ANALYSIS OF FINANCIAL DATA USING DATA MINING TECHNIQUES

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*Abstract*— The main idea of this paper is to analyze the vast data sets and to provide insights on different financial investments, the dataset which we are considering includes the different parameters related to financial investments for instance stocks, mutual funds or bit coins. The objective here is to provide the insights, analyzing the patterns, improve the risk management and predict the future trends, also to improve the decision making. The scope of the paper is to use the traditional data mining steps such as data pre-processing, data mining techniques such as regression analysis, clustering, decision trees. The application of the project is to provide investment decisions, risk management in financial investments, business strategies, forecasting of trends and fraud detection.

Keywords—Data mining, data pre-processing, clustering, decision trees, data prediction, regression analysis.

# Introduction

Data is a collection of distinct, objective facts about a process or an event that, by themselves, are not very useful and must be transformed into information. From straightforward numerical measures and text documents to more intricate information like location data, multimedia channels, and hypertext texts, we have been gathering a wide range of data.

Data mining is a trending and powerful field for performing advanced data analysis and it incorporates methods and tools from statistics and machine learning. Applications for advanced analytics and business intelligence make use of the information produced by this process, which comprises the examination of validated data.

The data mining techniques can be applied over the range of different sectors in the real-time such as research, education, transportation, healthcare, finance and banking, business transactions and much more.

In order to determine whether a business is steady and profitable enough to get capital investment, financial analysis of data is crucial. The balance sheet, cash flow statement, and income statement are where financial analysis concentrate their analysis.

Data mining methods have been applied to financial markets to uncover hidden patterns and forecast upcoming trends and behaviors. The mining of such data, especially the high-frequency financial data, often calls for advanced statistical, mathematical, and artificial intelligence techniques.

# Related work

## Data Mining Models

There are a lot of data mining techniques/models that can be used to analyze and extract the data. So, it is necessary to understand each method and the efficiency of different techniques so that we can decide for the correct data mining method that can produce effective results with consistency.

In general, there are various data mining methods in use and the most popular ones are logistic regression, SVM, Neural Networks [10]. There are lot of research studies on these methods, there is a study conducted by *Ken Ishibashi and his co-researchers [1],* they did a comparison on different data mining models to select a model that will be good for financial data. Their study validated those techniques such as SVM and NN produced a higher accuracy than of the existing models. There is another review study made by *Zhang. C [5],* he along with his co-researchers studied 75 articles for a concept called decision fusion which is to fuse the outcomes of different resources.

There are other studies that focus on NN techniques, *N. Srinivasan, C. Lakshmi [2],* mentioned in their study that intermittent training of the data results in high accuracy in the prediction of stock values for banking sector. There are different number of studies using neural networks are been presented in the reference articles [7][8][9] that are used not only to predict the data trends but also regarding data frauds.

There is a study made by *Bedour M. Alshammari and his co-researchers [11],* on stock market prediction where they presented about the data mining steps (from collection till prediction) clearly and reviewed and compared various techniques on stocks data. There are other studies which discussed the financial insights and recommendations [12][13] which is very near to our research.

# Methodology

The presented machine learning (ML) system for this project would probably use cutting-edge algorithms and techniques to analyze financial data and make wise decisions. The suggested system would be designed to address the shortcomings of the current system and enhance the precision, dependability, and understandability of the findings.

When it comes to ML modelling, typically there are two types of learning techniques, one is the supervised learning and unsupervised learning. The major difference of supervised and unsupervised learning is the labelling of the data, the unsupervised learning basically applies modeling on raw data which will be often used in identify patterns or to cluster the data. The supervised machine learning will learn the relationship between input and output through labelled training data, so is used to classify new data using these learned patterns or in predicting outputs.

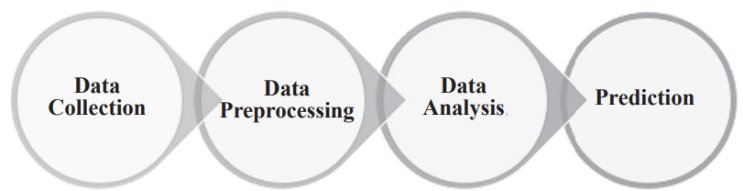


Fig. 1. Different stages of the system

## Data Pre-Processing

In any data mining project, the flow will start at data collection, we have collected the financial data which is used for stock value prediction. In the pre-processing stage the collected data is processed and analyzed to verify whether the data is biased or not, duplication of data, null values and outliers.

The dataset which we considered is of the size 851264 x 7, which includes different parameters related to the stocks, such as name of the stock(company), high and low values of each stock, open and closing values for the date. The data consists of various data types which includes double, long, object. From the pre-processing steps, we verified that data is pure and doesn’t consist any duplicated values and the outliers are removed and the null values are adjusted using statistical methods.

## Algorithm Selection

As discussed in the earlier sections, there are unsupervised and supervised learning techniques, in our project we discuss both the types of learning in different stages of the project.

The unsupervised learning such as K-means clustering is used to identify the patterns in the financial data and the number of clusters are identified using elbow method.

In the supervised learning we are using regression techniques, Neural Networks (NN) models and other techniques for the data prediction.

## Model Training

After the pre-processing of the data is completed, one of the main features will be selected for the prediction purpose. As we are using various NN and other data mining techniques we need to train all the models with the original data set, so we used the jupyter notebook powered by anaconda navigator as the software platform for this project, as the data is reasonable size there is not needed for any hardware assistance or any server assistance.

The presented approach would use prepared financial data to train ML models. Cross-validation methods may be used in this situation to enhance model performance and prevent overfitting. The financial data is divided as training and testing sets in a ratio of 80:20.

In this project we trained NN models such as Artificial Neural Networks (ANN) after going through various articles mentioned in the related work, we preferred to keep the number of layers to 6 [1][10] for efficiency of the model.

Along with ANN, we also used some regression techniques, boosted tree classifier models or ensemble models such as extreme gradient boosting (XGBoost) classifier. Apart from the ensemble methods we used other popular modelling, which is linear regression or logistic regression for data prediction.

## Model Evaluation

After all the models are trained using the training set, the models are evaluated using the testing set, in the model evaluation we are analyzing the accuracy of each model and evaluation report which consists of the parameters such as precision, f1-score and other related parameters which are useful to compare the models and analyze the hyper parameters used in the training of the models.

The accuracy of the models is analyzed for different values of the hyper parameters that are used in each model. The hyper parameters values are finalized on the best accuracy of the model and some of the hyper parameters such as number of clusters for k-means and number of layers for ANN are finalized using literature survey.

# Results

This project uses different models to predict the stock value based on the different values of the particular date, before training the model using the stock data, the data is cleaned up using pre-processing techniques and checked for null values and duplication of values. Here are some results from the pre-processing stage such as identified outliers, correlation results.

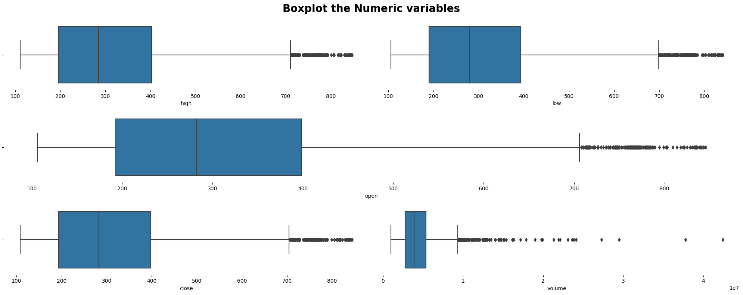


Fig. 2. Box Plot to identify the outliers

As it seems to have outliers in the data, but they aren’t considered as outliers, considering the stock data there might be some extreme values during the peak season.

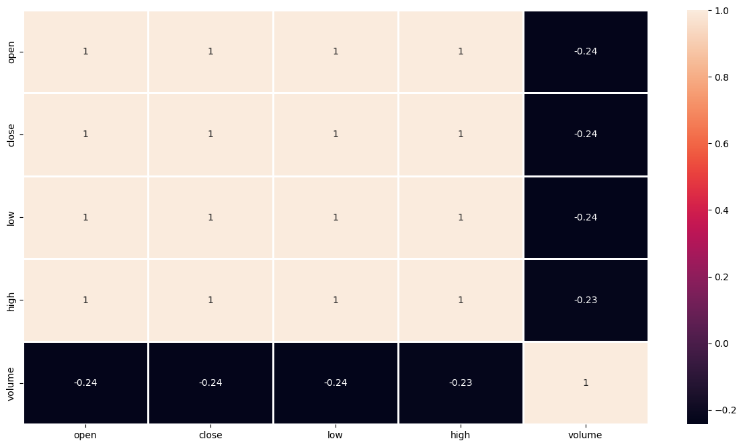


Fig. 3. Heatmap to display the correlation of the data

The below plot is to display the evaluation of the linear regression model. The plot is drawn in comparison of the predicted values versus the test data set that is created for evaluation of the model. This model achieved nearly 100% accuracy with a Mean Squared Error (MSE) and Mean Absolute Error (MAE) of 83.

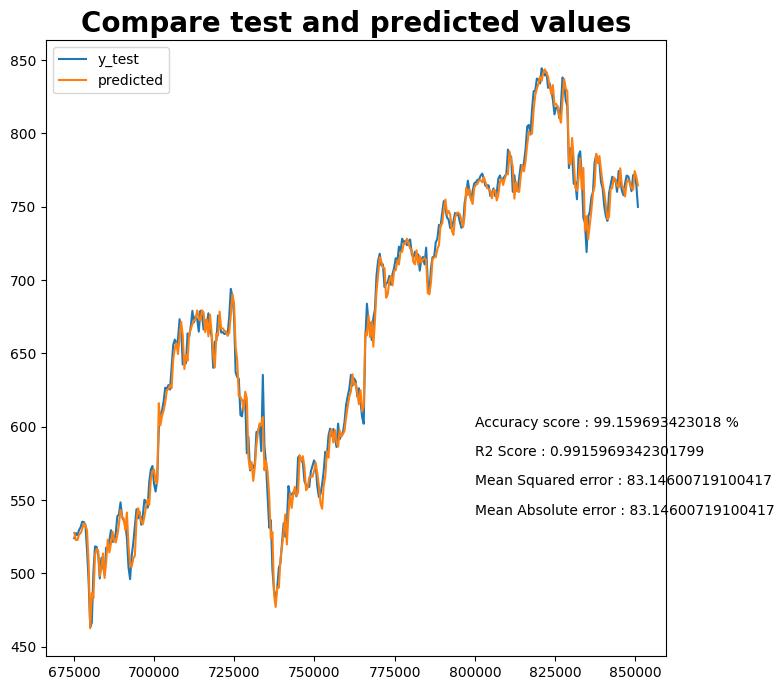


Fig. 4. Evaluation of Linear Regression Model

There are other models that are still under testing stage such as ANN and other boosted tree classifiers. Currently the methods aren’t providing better accuracy as expected. The comparison of prediction values against the testing data for ANN is provided below.

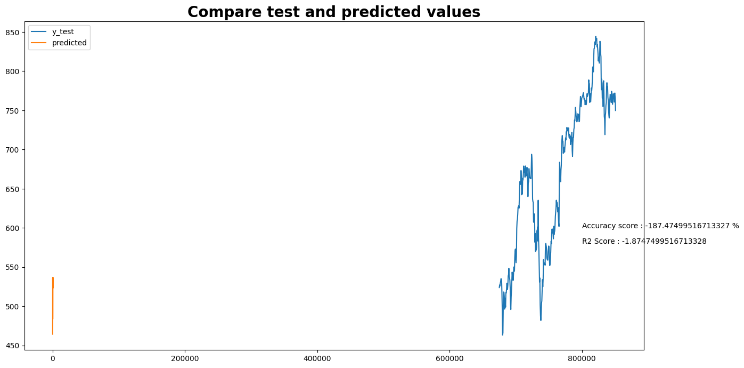


Fig. 5. Evaluation of XG boost model

As it is clearly seen that the predicted values aren’t better as expected from the accuracy value it is clear that the models such as XG boost aren’t preferable even though they are better at classification of the data.

The ANN has the minimum loss compared to the linear regression. As the neural networks divide the data into batches for each batch of data the prediction loss is getting reduced, that helps in getting less MSE for overall data.

# Discussion and Limitations

The current data consists of open, close, high and low stock values for each stock, it will be helpful in understanding and prediction of closing value for a particular day before the market get closed. But to estimate a high or low or closing value it might require special data which includes the different factors which might influence the stock price of that particular company.

Our project is better than current system which is available in the market, still there are few limitations that can be fixed to better the system. As we are dealing with larger datasets, we cannot predict the closing value of all company stocks at a time. If we are interested in a specific company, we can check for that stock value. Hence for the further improvement we are striving to modify the project such a way it shall increase the accuracy at a time able to analyze and give better prediction.

# Conclusion

From this project we are able to analyze the stock data and able to predict the closing value of the stock with higher accuracies with the linear regression model, and able to decrease the error using ANN model. But the classification model which we used XG Boost model isn’t predicting with good accuracy so we would like to conclude that the ensemble classifier aren’t good for prediction of stock value but regression and neural networks can be preferred as they are getting less error and high accuracy.

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