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Dynamic Price Optimization for the Future of Retail

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Abstract
Every organisation faces a problem of setting the prices of products. The main aim of marketing strategy of an organisation is to attain marketing objectives and satisfy the targeted market. The marketing decisions affect the prices of products to a great extent. The topic of dynamic price optimization for the future of retail has received a considerable amount of attention in recent years, from different scientific communities. This paper provide a brief introduction to the historical origins of quantitative research on pricing and demand estimation, point to different subfields in the area of dynamic pricing, and provide an in-depth overview of the available literature on dynamic pricing and learning. Our focus is on the operations research and management science literature, but we also discuss relevant contributions from marketing, economics, econometrics, and computer science.

Keywords
Dynamic Pricing, Demand Estimation; Learning, Optimization, Neural Network

I. Introduction

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurones) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurones. This is true of ANNs as well.

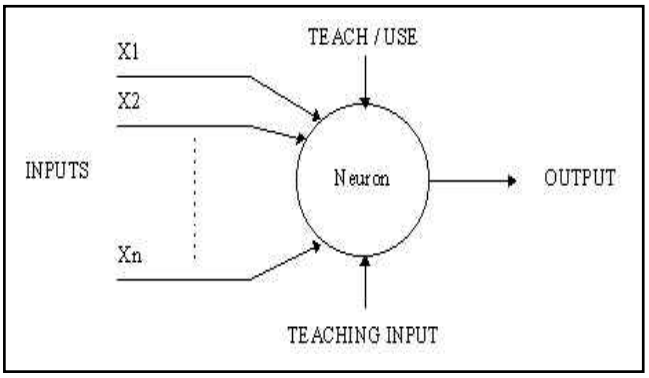

Fig. 1: Neural Network

In the global competitive business environment, manufacturers must maintain optimum quantity of finished goods inventory to reduce cost and to maximize the efficiency of supply chain. Companies aim to supply the required amount of finished goods in right place and at right time with right cost. In this regard, finding optimum amount of finished goods has received extensive attention among the researchers. Holding raw materials, work-in-process and finished goods are involved with various forms of inventory. Finished goods inventory is the amount of manufactured products on hand that awaits sale to customer. In this finished goods inventory model, demand is known and can be changed; products are produced and stored in a lot and set-up, inventory holding and material costs are considered. Successful inventory control involves a trade-off between the costs of inventory and the benefits of inventory. Finished goods are some of the most important forms of inventories, which involve a substantial amount of cost. The importance of determining the appropriate level of finished goods inventory helps for proper planning and control of factory operations and optimization of the overall process to minimize production cost and time to produce products of desired quality.

The data will be crawled from different similar websites, prices will be taken and then manipulated using trained neural network to get the best optimized price as the result set.

The advantage of this paper is, the time complexity will be reduced compared to the existing system.

II. Literature Survey

In[1] The author of this paperaims to identify classification criteria for good customers and bad customers in Iranian banks. This study can classified in applied studies group and the research strategy is descriptive. Artificial neural network technique is used for financial facilities applicants' credit risk measurement and the calculations have been done by using SPSS and MATLAB software. Number of samples was 497 and 18 variables were used to identify good customers from bad customers. The results showed that, individual loan frequency and amount of loan had most important effect and also status of customer's bank account, history of customer relationship with bank and received services had least important effect in identifying classification criteria of good and bad customers. The major contribution of this paper is specifying the most important determinants for rating of customers in Iran's banking sector.

In[2] The literature on dynamic pricing and learning has grown fast in recent years, with contributions from different scientific communities: operations research and management science (OR/MS), marketing, computer science, and economics / econometrics. This survey aims at bringing together the literature from these different fields, and at highlighting some of the older (and sometimes forgotten) literature where many important results and ideas already can be found.

In[3] A brief review of the literature to determine the finished goods inventory reveals that it is promising to use ANN. However, no particular research has been proposed to optimize finished goods inventory level considering the issues of products demand, setup cost, holding and material cost as input. To fill this gap, new tools or methods are important which can accommodate the fluctuating nature of the identified variables. By realizing the importance and the research gap, this paper deals with developing an ANN model which can be used to optimize finished goods inventory in a fuzzy

environment. The input parameters of the ANN model are products demand, setup cost, holding cost, and material cost.
In[4] The present study aims to design a methodical model based on Analytical hierarchy Process (AHP) and Artificial Neural Network (ANN) for estimation of player price in IPL. Based on expert view several key features are chosen for cricket player price calculation in IPL twenty-20 cricket tournament. Initial weights of attributes are calculated through AHP. Dataset is prepared using Open Source Information from the internet and offline experts. Back propagation neural network trains a pre normalized performance dataset of last three years IPL statistical dataset of 226 players. Finally, our proposed methodology gives a systematic way to select the important attributes and calculate the weights based on expert opinion to measure the optimal price for a player which will help the IPL team owner to select the player according their budget and strategies. A strict trade-off between 'budget conscious bidding' and 'performance based bidding' is thus optimized using this model.

III. Proposed Methodology

Fig 2: Working of proposed method

1. Setting Price Objectives Refers to set the goals of the pricing policy. An organisation can have multiple pricing objectives. Some of the price objectives are discussed as follows:

- **Survival**: Involves the formulation of a short-term price objective to face the fierce competition. The price of a product is reduced to increase sales volume.
- **Quality of a product**: Affects the price of products. An organisation incurs high cost in research and development cost in the price of the product.

2. Estimating the Product Demand Helps in knowing the factors that affect the demand of a product. Some of the important factors can be the prices of products, environmental factors, and income and expectations of customers.
3. **Analysing the Competitor Prices** Influences the decisions of setting the prices of products. The pricing strategies of competitors affect the demand of the product and lead to a loss of market share.
4. Selecting the Pricing Method Involves the selection of a technique for setting the price. There are various types of pricing methods used by organisations.
5. Selecting the Pricing Policy Involves a strategy or practice used by an organisation to achieve its pricing objectives.

Algorithm

1. Getting the raw data for manipulation and Traning

```
#step1:Installing the  Packages
library(neuralnet)

#Step2: Import the dataset
dataset<-read.csv("price-opti.csv",header=TRUE)

#Step3: Divide the dataset in trainset(70%) and testset(30%)
trainset=dataset[1:7,]
testset=dataset[8:10,]

#step4: Normalising trainset and testset
norm.fun=function(x)
{
  (x-min(x))/(max(x)-min(x))
}
trainingdata.norm=apply(trainset,2,norm.fun)
testingdata.norm=apply(testset,2,norm.fun)

#step 5: Train the network with neuralnet function
net<-neuralnet(selling.price~production.cost+product.
price+product.quality+delivery.time+after.sales.service+sellers.
reputation, data=trainingdata.norm, hidden =2, threshold = 0.01,
rep = 5,learningrate=0.05, startweights = NULL, algorithm =
"backprop", err.fct = "sse", act.fct = "tanh")

#step 6: generate rda file
save(net, file = "optimisation.rda")
load(file = "optimisation.rda")
```

2. Uploading model file to generate result.

```
#step 1: loading the rda file
load(file = "optimisation.rda")

#step 2:Reading the csv file
optimisationdata<-read.csv("useruploded.csv")

#step 3: Normalize the function
optimizedscaledvalue<- apply(optimisationdata,2,norm.fun)

#Step 4: compute a method for objects of class net, typically
produced by neuralnet.
optimizednetwork<-compute(optimisationnet,optimizedscaledv
alue[,1:6])

#step 5: calculating the prediction by removing selling
price(Denormalization)
optimizationresult<- optimizednetwork$net.result *
(max(dataset$selling.price) - min(dataset$selling.price)) +
min(dataset$selling.price)
optimisedresult=data.frame(prediction=optimizationresult)
optimisedresult
```

3. Accuracy using RMSE

```
RMSE=sqrt(sum((actual-prediction)^2)/ No of dataset)
```

We got RMSE=4.26.
Plotting the Trained Network and Actual V/S Prediction Graph

IV. Results

The below figure shows the output of proposed model. Sample input dataset is provided and the predicted output values are also shown.
Sample Input Dataset Provided:

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Table1: Input dataset

production cost	product price	product quality	delivery time	after sales service	sellers reputation	selling price
871.1901	879.99	1139.99	895.13	1029.98	986.2725	1066
296.9901	299.99	329.95	329.73	334.99	323.665	321
118.7901	119.99	159.99	129.26	149.98	139.805	138
791.9901	799.99	949.99	810.68	979.98	885.16	966
989.9901	999.99	1099.99	1054.99	1169.98	1081.2375	1128
178.1901	179.99	199.99	198.95	209.98	197.2275	203
1187.9901	1199.99	1299.99	1254.99	1529.98	1321.2375	1233
326.6505	329.95	349.99	340.37	389.95	352.565	375
128.6901	129.99	149.99	139.26	169.99	147.3075	146
1038.51	1049	1147	1104	1248	1137	1211

Output for sample dataset provided:

Table 2: output

	Predticted_Values
1	1039.1
2	326.67
3	151.99
4	943.39
5	1122.4
6	203.58
7	1278.6
8	361.4
9	159.12

V. Conclusion

This paper presents a optimization of price using neural network. The time complexity will be reduced in the proposed system and it also helps to know the product that is in demand.

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References

[1] *AHP-Neural Network Based Player Price Estimation in IPL Pabitra Kr. Dey1, Abhijit Banerjee2, DipendraNath Ghosh3, Abhoy Chand Mondal4*

[2] *A Dynamic Pricing Method in E-CommerceBased on PSO-trained Neural NetworkLiang Peng and Haiyun LiuSchool of economics, Huazhong University of Science and Technology*

[3] *APPLICATION OF INTELLIGENT METHODS IN COMMERCIAL WEBSITE MARKETING STRATEGIES DEVELOPMENT AlgirdasNoreika Department of Practical Informatics, Kaunas University of Technology Studentųst. 50, LT – 51368, Kaunas, Lithuania*

[4] *Prediction of Stock Exchange Share Price using ANN and PSO Atanu Pal (11111012) Diptarka Chakraborty (11111016) palatanu@iitk.ac.in diptarka@iitk.ac.in*

[5] *An artificial neural network model for optimization of finished goods inventory Sanjoy K. Paula* and AbdullahilAzeema*

[6] *NEURAL NETWORKS by Christos Stergiou and DimitriosSiganos*

[7] *Ajith Abraham, "Artificial Neural Networks" http://www.softcomputing.net/ann _chapter.pdf*

[8] *J. Kephart and J. Hanson, A. Greenwald. Dynamic Pricing by Software Agents, Computer Networks ,32,731-752 (2000).*

[9] *X. J. Wang, Y. L. Chen and W. Q. Zhu, The Pricing Strategies for Agents in Real E-Commerce, WINE 2005, LNCS 3828,887-894(2005).*