

1. Introduction

Gold is a global commodity in economic and currency markets. Gold is not only used in jewelry decoration and beautification but also has an important role in industries as a raw material [1]. The importance of gold makes gold a good deal for investment. Investing in gold has proven useful as a form of protection against economic instability [2]. History shows, when some countries had problems with the Balance of Payment they used gold as a protection against loans [3]. The price of gold is also having an important part of the world economy. The moment equities and bonds have a poor performance, gold becomes a good alternative to invest and get financial protection [4], but the fluctuation of gold price can increase the investment risk in gold [4]. Several factors can affect the fluctuation of the gold price, such as the exchange of the dollar, the cost of gold production, inflation, monetary policy, and geopolitics [5][6]. The fluctuation of gold price caused by the changes in the price of gold can produce large profits or significant losses for investors [7]. Therefore, the prediction of the gold price will be very important for investors in determining investment plan or policy to be chosen.

In the last two decades, gold price prediction which is a time series problem has been explored by many researchers. They used many methods, from statistical models to a modern way such as the machine learning method. Auto Regressive Moving Average (ARIMA) was applied by Nambier et al. to predict the gold price [8], but ARIMA has the pre-assumed linear from the model as the limitation. During the implementation of machine learning is getting popular, Dubey has developed and compared Support Vector Regression (SVR) and Adaptive Neural Fuzzy Inference System Learning to predict the gold price, the result was SVR method had a better ability to predict than ANFIS [9].

Deep Learning has extensive attention recently in the field of time-series prediction. In recent years, many studies also used deep learning to handled time-series prediction problems, a method called Back Propagation Bidirectional Extreme Learning Machine (BP-BELM) was applied by Zou and Xia in order to predict traffic flow, that method can obtain a 24,1797 RMSE score and more efficient than Bidirectional Extreme Learning Machine (BELM) [10]. Zheng et al. has developed an algorithm called Deep Belief Network (DBN) to predict exchange rate in INR/USD and CNY/USD, the result was 0,0073 for INR/USD forecasting and 0,0017 for CNY/USD in MAPE score [11]. The study from Zahrah et al. using LSTM to predict Foreign Exchange Rate in COVID-19 pandemic, the results are 0,00624 RMSE in daily price and

0,00135 in 1-hour price [12]. Deep learning can deal with the nature problem and noise of time-series prediction to produce more accurate prediction [5], however selecting optimum hyperparameter is one of the main challenges in applying deep learning. Determine optimum hyperparameter can produce a model that performed better than untuned parameters [13]. Tuning hyperparameter is also often more important than choosing an algorithm [14].

The previous research by Liviries et al. used a hybrid method between Convolutional Neural Network and Long Short-Term Memory (CNN-LSTM) to predicting multivariate daily gold price [5]. The result shows that CNN-LSTM has a better performance than SVR, Feed Forward Neural Network (FFNN) and LSTM in predicting gold. The data from previous was obtained from the Finance Yahoo website. The advantage of CNN can extract useful knowledge and learn the internal representation of time-series data, and LSTM networks will identify short-term and long-term dependencies effectively. Those advantages can lead to a good prediction in gold price time-series prediction, but it is necessary to determine what are the optimum hyperparameters in model CNN-LSTM that can lead to increase performance. The problem discussed in this research is how to identify the optimal hyperparameter in CNN-LSTM to predict the fluctuating gold price.

This research focuses on implementing the CNN-LSTM algorithm with tuned hyperparameters. The CNN-LSTM model from the previous research if observed closely used the fixed number of hyperparameters [4]. The contribution of this research is finding the best hyperparameters in the CNN-LSTM model that can predict the fluctuating gold price with tuning in batch size, LSTM unit, and using early stopping function. The study aimed to make the CNN-LSTM model perform better than the previous research [4]. With the best hyperparameters, it is expected the optimal result to predict the gold price to help people who want to invest in gold avoid losses.