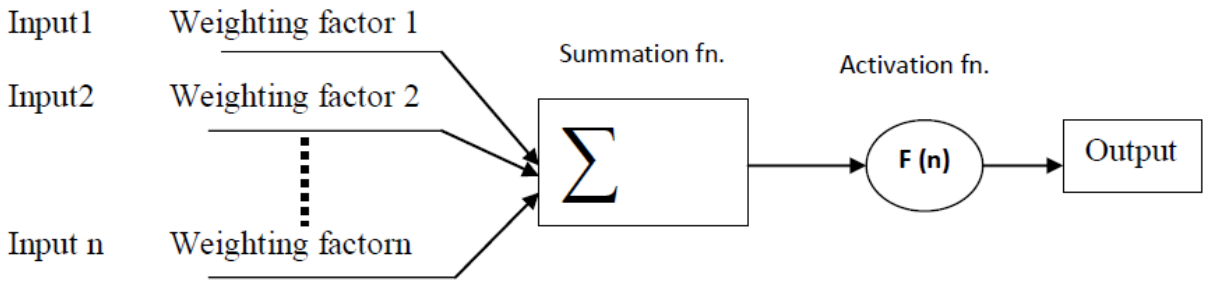

Fig. 1.2 The McCulloch-Pitts Neuron Model

An ANN model usually consists of an input layer, few hidden layers and an output layer. Each input is multiplied by a weighting factor and then transformed through an activation function to finally obtain an output. Different types of neural network model have been invented for different applications. Back-propagation approach uses a systematic method for training multi-layer neural networks. It works on a gradient descent procedure in which weights changes by an amount which varies proportionally to the derivative of the error function with respect to the given weight. In feedback networks approach, one output vector is assigned to each input vector. The response of network can return to input, thereby giving rise to an iteration process. Most important step for a neural network is training. The method of setting the value for the weights enables the process the training. The process of modifying the weights with the objective of achieving the expected output is called training a network. Generally, there are three types of training models supervised training, unsupervised training and reinforcement training. In supervised learning, inputs and outputs are provided simultaneously. The outputs obtained from the network model are compared with the desired value of outputs. Calculations for error are done, and at the same time weights are adjusted to new values. In unsupervised (self-organizing) learning, inputs are provided to the network but not the desired outputs. The system itself decides what method it will use to group the input data. In reinforcement training method, the network is only presented with an indication of whether the output is right or wrong. The network must then use this information to improve its performance.

Application of ANN for Demand Forecasting

1. S.M. Al-Fattah et. al [2001]

In this study, a new approach was developed to forecast the future production of U.S. natural gas using a neural network. The three-layer network was trained and tested successfully, and comparison with actual production data

showed excellent agreement. Forecasts of the network input parameters were developed using stochastic modeling approach to time-series analysis. The network model includes various physical and economic input parameters, rendering the model a useful short-term as well as long-term forecasting tool for future gas production.
The neural network model is found to be a useful tool for future gas production. It can also be used to examine the effects of various physical and economical factors on future gas production. With the neural network model developed in this study, we recommend further analysis to evaluate quantitatively the effects of the various physical and economic factors on future gas production.

2. BRENT S. TAYLOR [2015]
This study investigated the relationship between economic factors and monthly tire sales, using artificial neural networks (ANNs) and comparing the results to stepwise regression. Data for this research were collected through a privately held tire warehouse located in Wheeling, West Virginia. Research has shown that artificial neural network models have been successfully applied to many real world forecasting applications. However, up to this date no research has been found using artificial neural networks and economic factors to predict tire demand. The first part of this research describes why the chosen economic factors were selected for this study and explains the initial methodology with results. The next stage of the research gives details on why the methodology was revised and also clarifies why Google Trends and additional mathematical inputs were applied to the study. The final research focused on separating the master database into three different categories based on selling percentages. The results of the study show that the artificial neural network models were capable of forecasting the number of high selling tires, with a validation technique, but were unable to be applied sufficiently for the medium and low selling products. From this research, artificial neural networks, along with other predictor models, were shown to have limitations when predicting tire sales for this case study, at least when based on the defined economic factors that were used as inputs. For the top-selling tire category, the model could be used to predict sales and required inventory levels with the help of expert opinion validating the models predictions. The mid- and low-selling models could be used as a forecasting reference tool for the expert buyer. For the most part, the mid- and low-selling models tended to predict sales by using an average of sales history figures. Therefore, these models could be used as a guide to help businesses react to future demand, keeping in mind that some fluctuation is usually going to occur. Applying this research to nationwide tire sales could show better results by having an increased market size instead of focusing on a privately held business. However, with so much variability within the sales of this private business, it does make forecasting and predicting consumer behavior extremely difficult. According to Patrick Bower, a forecasting guru, “It would be great if there were a forecasting algorithm that reads consumers’ minds, but there isn’t.” (Bower, 2012) With that said, businesses have to make decisions on historical data, expert opinion, and relative parameters contributing to or relating to consumer buying behavior. Although the results in this research are not as strong as one would have hoped, great lessons were learned along the way, and some new sales prediction ideas were given for businesses in their future endeavors.

3. Kayla M. Monahan [2016]
This thesis aimed to forecast aircraft demand in the aerospace and defense industry, specifically aircraft orders and deliveries. Orders were found to be often placed by airline companies with aircraft manufacturers, and then suddenly they were being canceled due to changes in plans. Therefore, at some point during the three-year lead time, the number of orders placed and realized deliveries may be quite different. As a result, demand is very difficult to predict and are influenced by many different factors. Among these factors some are past trends, economic indicators and aircraft sales measures. In this study, these predictor variables were analyzed and then used with time series and multiple regression forecasting methods to develop different forecasts for orders and deliveries. The relative accuracies of forecasts were measured and compared through the use of Theil’s U statistic. Finally, a linear program was used to aggregate multiple forecasts to develop an optimal combination of all forecasts. The methods employed in this work were quite effective and produced a wholesome aggregate forecast with an error that is generally quite low for such challenging forecasting task.

CONCLUSION
Various researches show that artificial neural networks can be successfully used for demand forecasting in various industrial applications. This gives a simple method for recognizing the non-linear relationship between various factors which influence the demand of any product.

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