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Uncertainty Minimization In two Echelon Supply Chains Using Artificial Intelligence

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Abstract: A manufacturing supply chain is a network of suppliers, factories, subcontractors, warehouses, distribution centers and retailers, through which raw materials are acquired, transformed, produced and delivered to the end customers. Such a supply chain network must satisfy customers' demands at specified service levels and at the lowest possible cost. This paper aims to eliminate demand uncertainty in a two-echelon supply chain network by using artificial neural networks.

Keywords*:* Supply chain networks; demand forecasting, artificial neural networks.

1. INTRODUCTION

"Supply chain management (SCM) is the practice of coordinating the flow of goods, services, information and finances as they move from raw materials to parts supplier to manufacturer to wholesaler to retailer to consumer. This process includes order generation, order taking, information Feedback and the efficient and timely delivery of goods and services" [1]. One of the major purposes of supply chain collaboration is to improve the accuracy of forecasts [2]. Because future demand plays a very important role in supply chain networks, accurate forecasts are needed. Artificial neural networks (ANNs) have been used to solve different kinds of problems such as classification, regression, optimization, clustering, and forecasting. Based on its capacities, neural networks have been used to solve problems in different areas, e.g. time series prediction [1].In this paper, firstly, supply chain networks and artificial neural networks are defined. Then, a numerical example is presented to show the effectiveness of ANNs in demand forecasting for a two echelon supply chain.

2. SUPPLY CHAIN NETWORKS

The term of supply chain implies that there is only one player for each stage. However in practice, it is possible for a manufacturer to supply material from different companies and working with different distributors. For this reason, actually most of the supply chains are networks [3]. A SC network is a complicated whole that contains suppliers, manufacturers, distribution centers, retailers and the systems, sub systems, operations, activities that develop the supply chain and the relations among them [4]. SC network is a series of processes and echelons, which starts with the material/information suppliers and ends with the customer as shown in Figure 1 [5,6].

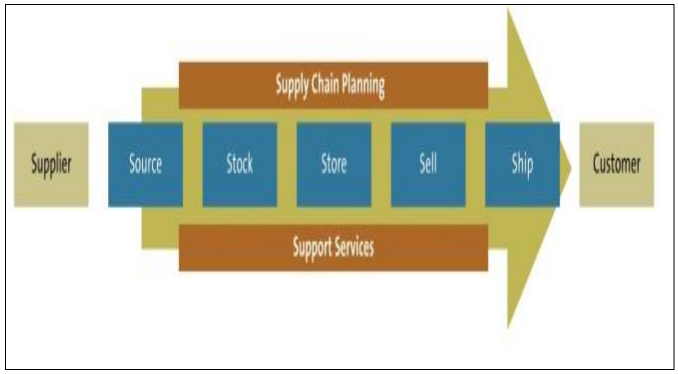

Figure 1. The echelons of a supply network

3. ARTIFICIAL NEURAL NETWORKS

In this section, the general artificial neural network (ANN) structure is defined shortly and MLP neural network model is introduced that it is used for our forecasting system. The ANN model development is a technique heavily researched and used in applications for engineering and scientific fields for various purposes ranging from control systems to artificial intelligence [7,8]. ANNs represent a connection of simple processing elements capable of processing information in response to external inputs [9,10,11,12].

Multi Layer Perceptron (MLP) is the most common neural network model, consisting of successive linear transformations followed by processing with non-linear activation functions. The network consists of a set of sensory units (source nodes) that constitute the input layer, one or more hidden layers of computation nodes, and an output layer. Each layer computes the activation function of a weighted sum of the layer's inputs. The learning algorithm for multilayer perceptrons can be expressed using generalized Delta Rule and gradient descent since they have non-linear activation functions [13,14,15,16].

4. A NUMERICAL EXAMPLE

Here, a two-echelon supply chain, including a warehouse and a distributor, is considered. The monthly sales data of the distributor, between the years of 1997–2005, are used to train the networks as inputs and outputs, and then the demand pattern forecasts for 12 months of 2006 are made based on time series analysis. MatLab 7.0 is used for ANN simulation. The network is trained on 108 data pattern. Then it is checked and tested with 25 samples (25% of the data set). The considered training error is the mean squared error (MSE) of the training data set at each epoch. The tangent hyperbolic function is used in the hidden layer of the modeled ANN. The output layer has linear activation function. The network has 1 input, 1 hidden layer with 10 neurons and 1 output. The training MSE value of this network is gained as 9.95576e-006/1e-005. The learning rateis 0.1 and the momentum is 0.001. The real values and ANN forecast values are shown in the Table 1.

Table 1. The comparison of real and ANN forecast values

Months	The real values	ANN forecast values
1	3900	4059
2	3840	3832
3	3880	3836
4	3940	3897
5	4020	3894
6	4280	4057
7	4400	4214
8	4520	4329
9	4640	4461
10	4720	4531
11	4700	4636
12	4680	4571

5. CONCLUSION

In this paper, the usage of ANNs is examined to eliminate demand uncertainty in a two-echelon supply chain. It has shown that the forecast results obtained from the network are very successful. Finally, it can be said that ANNs can be used such a time series problem effectively.

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