International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-8, June 2020

Use of Machine Learning Models in Sales Forecasts

Shefali Jumnani, Shraddha Agrawal, Samiksha Verma, Swasti Singhal

Abstract—In this paper, we present a brief survey of usage of various machine learning models and their role in retail sales forecasts. The purpose of this paper is to enlist a few popular approaches in retail sales and study their scope and areas of application. We analyze how these models have evolved over time stating the significance of each model in brief.

Keywords—autoregressive integrated moving average, artificial neural network, random forests, retail sales forecasting, support vector regression.

I. INTRODUCTION

In today's fast-paced and competitive world, there is an urgent need for organizations to have the right knowledge of the forecasting model suitable to their business. Most businesses require maintaining different inventory levels for different domains; thereby reducing distributional and operational costs and maximizing profits.

This is where retail sales forecasting comes into play. Retail sales forecasting is an advanced method of finding out an estimate of future sales based on historical data, patterns, trends, customer behavior and other such features in the retailer's environment.

Each forecasting technique used serves a special purpose and has a benefit of its own, which makes the selection of right technique extremely important. Our objective behind this paper is to present the different forecasting techniques used in different domains of retail sales forecast, stressing upon what technique suits best for what domain. Rest of the paper is organized as follows: Section II describes the scope of retail sales forecast and a brief review of the related work. Section III describes the techniques involved and finally, Section IV concludes the research study.

Revised Manuscript Received on June 30, 2020.
***** Correspondence Author
Shefali Jumnani*, Information Technology, Galgotias College of Engineering and Technology, Greater Noida, India. Email: shefalijumnani.sj@gmail.com
Shraddha Agrawal, Information Technology, Galgotias College of Engineering and Technology, Greater Noida, India. Email: shraddhaagr.173@gmail.com
Samiksha Verma, Information Technology, Galgotias College of Engineering and Technology, Greater Noida, India. Email: samikshavermabbk@gmail.com
Swasti Singhal, Information Technology, Galgotias College of Engineering and Technology, Greater Noida, India. Email: s.singhal@galgotiacollege.edu

II. BACKGROUND

Traditional methods of forecast included extensive, heavy work on spreadsheets followed by complex calculations and dependencies on naïve softwares where the accuracy was highly variant; depending on several parameters viz. past data, seasonal variations, customer behavior, consumer input, etc. Retailers would use the past year's data and their target business goals to predict the result. With time, came the advanced forecasting technologies that used a combination of demand modeling and machine learning. These techniques enabled retailers to identify hidden and extremely difficult patterns, which were unidentifiable or time consuming to discover through conventional approaches.

A. Literature Review

A number of forecasting techniques have surfaced and have been used in the retail sales industry in the recent years. This section outlines the previously published works in retail sales forecasts in brief.

Giri, Thomassey, Balkow and Zeng (2019) proposed using a deep learning and neural network regression model for forecasting new apparel sales. It utilizes the past information of the products with their images to predict sales. These images are first transformed into feature vectors and then combined with the past data for accurate forecasts. For prediction, back propagation neural network model is used. The model has been applied on small data sets and a significant accuracy is achieved.

Duan, Liu and Huang (2019) employed SVMR, BP Neural Network Algorithms and K-Nearest Neighbor Algorithms to predict the sales of various kinds of mobile phones in Chinese market. The results show the model developed using SVMR produced more accurate, precise and consistent results than the models built using other technologies.

Kahn (2014) demonstrates a comparison between forecasting process of new versus existing products with respect to data dimensions, analytics, plan etc. It suggests the core for new product forecasting lies not in data but in quality assumptions and prudence. It applies to various sections of the retail market-electronics market, fashion industry etc.

Lee, Kim, Park, and Kang (2014) use the Bass model approach for new product forecasting. The suggested technique has been tested on 3D television sales and the results show a higher accuracy than the traditional methods.

Lu, Lee and Lian (2010) suggested a hybrid MARS and SVR model for sales forecasting of IT products. The proposed model suggests using MARS for selection of variables and then applying SVR to predict accurate forecasts. The recommended model surpasses the performance of their respective individual models.

Vhatkar and Dias (2016) used Artificial Neural Network Model for forecasting the sales of oral-care products. This study compares the results obtained using ANN with forecasting techniques like ARIMA, SVM and GAs. It then suggests the most suitable method for oral-care sales forecasts.

B. Scope

This section outlines the summary of selected literature and the areas they have been employed in, in the retail industry.

Table-I: Analysis of various products in sales forecast

Title	Domain	Emphasis	Contribution
Forecasting New Apparel Sales Using Deep Learning and Nonlinear Neural Network Regression (2019)	Clothing	Extracting image feature vectors combining it with past data	Forecasting model for new apparel sales
Mobile Phone Sales Forecast Based on Support Vector Machine (2019)	Mobile Phones	Pre-processing Sales Data	Comparison of different forecasting techniques to predict Mobile Phone Sales
Oral-Care Goods Sales Forecasting Using Artificial Neural Network Model (2016)	Oral-care products	Data Collection and Preprocessing	Forecasting using Back Propagation Learning Algorithm
Pre-launch New Product Demand Forecasting using the Bass Model (2014)	Electronics	Pre-launch forecasting	Pre-launch forecasting based on the Bass model and statistical and machine learning algorithms
Sales Forecasting of IT Products using A Hybrid MARS and SVR Model (2010)	IT Products	Data Mining	Hybrid intelligent sales forecasting model
A Sales Forecasting Model for New-Released and Nonlinear Sales Trend Products (2010)	Books, Consumer electronics	Short and long term	Forecast Model for irregular and nonlinear sales items

III. MEHODOLOGY

This section describes the basics of some forecasting models that have been used in predicting sales of various products in the retail industry so far.

1) ARIMA: ARIMA is one of the statistical analysis prediction tool that enables us to use historical data and trends to predict future variables.It is one of the most commonly used model for linear data.It helps to maximise the forecast precision while using the least number of constraints.The detailed description of ARIMA is given in [2].

ARIMA comprises:
a) Auto Regression(AR) indicates that any sequence's present values depends on its own preceding values.

b) Moving Average(MA) indicates the present deviation from average depends upon previous deviations.

c) Integrated(I) is related with finding out the difference between the current and previous data values.

Each ARIMA model needs 3 parameters p,d and q to determine the type of ARIMA model to be used.These parameters can be described as follows:

p=the number of autoregressive terms.It demonstrates the influence of past values in the model by indicating the number of lag observations.The smaller the p value,the more likely it is stationary.

d=the number of times raw observations are differenced.

q=the number of moving average terms.

This order of ARIMA(p,d,q) is determined with the help of ACF and PACF plots.ACF is an auto correlation coefficient, a bar graph of the correlation coefficient between the sequence's current values and its own past values.The PACF plot is a partial auto correlation function.Unlike ACF,which finds correlations of present with the past,PACF finds correlations of the residuals. The steps for construction of an ARIMA model are depcted in the figure.

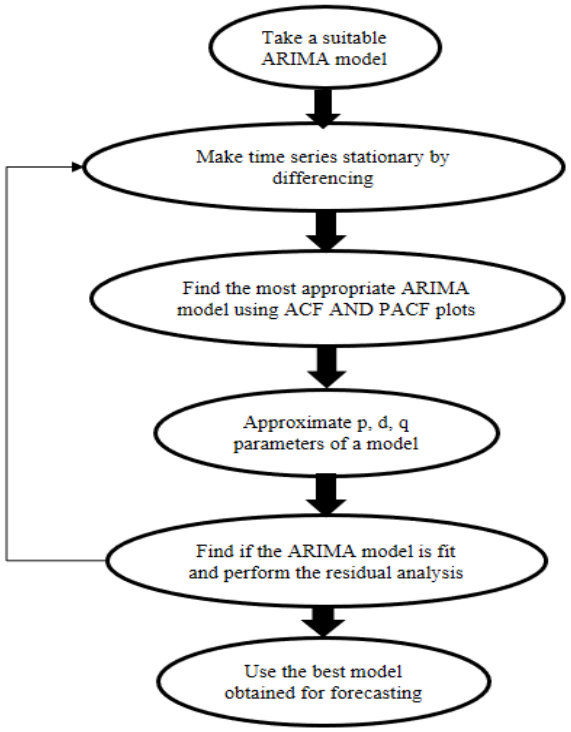

Fig. 1: ARIMA Model Flow Diagram

2) ARTIFICIAL NEURAL NETWORK: Artificial Neural Networks(ANN),a computational model evolved from Biological Neural Network, is composed of highly interconnecting units called neurons.

These neurons continuously assess information and transform inputs received to the outputs, processing it through one or more hidden layers in between. ANNs regulate their internal structures contiuously to give an optimal solution, that is, they have a self- adaptive nature.[13] describes a complete working of ANN and their role in retail sales forecast. ANN are an appropriate alternative to classical and traditional models which show heavy dependency on statistical assumptions.

It has been applied to various domains in forecasting-finance, sales, technology, pharmaceuticals, weather etc. They have proved themselves to be effective for sales forecast especially for those data sets which have non-linear relationship. Learning rate is an important factor for improving the accuracy of a neural network model.
Therefore, ANN with Adaptive Learning Rate(ANN-ALR) and Extended Adaptive Learning Rate(ANN-EALR) have been used by many researchers [14].

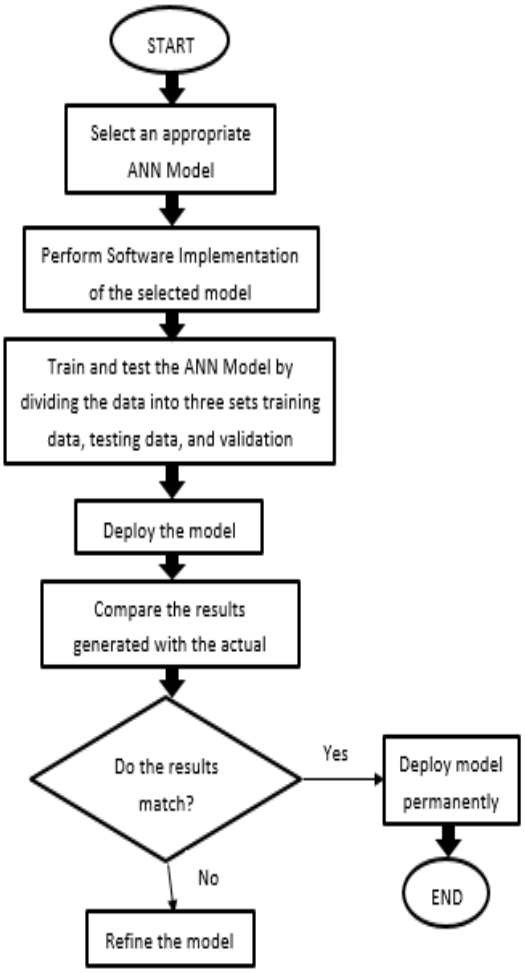

Fig. 2: ANN Model Flow Diagram

3) SVR: Support Vector Machines, introduced in 1992 by Vapnik and his co-workers, are a set of supervised learning algorithm used for both classification and regression purposes. In another terms, Support Vector Machine (SVM) is a classification and regression prediction tool that uses machine learning theory to maximize predictive accuracy while automatically avoiding over-fit to the data.

SVMs were widely used initially to solve classification problems,but with the advances it became possible to use SVM for regresion purposes as well [2]. SVMs can be applied to regression problems by the introduction of a loss function[5].Unlike other approaches,what SVR does is that it tries to fit the line within a predefined or threshold error value.It uses the highly popular “Kernel-Trick” for mapping into higher dimension spaces.

SVR easily applies to non-linear data and thus,helps in generating a more precise and efficient predictive model. A detailed study of Support Vector regression with all its workings is illustrated in [3].

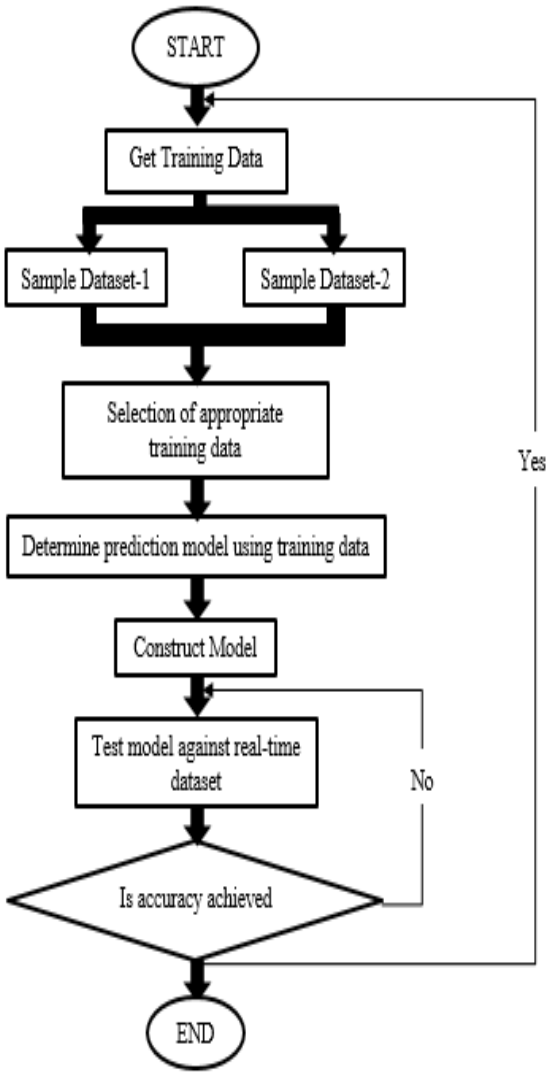

Fig. 3: SVR Model Flow Diagram

4) RANDOM FORESTS: Random Forests, an ensemble learning mechanism proposed by Leo Breiman in the 2000s, makes predictions by averaging over the predictions of several base independent models. Since its discovery, it has been extremely successful as a general purpose classification and regression method.[12]

A tree in random forest is made up of nodes and edges in a hierarchical structure. All nodes have only one incoming edge although there can be any number of outgoing edges from an internal node. A Random Forest implementation involves several decision making trees. This approach has gained a lot of popularity, and is one of the most widely used general purpose techniques for retail sales forecasting today. They are fast and easy to implement, produce highly accurate forecasts and can handle a large number of input variables without overfitting. [10]
The factors to consider when constructing a random forest for sales forecast are:
1) Determine an appropriate method for splitting the leaf.
2) The type of predictor to be used in leaf.
3) What is the method used to inject randomness in the tree.

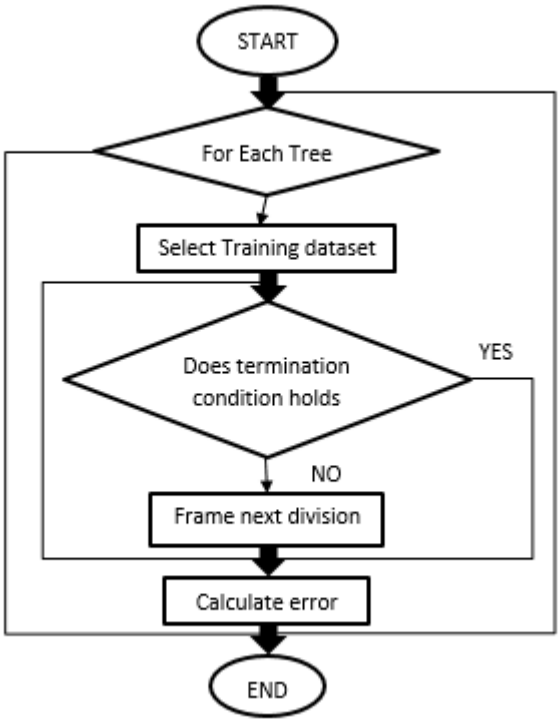

Fig. 4: RF Model Flow Diagram

IV. CONCLUSION

This study presents an overview of different forecasting techniques employed in different sections of the retail industry. A few popular approaches-ARIMA, SVM, ANN and Random Forests have been discussed. Some of the important conclusions are given below:

Although ANN has been developed as a successful model for forecasting, it cannot easily learn noisy data and has complex dimensions. It also has to deal with the issues of overfitting. Due to these limitations, it may not converge into optimal solutions. Also, the selection of parameters such as input variables, learning rate etc .is difficult.

SVM is widely used for forecasting and gives better forecast results as compared to ANN.RF has emerged to give significant comparable forecast results as SVM. Both SVM and RF have been used in recent developments and exhibit excellent performance. The solution provided by both of these models converges to global optimum and it does not suffer from overfitting.

REFERENCES

1. C. Giri, S. Thomassey, J. Balkow and X. Zeng, "Forecasting New Apparel Sales Using Deep Learning and Nonlinear Neural Network Regression" International Conference on Engineering, Science, and Industrial Applications (ICESI),2019.
2. C.J. Lu, T.S. Lee, C.M. Lian, "Sales Forecasting of IT Products using A Hybrid MARS and SVR Model", *IEEE International Conference on Data Mining Workshops.* doi:10.1109/icdmw.2010.
3. V. Jakkula, "Tutorial on Support Vector Machine (SVM)," School of EECS, Washington State University, Pullman 99164.
4. S.B. Kashia, H.R. Karimic , K.D. Thobenb, M. Lütjenb and M. Teuckeb, "A survey on retail sales forecasting and prediction in fashion markets," Systems Science & Control Engineering, Vol. 3, 154–161,2015.
5. Z. Duan, Y. Liu and K. Huang, "Mobile Phone Sales Forecast Based on Support Vector Machine," IOP Conf. Series: Journal of Physics: Conf. Series 1229 (2019) 012061,2019.
6. K.B. Kahn, "Solving the problems of new product forecasting. Business Horizons," 57(5), 607–615. Retrieved August 13, 2014,.
7. H. Lee, S. G. Kim, H-w. Park, & P. Kang, "Pre-launch new product demand forecasting using the Bass model: A statistical and machine learning-based approach," Technological Forecasting and Social Change, 86, 49–64. Retrieved August 12, 2014.
8. S. Vhatkara , J. Diasb, "Oral-Care Goods Sales Forecasting Using Artificial Neural Network Model", 7th International Conference on Communication, Computing and Virtualization 2016.
9. M. Teucke, A. Ait-Alla, N. El-Berishy, S. Beheshti-Kashi, & M. Lütjen, "A sales forecasting model for newreleased and nonlinear sales trend products," Expert Systems with Applications, 37(11), 7387–7393. Retrieved July 28, 2014.
10. H-K Lee , H-J Lee , J. Park , J. Choi and J-B Kim, "A Study of Predict Sales Based on Random Forest Classification", International Journal of u- and e- Service, Science and Technology Vol.10, No.7 (2017).
11. M. Kumar, M. Thenmozhi, "Forecasting stock index returns using ARIMA-SVM, ARIMA-ANN, and ARIMA-random forest hybrid models", Int. J. Banking, Accounting and Finance, Vol. 5, No. 3, 2014.
12. G. Biau ," Analysis of a Random Forests Model", Journal of Machine Learning Research 13 (2012) 1063-1095.
13. S. A. Kustrin, R. Beresford, "Basic concepts of artificial neural network (ANN) modeling and its application in pharmaceutical research", Journal of Pharmaceutical and Biomedical Analysis 22 (2000) 717–727.
14. P. M. Pawar, B. P. Ronge R. Balasubramaniam, A. S. Vibhute, S. S. Apte, "TechnoSocietal 2018", Proceedings of the 2nd International Conference on Advanced Technologies for Societal Applications - Volume 2, 2018.
15. K.J. Kim, "Financial time series forecasting using support vector machines", Neurocomputing, Vol. 55, pp.307 –319, 2003.

AUTHORS PROFILE

Shefali Jumnani currently pursuing B.tech degree in Information Technology from Galgotias College of Engineering and Technology.

Shraddha Agrawal currently pursuing B.tech degree in Information Technology from Galgotias College of Engineering and Technology.

Samiksha Verma currently pursuing B.tech degree in Information Technology from Galgotias College of Engineering and Technology.

Swasti Singhal received B.tech degree in Information Technology and M.Tech in Computer Science and .Currently pursuing Ph.D from Amity University, Noida .Presently she is assistance professor in Galgotias College of Engineering and Technology, Greater Noida. Her research interest includes machine learning, and software testing.