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Demand Forecasting of Dairy Products for Amul Warehouses using Neural Network

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Abstract: ***Demand forecasting is very intensive research area now a day as it significantly affects the revenue growth of industries. In this paper, demand forecasting of amul butter for "Aman warehouse private limited Agra" of different cities has been presented using artificial neural network technology. Supply chain consists of manufacture, warehouse and customer. Model of network has been build up with last three years historical data. First input variable is associated with population. Second and third input variables are associated with no of restaurant, hotels, colleges and types of places (sub parameter tourist, religious, historical, industrials) respectively. Output variable is linked with demand. Result shows that demand prediction using neural network in tunewise. He provided by Aman warehouse supply chain managers.***

Keywords: Network, forecasting, supply chain management, population.

1. Introduction

Seasonal changes are related to butters demand festival, government policy, types of place many types. These factors have effective on short term butter demand. These seasonal changes index used in this paper butter demand forecasting together with multi methodology. The projection technique was test and compared to actual data distributor situated at Agra up in India. Butter demand is demand by costumer because huge recruitment of urban, rural, hotels, restaurant and types of places. The developed forecasting accurately fatly and shortly. Neural network (NN) has been used for butter demand to correlate non-linear, multiple and complex application. The distributor of amul products such as butter, cheese, gee, milk, chokolate, spray are affected by factors such as the season, area, delay transport. These factors make it difficult to accurate forecasting the sales and demand of dairy products.

There are three input factors that following to butter forecasting.

- Population factors
- No of restaurant, hotels, college
- Types of places

The demand forecasting and neural network of literature reviews is show on section 2. Methodology is analysis in section 3. Section 4 presented the result are discussion. Section 5 presented the conclusion at future scope.

2. Literature reviews

The researcher has developed many direction of demand forecasting with that neural network approaches. Zhan-Li Sun et al.[1] Presented an artificial neural network application based on multivariate backprapogation analysis, which can accurately predict too many factors (shells, price, deigns and colures) in retailer fashion industries. Tug˘ba Efendigil et al. [2] proposed a CNN and ANFIS techniques based on many factors time series analysis, Which evaluated predict to real world historic data in goods consumer industries Istanbul (turkey). Kenji Tanaka [3] proposed sales forecasting model for improving the accuracy of demand prediction based on japans books in electronic media released. They indicated input factors electronic media sales demand and that the compare to total demand to these sales forecasting will improve the demand prediction accuracy. They used neural network application to evaluated of this indicator and improved prediction demand. In a study carried out of Yanrong Ni et al. [4], the future demand for a study of dairy industry and technology services was predicted with two factors (influence and impact) indentified as demand used nonlinear forecasting model input. The prediction of this study were made by ART and error forecasting model to the short term and long term method data family, and ultimately the results were compared. Vinutha H.D [5] used a short term load forecasting (STLF) neural technique to predict the demand of electric load at a city. This neural network was deigned to receive demand on days week and years. This study examined the effect of no of neurons in input factors to prediction electric load data. The study by Prasanna Kumar et al. [6], they collected the three years data valve manufacturing industries in

Mumbai, and they used in combined ANN model and training method evaluated to predict the future valve industries. Kochak and Sharma [7], The past sales data in (2011-2013) was processed by a back propagation neural network to future demand forecasting for this product in Madhya Pradesh India. The author observed power prediction no of neuron and no of neuron 10 can reduce prediction (mean square estimate) 1%. InYi Yang et al. of studied [8], They collected the months day data electricity demand in Australia, and they used in combination technique of back propagation (BP) neural network to predict the future valve industries. Evaluation and differential evolution algorithm (DE) .Ultimately, it was found that the hybrid network has 63% better RMSE than the classic network. The Jiang et al. [9] proposed genetic algorithm and feed-forward neural network for a hospital demand based on factors selection forecasting, which used method factors PCS and AIRM model forecasting reduce cost and improved profitability.

Nemati Amirkolaii [10] presented artificial intelligent technique based on forecasting aircraft spare parts, which can accurately to predict demand factors in aircraft spare parts. The study by Alireza Goli [11], they examined demand prediction of case study of dairy industry, and they used in combined hybrid artificial intelligence and met heuristic algorithms of comprehensive model evaluated to predict the future dairy industry.

3. Methodology

The researchers proposed work of data analysis using Neural Network, this methodology is planned to consider the influence of demand forecasting to predict.

3.1 Demand forecasting

There are servable time series prediction different model.

1. Naive forecast is simplest forecasting method. In this method forecast is given by the average or mean of the actual demand data for the previous period.
2. Simple moving average for no of periods is the average of past & periods only n periods not beyond that.
3. Trend forecasting method is process of making prediction of future based on past data or present data by analysis of trend forecast.
4. Multi linear regression forecasting is a mathematical measure of the average relationship between two or more variable in term of the original units of data.

3.2 Neural network

In This paper is used neural network technique. Neural networks present based on input variable and output variable basically deign model consider one or more layer, input layer, hidden layer, output layer. This network is described as follows.

An artificial neuron and multilayered neural network model are present in the signal flow from inputs *V*1, V2 …. *Vn* is considered to be non-linear. This flow is a neuron's output signal flow (*Op*).

$$Op = f(net) = f\left(\sum_{i=1}^{n}(WjVi)\right) \quad (1)$$

Where Wj & Vi is a weight vector and input value. *f*(*net*) is an activation (transfer). The net variable is scalar products of the weight and input vectors.

$$net = W1V1 + W2V2 + - - - + WnVn \quad (2)$$

Output value O is computed as:

$$O = f(net) = \{1 \text{ to } 0\ w\text{^}t\ x > \quad (3)$$

Neural network is most commonly feed forward error backprapogation type neural nets. In the network, the servable element are prepared into layer in all way that output signal from the neurons of given layer passed to all neuron all of neurons next year. Neural network goes flow to activation in single one layer direction, layer by layer. It is a smallest two input and output layer. More than or two hidden layer could added b/w input and output layer to increase power neural layer.

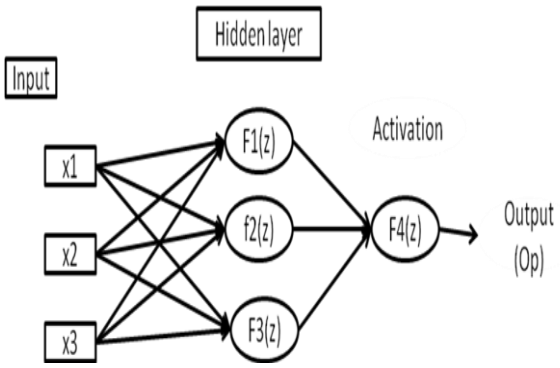

Figure 1: Neural network

3.3 Backprapogation or feed forward algorithm

Matlab R2013 NN tool box is used neural network consider well-designed estimated for demand forecasting. There is different backprapogation algorithm following as:

i) Batch gradient decent
ii) Variable learning rate
iii) Conjugate gradient algorithm
iv) Liebenberg marquardt

The **Liebenberg marguardt** was design to techniques second order training speed to Hessian matrix. These function has form sum squares, Hessian matrix can be consider as:

$$H = J\text{^}T\ J \quad (4)$$

Gradient can be compute as

$$G = J\text{^}T\ e \quad (5)$$

J is Jacobian matrix. It contain to first derivatives of the network error with respect weighted and biases. This matrix can be considered through backprapogation approaches compute complex hessian matrix.

4. Result

The sales distributor data has been collected of amul butters for Aman warehouse privet limited Agra as shown in table 1. There are used for three years (2016-2018) historical data and configured for backprapogation. We have a product data available from (2016-2018).

Table 1: (2016-2018) Three years Amul butter target data

Sr. no.	Cities	(2016) gross weight demand (kg)	(2017) gross weight demand (kg)	(2018) gross weight demand (kg)
2	Aligarh	31164	50821	53387
3	Firozabad	9262	20223	28437
4	Farrukabad	3219	8767	10469
5	Kashganj (kansiram)	1883	5297	5851
6	Etah	2983	7779	8151
7	Etawah	2162	21459	24083
8	Mainpuri	2237	12132	13122
9	Mathura	15473	44415	17728
10	Hathras (Mahamaya nagar)	5616	14864	15618

4.1 Forecasting variable

The input population is associate nine cities. There is Agra, Aligarh, Firozabad, Farrukabad, kashganj (kansiram), Etah, Etawah, Mainpuri, Mathura, Hathras (Mahamya nagar) (**www.census2011.co.in)** [12] as shown in table 3.

Table 2: Three year population input data

S .no.	Cites	(2016) Population (lack)	(2017) Population (lack)	(2018) Population (lack)
2	Aligarh	2783378	2830636	2877893
3	Firozabad	2720888	2765410	2809945
4	Farrukabad	4014750	4082914	4151079
5	Kashganj	2042708	2074195	2105682
6	Etah	2004360	2031536	2052262
7	Etawah	1703379	1727679	1751980
8	Mainpuri	1880761	1902031	1923302
9	Mathura	1540734	1561537	1582339
10	Hathras	1679463	1702340	1725218

The second input no of restaurant, hotels and colleges is associated nine cities in (**www.justdail.com)** [13] as shown on table 4.

Table 3: Three year no of restaurants, hotels, colleges input data

S. no.	Cities	Restaurant, Hotel, colleges (2016)	Restaurant, Hotel, colleges (2017)	Restaurant, Hotel, colleges (2018)
2	Aligarh	542	555	561
3	Firozabad	196	199	201
4	Farrukabad	97	99	100
5	Kashganj	46	47	48
6	Etah	251	255	258
7	Etawah	140	142	144
8	Mainpuri	119	121	123
9	Mathura	650	660	667
10	Hathras	220	224	227

The Third input types of places (tourist, religious, history, industrial) is associate nine cities in (**www.winkipedia.com**) as shown on table 5.

Table 4: Types of places input data

City/Area	Types of place
Aligarh	Tourist, history, industrials
Firozabad	Tourist, industrials, religious
Farrukabad	religious, history
Hathras	Tourist, history, industrial
Kashganj	religious, history
Etah	Religious, history
Etawah	Tourist
Mainpuri	Religious
Mathura	Tourist, religious, history, industrials

The demand forecasting evaluated error between actual data of 2018 and forecasting data 2018 and also formula available for the calculating of forecasting error in MATLAB coding

E_A = Absolute error = (Target– Predicted) (1)
E_R = Relative error = (Target – Predicted) / Target (2) $E_{\%}$ = Error % = [(Target – Predicted) / Target] * 100 (3)

Table 5: Predicted demand with Absolute error, Relative error, % Error

City	Target (2018)	Predicted (2018)	Absolute error	Relative error	Error %
Aligarh	53387	33112.68	20274.32434	0	0
Firozabad	28437	15633.87	12803.12521	0	0
Farrukabad	10469	6611.19	3857.810168	0	0
Kashganj(kansiram)	5851	6267.607	-416.6074342	0	0
Etah	8150	9338.265	-1188.264551	0	0
Etawah	24083	5995.588	18087.41224	0	0
Mainpuri	13122	8125.895	4996.104672	0	0
Mathura	17728	44527.39	-26799.39138	0	0
Hathras(mahamya)	15618	13255	2362.996799	0	0

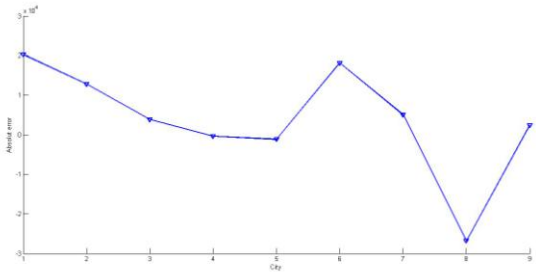

Figure 3: Absolute error vs City

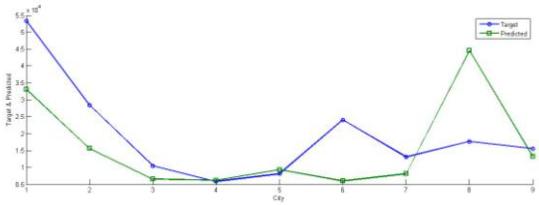

Figure 3: Target vs Predicted vs City

The project of network is used input factors (population, no fo hotels, types places) by training backprapogation methodology. Table (2,3&4) input factors correlated table (1) target test data using training method TRAINLM. The best result City vs absolute error is shown in figure 2 & City vs Predicted demand vs Target demand is shown in figure 3.

5. Conclusion

In this paper we have presented performance of product demand forecasting. The researcher proposed effective of forecasting the demand singles in the supply chain with neural network (NN) and best training method. The effective demand forecasting has been carried out for Aman warehouse Private Limited, Agra (U.P.) in India. Models for demand prediction has been prepared using three years historical data and configured by neural network. Predicted demand and target demand are out of nine cities in tune wise with less absolute error. Model can be further than city tune wise. Hence this model can be utilized for the predicted of Amul butters demand.

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