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# Enhancing Stock Price Prediction With Regularized GRU-LSTM Neural Networks

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**ABSTRACT:** Predicting stock prices is a formidable challenge due to the intricate and nonlinear nature of the stock market, influenced by various factors. One approach that has shown promise is the use of Neural Network algorithms, which are well-suited for analyzing time series data and often yield satisfactory results. In this study, we introduce a novel Regularized GRULSTM neural network model for short-term forecasting of stock prices. Building upon existing models, our approach enhances predictive accuracy by incorporating regularization techniques. Experimental results demonstrate the superiority of our proposed model over conventional GRU and LSTM networks in forecasting the closing prices of two selected stocks. By leveraging advanced neural network architectures and regularization techniques, our model offers a promising avenue for more accurate and reliable stock price predictions in financial markets.

**KEYWORDS** - LSTM; GRU; Time series prediction, SVM, RF.

## I.INTRODUCTION

The stock market has garnered increasing attention in recent years due to its potential for high returns, despite the inherent risks involved. Consequently, predicting stock price indices has become a focal point for both individual and institutional investors. For instance, in 1970, Fama introduced the Efficient-Market hypothesis, positing that asset prices reflect all available information at any given time. Additionally, the rise of algorithmic trading has led to a significant portion of transactions in the US stock market being executed through automated processes, highlighting the growing reliance on computational methods in financial markets. Various conventional machine learning techniques, including support vector machines, decision trees, k-nearest neighbours, and artificial neural networks (ANN), have been proposed for stock market prediction. While these algorithms are effective in numerous scenarios, they encounter stability issues when applied to highly volatile and non-linear problems like stock market prediction [1]. The unpredictability of stock price forecasts has significant ramifications for global finance, underscoring the importance of robust risk management strategies in stock valuation predictions. It is imperative to assess risk effectively in order to make informed decisions and mitigate potential financial losses [5]. In contrast, deep learning has emerged as a promising approach for addressing such challenges, demonstrating robust performance in these complex environments [1]. As a result, neural network models, known for their ability to model complex, non-linear relationships, have gained popularity in stock price prediction tasks. Artificial Neural Networks (ANN) is commonly employed to analyze non-linear data. However, conventional ANN models often fall short in delivering sufficient accuracy for certain tasks. To address this limitation, researchers have explored alternative approaches such as Long Short-Term Memory (LSTM) networks, as demonstrated in prior studies [1][3]. Additionally, methods like Radial Basis Function (RBF) [2] and conventional ANN architectures [4] have also been investigated for improving predictive accuracy in various applications.

Recurrent Neural Networks (RNNs) have emerged as powerful models for processing sequential data, offering the ability to capture complex nonlinear relationships. Among RNN structures, Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) have proven to be particularly effective. LSTM incorporates memory cells within its architecture, allowing the network to retain and process previous information dynamically, leading to more accurate predictions [3]. On the other hand, GRU, similar to LSTM but without an output gate, offers faster processing due to its reduced parameter count.

While LSTM excels in preserving and processing long-term information, making it suitable for large datasets, GRU's efficiency makes it preferable for tasks where speed is crucial. In this study, we propose a novel Regularized GRU-LSTM network model that combines the strengths of both LSTM and GRU architectures. By leveraging the advantages of both models, we aim to achieve enhanced performance in predicting the closing prices of two stocks.



## II.RECENT WORKS

Numerous studies have delved into the realm of stock price prediction, employing a plethora of machine learning algorithms tailored to handle the complexities of financial data. Among these algorithms, Support Vector Machines (SVM) [2] have garnered widespread attention and adoption for their adeptness in classification tasks and their capability to construct regression models suited for predicting stock prices. Similarly, Random Forest (RF) algorithms have emerged as a popular choice owing to their proficiency in handling vast datasets and adeptness at capturing intricate non-linear relationships inherent in stock price data.

Artificial Neural Networks (ANN) [4] have also emerged as a promising tool for stock price prediction, leveraging their capacity to discern intricate patterns and relationships embedded within historical stock market data. Meanwhile, the rise of Long Short-Term Memory (LSTM) [3] networks, a specialized form of recurrent neural networks (RNN), has been particularly noteworthy. These networks excel in capturing long-term dependencies within sequential data, making them well-suited for modelling the time series nature of stock prices.

Moreover, Radial Basis Function (RBF) networks have garnered attention for their proficiency in approximating complex non-linear functions and extracting salient patterns from stock market data [2]. Together, these diverse machine learning algorithms offer a rich array of approaches for predicting stock prices, each bringing unique advantages and considerations to the table, including accuracy, computational efficiency, and interpretability.

## III.PROPOSED WORK

The objective of this study is to improve the accuracy of stock price prediction through the utilization of stacked Long Short-Term Memory (LSTM) and stacked Gated Recurrent Unit (GRU) models. By integrating multiple layers of LSTM and GRU networks, the model aims to capture intricate temporal dependencies present in the stock price time series data. This approach facilitates the learning of hierarchical representations of the data, enabling the extraction and integration of subtle patterns crucial for enhancing prediction accuracy. The effectiveness of the stacked LSTM and stacked GRU architectures will be evaluated through rigorous experimentation, with the potential to yield significant advancements in forecasting future stock prices.

### stock prices Dataset

The dataset used in this study was obtained from the popular dataset repository known as Yahoo Finance, which is widely recognized for providing benchmark datasets for research purposes. It comprised 2417 records and included 6 attributes extracted from the website. These attributes, such as Adj close, High, Low, Min, Max, Volume, Date, etc., are commonly found in stock price prediction datasets and play a crucial role in predicting stock prices. The dataset covers the time period from January 1, 2013, to August 8, 2022, providing a comprehensive range of historical stock market data for analysis and prediction.

```

Date,Adj Close,Open,High,Low,Close,Volume
2013-01-02,12.87,12.8,12.9,12.66,12.87,65420000
2013-01-03,12.92,12.86,13.04,12.82,12.92,55018000
2013-01-04,12.96,12.88,12.99,12.83,12.96,37484000
2013-01-07,13.42,13.15,13.49,13.13,13.42,98200000
2013-01-08,13.32,13.35,13.45,13.18,13.32,60214000
2013-01-09,13.32,13.41,13.48,13.27,13.32,45312000
2013-01-10,13.27,13.43,13.44,13.11,13.27,57268000
2013-01-11,13.4,13.26,13.42,13.21,13.4,48266000
2013-01-14,13.64,13.4,13.71,13.38,13.64,85500000
2013-01-15,13.6,13.53,13.64,13.47,13.6,46538000
2013-01-16,13.45,13.53,13.56,13.39,13.45,41312000
2013-01-17,13.52,13.57,13.6,13.46,13.52,37692000
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2022-07-27,120.97,117.31,121.9,117.16,120.97,61582000
2022-07-28,122.28,121.57,122.84,118.08,122.28,82245500
2022-07-29,134.95,134.9,137.65,132.41,134.95,148892900
2022-08-01,135.39,134.96,138.83,133.51,135.39,76846900
2022-08-02,134.16,134.72,137.44,134.09,134.16,61922400
2022-08-03,139.52,136.21,140.49,136.05,139.52,71827800
2022-08-04,142.57,140.58,143.56,139.55,142.57,70585000
2022-08-05,140.8,140.1,142.86,139.6,140.8,50686900
2022-08-08,139.41,142.05,144.23,138.29,139.41,52229000
    
```

Fig: stock price prediction dataset

### 3.2 Stacked LSTM

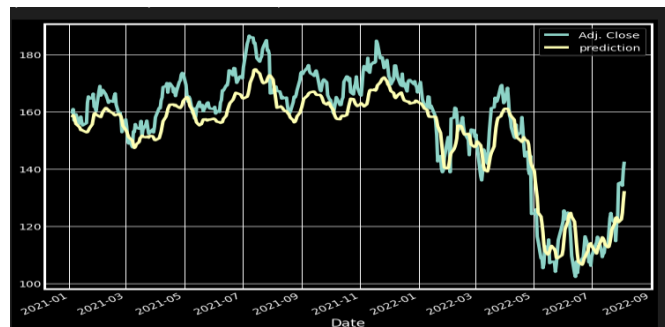
The study proposes utilizing a stacked Long Short-Term Memory (LSTM) model for predicting stock prices. This approach involves stacking multiple layers of LSTM cells, enabling the model to capture intricate temporal dependencies within the stock price time series data. By processing sequential information in a hierarchical manner, the stacked LSTM architecture facilitates the extraction of subtle patterns and trends, thereby enhancing the accuracy of future stock price predictions. The effectiveness of the stacked LSTM model will be thoroughly evaluated through rigorous experimentation, with the goal of achieving notable advancements in forecasting accuracy and performance compared to conventional LSTM architectures.

### 3.3 Stacked GRU

In a stacked Gated Recurrent Unit (GRU) model, multiple layers of GRU cells are utilized to capture complex temporal dependencies inherent in stock price time series data. Each layer within the stacked GRU network is comprised of numerous GRU cells, each endowed with its unique parameters. The computations conducted within each GRU cell entail a variety of mathematical operations, including element-wise multiplications, additions, and activation functions. Denoted as  $h_t^{(l)}$ , the hidden state of the  $l$ -th layer GRU cell at time step  $t$ , and  $c_t^{(l)}$ , the cell state of the  $l$ -th layer GRU cell at time step  $t$ , where  $l$  denotes the layer index.

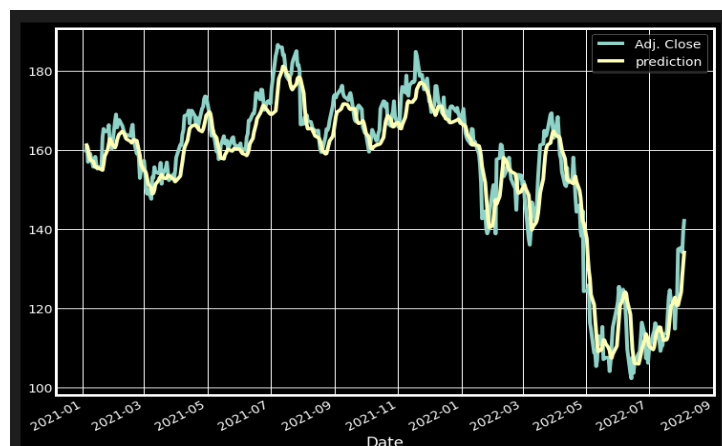
## IV.RESULTS AND DISCUSSION

### LSTM



The displayed chart depicts a stock price graph featuring two distinct lines: one representing the actual adjusted closing prices of a stock, while the other delineates predicted prices over a specified period. The horizontal x-axis denotes the timeline, spanning from January 2021 to September 2022, while the vertical y-axis illustrates the price scale, ranging from 100 to above 180, indicating values in a currency unit. Within the chart, the actual adjusted closing prices are depicted in a dark blue or black hue, labelled as 'Adj. Close,' while the predictions are rendered in a lighter shade, possibly yellow or light green, labelled as 'prediction.' Notably, both lines exhibit a semblance of similarity, implying a degree of accuracy in the prediction model, as the forecasted values often closely align with the actual prices.

### GRU



The graph illustrates the comparison between the actual adjusted closing prices of a financial asset, represented by a light blue line, and its corresponding predicted prices, depicted by a yellow line, spanning from January 2021 to September 2022. It is evident from the chart that both lines exhibit volatility and move in tandem, implying a degree of accuracy in the prediction model. Notably, towards the end of the period, there is a notable sharp price drop followed by a subsequent rise, with the prediction line reflecting these fluctuations. This suggests that the model may possess some predictive capability in forecasting trends. However, the real-world effectiveness of the model would hinge on its consistency and adaptability to changes in the market dynamics.

## V.CONCLUSIONS

In Conclusion, our research presents a novel Regularized GRU-LSTM model for predicting stock prices, surpassing the performance of baseline GRU and LSTM models. By integrating regularization techniques, the model demonstrates improved generalization, effectively capturing intricate nonlinear patterns in stock data. The model's accuracy in short-term forecasting underscores its potential to assist investors in decision-making processes. Future investigations may explore hybrid approaches incorporating SVM and RF for additional enhancements. In essence, our study contributes to the advancement of predictive capabilities in financial markets, facilitating informed investment strategies.

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