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Designing an Intelligent Agent Using Machine Learning for Inventory Monitoring

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Abstract. An accurate prediction model has both academic and practical significance to machine learning, as a branch of artificial intelligence, as well as decision making. Therefore in this paper, a general Artificial Neural Network Prediction Package (ANNPP) has been developed by MATLAB7.8.0 (R.2009.a) programming .In addition to it, an Intelligent Agent (IA) program has been defined as an agent function which maps every possible percepts sequence to a possible action to find out optimized reorder point(ROP) level in retail sector, applying ANNPP. This novel approach enhances accuracy of ROP level by adding more –distribution free -factors against the traditional method which is based on some assumptions such as normal distribution and specific factors. In this novel methodology, data- training and testing data- were presented in ANNPP to find out the winner model and Intelligent Agent has been designed to determine optimized ROP level based on the best model in the package.

Keywords: Machine Learning, Artificial Neural Network Prediction Package, Intelligent Agent, Reorder Point Level

1. Introduction

In general, machine learning involves adaptive mechanisms that enable computers to learn from experience, learn by example and learn by analogy. The most popular approaches to machine learning are artificial neural networks and genetic algorithms [1]. Artificial neural network (ANN) was developed in an attempt to simulate the human brain's cognitive learning process. It is a technology that has been mainly used for prediction, clustering, classification and alerting to abnormal pattern [2] .In this study ANN programming is applied as a supervised learning technique for prediction. Since there are different kinds of training algorithms , transfer functions, number of hidden layers and amount of neurons in ANN, so we have developed an ANN prediction package in MATLAB to find out optimized output with considering these parameters as well as other required parameters . In other words, while computing, variant training algorithms such as 'trainlm','traingdm','traingd','trainscg' and transfer functions namely 'purelin' ,'logsig','purelin' and variant structures of ANN are tested and stored in memory or package to obtain the best result.

The Reorder Point is the threshold at which you should order more products to prevent shortages while also avoiding overstock. The reorder point formula is as below:

$$R = \overline{d}\,\overline{L} + Z * SQRT\left(\overline{L} * \sigma_d^{\,2} + \overline{d}^{\,2} * \sigma_L^{\,2}\right)$$

Where $\bar{d}$ demand is during lead time, $\overline{L}$ is lead time, z is service level and σ_d is standard deviation of demand and σ_L is standard deviation of lead time.

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In this formula demand is supposed as a normal distribution, but in practice, store managers of retail sector never follow this formula, because many other factors can influence Reorder Point and parameters might be non-normal distribution. So in proposed method by using the ANNPP we have taken many influence factors into consideration as per actual experience and market, so as to get the optimal inventory control strategy under different factors.

How to accurately set the reorder point of dynamic inventory under the determined factors and how to enhance the profitability by reducing inventory cost? We have attempted to answer this question by developing ANNPP and entering any number of factors, collected based on experience which can influence on ROP level. That means ANNPP is flexible in terms of number of inputs (factors).The last we have designed IA based on winner model out of ANNPP to control the inventory items in terms of ROP level.

An agent is a system that perceives its environment through sensors or databases and acts upon that environment through effectors. It is mapping from percept sequences to actions that an agent instantiates, as per Figure .1

In this study a framework of IA for inventory item monitoring was designed to reduce the inventory cost and increase customer service level, as IA can set the ROP level(as an action) based on accurate prediction.

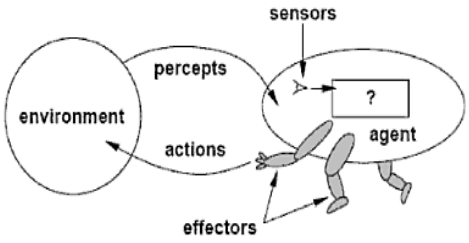

Fig. 1: The agent entity

2. Related work

ANN is newly developed method for nonlinear problem [3]. It has already been widely applied in the area of sales and safety stock forecasting [4] [5] [6]. This is due to their high ability to learn from experience in order to improve their performance and to adapt themselves to changes in the environment. Efendigil et al (2008), proposed a new forecasting mechanism which is modeled by artificial intelligence approaches including the comparison of both artificial neural networks and adaptive network-based fuzzy inference system techniques to manage the fuzzy demand with incomplete information [7]. Li.T et al(2008), Designed and developed a 3-layer BP neural network model for the forecast of the enterprise inventory.[8]

Hua et al (2008) combined Rough sets and ANN to analyze inventory early-warning in supply chains. The introduction of Rough sets cuts down the input dimensions of ANN, and the ANN algorithm was improved by adding the momentum factor and applying adaptive learning rate. [9] Zhang.L et al (2008) focused on the forecasting of safety stock according to the survey questionnaire [10].Emerson .D et al (2004) developed a framework, with machine learning, for automated supply chain configuration [11].Rezaei.H.R (2012) proposed two different intelligent methods based on clustering ANN and Fuzzy-Association rule to obtain safety stock in retail sector[13][14].

3. Methodology

The different methods to be employed for the research and they have been applied for the study, are provided below:

- Identifying the Data Source
- Preparing Data for Analysis
- Training and Building Models and ANNPP
- Validity / testing the Models
- Identify the winner model (Minimum MSE or SSE or another criteria) from ANNPP
- Design an Intelligent Agent by winner model

3.1. Designing and programming ANN models / developing ANN package

Designing ANN models follows a number of systemic procedures. In general, there are seven basics steps: (1) collecting data, (2) preprocessing data, (3) building the network, (4) train, (5) test performance of the models, (6) saving results in package and (7) Identify winner model ,i.e. minimum error

3.2. Design IA

Availability of item in inventory (status) compares with optimized ROP extracted from ANNPP, we have defined: vector <item-number, status> as percepts and alarm as action for mapping from percept sequences to action in IA.

Function of IA is mapping from observation of item availability compared with optimized ROP level to possible action.

4. Experiment and Result

4.1. Dataset

Data are collected from a retail sector in Sweden , whole items are grouped based on homogeneity ,11 features of 101 record(main sample) were applied in ANN. Input variables, affecting on ROP before data reduction are as follows:

Input vector=<x_1= lead time, x_2=standard deviation of lead time, x3=item cost, x_4=shortage cost, x_5=item criticality [0-1], x6=service level, x7=demand, x_8=standard deviation of demand, x9=supply reliability>,x10=<space cost>

Output vector=<x_{10}=ROP level>

where x1 ,x2,x3,…,x10 are the inputs to the neuron with corresponding weights w1 ,w2,w3,…, wn which model the synaptic neural connections in biological nets and act in such a way as to increase or decrease the input signals to the neuron.

It is mentioned that ANNPP can automatically set to new data (any number of variable as per store manager experience and past data i.e. Addition to classic formula for ROP)

4.2. Create a network by Matlab /ANN Prediction Package

Using the Matlab 7.8.0(R.2009.a) , variant nets namely different structures, transfer function ,algorithm algorithm as well as normalization methods were built.

4.3. training and testing network

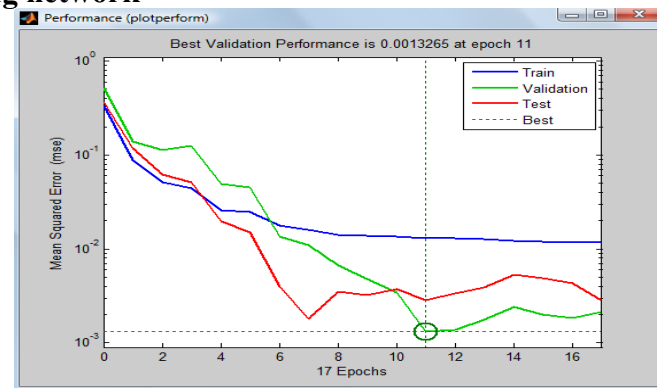

Fig.2: Winner net performance

60% of data applied in training process, 15% in testing and the same amount in validation model.

The winner model was as below: (Figure 2)

Structure 10-10-10 -1 layer , normalized between .1 to .9 , tansig , logsig, purelin were transfer functions from input to output layer and trainlm as training algorithm for this set of data was winner because of having minimum error. Mse of test data=0.006, Mse of train data=0.0013266

An agent is defined as a mapping from percept sequences to actions that an agent instantiates. Let O be the set of percepts that the agent can observe at any instant, and A be the set of possible actions the agent can

carry out in the external world (including the action of doing nothing)[15] .The agent function f: $O^* \rightarrow A$ denotes agent's behavior under all circumstances. Agent program is design of the program to implement this mapping.

Percepts: Item-Number, Status

Action: Alarm

Agent: Percept* ⟶ action

Percept Sequence	**Action**
[Item-number, status ≤ Reorder-point level)]	Alarm
[Item-number, status > Reorder-point level)]	Doing nothing

Function Inventory-Monitoring [item number, status]

If status ≤ Reorder-point level then return Alarm

Else Doing Nothing

Agent compares status with ROP, if available item is less than ROP, Agent gives an alarm, and otherwise it does nothing. Proposed IA can determine ROP level as well as safety stock in inventory to prevent stock out and decrease inventory cost.

5. Conclusion

This paper designs an Intelligent Agent for Inventory Management to set the Reorder Point level of each item based on the accurate prediction, considering parameters which influence on it. In addition one artificial neural network prediction package called ANNPP is developed in MATLAB which is able to find out optimized Neural Network as a winner net. ANNPP supports the IA by finding optimized ROP level extracted from winner net and Agent can compare it with amount of that item in inventory , if available item is less than ROP , Agent give an alarm , otherwise it does nothing. Proposed IA can substantially effect on cost reduction and prevent stock out because of being optimized in performance.

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