

OPTIMIZING ARTIFICIAL INTELINGENCE TO PREDICT INDONESIAN GREEN BANKING STOCK

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Abstract:

The world is turning green, from waste recycling to wind and solar power generation, which supports the significance of green investments. Everyone is aware of the negative effects of climate change, and the majority of people are very interested in finding solutions. In other words, making green investments may be a good strategy to lessen the environmental burden that humans have caused.

In order to address the aforementioned issues, this project will create a hybrid machine learning system for the Green Banking Stock which included in SRI KEHATI index, an Indonesian green index, using the Long Short Term Memory (LSTM) Method in order to predict the index movement using Phyton programming language.

The study's findings demonstrate that the software's predictions have a tolerable error rate. Median Absolute Error, Mean Absolute Percentage Error, and Median Absolute Percentage Error are the three different error metrics that are utilized.

Keywords: *Artificial Intelligence, Machine Learning, Deep Learning, Green Investment, SRI KEHATI, LSTM, Phyton*

1. Introduction

The globe is turning green, from wind and solar power generation to waste recycling, which supports the significance of green investments. People are aware of the negative effects of climate change, and are very interested in finding solutions. In other words, making green investments may be a good strategy to lessen the environmental burden that humans have caused.

As a result, it is made clear that businesses are accountable for both growing their bottom line and fostering social and economic development that is compatible with the environment. As a result, ethical and religious groups have inspired socially conscious investments to be undertaken in the market.

Green investments started to appear as a result of social investments that were efficient and responsible. Sustainable development is the long-term goal of green investments. The need to discover the elements that improve green investments, which have multiple advantages for the economy, the environment, and implicitly for private enterprises, served as the impetus for adopting this theme (Han et al., 2022). Consequently, this study investigates and evaluates the effects of green investments and the resulting organizational changes. The perception that customers have of businesses that make green investments is also highlighted in this article, as is the tendency of stakeholders to favor "green" businesses over conventional ones. Subsequently, the study analyzes the key factors that affect decision-making in green investment (Chițimiea et al., 2021).

Environmental, social, and governance (ESG), socially or sustainably responsible (SRI), and responsible investing (RI) are additional terms for green investments (Inderst et al., 2013). The idea describes the investing activity of businesses that work to preserve natural resources, lessen pollution, cut carbon emissions, employ alternative energy sources, and protect the environment.

In Indonesia, the most widely used green index is SRI KEHATI index. The Sustainable and Responsible Investment (SRI) -KEHATI Stock Index, which was released by the KEHATI Foundation in conjunction with the Indonesia Stock Exchange (IDX) on June 8, 2009, is a green index that refers to the United Nations' Principles for Responsible Investment (PRI). The SRI-KEHATI Index is currently the only source for investing guidelines that prioritize ESG issues in the Indonesian capital market, with business selection rules that use the Sustainable Responsible Investment (SRI) and environmental, social, and governance (ESG) principles. KEHATI aims to foster mutualism between the business sector and the conservation community through the SRI-KEHATI index. (Kehati, 2022)

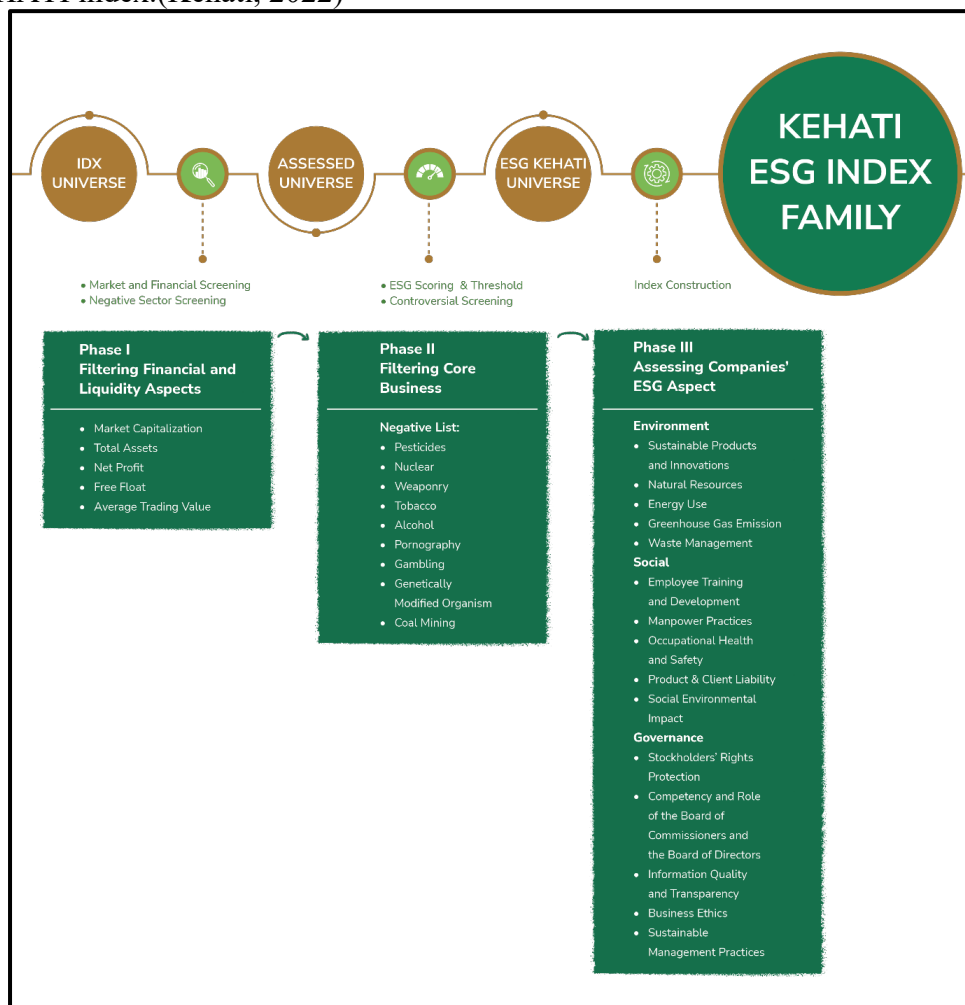


Figure 1: Selection Phases of KEHATI ESG INDEX

KEHATI Foundation conducted the selection of Indonesian public companies using three phases as shown in the figure 1. The first phase filters financial and liquidity aspects. The second phase is done by filtering how these companies conduct their core business practices. And the last phase is assessing companies's environmental, social and governance (ESG) aspect.

The SRI-KEHATI index's current composition, which is reviewed and updated twice a year in May and November, comprises of 25 shares of publicly traded firms that are listed on the IDX. Since its inception, this index has historically outperformed a number of important indices, including the Composite Stock Price Index (CSPI), LQ45, JII, and others.

In the period from December 2021 to May 2022, there are 25 companies are included in the SRI KEHATI index as shown in table 1 below.

Table 1 list of 25 companies included in SRI KEHATI index in the period from November 2021 to May 2022.

Kode	Nama Saham	Keterangan
AKRA	AKR Corporindo Tbk.	Baru
ASII	Astra International Tbk.	Berubah
ASSA	Adi Sarana Armada Tbk.	Baru
BBCA	Bank Central Asia Tbk.	Berubah
BBNI	Bank Negara Indonesia (Persero) Tbk.	Berubah
BBRI	Bank Rakyat Indonesia (Persero) Tbk.	Berubah
BBTN	Bank Tabungan Negara (Persero) Tbk.	Berubah
BMRI	Bank Mandiri (Persero) Tbk.	Berubah
BSDE	Bumi Serpong Damai Tbk.	Berubah
DSNG	Dharma Satya Nusantara Tbk.	Berubah
INCO	Vale Indonesia Tbk.	Berubah
INDF	Indofood Sukses Makmur Tbk.	Berubah
INTP	Indocement Tunggul Prakarsa Tbk.	Baru
JSMR	Jasa Marga (Persero) Tbk.	Berubah
KLBF	Kalbe Farma Tbk.	Berubah
LSIP	PP London Sumatra Indonesia Tbk.	Berubah
PGAS	Perusahaan Gas Negara Tbk.	Berubah
POWR	Cikarang Listrindo Tbk.	Berubah
PTPP	PP (Persero) Tbk.	Berubah
SIDO	Industri Jamu dan Farmasi Sido Muncul Tbk.	Berubah
SMGR	Semen Indonesia (Persero) Tbk.	Berubah
TLKM	Telkom Indonesia (Persero) Tbk.	Berubah
UNTR	United Tractors Tbk.	Berubah
UNVR	Unilever Indonesia Tbk.	Berubah
WIKA	Wijaya Karya (Persero) Tbk.	Berubah

This research will focus on the banking companies included in SRI KEHATI index. There are five banks included, namely Bank Central Asia Tbk (BBCA), Bank Negara Indonesia Tbk (BBNI), Bank Rakyat Indonesia (BBRI), Bank Tabungan Negara Tbk (BBTN) and Bank Mandiri Tbk (BMRI).

Besides, the raising issue of Green Investment, in this twenty-first century, Any growing economy's, nation's, or society's prosperity is greatly influenced by the consumer economy and its stock prices, which are centered on the financial market (Nti et al., 2020) (Göçken et al., 2016) (Nassirtoussi et al., 2014) . Furthermore, investment in the stock market has witnessed tremendous and ongoing growth over the previous few decades as a result of technological advancements, a competitive economic environment, and rigorous rivalry. Some of the rapid and continuous key development are

1. Changes in financial microstructures, for instance the expansive use of electronic trading and the combination of different asset classes and countries are among the important trends that are occurring rapidly and continuously. Changes in financial microstructures, such as the spread of electronic trading and the blending of markets across asset classes and countries, are among the important trends that are occurring quickly and continuously.

2. The development of investment strategies that consider the exposure to risk variables rather than asset classes.

3. The expansion of processing power, the generation and management of data, and analytic techniques.

4. The emerging trend of algorithmic traders outperforming human, discretionary investors in terms of investment performance (Jansen, Stefan 2017)

These four crucial characteristics have encouraged hedge funds and investment firms to further develop algorithmic trading techniques in order to generate more consistent and predictable profits over time. As a result, the research will talk more about how well algorithmic trading techniques can forecast stock market behavior.

Additionally, Saini and Sharma (2019) in their study comparing fundamental and technical analysis, also discuss different prediction methods, such as time series analysis and machine learning algorithms like the artificial neural network (ANN), which are used to forecast stock prices. Although there has been study in artificial intelligence (particularly on deep learning) for the past 20 years, the findings are still controversial, leaving room for additional research studies. Additionally, deep learning won't produce the same outcomes due to its structure and complexity, so the method of extracting information learned by deep learning may vary each time.

In addition of deep learning methods, each can be improved further by adjusting the deep learning procedure options in addition to deep learning techniques. A distinctive system can be made by specifying the number of neurons and the quantity of hidden levels. For instance, Niaki and Hoseinzade (2013) show that it is necessary to run the initiation several times in order to reach a conclusion that is statistically supported because deep learning produces various outcomes depending on the random value used to initialize it (Jiang, 2021).

Problem Formulation

Based on the background above, the problem formulations in this research are:

1. How to implement machine learning method to make investment recommendation in the stock market using Python programming language.
2. How effective is the machine learning method in recommending investment decision?
3. How to optimize portfolio based in the machine learning recommendation
4. How to execute trades in the real stock market

Research Objectives

The objectives of this research are :

1. To build a machine learning using Python programming language to help investors to make investment decision.
2. To examine the effectiveness of machine learning to predict the Indonesian green banking stock which included in SRI KEHATI index

Research Benefits

This research is expected to provide benefits for researchers and potential investors

For potential stock trader, the machine learning built of this study can be used as a basis for decision making for investing.

Additionally, for further research, this research recommends to develop modified machine learning method to refine the machine learning built in this research.

Limitation of Problems

This research has several limitations of the problem, namely :

1. The historical stock data used is Indonesia green index namely SRI KEHATI. The index data will be retrieved using yahoo finance API from yahoo finance.
2. The data observed in this research is 10 years, starting from January 2011 to June 2022

2. Research Method

This study employs a quantitative methodology that uses numbers or qualitative data that has been transformed into numbers. For the period of January 2011 to June 2022, the study used stock market movement data of Green Banking Stock included in SRI KEHATI index price.

A statistical formula will be used to process the data, and the findings will be examined in order to draw a conclusion. The research methodology describes the layout of the activities, the range of the objects, the primary tools and materials, the settings, the data collection strategies, the operational definitions of the research variables, and the analytic strategies.

Data Population And Sample

The data population in this research are daily closing Green Banking Stocks of SRI KEHATI index price from 1 January 2011 to 31 December 2021.

Source And Type Of Data

The SRI KEHATI Index price data is retrieved from yahoo finance using yahoo finance Application Programming Iinterface.. The phyton programming language will retrieve data and library from :

1. Yahoo Finance that provides stock market data that can be accessed directly from Phyton programming language
2. Numpy Library that supports Phytons for processing scientific calculation
3. Math library that supports Phytons for processing mathematical functions
4. Mathprolib library that supports Phytons for data visualization and formatting
5. Pandas library that supports Phytons with flexible, fast and expressive data structures
6. Keras library that supports Phytons for building Deep Learning and Neural Network
7. Sklearn library that supports Phytons for measuring model and performance and errors

The Method Of Analyzing And Processing Data

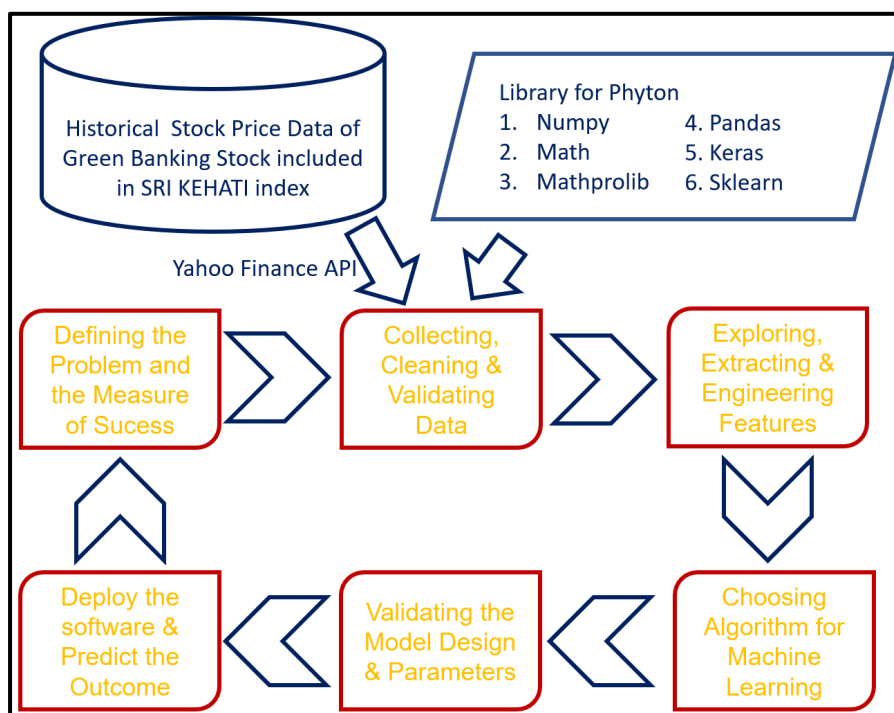


Figure 2 The Method of Analyzing and Processing Data

The effort needed at various phases will vary depending on the project since the aforementioned processes are carried out iteratively throughout the sequence, however this process should generally comprise the following steps :

1. State the problems, design the target metric, and design success criteria
2. Gather, purify, and verify the data
3. Identify the data and construct informative features
4. Select suitable algorithm for the machine learning and the data
5. Develop, test, and fine-tune the model
6. Apply the model to resolve the initial problem (Sudiyono, 2022).

The Long Short Term Memory Algorithm, part of Recurrent Neural Network, will be used in for the above process. The algorithm will be built using Python programming language.

Long Short Term Memory (LSTM)

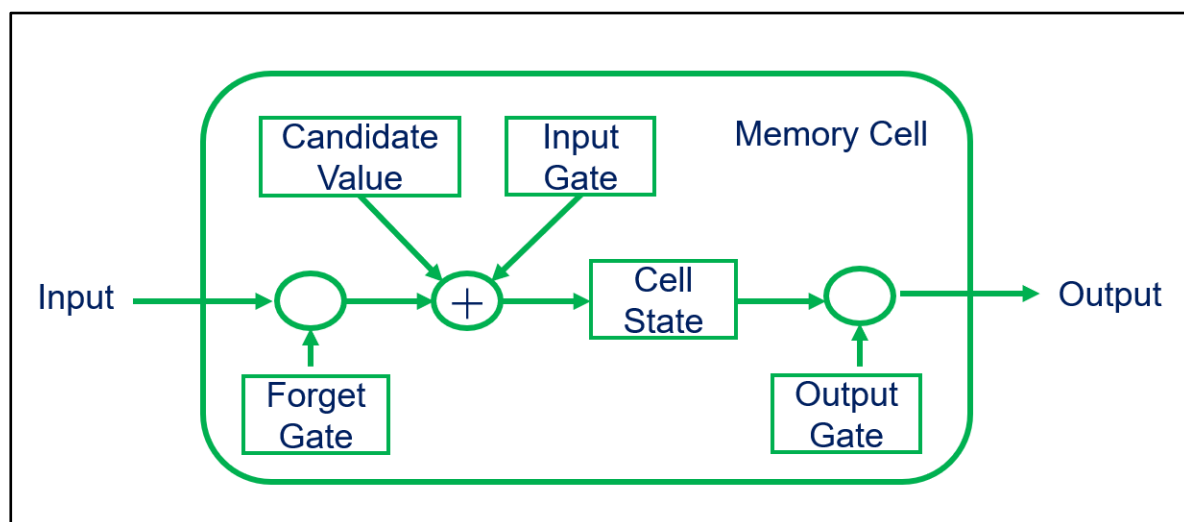


Figure 3 LSTM Structure

Artificial intelligence (AI) has a branch called machine learning, which is a learning process that begins with the identification of the learning-domain and ends with testing and applying the learned information to an issue. (Perwej and Perwej 2012). Many machine learning algorithms have been created and used to forecast the stock market. (Dunne 2015; Paik and Kumari 2017). Additionally, one of the many variants of recurrent neural network (RNN) design is long short-term memory (LSTM)(How et al., 2016) In this part, the RNN algorithm and its LSTM architecture for closing price prediction are introduced. This research will start with the most basic recurrent neural network model that is feasible and then will be continued with LSTM model.

The aforementioned Long Short Term Memory structure is the same as that found in (Graves, 2014), (Olah, 2015), and (Chollet,2016). Additionally, (Karpathy, 2015) and provide several key introductions to the LSTM approach with transparent, step-by-step illustrations (Britz, 2015).

The LSTM technique falls within the category of recurrent neural networks (RNN). The purpose of the LSTM network is to improve the ability to learn long-term dependencies and to overcome the inherent issues that RNN previously encountered, such as expanding gradient (Sak et al, 2014). An input layer, an output layer, and one or more hidden layers are the three layers that make up an LSTM. The memory cell refers to the hidden layer. In Figure 2 above, the structure of a memory cell is depicted (Sudiyono, 2022) The memory contains three crucial gates.

- The forget gate determines which data should be removed from the memory cell.
- The memory cell's input gate decides which data to add.
- The output gate selects the data to be output.

3. Results and Discussion

The research produced calculations and stock market predictions using the LSTM Method, an artificial recurrent neural network (RNN) architecture. In order to ensure that the training process is more correct, this research breaks the calculation up into 16 steps.

To make sure the data processed is correctly retrieved, the software will first display data starting on January 1, 2011, up to the most recent data that is currently available in the market. Figure 3 below depicts the software's initial display.

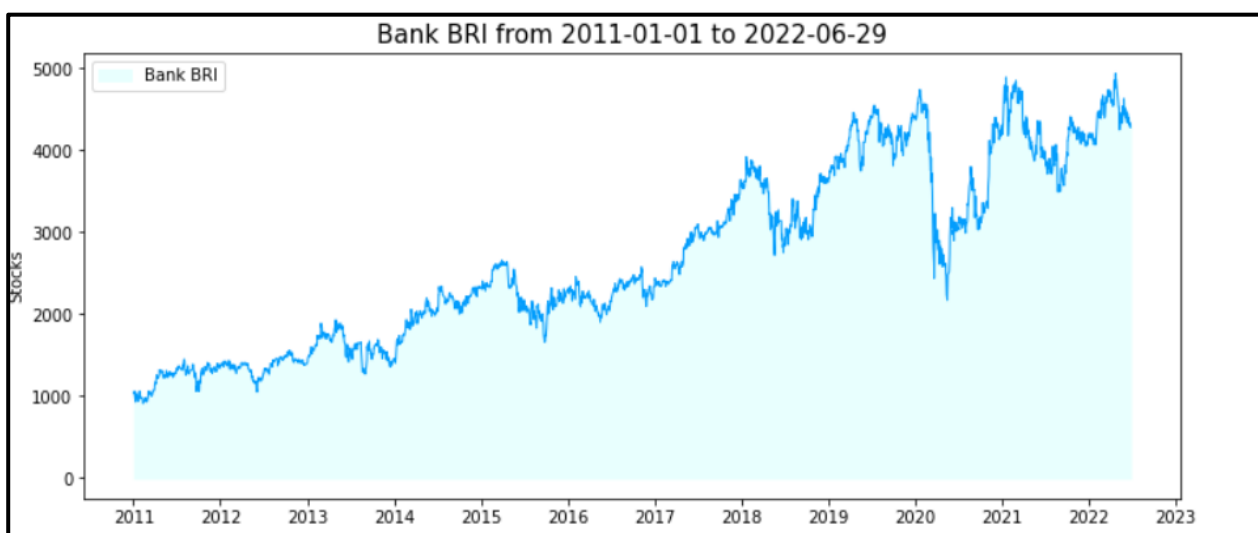


Figure 4 The Initial Display of the Software.

The software will then compute the mean absolute error (MAE), mean absolute percentage error, and median absolute percentage errors, among other absolute errors. The goal of this procedure is to guarantee that the system's inaccuracy is not too large. The figure 4 below shows these three absolute mistakes.

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Median Absolute Error (MAE) = 122.7
Mean Absolute Percentage Error (MAPE) = 3.29 %
Median Absolute Percentage Error (MDAPE) = 2.09 %
This software is developed by Widhiyo Sudiyono
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Figure 5 the calculation of absolute errors

The software also compares the test prediction to the actual stock price after displaying the data used for training. Additionally, the software displays a % estimate of whether the price would rise or fall, as shown in figure 5 below.

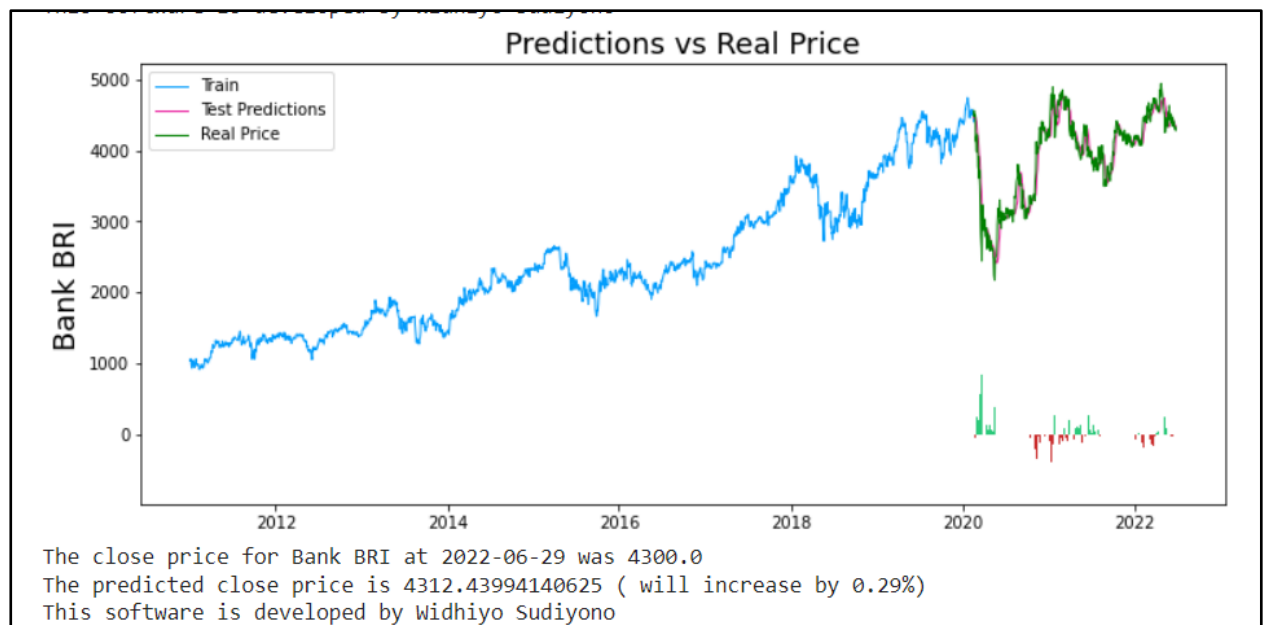


Figure 6 Prediction Result

The software displays the historical data as a light blue line and a black line, as seen above. The historical data used to train the LSTM network are represented by the light blue line. To contrast the actual price with the software's prediction, the pink and black lines are displayed. As

can be seen, the forecast was made with a tolerable degree of accuracy, and the various absolute error calculations support this.

4. Conclusion

Recurrent Neural Networks (RNNs) have been upgraded to create Long Short Term Memory (LSTM) (RNN). LSTM can maintain and manage the memory of each input by using memory cells and gate units, in contrast to RNN, which is unable to learn to the linked information since the old memory saved will be erased or replaced with new memory. The software created has demonstrated a notable success rate in producing green banking stock price predictions that are included in the SRI KEHATI index.

Further research should be concentrated on modified LSTM layers, such as introducing additional dropout, the use of different oscillation of dataset and adjusting the number of epochs, to test how satisfactory the predictions are. Alternatively, the further research could also attempt to combine sentiment analysis with the LSTM technique. Based on the results of this study, further research also might attempt to reduce the number of epochs, to use various instability of datasets to know how accurate the predictions are, or to combine sentiment analysis and the LSTM technique to see how the the optimization done affect the stock market's uncertainty.

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