ARTIFICIAL NEURAL NETWORK AND STOCK PRICE PREDICTION

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ABSTRACT

The main objective of this research is to examine the performance of neural network (NN) to predict stock price. This research propose to use daily closing price of TELKOM share for the observation period. Authors propose to use TELKOM share because it is one of the most liquid and blue chip stock in Indonesian Stock Exchange (IDX). This research use purposive sampling. The authors propose to use Artificial Intelligence Neural Network (ANN) to predict stock price. From literature review ANN can predict stock price more accurately than traditional way like linear regression. The Artificial Neural Network (ANN) model use backpropagation algorithm for training session and feed forward NN for testing the output. The authors propose ANN with five nodes outperform ANN with fewer (two) nodes. The reason is that the information contained in five nodes ANN provide more accurate information than two node ANN. Consequently ANN with five nodes can predict stock price better and more accurately than ANN with two nodes. The average percentage error should be less for ANN with five nodes then the percentage error of ANN with two nodes.

***Keywords**: Artificial Intelligence, Neural Network, nodes, algorithm, backpropagation, feedforward*

INTRODUCTION

Fundamental analysis, technical analysis, and linear regression is a common traditional method to predict stock price and stock returns available in market for a few decades. There are some assumptions for stock price movement that is not realistic when we use traditional linear regression technique to predict stock price. Researchers and engineers around the world has been trying to develop better ways to predict stock price and returns. Predicting the movement of stock price is challenging but yet important, not only for individual or institutional investors, but also for all stakeholders. There are several ways to predict stock price done by researchers around the world.

Besides traditional method there is a better alternative method to predict stock price or stock return which is Artificial Intelligence (AI) i.e Artificial Neural Network (ANN), Support Vector Machines (SVM), Long Short Term Memory (LSTM), machine learning, deep learning or other AI methods. In this research authors try to propose a more efficient, and more accurate way to predict stock price using an advanced and up to date technology which is AI specifically ANN. Authors propose ANN with five neurons can predict better than with two neurons (nodes).

Stock price is a random walk. There are a lot of random dynamic variables that could affect stock price and stock return. Rational factors, like macroeconomic factors, industry factors, and the fundamental factors in a firm could affect stock price and stock returns. But not only rational factors, irrational factors also play a significant role in determining stock price and stock returns,

AI that incorporates human intelligence into machines is one way to define AI broadly, and any computer program with elements of human intelligence is referred to as AI. For the aspect of ML, a subset of AI called ML consists of all techniques that let computers learn from data without being explicitly programmed. The goal of ML is to train computers using the available data and methods.

Predicting the stock market is challenging yet crucial for investors, traders, and researchers. Various methods, including mathematical, statistical, and Artificial Intelligence (AI) techniques, have been proposed to forecast stock prices. AI techniques, particularly Machine Learning (ML) and Deep Learning (DL), have gained more attention (Song & Jain, 2022, Alshater, Kampouris, Marashdeh, Atayah, & Banna, 2022; Chhajer, Shah, & Kshirsagar, 2022;Mokhtari, Yen, & Liu, 2021; Samitas, Kampouris, & Kenourgios, 2020; Liang, Tang, Li, & Wei, 2020; Macchiarulo, 2018; Sun, Lachanski, & Fabozzi, 2016).

Different researchers and engineers have used different approaches when discussing the prediction of stock prices using AI technology (Shmueli & Tafti, 2022; Petropoulos et al., 2022). By combining better technology and better information it can have better prediction accuracy in stock markets (Kumar et al., 2022a,b; Smyl, 2020; Bustos & Pomares-Quimbaya, 2020, p. 156).

A crucial and important research question is as follows: can ANN with more nodes predict stock price better fewer nodes ?

1.1 Problem Statement

Problem statement in the study elaborated as follow:

ANN with five nodes can predict stock price better than two nodes

1.2 Research Objective

The objective of this research is to examine whether ANN with five nodes can predict stock price better than with two nodes. The research is also aimed to build awareness on the advantageous of ANN over traditional methods. AI can also be used for sustainable development reason of financial and investment decision for investors, corporations, and all other stakeholders.

1.3 Significance of the Research

As mentioned above, the research is to test the capability of AI in predicting stock price. Predicting stock price is of significant important for not only investors but also for all other stakeholders. By knowing

the trend of price movement, one can make a better investment decision. Consequently, this research also suggests the investment opportunities for individual investors and institutional investors or for all other investors and stakeholders in the financial market. Also AI is of significant importance for corporations to develop their financial decision support systems which is very important for the growth and sustainability of their enterprises.

LITERATURE REVIEW

Previous Researches

2.1 Previous researches about AI and stock price prediction

AI plays a crucial and important role in determining the growth and sustainability of an enterprise. Researchers and engineers have been striving to develop better AI to help human doing work more efficiently and more effectively and more productive. One important and useful application of AI is the use of Artificial Neural Network (ANN) technique to predict stock price (Kumar D, Murugan S, 2013). Stock market or capital market contributes largely to the welfare of economy and social welfare of a nation around the globe. It also contribute significantly to the growth and sustainability of an enterprise. Many researchers and engineers have been working hard to develop better AI systems to predict stock prices.

AI incorporates many factors to perform stock prediction tasks, such as data quality, feature selection, model architecture, parameter tuning, and evaluation metrics, that could affect the performance of AI techniques (Hewamalage, Bergmeir, & Bandara, 2021; Bustos & Pomares-Quimbaya, 2020, p. 156). Part of AI that has been used and developed for a while is Machine Learning (ML).

Machines learn how to make decisions using the data and information processed. In essence, ML is just a method for making AI. A more advanced method is DL. DL, A subset of ML, includes the artificial neural network (ANN) that mimics the structure of biological neural networks seen in the brain. Every time the brain learns new information, it attempts to make sense of it by comparing it to previously learned knowledge. DL uses a strategy similar to the brain, which organizes information by categorizing and labeling objects. Generally speaking, DL is more accurate than ML and performs exceptionally well on unstructured data, but it also needs a massive amount of training data and expensive hardware and software (Jakhar & Kaur, 2020).

Many systematic reviews have synthesized statistical results concerning AI and stock price; however, consensus is lacking on which AI techniques are most effective and suitable for stock market prediction and how they compare with other methods. (Makridakis, Hyndman, & Petropoulos, 2020). A recent literature review identified several gaps and emphasized the need to

reconsider how we approach AI and stock using analysis from previous systematic reviews (Pinto, Figueiredo, & Garcia, 2021).

Stock prices are driven by new information that cannot be obtained utilizing an analysis through the stock market, according to two significant financial theories: the Random Walk Model (Fama, 1995; Fama, Fisher, Jensen, & Roll, 1969) and the Efficient Market Hypothesis (Fama, 1965). Nevertheless, numerous researchers and engineers have disproved the underlying assumptions of these two hypotheses and demonstrated that the market could be partially forecast in accordance with socioeconomic theory and behavioral economics/finance (Chong, Han, & Park, 2017; Oliveira, Cortez, & Areal, 2017; Patel, Shah, Thakkar, & Kotecha, 2015; Weng, Ahmed, & Megahed, 2017).

Recent research suggests that the methods of stock market analysis are split into mathematical and AI techniques. Mathematical-related technology refers to statistical tools, and AI technology refers to ML algorithms (Januschowski et al., 2020).

Furthermore, it has been observed that most of the selected studies utilize ML algorithms to analyze the performance of stock market prediction (Kumar, Sarangi, & Verma, 2022a). Previous research has established that ML, a subset of AI, includes DL to p redict stock price(Jakhar & Kaur, 2020). From this perspective, the various techniques utilized to predict stock prices can be preliminarily split into Traditional ML algorithms, and DL and Neural Network (NN) (Soni, K, & Tewari, 2022). However, numerous traditional ML, DL, and NN methods exist for predicting stock prices. One of the most significant current discussions in predicting the stock market is which methods are most frequently employed to forecast stock market prices (Li & Bastos, 2020). This is the motivation for authors to do this research. One important research question is, Can ANN with more nodes predict more accurately than NN with fewer nodes ?

Proposition : ANN with five nodes can predict stock price better than ANN with two nodes.

DATA AND RESEARCH METHOD

3.1 DATA

The propose input data used are Stock Index, Net Asset Value, Price Earning Ratio, Market to Book Ratio, and Earning Per Share.

3.2 RESEARCH METHODS

From the literature review most of the researchers NN The method use in this research is systematic review of AI to predict stock price. Major percentage of data about 90 % is used as training session and to adjust the weight. This research use backpropagation algorithm for training session. About 10 % of the data is used as input to check the error for the performance output and it used feed forward NN.

To measure the performance of output we use Mean Absolute Percentage Error (MAPE), Mean Square Error (MSE), Mean Absolute Deviation (MAD) and Root Mean Square error (RMSE).
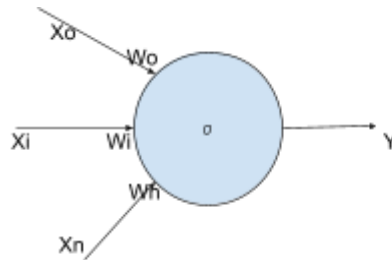
The formula are as follows:

$$\text{MAPE} = 100 * 1/n \sum [\![|(a\_i - p\_i)/pi|]\!]$$

$$\text{MAD} = (\sum [\![|a\_i - p\_i|]\!])/n$$

$$\text{RMSE} = \sqrt{(\text{mean } [\![|a\_i - p\_i|]\!]^2)}$$

The NN has the following structure:

Where
    Xo…Xn   are inputs
    Wo…Wn   are Weight
    Y   is output

Fig 3.1   Neuron (Node) Model

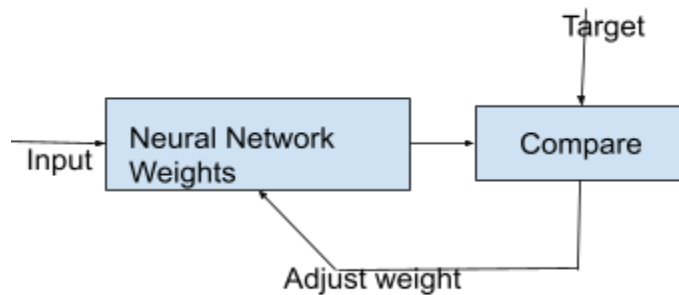The structure of training session is as figure follows:

Fig. 3.2 Training session

The main steps for algorithm using the Backpropagation NN is as follows

Step 1: Feed the node with the normalized input data sample, and compute the corresponding output;

Step 2: Compute the error between the output(s) and the actual target(s);

Step 3: Adjust the connection weights and membership functions;

Step 4: IF Error > Tolerance THEN go to Step 1

    ELSE stop.

The output Y is a function $\int(x)$ of x which is Sigmoid of x The function to perform the process above is   Y = f(x)= $\int(x)$

PROPOSED RESULTS

In the forward propagation, we propose that NN with five nodes can predict stock price better than with two nodes using daily data for a few days of observation. Here are some of the proposed results for the ANN model with the performance indicators, price prediction errors compared with actual price as follows:

Here are some of the propose results for ANN with two and five nodes.

Table 4.1 Average Percentage error NN with two nodes

Date	Actual Price	Predicted Price	Error (%)
1 July 2024	3090	??	??
2 July 2024	3040	??	??
3 July 2024	3030	??	??
4 July 2024	2960	??	??
5 July 2024	3020	??	??
8 July 2024	3080	??	??
9 July 2024	3080	??	??
10July 2024	3160	??	??

To be processed by authors

We propose that the results of the percentages Error of two nodes process should be larger than the percentage Error of five nodes.

Table 4.2 Average percentage Error NN with 5 nodes

Date	Actual Price	Predicted Price	Error (%)
1 July 2024	3090	??	??
2 July 2024	3040	??	??
3 July 2024	3030	??	??
4 July 2024	2960	??	??
5 July 2024	3020	??	??
8 July 2024	3080	??	??
9 July 2024	3080	??	??
10 July 2024	3160	??	??

To be processed by authors

We propose that the percentage error for the model with five nodes should be less than the percentage error of two nodes. The reasons behinds it is that more information from determinant factors is included in five nodes NN than in two nodes.

CONCLUSION and SUGGESTION

AI has been playing a vital role in financial market. NN can predict more accurately than traditional methods because it can capture the dynamic and nonlinear characteristics of assets in capital markets. In this research, the authors propose that NN with five nodes can predict more accurately than NN with two nodes. NN with five nodes outperform NN with two nodes.

The limitation of this research is that it only use rational factors that determine stock price. For further research, one could use consider also irrational factors i.e. sentiment or investors behavior factors to improve the performance of artificial NN.

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