**Final Project:**

**Stock Price Prediction Using Machine Learning Techniques**

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**Introduction**

Accurate prediction of stock returns is a challenging task today due to many uncertainty factors that affect financial stock's volatile and non-linear nature. Using the human ability to think critically by considering fundamental factors or looking at technical graphs to analyze stock may not be enough due to the vast amount of data to ponder in stock analyzing and forecasting. By taking advantage of the computational capabilities of machine learning and robust algorithms, the stock market prediction has become more efficient. Its ability in predictive analytics is suitable for the complex areas of human activity like the stock market, which reflect the thoughts and decisions of humans. The behavior of individual stocks sometimes does not always respond to economic factors, which is why there is the statement that the market status does not correlate with the health of the economy overall (Madrick, 2020). Therefore, the fundamental analysis technique considers economic data at a certain point in the past to predict the future may not provide accurate results. As the information coming into the market is getting closer to real-time, algorithms are used to learn investors' behavior through previous stock price performance and then provide a more accurate prediction of their future actions.

Machine learning can learn new things based on previous data, and its algorithms become better when data increase. The stock market generates tons of data daily, and thus, machine learning can become a perfect fit to analyze the stock markets (Joshi, 2020). For stock market prediction, Machine learning works in the same way as financial analysts do. It starts with studying previous stock market prices, then examining its trends, and using that information to predict the future movement of the stocks (Joshi, 2020). Machine learning deployed in predictive modeling is primarily expected to minimize the error of a model or make the most accurate predictions possible (Brownlee, 2016). We can check whether the algorithm performed accurately by comparing its result to the actual stock performances; as a result, more effective improvements will be applied to the algorithms.

In predictive modeling, statistical techniques using machine learning are utilized to predict possible future stock prices supported by historical and existing data. Three types of models have been chosen for this project : Simple Linear Regression, Quadratic Polynomial regression, and K Nearest Neighbor (KNN)

**Simple Linear Regression:** developed as a model for understanding the relationship between input and output numerical variables. The model predicts future stock prices from its price in the past and assumes a linear relationship between them. Therefore, the model can understand patterns that a given dataset fits in a simple linear equation.

Chart, scatter chart

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Chart

Description automatically generated with medium confidence**Quadratic Polynomial Regression:** developed as a model for dealing with complex data that applying linear regression model might not be accurate. The polynomial model produces curves that adjust with the data rather than the lines. The equation of the polynomial model would be :

This project includes higher degree polynomial terms: x2 polynomial(2) and x3 polynomial(3) that allows the fit of more flexible models representing the relation between the result and some continuous predictors.

Diagram

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**K Nearest Neighbor (KNN):** its algorithm is developed for feature similarity to predict the values of any new data points. In other words, the new data point is assigned a value based on how closely it resembles the points in the training set (Singh, 2018).

Chart, scatter chart

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This report aims to understand stock analysis and price predictions using Python code. The initial process starts by selecting interested stocks to explore trading elements such as stock price and volume. The following process performs stock analysis by comparing performances between stocks, their sector, the market, and economic factor. Lastly, the stock price prediction is operated by using individual stock price data sets to predict its future price through the models mentioned above.

**Exploratory Data Analysis**

Data set used in this project

* Three common stocks : AAPL (Apple Inc.), GOOG (Alphabet Inc.), and AMZN (Amazon.com Inc.). The historical stock prices is kept on a daily basis in a file format .xlsx
* NASDAQ Composite index and NASDAQ 100 Technology Sector are selected to represent the performance of the market and sector, respectively. Both indexes will be used to compare the performance of individual stocks. The index price data are also collected on a daily basis in a excel file (.xlsx)
* US 10 Years Bond Yield historical data represent investors' confidence in the economy. The bond yield will be used as a proxy to compare the stock performance with the economic condition. Its historical data is gathered daily in an excel file.

These data sets will be extracted using the following codes:

Graphical user interface

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Pandas was implemented to manage time-series data that contains extensive tools for working with dates, times, and time-indexed data. In working with trading dates, the Python objects residing in the build-in datetime module will be executed to change different date formats into the same format. Then, convert the data frame column into an index. Numpy will be used for array oriented computing and Matplotlib for visualization.

**Data cleanup**

For stock and index data frame (Amzn, Appl, Goog, Nasd, techSec\_df), the different date format in the date column is converted into the same format by creating a function that change one format to desired format (‘%Y-%m-%d’) through function datetime and strip time. And then make that date column to become the data frame's index. After dealing with the date format, data in other columns must be changed from string to float and remove $. However, US bond data frame (usBond\_df) has a different way of dealing with date formats because the trade date is recorded in the form of the month name. Therefore, a dictionary is used to deal with this problem, and stripe time is still used to convert the format to ('%Y-%m-%d') same as the date format of stocks and indexs. The next step is merging data frame, which includes stocks, market index, sector index, and bond yield. Before putting all data together, make sure that the name of columns has been changed since each data frame has the same column name, such as "Close/Last". It should be specific which ones belong to which stock. The merged data frame will show as following Table

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Nevertheless, some data is missing after merged data frames due to mismatched operating dates between stock, index, and US bonds. Therefore, filling the missing value will be done in the next step. The function .interpolate(option='spline') was implemented to fix a problem based on fixed data points.

The data frame with missing value

Chart

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Chart, line chart

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Description automatically generatedAfter fixed the problem with interpolate

As a result, I got completed data frame which ready to be used in next step

Table

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**Data visualizations**

Competitor Analysis

Pandas provide the correlation function that can generate coefficients show how strong the relationship is and percentage change function, pct\_change(), that can calculate stock return. The information from the completed data frame with these functions were utilized to analyze how one stock performed relative to other stocks, which are the same technology company, and how the stocks performed compared to their sector and the market. Therefore, the correlation value is used to see does one stock affect others or whether the sector and market affect those stocks. To further improve the analysis, the relationship is plotted as a scatter matrix to visualize possible correlations among stocks, the sector, and the market. Additionally, the heat map is used to visualize the correlation ranges. The lighter the color, the more correlated the two objects are.

Table

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The analysis result found that the most positive correlations occurred between Google and Amazon returns compared with other stock relations. Google and Apple return also has the highest correlations with the NASDAQ index and technology sector among the stocks. In other words, the correlation coefficient ranges close to 1 showing two stocks or a stock and a benchmark market index are moving in the same direction. For visualization, the scatter matrix shows that most stocks' distributions have approximately positive correlations, and the heat map clearly shows that Apple and Google have strong correlation with the market and technology sector.

Stock and Return Analysis

The individual stock risk and return were analyzed and presented by the neat chart to understand which stocks are worth buying. In this analysis, the average of returns (Return Rate) and the standard deviation of returns (Risk) were extracted to plot in the graph. The chart of risk and return comparisons show that Google is attractive stock because it gives the highest return with the lowest risk.

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Time Series Analysis

The stock market data need Time Series Plot because the data were collected over a period of time, and it can observe that the data are made at evenly spaced intervals throughout time (Kumar, 2022). The necessary libraries such as pandas and matplotlib.pyplot play an essential role in creating a visualization of this type of data. plt.subplot is used to create multiple subplots which generate a figure and a grid of subplots and also manage how the individual plots are created in the frame.

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The multiple graphs above showed the closing value in ($) of the NASDAQ and NASDAQ 100 Technology sector indexes in relation to the year, the closing value in ($) of individual stocks in relation to the year and their volume, and the closing value of US bond price as a percent of the bond’s face value in relation to the year and its percentage change over the period.

**Predictive Models**

Table

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Preprocessing

Text

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1% of data was chosen to use in the prediction. In other words, there are totally about 3000 observations, and they were taken off around 30 days. The nature of the Time series prediction is that the previous data are used to describe the following data. If the data was taken too much, fewer data would be left to train with the model. As a result, there is an increasing chance of the model going wrong.

The stock price observation of approximately 30 days is used to predict the future stock price in the next one month. Therefore, the data have the amount of 3011, 2980 will be trained, and it was tested by predicting if for 30 days. Executing the function below allows the models to have 2980 data to train. However, the models need to be tested before the actual prediction that the data is divided to keep 20% (around 600 observations; about two years) to see how well the training performance can do.

The libraries imported to apply in machine learning session as following:

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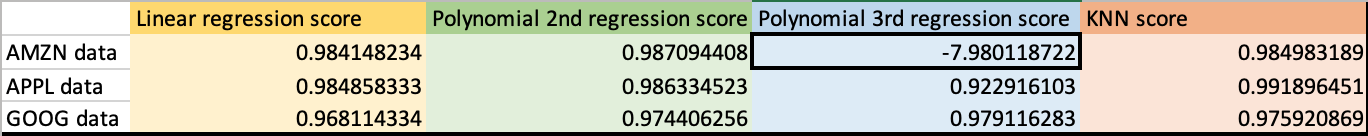
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Next step, the train function is created to train the data with four models: Simple linear regression, Quadratic Polynomial Regression degree 2, degree 3, and K Nearest Neighbor. Once the training is complete, the result is evaluated with evaluateTest function to see the confidence value of the model or the discrepancies that occurred.

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The result showed that Almost model used for training prediction stock price has minor discrepancies. A model's confidence values for each stock are about 95% or higher. However, the Quadratic Polynomial Regression degree 3 is not suitable to use with Amazon stock because it showed a negative number at around -7.98. In other words, this model did not fit with the data set.



After training and evaluating stage, these models predict three stock prices ; AMZN, APPL, GOOG for 1 month later. The models used 1% of data extracted earlier for forecasting. The forecasted values were added over the last date for the next 30 days, as we can see in the stock price visualization as following:

Graphical user interface, application

Description automatically generated**Amazon stock prediction**

Graphical user interface, application, Word

Description automatically generated**Apple stock prediction**

**Google stock prediction**

Graphical user interface, application

Description automatically generated

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