

# Demand Forecasting for Retail Demand with Online Platform

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*Abstract* — Online platforms have become popular for shopping any product now-a-days. The offers and discounts available with these platforms are attracting more and more people to buy products from online options. It may be a platform like amazon, flip kart or personalized product selling website like croma , reliance digital for electronic products and nykaa fashion, myntra etc for fashion related stuff. The brands like Hitachi, Phillips, Sony have their online stores where they offer bigger discounts on their products to attract customer for hassle free purchases. Moreover they spend hefty amount of money behind automation of decision support systems which include accurate prediction of demand of particular products. In this research, demand of particular electronic products is forecasted. Quantitative demand forecasting needs various categorised data like season, holidays, promotional expenses done because of constant variations in demand, seasonal changes and changing trends of market. The process needs data from online electronics store which is available thru Kaggle and data.world websites. Use of forecasting models like Modified ARIMA (AutoRegressive Integrated Moving Average) to predict product demand that performs more accurate results in comparison to the existing state of art technique.

**Keywords:** Machine Learning, Base Line Model, Time Series

## I. INTRODUCTION

Over the past decade, the online sales market has grown exponentially. E-Commerce is responsible for more than \$2.3 Trillion in 2018 and it is expected to double by 2021. Statistics show an average human spends more than 3 hours on phone and 35 minutes out of those in surfing e-commerce Sites. With the availability of internet everywhere people are choosing to purchase their necessary products online. The advertising over the social media platforms is also contributing to the increase in online sales apart from having their own online portal's. The company's also sell their products on Ecommerce sites. Over the past decade, Amazon, Ebay have emerged as the leaders in Ecommerce market and presence of their products on these platforms have become a necessity for the companies. The major advantage of these sites is their ability to ship products across the country and globally. So, the regions which cannot be reached through retail stores there are reached through these E - commerce sites.

In case of new products, the companies have their own strategies in deciding the price of the products but that's not the case with used products. The websites give sellers the liberty in deciding the selling price of the product and they take a share of it for providing the platform. But this approach has resulted in many complications. Often, the seller's listed selling price and the product specifications and brand values won't be in sync and these products end up on websites for months without being sold. This approach won't help the user as well as the website. So, almost all the used product

websites have decided to have their own price prediction models.

There are 3 main factors that decide the sale of the product. First the product title, Users generally use keywords like brand name, product specification while searching the product. Second is the Category, the products need to be categorized properly as the user could also use the category to filter the products. Finally, the most important attribute is the Item description, the users go through the description keenly before choosing the product. So, the description needs to be specific. These factors will be the deciding elements in price prediction.

The major factors Product Name, Product Category and Product Description are textual unstructured parameters. They cannot be directly fed into any unsupervised learning model. So, all the textual features need to be converted into fixed length vectors then they can be used as input for the machine learning models. Another issue is, while dealing with textual data it is important to have large amount of data to avoid overfitting.

The purpose of this study is to predict the price, sales and demand of the product based on the product features like Product Name, Category, Condition, Brand Name and shipping status for E-commerce sites and used product markets. The data is taken from online platforms because there is a huge amount data can be collected centrally and we get better future predictions.

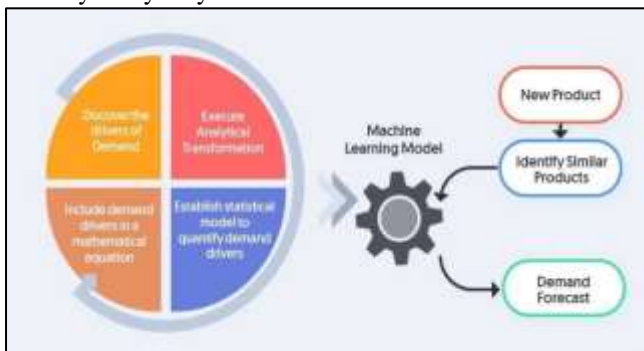
Demand Forecasting is the process of making future estimations in relation to customer demand over a specific period. It is always challenging for E - Commerce retailers. Sales forecasts give the retailers a bigger picture. They get a general idea of the coming years so that they can build up their objectives to maximize their profit and success. Accurate demand forecasting can lead to an improved sale of products, storage management, business decision performance, the satisfaction of customer demands and cost reduction thereby preventing product backlog or shortage on the inventory side. Because of the rapid development of information technology in diverse fields, it has become a critical and challenging task to come up with an effective sales forecasting model as volatility of product sales has increased day by day.

In this research we specify that we working on Retail demand because all researchers are done still these topics that is on stock price, bitcoin price, regular trends of some kinds of very highly sold data. But online platforms are sold large amount of retail products and also they collected large amount of data.

We know that there are multiple online platforms like amazon, flip kart, ajio, big basket, where we buy the products also there are personalized product selling website like croma, reliance digital for electronic products and nykaa fashion, myntra etc for fashion related stuff. The brands like Hitachi, Phillips, Sony also have their own stores where the

customer get better discounts and profits to buy the products. Through this online platforms data centrally collected properly at the server and we use this data for any type of analysis and get better predictions.

To demand forecast, we will need past data with a good volume and these data is processed for data cleaning, normalization and other preprocessing stages by using various machine learning algorithms. Then data is categorized into numerical and categorical attributes. After categorization of data find out its trends, type of data, their meanings, their higher and lower limits is etc... are important for the process to understand the demand. For these process, the data needs to be centralized on a server only then it can be collected properly and can use further for any type of analysis. Data can be collected on Kaggle or data. World. The data is centrally collected with multiple servers with online platforms. We predict data on a daily basis, like weekly, monthly and yearly.



## II. PROBLEM STATEMENT

- Predicting the demand of a product is a tough challenge since very similar products having minute differences such as different brand names, additional specifications, quality, demand of the product, etc. can have very different prices.
- Price prediction gets even more difficult when there is a huge range of products, which is common with most of the online shopping platforms.
- There are no low latency constraints in this problem. Once a product is listed on the app, we need not suggest its price immediately.

## III. MOTIVATION

- Prediction is one of the major topics for researchers of machine learning across the globe.
- Rising buying trends from e-commerce platforms provides enormous data that needs to be analyzed in order to get future directions and decision making process Hybrid approach of existing machine learning approach can lead to better results. • There are no low latency constraints in this problem. Once a product is listed on the app, we need not suggest its price immediately.
- Electronic products like laptops, televisions, microwaves are sold in a high number during festival seasons and sales online. The buying trends in other time of the year can be studied to get more profits.

## IV. LITERATURE REVIEW

In 2021 5<sup>th</sup> International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT) |978-1-6654-4930-4/21/\$31.00 ©2021 IEEE | DOI: 10.1109/ISMSIT52890.2021.9604550, Mustafa ÇETİN Istanbul Technical University Information Institute Istanbul, Turkey cetinmus@itu.edu.tr and Yunus KOÇ Istanbul Technical University Information Institute Istanbul, Turkey kocyun@itu.edu.tr is Mobile Phone Price Class Prediction Using Different Classification Algorithms with Feature Selection and Parameter Optimization that mainly focus on the phone price is expensive compared to its features. For this, it is necessary to make price and performance comparisons between many phones and their features. Machine Learning algorithms can make a comprehensive comparison of phones and their features in a short time and it also handle complex and large-scale data, assist many areas to make life easier. This research include Random Forest Classifier, Logistic Regression Classifier, Decision Tree Classifier, Linear Discriminant Analysis, K-Nearest Neighbor Classifier and SVC methods are compared to predict mobile phone price class. The “Mobile Price Classification” dataset which is taken from Kaggle.com is used to evaluate performance of methods. classifiers and feature selection methods are compared according to their classification performance. Hyperparameter is also examined for improving classification accuracy.

2022 International Conference on Electronics and Renewable Systems (ICEARS) | 978-1-6654-8425-1/22/\$31.00 ©2022 IEEE | DOI: 10.1109/ICEARS53579.2022.9752248 B N Varaprasad, Ch.Kundan Kanth, G.Jeevan, Y.Kalyan Chakravarti Department of Information Technology, Velagapudi Ramakrishna Siddhartha, Engineering College, Vijayawada, India Stock Price Prediction Using Machine Learning Technique which is mainly focus on the Stock prices fluctuate on a daily basis. So, to get an accurate predictions of stock market future pricing, we used machine learning algorithms to get better profits in stock market. It has Machine learning techniques, Regression, Long and Short-Term Memory Network,, Simple Linear Regression and LSTM used for predictions. The dataset is taken from www.nseindia.com. Using Machine Learning Techniques, we create a hybrid system model for stock market price prediction that improve accuracy and performance and reduce the computing complexity.

2020 IEEE 13th International Conference on Cloud Computing (CLOUD) Guang Zheng, Hui Zhang, Jingjing Han, and Chenhui Zhuang, Lei Xi, College of Information and Management Sciences Henan Agricultural University Zhengzhou, P.R.China The Research on Agricultural Product Price Forecasting Service Based on Combination Model that mainly focus on the Agricultural products planting was always restricted and affected by the climate. The system could conduct the analysis and prediction for the market price through the combined forecasting method of wavelet transform and BP neural network. On the basis of this combined forecasting method, the agricultural product price forecasting service system with functions of price data service and price forecasting service was designed based on

DOA architecture. ARIMA can be used for time series analysis. To evaluate the effect of the combination prediction model, the Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE) and Root Mean Square Error (RMSE) were selected to measure the accuracy of the prediction results. The combination prediction model based on wavelet transform and BP neural network proposed in this paper could predict the price fluctuation of a variety of agricultural products. It could provide important practical significance for agricultural producers, operators, consumers and relevant government departments.

According to the research In International Journal of Engineering Research & Technology (IJERT), ISSN : 2278-0181, Vol. 9 Issue 04, April-2020, Sandeep Chavan<sup>1</sup> Assistant Professor, Dept. of Computer Engineering, Bharati Vidyapeeth College of Engineering, Mumbai, India and Simsri Panchal<sup>2</sup>, Tanvi Sawant<sup>3</sup> and Janhavi Shinde<sup>4</sup> U.G Student, Dept. of Computer Engineering, Bharati Vidyapeeth College of Engineering, Mumbai, India paper is Predicting Online Product Sales using Machine Learning that the promotional marketing strategies and social interactions such as online review and answered questions are both important for influencing sales. That approaches to Random forest and multiple linear regression algorithms were used to train data to create a model. ETL that is extract, transform and load tool was used to get data from one database and transform it into suitable format. Natural Language Processing algorithms and Natural Language Toolkit (NLTK) provides libraries for classification, multiple linear regression used for prediction. And that produces Sales Prediction for goods can be significant to ensure that loss is minimized as a result.

In Journal of Physics: Conference Series, ICCPET 2020, IOT Publishing, 1712(2020) 012042, doi: 10.1088/1742-6596/1712/1/012042

Karandeep Singh\*, Booma P M and Umopathy Eaganathan Asia Pacific University of Technology & Innovation (APU), Malaysia related to E-Commerce System for Sale Prediction Using Machine Learning Technique E-Commerce is to provide convenience to the customers where they do not have to go to a physical store make a purchase. As they will be able to make the purchase online and the item will be in their door step in the following days. That mention Convolution neural network (CNN) is used for sales prediction and achieved goal. The five algorithms ExtraTree, ARIMA, Random Forest, Lasso and Neural network are used for time series analysis. For Testing used the Mean Absolute Error evolution  $r^2$  score. Winter's exponential smoothing, time series decomposition and ARIMA are 3 different approaches used for better accuracy. Extreme Gradient Boosted algorithm used for testing approach. At last The model which have the best prediction range, is chosen as the best algorithm. This best algorithm will then be integrated into a web application which will also built by the researchers.

In Elcio Tarallo et al. / IFAC PapersOnLine 52-13 (2019) 737 – 742, Elcio Tarallo \* Getulio k. Akabane\*\* Camilo I. Shimabukuro\*\*\*, Jose Mello \*\*\*\* Douglas Amancio \*\*\*\*\*, \*Centro Paula souza. Sao Paulo , Brazil Machine Learning in Predicting Demand for Fast-Moving Consumer Goods : An Exploratory Research which is our base paper that directly target to the More accurate sales

predictions using machine learning techniques for the fast moving consumer goods for short shelf life and highly perishable products. Which includes The Statistical Techniques and tools have been used by companies to estimate demand. Moving Average; Hybrid approaches with a Radial Basis Function Network; Fuzzy algorithms; Generic algorithms; Support Vector Machine (SVM); Logistic Regression are machine learning techniques used for predicting time series. Deep Learning as the Stacked Denoising Autoencoder. At last Machine Learning benefits and characteristics applied in improving demand forecasting accuracy in the FCMG industry, which is key element of companies. Proper investigation about factors that affects demand forecasting are studied. The data is used for long term planning and decision making regarding a future product sales.

In Journal of Physics : Conference Series, 19<sup>th</sup> International Conference “Aviation and Cosmonautics” (AviaSpace-2020), 1925(2021) 012033, doi : 10.1088/1742-6596/1925/1/012033, P S Smirnov<sup>1</sup> and V A Sudakov<sup>1,2\*</sup>, <sup>1</sup>Institute number 8 “Information Technology and Applied Mathematics”, Moscow Aviation Institute (National Research University), 4 Volokolamskoe Highway, 125993, Moscow, Russia, <sup>2</sup>Department “Problems of mathematical modeling and high-performance computing”, Keldysh Institute of Applied Mathematics (Russian Academy of Sciences), 4 Miusskaya Square, 125047, Moscow, Russia the title is Forecasting new product demand using Machine Learning that shows Accurate predicting demand for a new product can lead to significant increase of profits and customers can buy quicker and at lower prices and optimize production, management and logistics in order to minimize costs and The RMSE is one of the simplest metrics frequently used to draw conclusions about model accuracy both in time series forecasting and in standard regression models. The Gradient Tree Boosting algorithm used for Regression. The proposed model satisfies initial all conditions and requirements and analysts for optimizing sales assortment, planning and logistic optimization.

In Computers, Materials & Continua, DOI : 10.32604/cmc.2022.020782 Article CMC, 2022, vol.70, no. 2, Mohamed Ali Mohamed, Ibrahim Mahmoud El-Henawy and Ahmad Salah\* Faculty of Computers and Informatics, Zagazig University, Zagazig, Egypt \*Corresponding Author: Ahmad Salah. Email: ahmad@zu.edu.eg Received: 07 June 2021; Accepted: 08 July 2021 Price prediction of seasonal items using machine learning and statistical methods Mainly focus on the predicting price for retail goods and seasonal items. Work on a real dataset of items from an online retailer and provides better price for seasonal items. ML Based models like support vector regressor (SVR), Random Forest, Ridge, Linear regression and statistical models (ARIMA) are used to predict the prices of these items. The proposed models are evaluated on four different metrics, namely, Mean Absolute Error (MAE), Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), and R-squared. The random forest machine learning-based model and the ARIMA statistical-based model to address the problem of predicting seasonal goods' pricing.

In Proceedings of the International Conference on Industrial Engineering and Operations Management Nsukka,

Nigeria, 5 - 7 April, 2022 Professor Mary Jane Samonte, Ph.D. School of Information Technology, Mapúa University, Manila, Philippines, mjcsamonte@yahoo.com, Elixeline Britanico, Karmin Eda Mae Antonio, John Emmanuel J. Dela Vega, Tia Julienne P. Espejo, Danielle C. Samonte, School of Information Technology, Mapúa University, Makati, Philippines Applying Deep Learning for the Prediction of Retail Store Sales To pursue a deeper understanding in founding a prediction model for forecasting retail sales by using deep learning techniques. Long Short-Term Memory, Artificial Neural Network, Convolutional Neural Network, Recurrent Neural Network, Deep Neural Network with LSTM are deep learning technique in sales forecasting. Machine learning techniques are Random Forest, Linear Regression, Decision Tree, Support Vector Machine, Auto-Regressive Integrated Moving Average, Extreme Gradient Boosting (Xgboost), and Gradient Boosting Machine with RF being the most utilized machine learning from all the techniques mentioned. To interpret and analyzing data, deep learning produces more accurate results in analyzing large data and preferable in terms of performance and output.

In Hindawi Scientific Programming Volume 2021, Article ID 2179692, 9 pages <https://doi.org/10.1155/2021/2179692> School of Digital Trade, Jiangxi University of Engineering, Xinyu 338000, China, Correspondence should be addressed to Xiaoting Yin; 8078yinxiaoting@yzpc.edu.cn Received 18 October 2021; Revised 27 October 2021; Accepted 28 October 2021; Published 28 November 2021, Academic Editor: Rahman Ali Prediction of Merchandise Sales on E-Commerce Platforms Based on Data Mining and Deep Learning Proper demand forecasting is strategic and mainly affected in different data analysis. Here we have used E commerce data that performs comparatively better results for products demand. ML Approach with Support Vector Machine (SVM), decision tree and Logistics Regression. That compare with our base paper results.

## V. RESEARCH GAP

Use all machine learning processes, it is not necessary to give accurate prediction results every time.

In this project, there are very huge amount of data can be used so, data loss can lead to outlire problem which can affect on results.

Demand planners need substantial input from the sales and marketing teams. It's uncommon for processes to be manual and labor intensive, thus taking up a lot of time. (It can be time consuming and resource intensive).

The quality of data and data acquisition process can largely affect on the prediction.

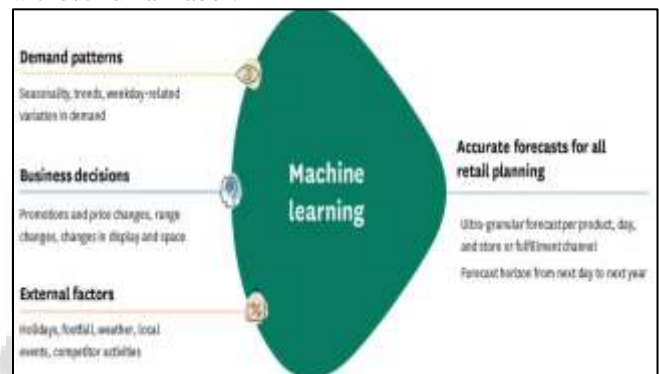
Customer trust - it can be difficult to establish a trusted brand name, especially without a physical business with a track record and face-to-face interaction between customers and sales staff. You need to consider the costs or setting up a good customer service system as part of your online offering.

## VI. METHODOLOGY

### A. Machine Learning

Machine learning gives a system the ability to learn automatically and improve its recommendations using data alone, with no additional programming needed. Because retailers generate enormous amounts of data, machine learning technology quickly proves its value. When a machine learning system is fed data—the more, the better—it searches for patterns. Going forward, it can use the patterns it identifies within the data to make better decisions.

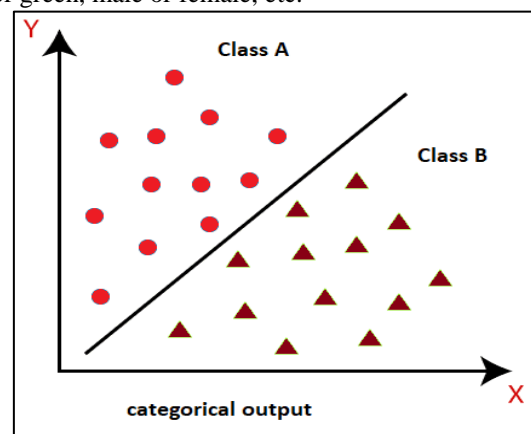
Machine learning makes it possible to incorporate the wide range of factors and relationships that impact demand on a daily basis into your retail forecasts. This is enormously valuable, as just weather data alone can consist of hundreds of different factors that can potentially impact demand. Machine learning algorithms automatically generate continuously improving models using only the data you provide them, whether from your business or from external data streams. The primary benefit is that such a system can process retail-scale data sets from a variety of sources, all without human labor.



### B. Classification

Classification is a supervised machine learning process of categorizing a given set of input data into classes based on one or more variables. Additionally, a classification problem can be performed on structured and unstructured data to accurately predict whether or not the data will fall into predetermined categories.

Classification in machine learning can require two or more categories of a given data set. Therefore, it generates a probability score to assign the data into a specific category, such as spam or not spam, yes or no, disease or no disease, red or green, male or female, etc.

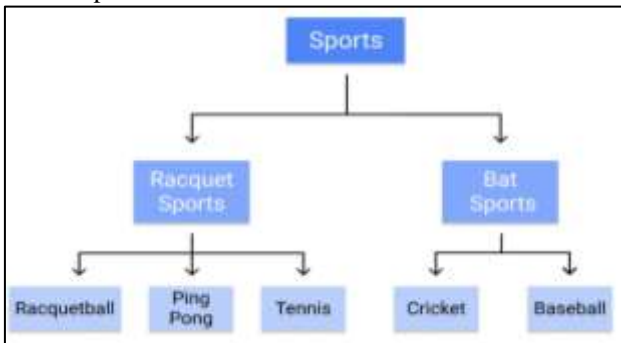


1) *Classification Techniques:*

The study of classification in statistics is vast, and there are several types of classification algorithms you can use depending on the dataset you're working with. Below are the most common algorithms in machine learning.

2) *Decision Tree:*

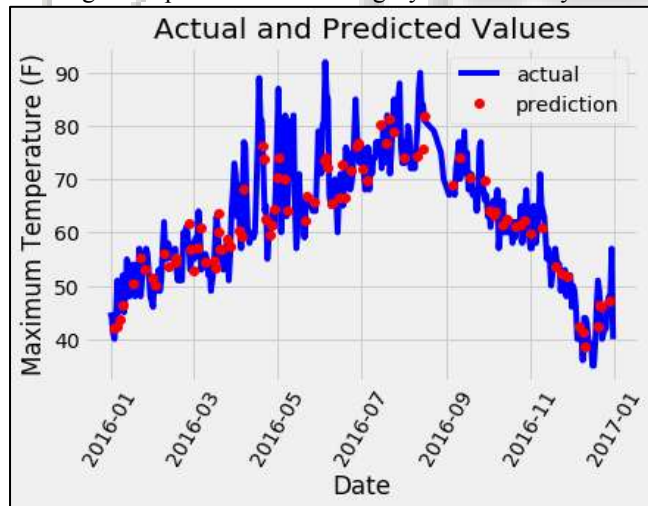
A decision tree is a supervised learning algorithm that is perfect for classification problems, as it's able to order classes on a precise level. It works like a flow chart, separating data points into two similar categories at a time from the "tree trunk" to "branches," to "leaves," where the categories become more finitely similar. This creates categories within categories, allowing for organic classification with limited human supervision.



3) *Random Forest:*

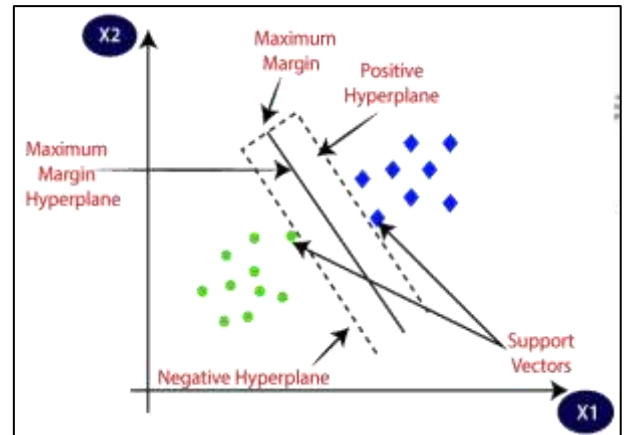
The random forest algorithm is an expansion of decision tree, in that you first construct a multitude of decision trees with training data, then fit your new data within one of the trees as a "random forest."

It, essentially, averages your data to connect it to the nearest tree on the data scale. Random forest models are helpful as they remedy for the decision tree's problem of "forcing" data points within a category unnecessarily.



4) *Support Vector Machines:*

A support vector machine (SVM) uses algorithms to train and classify data within degrees of polarity, taking it to a degree beyond X/Y prediction.



5) *Regression*

Regression is a method for understanding the relationship between independent variables or features and a dependent variable or outcome. Outcomes can then be predicted once the relationship between independent and dependent variables has been estimated. Regression is a field of study in statistics which forms a key part of forecast models in machine learning. It's used as an approach to predict continuous outcomes in predictive modelling, so has utility in forecasting and predicting outcomes from data. Machine learning regression generally involves plotting a line of best fit through the data points. The distance between each point and the line is minimised to achieve the best fit line.

C. *Feature Selection*

We sometimes face problems which have a lot of features. They are even large numbers like 99 100 features. Now, some of these features are not very useful in model prediction. But they increase the dimensionality of feature set, thus making it hard to analyze, increases the time for training, and also decrease the accuracy. So such features must be removed.

D. *Arima*

ARIMA is an acronym that stands for AutoRegressive Integrated Moving Average. It is a generalization of the simpler AutoRegressive Moving Average and adds the notion of integration.

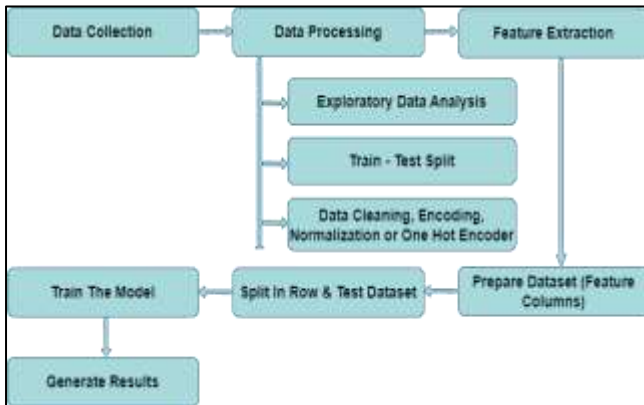
The ARIMA equation is a regression type equation in which the independent variables are lags of the dependent variable and/or lags of the forecast errors.

The equation of the ARIMA model is given as :

$$y'(t) = c + \phi_1 * y'(t-1) + \dots + \phi_p * y'(t-p) + \theta_1 * \epsilon(t-1) + \dots + \theta_q * \epsilon(t-q) + \epsilon_t$$

A value of 0 can be used for a parameter, which indicates to not use that element of the model. This way, the ARIMA model can be configured to perform the function of an ARMA model, and even a simple AR, I, or MA model.

## VII. PROPOSED FLOW



Explanation of Proposed Flow:

For Demand Forecasting, we follow some steps which are given here:

### 1) Gathering Data Collection:

Gathering the data is one of the most important stages in workflows. We will need large amount of data to perform these. The data needs to be centralized only then it can be collected properly and can use for further any type of analysis.

### 2) Data Pre-processing:

Once your data is collected, you need to pre-process it. Pre-processing involves cleaning, verifying and formatting data into a usable dataset. So, you can easily find your necessary information and make your data more attractive.

### 3) Building Datasets:

Once you have a datasets, you are ready to train your model. These datasets are useful in algorithms to learn appropriate parameters and features used in classification.

This phase involves breaking processed data into three datasets—training, validating, and testing.

Training set –It is used to initially train the algorithm

Validation set –It is used to estimate the accuracy of the model.

Test set –It is used to assess the accuracy and performance of the models.

### 4) Training and refinement:

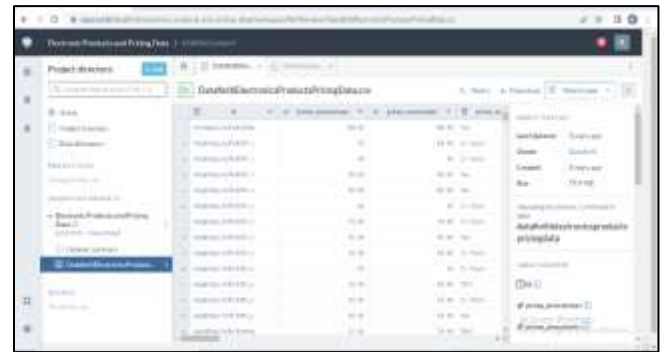
Once training is complete, you can then refine the model using your validation dataset. This may involve modifying and discarding variables and includes a process of tweaking model specific settings (hyperparameters) until an acceptable accuracy level is reached.

### 5) Machine Learning Evaluation:

Finally, after an acceptable set of hyperparameters is found and your model accuracy is optimized you can test your model. Testing uses your test dataset and is meant to verify that your models are using accurate features. Based on the feedback you receive you may return to training the model to improve accuracy, adjust output settings, or deploy the model as needed.

## VIII. DATASET

For Demand Forecasting, we need large amount of data. If we have more data, large amount of data we get a better future predictions and give the better chances for results. So, for this process we, gathered data from Kaggle.



## IX. RESULTS

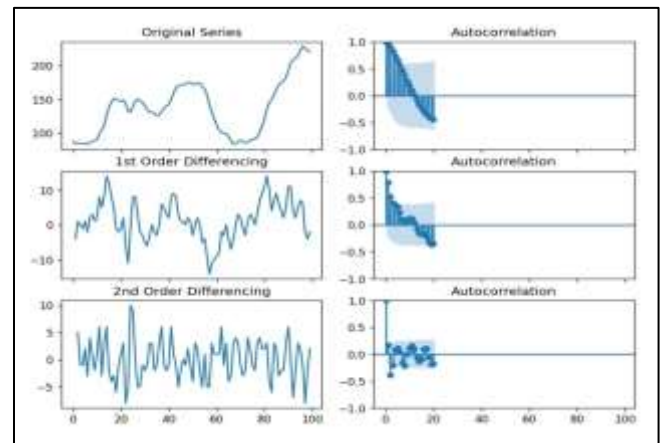
### A. Data Table:

To check column wise distribution of given data, we divided the columns in categories of its data. Then these data is classified into a new matrix then applied PCA by featuring category wise data. This columns added into a new feature column data sets.



Results:

Model is trained with new modified data. The results are displayed with standard error, accuracy, co-efficient and loss of data.



## X. CONCLUSION & FUTURE WORK

In this research, artificial intelligence is used to predict for E - Commerce business products; which is utilized by many researchers in different activities of E - Commerce business. To apply deep learning approach in more time efficient way with the existing methodology.

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