Stock Market Predictions

with Artificial Intelligence

Jennifer Sissi Lange  
Department of Information Systems  
Hanyang UniversitySeoul, Republic of Korea  
9207120238

Jenni-sissi.lange@debeef.de

Kerk Zhong Zhe  
Department of Electronic Engineering

Hanyang UniversitySoul, Republic of Korea

9206820235

Kerk0013@e.ntu.edu.sg  
Jade Lu  
*Department of Computer Science*Hanyang UniversitySeoul, Republic of Korea

9206220239  
Jlu23@student.gsu.edu

Gin Lo Hoi Ching   
Department of English Language and Literature  
Hanyang UniversitySeoul, Republic of Korea  
S216213@hsu.edu.hk

*Abstract*—This paper describes an approach on how to use artificial intelligence to predict a possible rise or fall of the stock market value in the near future.

Keywords—Artificial Intelligence, Decision Tree, Random Forest, Receiver Operating Characteristic, Dataset Modification

# Introduction

The stock market is a dynamic system that presents the economic well-being of companies. Investors and market participants tend to make decisions based on the traditional econometric models and technical analysis indicators. Due to the complexity of the past performance of the stock, the accuracy of the traditional method is not highly reliable. This uncertainty and the unpredictability of the stock market means investors might face serious financial risks in optimizing their investment strategy. 61% of Americans own stock because they are more open to buying stock (Caporal, 2023). There is a need for a sophisticated and data-driven solution that can provide more reliable and actionable predictions.

In this project, an AI model is proposed to predict the stock market trend and to capture the intricate patterns and subtle relationships within financial data. An ensemble learning model utilizing Random Forest and Decision Tree algorithms to analyze historical stock market data and price movements will be developed. The model will provide labels to indicate the trend of the stocks. The user could make better decisions based on our model.

By providing more accurate and reliable predictions, this model can help investors make informed investment decisions, optimize portfolio management strategies, and mitigate financial risks. Financial institutions can benefit from improved risk assessment and asset allocation, leading to enhanced profitability and stability. Moreover, a more precise understanding of market trends can contribute to overall market efficiency and investor confidence.

# Dataset

## TESLA Stock Dataset (TSLA)

The TESLA dataset includes approx. 10 years of the TSLA stock data from June 29, 2010 - February 3, 2020. The original dataset was slightly modified removing Adj Close for consistency reasons. So the features that are included in the modified dataset are as follows: Date, Open, High, Low, Close, Volume, and Rate of Change. The prices are based on USD.

## SAMSUNG Stock Dataset (SSNLF)

The SAMSUNG dataset includes decades of SSNLF stock data from January 4, 2000 - May 23, 2022. The prices are also based on USD. It’s also modified as described in the TESLA Stock Dataset description.

## TWITTER Stock Dataset (TWTR)

The TWITTER dataset was chosen to be used because of its interesting history. Due to Elon Musk’s purchase of Twitter back in 2022, it became a private company, was delisted from the New York exchange, and is no longer in the stock market. So this dataset contains its history on the stock market from November 7, 2013 - October 27, 2022. The prices are also based on USD. It’s also modified as described in the TESLA Stock Dataset description.

# Methology

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## Original Dataset

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**Date** - Includes the year, month, and day in that order (YYYY-MM-DD)

**Open** - This is the opening price of the day.

**High** - The highest price of the day.

**Low** - The lowest price of the day.

**Close** - This is the closing price of the day.

**Volume** – The total amount of shares traded in the day.

**Adj Close** - This means the adjusted closing price of the day. It’s adjusted to better reflect the stock’s value after anything such as corporate actions would affect the stock price after the market closes. However, this was taken out for consistency reasons.

## Modified Dataset and Features

The dataset is extended with modified data to make the dataset bigger and create more data for the AI to train on. With the additional created data, possible patterns and relationship between different information will be recognized by the AI. In the following it is described how the data is going to be modified and extended.

**Slope/rate of change -** It is calculated using the formula above. Its purpose is to help train the AI to take into consideration the influence the stock prices on the days before have on the stock prices on the day of. It helps the AI recognize certain patterns happening in the given datasets. For instance, when calculating the rate of change for the opening price, y2 would be the opening price of the current day, y1 would be the previous day’s opening price, and x2 - x1 would be the number of days. The slope is calculated as follows:

Then this calculation would be repeated based on the fixed number of days. The following figure illustrates the calculation of the slope

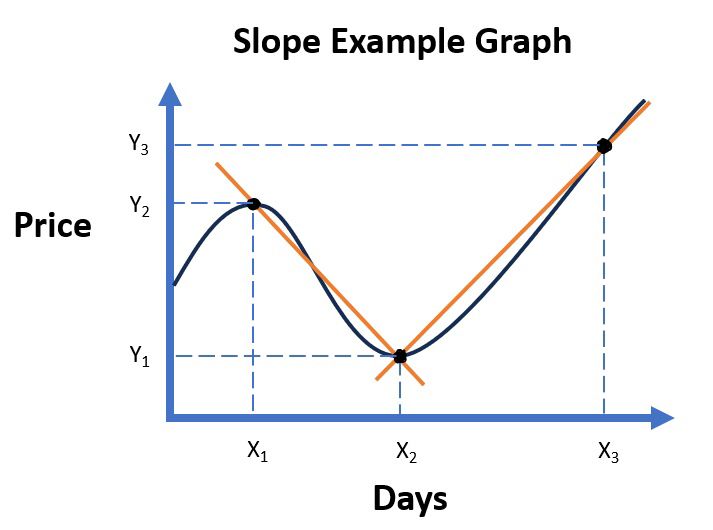


Figure 1 - Calculation of the slope

**Average slope -** Using the outcome of the calculation of the slopes, the average of those single slopes can be calculated, allowing one to determine whether the price will rise or fall. If the number is positive, the value increases. If the number is negative, the value falls.

**Number of rises and falls -** In this new feature, the individual calculated slopes are taken into account again. The number of slopes that have a positive or negative sign are counted. This means that the number of times the value of the share rises or falls in a certain time frame is counted. In this way, it is intended that the artificial intelligence in this work may be able to recognize patterns of behavior on the stock market in order to predict the further course. In the following illustration, the rising and falling of the price is shown with arrows.

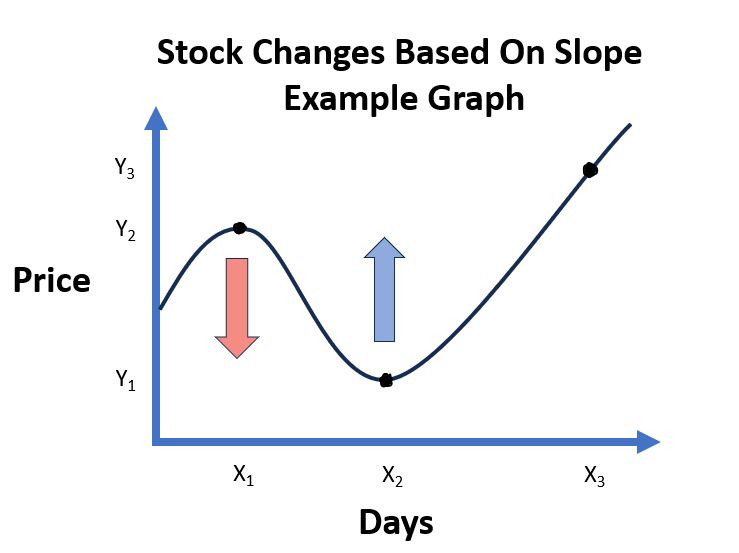


Figure 2 - Stock price changes based on slope

**Difference between High and Low -** Here the difference between the High and Low prices are calculated. This is done for the current day and for all past days of a certain time frame. The difference shows how much the price fluctuates within a day. This is intended to illustrate further behavior in the stock market in order to identify certain patterns.

**Average difference between High and Low -** The average difference between high and low is calculated. This summarizes whether the difference in the days is generally high.

**Difference between Open and Close -** Here the difference between the High and Low prices are calculated. This gives us more information based on the stability of the price. This is intended to provide further information that may be useful in exploring patterns for the artificial intelligence.

**Average difference between Open and Close -** Similar to the high and low values, an average difference between open and close is also calculated here over a specific time window.

## Creating a label

The labels 1 and 0 are used to predict a rising or falling price. The labels are determined on the basis of the average rate of the low value. A positive slope is labelled 1 and a negative slope is labelled 0. The low value, which represents the lowest price on a day, is used to forecast based on a worst-case scenario.

## Distribution of the dataset

In terms of training and testing the created model of artificial intelligence and the modified dataset will be split up 70% of the data will be used for training and 30% used for testing. The amount of training data is distributed as such because there needs to be as much data to train the AI. On the other hand, there must be enough testing data available to ensure an accurate testing result.

## Implementation of the code for modifying and labelling the dataset

Several functions were declared for the realization of the project and subsequently applied. Their use is described below. The exact code can be found in the jupyter notebook file, which is included in the appendix.

**def combine\_data(trade\_datas):**

* This function is used to merge different datasets. A list of DataFrames is passed, which are combined into one at the end. Since datasets from different companies is used in this project, it is necessary to merge them in a standardized way.

**Def modify\_data(trade\_data,t\_previous\_days, t\_label\_days)**

* This function is used to modify a data set. The purpose of modifying the data set is to extract more information from the given data set and use it as an additional feature. The new features are used, for example, to recognize temporal patterns. The label is also created in this function. To execute the functions, the dataset is required as well as the number of days immediately before and after the respective data point that are to be analyzed.

**def plot\_label\_visualization(data):**

* This function displays the result of the automatically created labels. The progression of a price is displayed graphically. For each label, 3 data points are selected at random and displayed in the graph in the form of dots in different colours. A vertical line with the respective colour is then drawn for each data point, making it clear which point in time is being considered for a forecast.

## Function of a Decision Tree

## Function of a Random Forest

## Implementation of the code to create the model

# Evaluation and analysis

## Receiver operating characteristic

## Results

## Comparison of the results

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# Related Works

# Conclusion

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