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Research Article

A Comparative Analysis of Long Short-Term Memory Networks and Artificial Neural Networks for Gold Price prediction

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ABSTRACT

We have come up with an extra simple approach to sum up your research's objectives and results We looked into gold price prediction, which is a continually sought- after investment option. For this aim, our research compared various methods. We took use of temporal trends in the gold price data by using LSTM networks. Furthermore, we examined how well Artificial Neural Networks (ANN) predicted actual gold prices. By combining ANN, our unique method maximizes the benefits of both models. ANN has become a powerful technique for capturing intricate relationships in data, which is noteworthy. According to this research, hybrid models such as ours can improve the prediction of gold prices, assisting with risk management and investment choices. As the price of gold fluctuate frequently, more people are choosing to invest in gold. However, investing in gold may become riskier due to the unpredictability of these price fluctuations. This is where "Gold Price Prediction" enters the picture; its main goal is to predict future gold prices by utilizing various machine learning approaches.

Keywords: Artificial Neural Network, LSTM, price prediction

I. INTRODUCTION

This research compares two gold price prediction systems that have gained popularity in recent decades: LSTM and Artificial Neural Network. Within this framework and machine learning methods have become highly effective instruments for financial asset price prediction. In particular, there has been a noticeable increase in the integration of (LSTM) networks with (ANNs). LSTMs are especially well- suited to simulating the dynamics of gold prices because they are experts at capturing temporal relationships within sequential data, whilst ANNs provide a flexible framework for pattern identification. Our major goal in using these methods is to estimate gold prices with confidence. Many economic factors impact these projections, which are based on historical pricing data. In this setting, price prediction takes on a central role in influencing economic decision-making processes and broadens its applicability to a variety of uses. First and foremost, price prediction is a crucial component of speculative activity, providing the chance to profit from wise investment choices. These forecasts may be used by traders and investors to make well-timed purchase or sell decisions, maximizing profits and lowering risks. Furthermore, the knowledge gathered via price prediction has important ramifications for developing the best possible public policy. The government may decide strategically on monetary and fiscal policy, abroad, and currency conversion rates by knowing the expected movements in gold prices. Making such well-informed policy Choices may have a big influence on the economy's development and strength. Artificial Neural Networks are computational models modeled after the architecture and operations of the human brain. An ANN is made up with layer of linked neurons, each having a weight. These networks are useful for tasks like regression, classification, and time series forecasting because they can recognize intricate patterns in data. Because of their reputation for modeling non-linear correlations in data, ANNs are very well suited for capturing the complex dynamics of financial markets, particularly the gold market.

ANN would use historical gold price data as input and learn to find patterns and relations in the data in order to predict the price of gold. It can then forecast future gold prices using the knowledge it has acquired.

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When using LSTMs for gold price prediction, the model learns to predict future prices by using a series of historical gold prices as input. The ability of LSTMs to retain and update information over time—a feature that is essential for identifying the time-dependent patterns in gold prices— comes from their memory cells. For jobs like these, LSTMs can perform better than typical feed forward ANNs because of their innate ability to handle sequences.

Both ANN and LSTM models are trained using optimization techniques like gradient descent and back propagation, which modify the model's weights to lower the inaccuracy of prediction.

II. LITERATURE SURVEY

[1] In order to anticipate gold prices, this research thoroughly compares Artificial Neural Networks and systems, providing insights into the respective benefits and drawbacks of each technique. In addition, a hybrid model is shown as a possible improvement for gold price prediction. The results highlight how these models may be used to estimate gold prices and how well they work in various scenarios. This research conducts a comprehensive comparison between Artificial Neural Networks (ANN) and Neuro-Fuzzy systems for gold price prediction. It elucidates the advantages and limitations of each technique while proposing a hybrid model as a potential enhancement for gold price forecasting. The findings underscore the utility of these models in estimating gold prices across different scenarios, shedding light on their effectiveness in predictive accuracy.

[2] Gold Price Prediction and Modelling using Deep Learning An overview of the literature on deep learning methods for gold price prediction and modeling provides a useful synopsis of current understanding and future possibilities for this field of study. In the context of forecasting gold prices using deep learning techniques, it aids practitioners and academics in understanding the state of the art and pointing up possible directions for future investigation. The survey provides a thorough analysis of previous investigations and studies that have applied deep learning methods to the prediction of gold prices. It addresses deep learning architectures, datasets, research methods, important discoveries, and any special contributions or difficulties noted in the literature. This literature review offers a comprehensive exploration of deep learning methodologies in the realm of gold price prediction and modeling. It is invaluable resource for practitioners and academics alike, offering insights into current research trends and future avenues of exploration. By analyzing previous studies and investigations utilizing deep learning techniques, the survey elucidates key aspects such as architectures, datasets, research methods, significant findings, and challenges encountered in the literature.

[3]. Gold Price Prediction using Machine Learning

It proposed System says that algorithms and machine learning techniques used to forecast gold prices. Neural networks, time series analysis, and regression models could all be covered in this section. This review provides comprehensive insights of machine learning applications in gold price prediction. It tackles the process of feature selection and engineering, highlighting the important variables and indications taken into consideration in the process. It provides useful insights for scholars and practitioners interested in this topic by covering the procedures, data sources, difficulties, and assessment measures. Identification of the data sources used in gold price prediction, such as historical price data, economic indicators, and other relevant sources. This research paper comprehensively examines the application of machine learning techniques, including neural networks, time series analysis, and regression models, for gold price prediction. It delves into feature selection and engineering, elucidating key variables and indicators considered in the process. By addressing data sources like historical price data and economic indicators, it offers valuable insights for both scholars and practitioners interested in gold price forecasting.

[4] Gold Price Forecast based on LSTM Model

The proposed System says creation and usage of a particular model for predicting gold prices is perhaps the paper's main focus. Here's a quick rundown of what may be in the paper Detailed description of the LSTM-CNN model's architecture, highlighting how LSTM and CNN components are combined to make predictions. Before going into depth about the model's architecture, the article talks about data sources and preparation procedures. It displays

assessment metrics and experimental findings to demonstrate how well the model predicts gold prices. The paper focuses on the development and utilization of a specialized LSTM-CNN model for gold price prdiction. It provides a detailed exposition of the model's architecture, emphasizing the integration of LSTM and CNN components for predictive analysis. Preceding the architectural discussion, the article outlines data sources and preparation methodologies. Furthermore, it presents assessment metrics and experimental results to showcase the model's efficacy in predicting gold prices.

[5] Prediction of gold price Using Machine Learning

The paper's literature review cites earlier research on machine learning techniques, such as linear regression, SVM, ARIMA, and ANN, for gold price prediction. To improve forecast accuracy, these studies also take other economic indicators, such as the S&P 500 index, the cost of crude oil, with the currency rates for USD,, into account. The study uses five machine learning techniques—linear regression, ANN, DT, RF, support vector regression (SVR), and linear regression— to forecast gold prices. The best-fit model is determined by comparing the models' performances. The paper reviews previous research on gold price prediction using machine learning techniques like linear regression, SVM, ARIMA, and ANN, often considering additional economic indicators for improved accuracy. It subsequently applies five machine learning methods—linear regression, ANN, DT, RF, and SVR—to forecast gold prices, selecting the most effective model based on performance evaluation.

III. PROPOSED METHODOLOGY

1. Data Collection and Preprocessing:

Acquire past gold price information from dependable sources such as databases, financial websites, or apps. Utilizing methods like interpolation or outlier removal, clean up the data by addressing missing values and outliers.to make sure that every feature has a comparable scale, normalize or scale the data. Z-score normalization and min-max scaling are popular techniques.

2. Feature Engineering:

Provide pertinent aspects that might aid in identifying trends in the data on gold prices. Adjusting averages (such as 7-day and 30-day) to take trends into account is one way to do this. technical indicators that measure mood in the market, such as the MACD and R/SI. Economic factors that might affect the gold price include inflation and interest rates.

3. Data Splitting:

Separate the dataset into three groups: test, validation, and training sets. Usually, 70% is allocated for teaching, 15% goes toward validation, and 15% is used for testing.

4. ANN Model Design:

Decide on the design of your artificial neural network (ANN), taking into account the number of layers, neurons per layer, and activation functions. Create an output layer with a single neuron for gold price prediction and an input layer that matches the amount of input characteristics. Ascertain the optimization technique (such as Adam or SGD) and the loss function (such as Mean Squared Error) for training.

5. Training the ANN:

Set up the ANN model. Describe the optimization algorithm and the loss function. In order to avoid over fitting, train the ANN using the training dataset while keeping an eye on the loss on the validation set. Try varying the hyper parameters (For example, the batch size and learning rate) and cease training once the model reaches convergence.

6. Model Evaluation:

Use suitable evaluation measures of statistics to assess the trained ANN on the test dataset. To evaluate the performance of the model, compare the actual and anticipated prices for gold.

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7. LSTM Model Design:

Create the LSTM architecture, making sure the output layer has a single neuron for gold price prediction and the input layer has the proper input shape. Indicate how many LSTM units or layers the model has so that it can recognize sequential patterns to avoid over fitting, think about utilizing dropout layers, where you may play around with different dropout rates.

8. Training the LSTM:

Set up the LSTM model at first. Describe the optimization method (such as Adam or RMSprop) and the loss function (such as Mean Squared Error). Utilizing the training dataset, train the LSTM model. LSTMs efficiently handle sequential input by preserving their recollection of previously stored information. To prevent over fitting, implement early stopping by keeping an eye on the validation set's loss

IV. IMPLEMENTATION

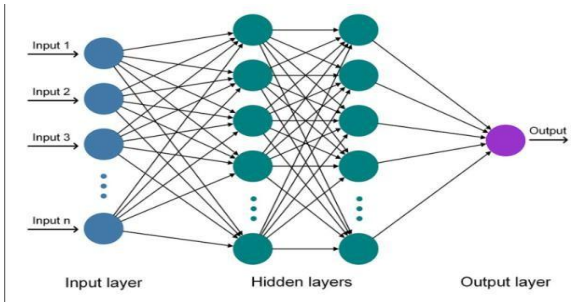
This study is intended to predict gold prices utilizing historical data from the Forex market. The dataset, encompassing closing prices per ounce between September 17, 2010, and January 21, 2011, forms the basis of implementing ANN model. The selection of input variables is a critical aspect, with considerations including the number of neurons, hidden layers, and the amount of information input, the learning method, the transfer function, and the type of network. These parameters collectively shape the architecture and behavior of the ANN, influencing its predictive capabilities.

In the exploration of network topologies, specific attention is dedicated to identifying the ideal configuration. The study delves into two key parameter categories: input and output. Input parameters encompass the intricacies of the neural network, including the 15 neurons in the input layer, three hidden layers, and careful selection of input features to enhance the model's understanding of gold price dynamics. The learning method, a crucial component, is strategically chosen to strike a balance between convergence speed and accuracy during training. The application of the hyperbolic tangent sigmoid transfer function to each neuron introduces nonlinearity to the decision boundary, enabling the model to capture complex relationships within the gold price data.

Output parameters play a crucial role in assessing the model's performance. Performance metrics such as Mean Squared Error (MSE) and Mean Absolute Error (MAE) offer quantitative

insights into the accuracy of predictions. The number of learning epochs, representing the iterations through the dataset during training, provides valuable information about the model's convergence behavior and learning trajectory.

The overall architecture of the ANN model adheres to a back propagation feed forward network with a specific structure denoted as (15-3-1). This configuration, with 15 neurons in the input layer, three hidden layers, and one output neuron, is meticulously designed to strike a balance between complexity and computational efficiency. Throughout the model development, a critical trade-off analysis is conducted, considering the delicate balance between accuracy and learning time. This ensures that the resulting ANN model achieves optimal predictive performance while being mindful of computational resources and training efficiency.



(Fig 1) ANN Networks

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LSTM

The architecture is presented by the following equations.

1. (t) = k1(1 + e k2t) eq1
2. it = σ(wi .[ht−1, xt], bi) eq2
3. ft = σ(Wf .[ht−1, xt], bf) eq3
4. ot = σ(Wo.[ht1, xt] + bo) eq4

Equations (2), (3), and (4), respectively, indicate the values entered, ignore, and output gate equations. To get the output,

the activation function takes as inputs the weighted total of the cell's condition at period t, the result at time t-1, and its data at time t. σ represents the activation function, or logistic sigmoid function, in most cases. Bx is a representation of the biases for each gate(x) [33]. The final cell state, alternative unit state, and output formulae are as follows:

5.c˜t = tanh(wc.[ht−1, xt] + bc) eq5

6.ct = ft ∗ ct−1 + it ∗ c˜t eq6

7.ht = ottanh(ct) eq7

This article develops and creates an LSTM network to forecast the features of the gold price. The results show that the model we have suggested outperforms standard methods such as CNN, complex regression, SVR, ARIMA, and the covariance matrix estimation. It would also be better to test other RNN variants outside of the LSTM component in the one we have. Using reversible LSTM network structures, for instance, can perhaps produce better results.

V. RESULT

For tuning the ANNs for predicting gold prices, various parameters can be adjusted to enhance model performance. After conducting extensive experiments, it was observed that the two most influential factors affecting the outcomes were the number of levels (likely referring to the number of layers in the neural network) and the learning rate.

The number of levels or layers in an ANN is a crucial architectural consideration. In simpler terms, it relates to the depth of the network. It was found that modifying the depth of the network had a substantial impact on the predictive capabilities of the model. Additionally, the learning rate, which determines the step size during the training process, emerged as another key tuning variable. The learning rate affects the convergence of the model and its ability to adapt to patterns in the data.

If the gold price data is characterized by stability, simplicity, and short-term trends, an ANN may prove to be a suitable choice for prediction purposes. ANNs are known for their ability to capture complex relationships in data and can often yield excellent results. They are relatively straightforward to apply, making them an attractive option for scenarios where the underlying patterns are clear and straightforward.

Besides, Long Short-Term Memory networks (LSTMs) are introduced as an alternative, particularly in cases where the gold price data is complex, exhibits long-term dependencies, anomalies, and non-linear trends. LSTMs are a type of recurrent neural network (RNN) intended to handle linear data effectively. They surpass at capturing patterns in time series data and are particularly adept at recognizing long-term dependencies. In situations where the gold price data presents challenges such as non-linearity and intricate patterns over extended periods, LSTMs are anticipated to outperform ANNs.

In summary, the choice between ANNs and LSTMs for predicting gold prices depends on the characteristics of the data. ANNs may be suitable for straightforward and short-term trend data, while LSTMs are recommended for

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more complicated scenarios with long-term dependencies and non-linear trends. The selection of the appropriate model depends on a careful consideration of the specific features and patterns inherent in the gold price dataset.

Gold Price Modeling:

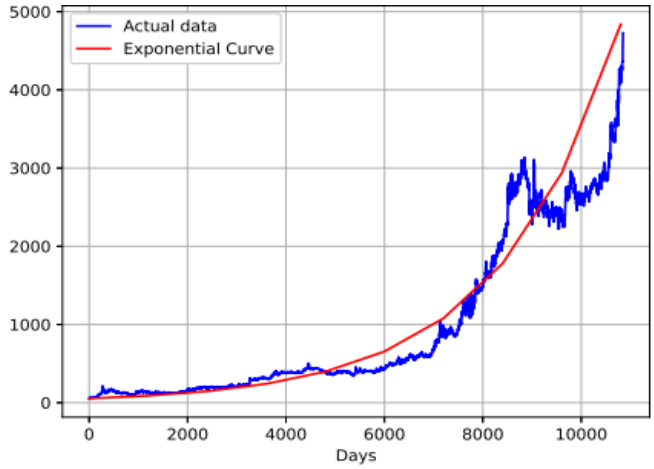

Fig 2) Gold price modelling using LSTM

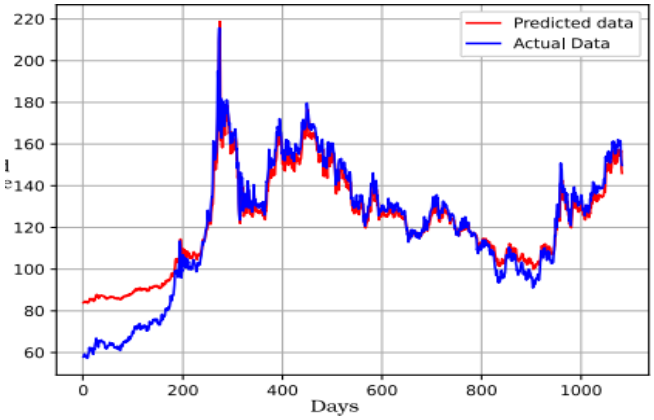

Fig 3) Gold price modelling using LSTM

VI. COMPARISON

Papers 1, 4, and 5: Focus on utilizing various machine learning techniques for gold price prediction, covering neural networks, time series analysis, regression models, and other methods.

Paper 2: Conducts a comparative analysis between Artificial Neural Networks (ANN) and Neuro-Fuzzy systems, proposing a hybrid model.

Paper 3: Specifically explores deep learning methodologies for gold price prediction and modeling.

Depth of Analysis:

Papers 1 and 4: Provide detailed analyses of machine learning techniques, including feature selection, engineering, and model architecture.

Paper 2: Conducts a comparative analysis between ANN and Neuro-Fuzzy systems, exploring their advantages, limitations, and proposing a hybrid model.

Paper 3: Offers a comprehensive exploration of deep learning methodologies in gold price prediction, covering architectures, datasets, research methods, significant findings, and challenges.

Contributions:

Papers 1, 2, and 3: Contribute valuable insights into the application of machine learning and deep learning techniques for gold price prediction.

Paper 4: Introduces a specialized LSTM-CNN model for gold price forecasting, providing detailed architecture and experimental results.

Paper 5: Contributes by reviewing and applying multiple machine learning methods for gold price prediction, emphasizing on selecting the most effective model.

Audience Impact:

All papers cater to both scholars and practitioners interested in gold price forecasting, offering valuable insights, methodologies, and experimental results.

VII. CONCLUSION

In the realm of predicting gold prices, the choice between ANNs and Long Short-Term Memory networks (LSTMs) is deeply intertwined with the nature of the gold price data under consideration. ANNs emerge as a suitable option when the data exhibits simplicity, stability, and short-term trends. Their effectiveness lies in their capacity to capture underlying patterns efficiently, and they are particularly advantageous for their computational simplicity and quicker training times. This makes ANNs an appealing choice when the gold price data is relatively straightforward.

Conversely, LSTMs become a more promising alternative when the gold price data becomes intricate, characterized by non-linear patterns, anomalies, and long-term dependencies. LSTMs, as a type of recurrent neural network, are adept at handling sequential information, making them well-suited for the challenges posed by complex time series data.

Their ability to capture nuanced dependencies over extended periods positions them as a superior option for scenarios where the gold price data presents a higher degree of complexity.

In practical terms, it is often prudent to experiment with both ANN and LSTM models, subjecting them to rigorous evaluation using a validation dataset. This empirical approach allows for a comprehensive assessment of each model's predictive accuracy, facilitating an informed decision regarding which model aligns better with the specific task of predicting gold prices.

Beyond the technical considerations, the research underscores the historical significance of gold as a commodity and emphasizes its pivotal role in preserving global economic stability, particularly through the accumulation of gold reserves by central banks. Notably, major businesses and investors have recently shown a marked interest in sizable gold investments. However, the volatility and complexity inherent in predicting the price of gold are acknowledged, underscoring the importance of leveraging advanced predictive models to navigate this intricate market effectively.

The research suggests that accurate predictions are not only beneficial but essential for key stakeholders, such as

central banks and investors, aiming to maximize their financial benefits. Accurate projections serve as valuable tools for making well-informed decisions on whether to buy or sell gold, highlighting the strategic importance of deploying sophisticated predictive models in the context of gold market dynamics

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