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Artificial Neural Network Approach for Inventory Management Problem

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***Abstract*—**The stock management of raw materials and finished goods is a significant issue for industries in fulfilling customer demand. Optimization of inventory strategies is crucial to enhancing customer service, reducing lead times and costs, and meeting market demand. This paper suggests finding an approach to predict the optimum stock level by utilizing past stocks and forecasting the required quantities. In this paper, we utilized Artificial Neural Network (ANN) to determine the optimal value. The objective of this paper is to discuss the optimized ANN that can find the best solution for the inventory model. In the context of the paper, we mentioned that the k-means algorithm is employed to create homogeneous groups of items. These groups likely exhibit similar characteristics or attributes that make them suitable for being managed using uniform inventory control policies. The paper proposes a method that uses the neural fit algorithm to control the cost of inventory.

***Keywords*—**Artificial Neural Network, inventory management, optimization, distributor center.

I. Introduction

INVENTORY optimization techniques can be applied in industries at the start of the process where raw material reaches the plant and each level of the process needs to be maintained. According to [7], [16], and [17], it is only possible to minimize the overall cost of the supply chain when every supply chain link optimizes the base stock level. The problem behind this is that the excess stock level and shortage level are not static every time. Reference [20] developed an efficient approach using a genetic algorithm to determine the most probable stock level for inventory optimization in the supply chain cost. Reference [13] proposed an innovative and efficient methodology to facilitate the precise determination of inventory optimization in the supply chain, ensuring minimal total supply chain cost. MATLAB 7.4 was utilized to implement the proposed approach and evaluate the performance. The genetic algorithm performed well, as anticipated. References [13], [18], and [19] discussed the application of control theory to the problem of timely acquisition of extra production capacity. Reference [12] presented an inventory control algorithm of mathematical models of the inventory system. The algorithm was implemented as software modules in the MATLAB program [20]-[22].

The algorithms provided solutions to basic inventory control problems for each type of company. Inventory control algorithms and software modules can be developed based on more elaborate mathematical inventory models and by including new algorithms that take into account the dynamics and stochastic nature of processes in an inventory system. References [10], [23], and [24] considered a periodic review of fully back-ordered order up-to-level (R, S)-system with stationary gamma-distributed demand and constant lead time. The stock-out probability and the fill rate are two service level requirements that are handled concurrently and calculated the exact safety factors for different model parameters [10]. The behaviour of the resulting order was studied through simulation and appeared to be quite satisfactory. Reference [8] determined the quantity of blood units that must be obtained by hospitals and processed by the blood center in order to reduce overall costs as well as levels of shortage and waste in the blood supply chain. References [1], [25], and [26] presented a careful study and analysis of the existing manual sales and inventory control system of a pharmaceutical store. They aimed to design and develop a computer-based system to increase the efficiency and accuracy of the business operations of the pharmaceutical store. This work demonstrated the effective and efficient use of a computer-based drug sales inventory control system and other software applications, where an intuitive and flexible user interface played an important role. References [11] and [14] discussed the construction of an ANN model that can be used to facilitate the optimization of inventory levels and thus improve the ordering system and inventory management. Reference [2] investigated the application of ANN in the ordering system of companies. The model was developed to optimize the order amount according to the current demand in the market. Reference [18] investigated inventory optimization in the auto industry using swarm optimization. References [2], [27]-[29] introduced the complete programming of the system in detail using MATLAB 7.0. According to [15], [30]-[32], statistical methods can help identify the best neural network for reducing inventory levels by up to 50% in any organization. Reference [5] developed an ANN model to find the optimum level of finished goods and the levels of holding and carrying inventory.

References [6], [33], and [34] discussed the MFT algorithm to minimize the simulation time compared to other approaches. Reference [3] analysed research in neural network design and the optimal values of genetic algorithm operators. Reference [6] presented a review of the state-of-the-art view of the depth and breadth of NN optimization through GA searches. References [4] and [35] presented a review of prediction techniques using

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ANNs. The technique was used to improve the prediction accuracy of the model with experimental data. Reference [9] provided an overview of ANNs, explaining the working and training of ANN, as well as its applications and advantages.

II. Preliminary

In neural fitting, we can compute the approximate solution to find the best among them. It belongs to a particular class of evolutionary algorithms that are inspired by biology. It is a simulation where solutions are represented to determine the best fit. In this approach, solutions can be encoded using numeric coding other than binary coding. This paper proposes a method that utilizes the neural fit algorithm to control the cost of inventory. Here, we will employ the Neural Cluster Algorithm to maintain the stock level. We are considering k-clustering and the supply chain length μ, which refers to the number of members in the supply chain, such as factories, distribution points, and suppliers. We take the three stages of inventory factory to distribution centers 1 & 2.

The factory serves as the manufacturing unit, where a significant amount of goods is stocked. Inventory optimization techniques can be applied in industries at the beginning of the process when raw materials reach the plant. It is necessary to maintain each level of the process to ensure smooth operations. The massive stocks are held here in this area and transported as per the requirements of other distribution centers. The material has to first move to distribution center 1 and then to transport to the other center 2. In the supply chain system, we focused on the massive stock holding area and the manufacturing area of material as well as the distribution point. The distribution points are placed in the middle of the procedure where we supply the material for shipment. In our study, we take the two distribution points and then ship them to the supplier. This chain is very critical for inventory control and material handling. Our method's job is to forecast an ideal stock level using historical data, ensuring that there is seldom a shortage and that there is never an excess of inventory using the forecasted stock level. It follows that our method ultimately determines the minimum stock levels required at the plant, distribution center 1, and distribution center 2, the three supply chain participants.

In the beginning, there is an excess or shortage of stock at the distribution points. There are two choices for representing the inventory control by zero and non-zero. Non-zeroes refer to the requirement of inventory to control. The non-zero data states both the excess number of stocks as well as the shortage amount. The excess amount is given as a positive value and the shortage amount is mentioned as a negative value. The first process is to prepare the cluster of stock levels that may be in excess or shortage. The k-means algorithm is a popular unsupervised machine learning technique used for clustering data points into distinct groups. It works by iteratively assigning data points to the nearest cluster centroid and updating the centroid based on the mean of the assigned data points. This is done simply by clustering the zero and non-zero values. They arrange the data (stocks) in a significant manner as a K-mean cluster.

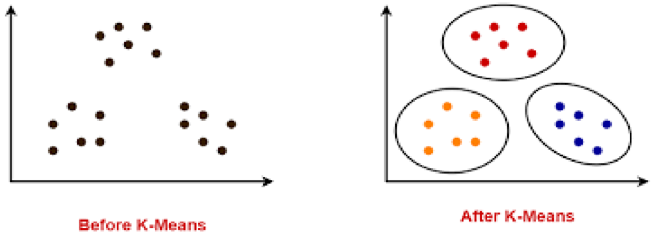

Fig. 1 K-mean cluster data

In Fig. 1, the most recent data and previous stock levels may be utilized. The fill rate and the stock-out chance were two service-level requirements that were handled concurrently. All of these points are connected to Fig. 1. The inventory sheet is created randomly from the stock levels within the lower and upper limits at factory and distribution centers 1 & 2. The initial data of inventory prepared with the raw data taken from the initial factory, distributor center 1, distributor center 2, and the supplier point are fixed requirements for further process.

III. Result and Discussion

Table I shows the stock levels at distribution centers 1 & 2. The factory data show the manufacturing at the factory point; distribution point 1 & 2 shows the quantities to be dispatched to the supplier points or warehouses. The data of the quantities at the supplier end have to be fixed and they have to be maintained for the customers. According to table data the supply point is used to deliver the material as per the demand of the customer. There are experimentally 94 data collected but we have taken 28 types of observation due to repetition of stock requirement. The output y is determined by the inventory levels x_1, x_2, and x_3, and the goal is to optimize them using a neural network.

A. Experimental Result and Analysis

Network builders need to experiment with numerous neural networks before finding the right one for the problem at hand, enabling effective reduction of inventory levels. There is no general theory that specifies the type of neural network, number of layers, number of nodes (at various layers), or learning algorithm for a given problem. The data from Table I will be used for the neural network fitting curve as the output target is required to maintain each time. For training the process of neural networking we use Table I center data as input and the target is fixed. Now we use the neural network in MATLAB for training the process.

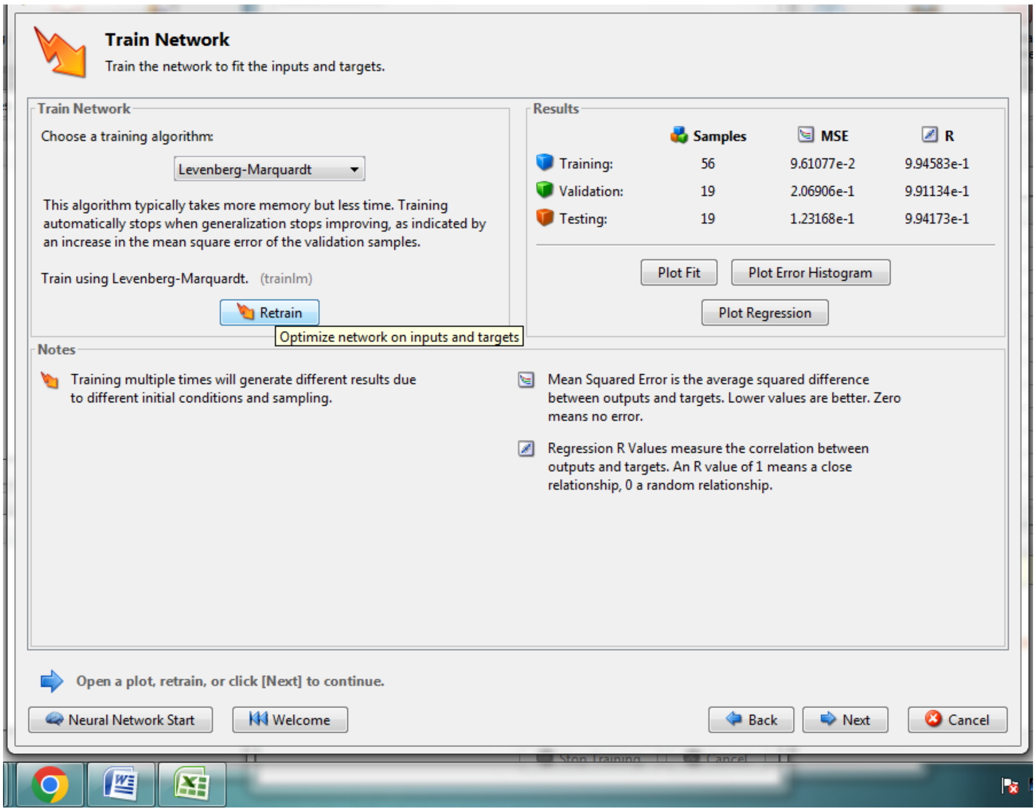

Fig. 2 Training Process in ANN

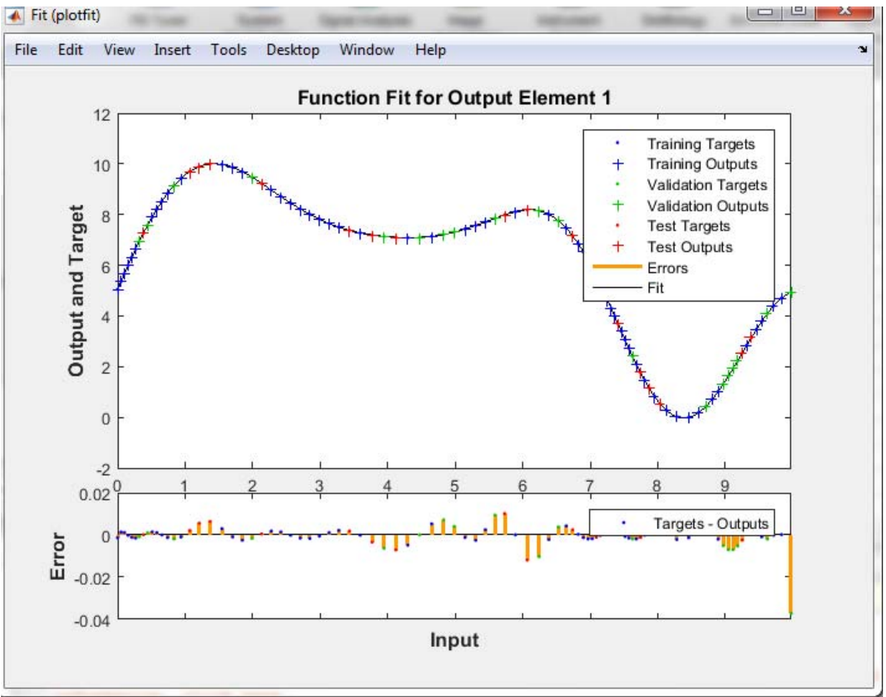

Fig. 3 Fitting Function

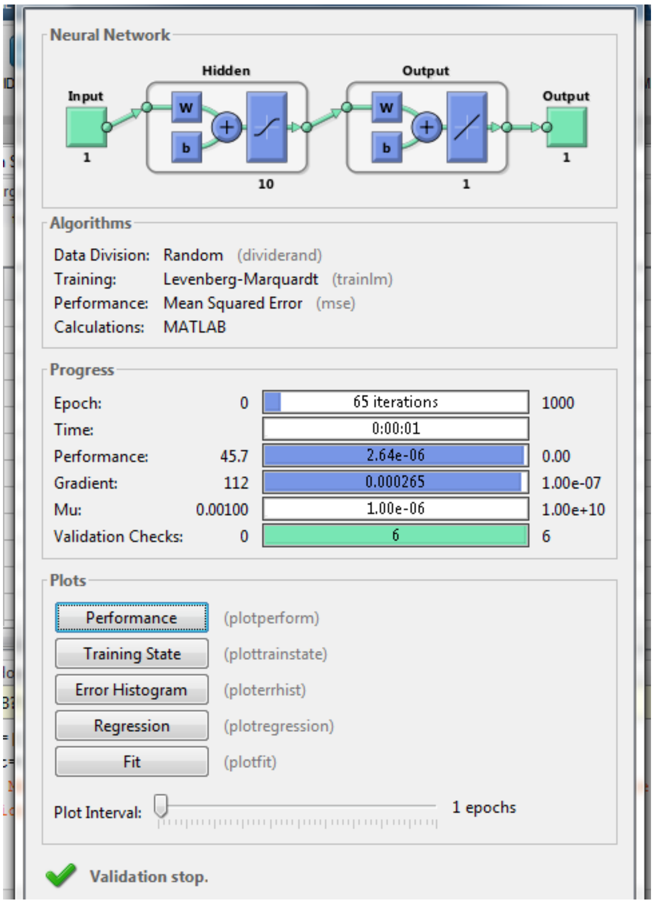

Fig. 4 Neural Network Performance

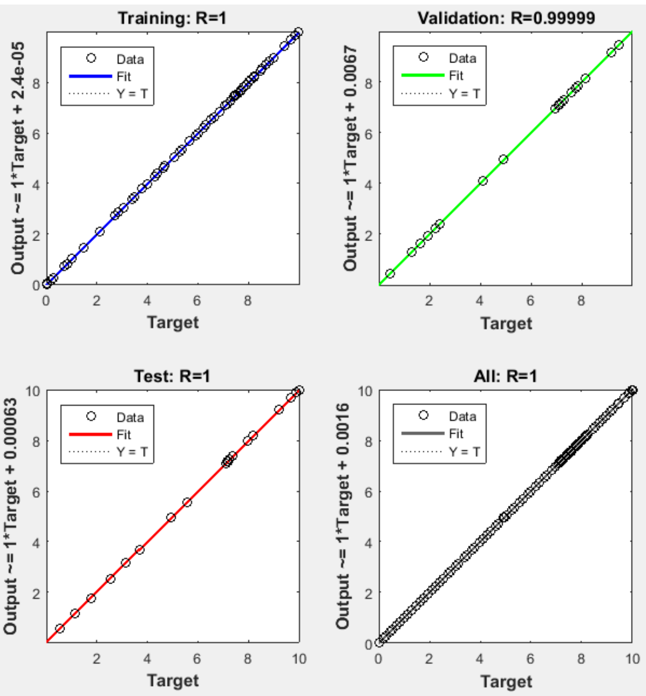

Fig. 5 Output Validation

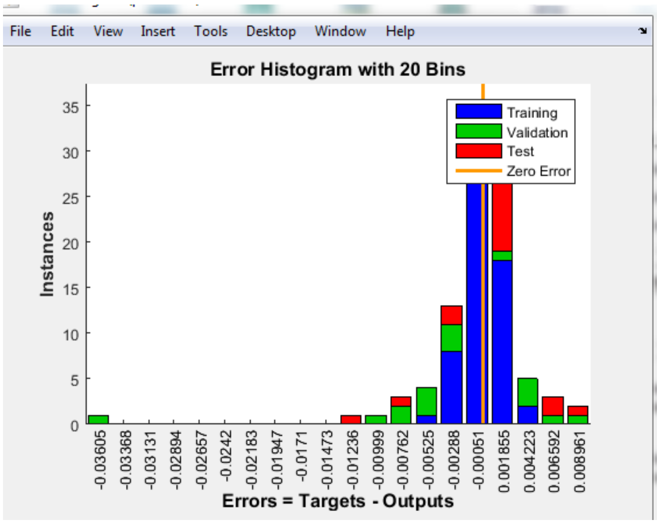

Fig. 6 Error Histogram

TABLE I
DATASHEET OF QUANTITIES FOR OPTIMUM INVENTORY

S.No	Input			Target
	Factory	Distributor center-1	Distributor center-2	Supplier point (app. 200)
1	-591	-329	269	200
2	-479	-796	-548	210
3	-591	-329	269	202
4	494	392	285	206
5	-591	-329	269	209
6	372	573	-345	196
7	999	-934	108	205
8	146	118	532	211
9	-591	-329	269	231
10	-591	-329	269	185
11	-746	721	-677	186
12	792	-456	837	176
13	-591	-329	269	190
14	-550	-634	158	181
15	611	-295	-443	161
16	497	-170	847	157
17	-992	268	-270	206
18	162	969	-507	203
19	482	-471	761	191
20	-591	-329	269	176
21	671	-768	-367	177
22	446	-916	129	202
23	-278	582	-573	201
24	-758	-766	367	183
25	-208	-306	403	173
26	-437	-850	407	177
27	-591	-329	269	191
28	297	342	686	182

The real data from industries can be used to establish and validate the neural network model. Training the neural network processes the experimental data into input-output data sets that are fed to the network. The neuron gives a signal to the neurons in the adjacent layer through a non-linear activation function. The training epoch set for each neural network is 10,000, and it was trained using the feed-forward technique. Reducing the

Mean Squared Error (MSE) is the training's main goal. According to the suggested neural network's training results, error (MSE.0001) is reached after 65 epochs. To identify the optimal network, many training procedures are evaluated. The network's transfer function is modified and tested at the hidden and output layers during the design stage. We used the training Levenberg-Marquaredff algorithm for performance MSE. With a coefficient of determination (R2) and Mean Absolute Percentage of Error (MAPE) value between the model prediction and actual values of 0.9999 and 0.0001, respectively, over 6 samples, the neural network performed well.

IV. Conclusion

An ANN model can be developed for industrial inventory control of finished goods as well as raw materials. It can be used to optimize the setup cost, material handling cost, and carrying cost of the inventory. The multilayer feed-forward ANN of 4 inputs and 10 hidden layers of neurons provides an output which compared with the target. The paper showed the result of the ANN model and proved that the model has provided a better optimistic result for inventory control.

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