

## Price Suggestion and Price Prediction Algorithms

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**Abstract** - *In the current scenario with the advancement of technology, the online sales are dominating offline sales. Among 10 people, nearly 6 people are opting for online purchase. In this process, there is a lot of increase in category of price points which has both pros and cons. The advantage is that the customer has more number of choices to select but this leads to a dilemma in choosing a product with optimal price. This paper uses fast and high-performance decision tree algorithm called Light GBM for price suggestion which can be a solution to such kind of issues. In another scenario the purchase in the stock market takes place with the help of a trading agency. The customer wants to know the future trends of the company or entity so that he/she can decide whether to buy it or not. The development of the stock price prediction model helped the customer to check the required information on their own. This paper analyses various price prediction algorithms namely Auto ARIMA, Prophet and LSTM. The analysis shows that Auto ARIMA is the most suitable algorithm for stock price prediction problem among chosen algorithms.*

**Keywords:** Price suggestion, price prediction, Light GBM, Auto ARIMA, Prophet, LSTM.

### 1. Introduction

Price is the most effective attribute in the field of marketing and business. Price suggestion is a process of suggesting prices of the products by considering number of factors like condition of the product, specifications of the product, brand value of product etc. The idea is to consider these factors and give them as an input to the machine learning model so that it can predict the prices based on these factors. The price suggestion problem comes under regression as the output will always be discrete in nature and is not in a category. Regression comes under supervised learning. For example, consider a product X of company Y. Suppose a customer wants to buy this product online, the cost of the product may be different in different websites. Price Suggestion model gives the worth price of the product for the customer.

To understand price suggestion problem much more precisely, let us consider a problem. This is a real-world kind of problem. The problem is about prices of smartphones. In the present situation we are regularly witnessing launches of smartphones. Consider a company X launches a smartphone. The features of this smartphone are snapdragon 730 processor, 6.55-inch screen size, 64MP primary camera with 12MP wide angle camera and 4MP macro lens, 32MP camera front camera, Bluetooth 5.0, 3.5mm headphone jack, AMOLED screen, and 4980mah battery. The price of this smartphone is Rs.21,000. In this present market, the price points are increased and for each price point there is a minimum of 5 smartphones available from various companies. Now coming to the present problem, let's assume there are three more companies are also offering smartphone with similar specifications but the prices are little bit different. The prices of the smartphones from these companies are Rs.20,000, Rs.23,000 and Rs.22,500. Now, the customer who is wishing to buy a smartphone of around Rs.20,000 price point would be in dilemma to choose between these four smartphones. The customer wants to know which smartphone among these four is value to money one.

Price suggestion model solves such problems by taking into account features of the phone which can be brand value, any water-resistant rating for the smartphone etc. Based on all these features, smartphone specifications the price suggestion predicts the price of the smartphone. Now the customer can decide whether the pricing is done appropriately or not based on this.

Stock price prediction is a process of predicting the future stock prices of a company or an entity by analysing previous data. The stock market prices are not stable and change significantly time to time. We can see drastic changes in stock prices within a stretch of few minutes. Generally, we can say that it is volatile in nature which involves huge risk. The irregular trend in the stock market can be the main problem.

With the advancement in Machine Learning, there have been solutions to many kinds of problems. In the current market, we can see product releases frequently. The customer will have the curiosity to know the pricing of the product even before its launch which has motivated us toward the work in this paper to suggest the price of a new product based on the prices of the similar products available in market and also to help the customer in his

decision making process to purchase a product with optimal price. Light GBM algorithm is used to analyse and suggest the price of a product.

Stock price is an exception to price suggestion as prices of the stocks vary continuously. It is needed to predict the market and stock prices to help the customers attain a higher profit which has driven us to analyse Auto ARIMA, Prophet and LSTM price prediction algorithms.

The work in this paper discusses about literature review in section 2, objective of the work in section 3, algorithms in section 4, implementation, results and conclusion in sections 5 and 6 respectively.

## 2. Literature Review

Yun Ju, Guangyu sun et al. [1] had proposed a model for wind power forecasting using Light GBM to achieve higher accuracy for the wind power forecasting model. Elena-Adriana Minastireanu et al. [2] developed an Online click fraud detection model using Light GBM algorithm. Lot of advertisements pages will pop up while using Internet. To avoid this problem, the author developed an online click fraud detection model with an accuracy of 98%.

Zeng et al. [3] developed a model to classify the mental state of a driver to avoid accidents. They used EEG analysis method for this problem. They trained performed random tests to check the accuracy of the model. The model developed here using Light GBM algorithm recorded an average of 95% accuracy. This proves Light GBM is an efficient algorithm.

Anghel et al. [4] performed benchmarking for gradient boosting tree-based algorithms. They performed this benchmarking on Light GBM, Catboost and XG Boost. They ran several tests to find the best one among three. They were some significant results in these tests. They could not pick one best algorithm from these three. But they concluded that Light GBM and XG Boost are better in their ways. They also found some cons from these two algorithms also from the test results.

Chen et al. [5] developed a model for citation intent recognition. Light GBM is the one method used for this problem and BERT is another method used for this problem. They ran various tests to build an efficient model. They used MAP measure to calculate the error of the model. The two methods showed some significant results. The Light GBM algorithm recorded MAP value of 0.41. The BERT method recorded MAP value of 0.4. These values prove that both these methods are efficient ones for this problem.

From the above analysis, Light GBM is an efficient algorithm for both linear and non-linear kind of problems. The leaf wise tree growth is the main reason for its higher accuracy. It has faster training speed and capability to handle large scale data efficiently.

Hiba Sadia et al. [6] discussed about the process to find out the best suitable model for stock price prediction problem using Random Forest and Support Vector Machine. After implementing these algorithms on the problem, they proved that Random Forest algorithm is best among the two algorithms.

Vani et al. [7] developed a machine learning model for stock price prediction using LSTM and Auto Arima. After the implementation of these algorithms, the author obtained significant results. It is concluded that both these algorithms can handle stock price prediction problem efficiently.

Sushrut Deepak et al. [8] proposed various approaches for stock price prediction. They showed the procedure to remove noise from the data. Neha Bhardwaj et al. [9] analysed the stock price prediction problem using various machine learning problems. The algorithms chosen here are KNN, Auto Arima and Random Forest.

Bibek Maharjan et al. [10] developed a machine learning model for stock price prediction problem using Support Vector Machine and LSTM. Here the author also developed a web application which can be used to check the stock prices. They obtained accuracy around 78% to 90% for both algorithms. Xuan-Hien Le et al. [11] developed a flood forecasting model. The algorithm used here is LSTM. It became a very useful model in the field of hydrology. The results shown by the flood forecasting model were also significant.

Cayir et al. [12] developed a machine learning model for bitcoin price forecasting. Prophet is the one algorithm used here for bitcoin price forecasting and Auto Arima is another algorithm used here. The language used here to implement the algorithms is R language. They obtained an accuracy of 94.5% for prophet algorithm and only

68% for auto arima algorithm. This shows that Prophet is more suitable for bitcoin price forecasting than Auto Arima.

Alsharif et al [13] developed a model for predicting the average solar radiation. This model would be useful in the areas where there is scarcity of electricity which predicts the solar radiation amounts for a given period of time. They used Auto Arima algorithm for this problem and depicted the predicted values using seaborn package. They got significant tests using Auto Arima algorithm. This shows Auto Arima is an efficient algorithm for time series forecasting. Torres et al. [14] developed a model for stock price prediction problem using Random Forest algorithm using dataset of Apple Stocks.

The study shows that LSTM, Prophet and Auto ARIMA algorithms can be used for time series forecasting problems.

### 3. Objectives of the Work

The objective of price suggestion is to suggest product prices to the customers. This model is also useful to the product manufactures because it can predict prices of the given product. There will be many products like clothing, gadgets etc which are launched by the companies in regular time periods. The customers have a curiosity to know the price of products before its launch. To overcome this, we developed a price suggestion model. This price suggestion model predicts the prices of the products based on the features of the product. It uses the data of similar products of different companies to predict the price of the current product. It compares the prices of the similar products of different companies and based on the features of the current product, it can suggest a price.

Along with price suggestion we also analysed the performance of various prediction algorithms like Prophet, Auto Arima and LSTM for stock price prediction. The objective of stock price prediction is to predict the future stock price of a particular company or an entity with high accuracy.

## 4. Algorithms

### 4.1 Price Suggestion using Light GBM algorithm

- Basically, Light GBM algorithm [1] is a gradient boosting framework that comes under tree-based kind of learning algorithm.
- It follows leaf-based tree growth instead of level-wise tree growth [11].
- It has faster training speed and is highly efficient.
- The efficiency of Light GBM algorithm is due to its leaf-wise tree growth.
- Light GBM algorithm can handle larger datasets efficiently.

### 4.2 Stock Price Prediction Algorithms

#### 4.2.1 Long Short Term Memory

- LSTM stands for Long Short Term Memory [3, 11].
- The LSTM algorithm is capable of storing the past information for the future purpose.
- It forgets the information which is not required.
- LSTM consists of three gates namely input gate, output gate and forget gate.
- The input gate is used take information as an input.
- The forget gate is used to remove unnecessary information.
- The output gate is used to choose to the information i.e. the output to be displayed to the user.

#### 4.2.2 Prophet

- Prophet algorithm is developed by Facebook [12].
- Prophet is mostly used for time series forecasting problems.
- Prophet algorithm is robust in nature and can also handle the non-linear trends very efficiently.
- The outliers are also handled in Prophet algorithm.

#### 4.2.3 Auto ARIMA

- ARIMA stands for Auto Regressive Integrated Moving Averages.
- In Auto Arima there are mainly three components namely Auto Regressive term, Moving Average term and Differencing term [7].
- The Auto Regressive term consists of the previous values used for prediction.
- The differencing term consists of number of times the operation for differentiation is to be performed on the given series.
- The Moving Average term consists of the previous error values obtained.

## 5. Implementation

### 5.1 Price Suggestion using Light GBM algorithm

The basic steps used for price suggestion are:

1. Understanding the problem.
2. Gathering the requirements i.e. dataset.
3. Choosing an algorithm and applying it on the problem.
4. The output will be the model which should have a minimal error value.

Light GBM algorithm is used for price suggestion problem [19]. The dataset contains columns like product name, brand name, condition, shipping status and price. The dataset we are using for price suggestion problem is from Kaggle website[15].

Based on the predicted prices, RMSE value is calculated and has recorded RMSE value of 0.8 for Light GBM algorithm. The reason for less error value of Light GBM is because of its faster training speed and capability to handle large scale data. For price suggestion, Light GBM is one of the best algorithms to suggest prices automatically.

For example, we can compare an item of test data whose price is predicted by the model with prices of similar products in the train data. Consider the item with item\_id = 29, the price of this product predicted by model is \$11.4. Now we will consider similar items present in train data namely items with item\_id = 93 and 100. The prices of these items are \$10 and \$12. The model predicted appropriately correct price based on its features like item\_condition, shipping\_fee etc. This is the reason for less RMSE value for this price suggestion model.

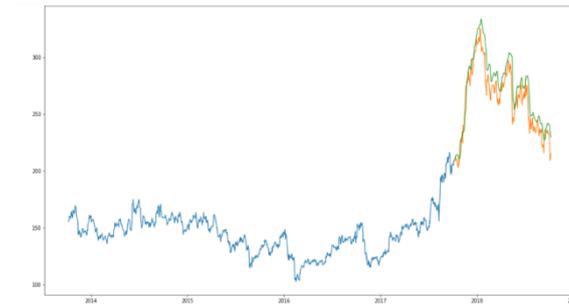
### 5.2 Analysis of Stock Price Prediction algorithms

This paper analyses the performance of Auto ARIMA, Prophet and LSTM prediction algorithms to seek an efficient and accurate algorithm for Stock price prediction [17]. The dataset we are using for stock price prediction is Tata Stock Price from Quandl website [16].

test_id	name	price
0	Breast canc	15.51046
1	25 pcs NEW	12.89827
2	Coach bag	30.93546
3	Floral Kimo	20.73431
4	Life after D	12.47294
5	iPhone 6 Plus	11.09823
6	Vintage Car	21.7432
7	Rose Gold S	18.01618
8	Daisy Marc	29.9265
9	Rose Brush	7.586543
10	BNWT Coac	35.69023
11	"John Carpe	15.55899
12	Tuff Jeans C	20.88097
13	Lululemon	49.90789

Figure 1: The prices predicted by the model

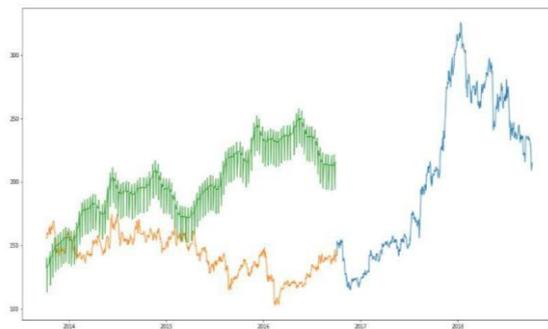
The Figure 1 shows the prices of the test data which are predicted using Light GBM algorithm.



**Figure 2: Graph showing the predicted price and the actual price using LSTM**

Figures 2,3 and 4 show the performance of LSTM, Prophet and Auto ARIMA algorithms respectively. The green line indicates predicted prices, red line indicates actual prices and blue line indicates train data.

Prophet algorithm is completely based only on the past data. As the stock market operates on an irregular manner it has recorded higher RMSE value making it less preferable over other algorithms chosen for stock price prediction problem. LSTM algorithm uses three gates approach based on various parameters. The disadvantage of this algorithm is its over fit property. This is the reason for the RMSE value of LSTM algorithm. Auto Arima recorded lesser RMSE value among the chosen algorithms as it can handle time series forecasting problems efficiently which makes it more suitable for stock price prediction problem among the chosen algorithms.



**Figure 3: Graph showing the predicted price and the actual price using Prophet**



**Figure 4: Graph showing the predicted price and the actual price using AutoARIMA**

**Table 1: Performance of the stock price prediction algorithms**

Algorithm	RMSE Value
Long Short-term Memory	13.43
Prophet	69.06
Auto ARIMA	3.002

## 6. CONCLUSION & FUTURE SCOPE

In this paper, we implemented a price suggestion model and also analysed various stock price prediction algorithms. A Price suggestion model comforts the customer to purchase a product with optimal price and utmost satisfaction. The work in this paper implemented Light GBM algorithm for Price suggestion and analysed that it is an effective model with a minimal RMSE value of 0.8

In order to predict the Stock Market Price Auto ARIMA, Prophet and LSTM algorithms are implemented and the results show that Auto ARIMA algorithm is the most suitable algorithm for stock price prediction problem among the chosen ones as it can handle time series forecasting problems efficiently.

The paper can be further enhanced by using different datasets of various types of products. Even a web application can be developed and this model can be integrated to that application in order to serve as a price suggestion application.

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