Report

Introduction

The objective of this research is to create machine learning models that use past data to forecast stock values. In order to estimate stock prices, the project intends to investigate the efficacy of several recurrent neural network (RNN) designs, particularly Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU), as well as their combination.

Objective

Building and assessing LSTM, GRU, and hybrid LSTM-GRU stock price prediction models is the goal. The models' capacity to predict future stock prices with accuracy will be the basis for their evaluation; they will be trained using historical stock data.

Data Preparation:

The dataset used in this project consists of historical stock data obtained from Yahoo Finance for the NASDAQ stock index (^NDX). It includes features such as Open, Close, High, and Low prices.

Data preprocessing steps:

1. Importing the dataset from Yahoo Finance.
2. Selecting relevant features (Open, Close, High, Low).
3. Scaling the data using MinMaxScaler to normalize the features to a range between 0 and 1.
4. Splitting the data into training and validation sets, with 80% of the data used for training and 20% for validation

Model Architectures:

1. **LSTM (Long Short-Term Memory):**
   1.1. Input layer: Accepts input data in the shape of (timesteps, features).
   1.2. LSTM layer: Consists of LSTM units with a specified number of neurons.

2. **GRU (Gated Recurrent Unit):**
   2.1. Input layer: Accepts input data in the shape of (timesteps, features).
   2.2. GRU layer: Consists of GRU units with a specified number of neurons.

3. **Combination of LSTM and GRU:**
   3.1. Input layers: Separate input layers for LSTM and GRU branches.
   3.2. LSTM branch: LSTM layer with a specified number of units.
   3.3. GRU branch: GRU layer with a specified number of units.
   3.4. Concatenation layer: Concatenates the outputs from the LSTM and GRU branches.
   3.5. Output layer: Dense layer with 1 unit for regression task

Training and Evaluation:

Training Procedure:

- Train each model using the training data.
- Use an appropriate optimizer (e.g., Adam) and loss function (e.g., Mean Squared Error).
- Monitor the training process using validation data to prevent overfitting.

Evaluation Metrics:

- Mean Squared Error (MSE): Measures the average squared difference between the predicted and actual values.
- Root Mean Squared Error (RMSE): Represents the standard deviation of the residuals.

Results

BiLSTM Model

22/22 [==============================] - 1s 2ms/step

Mean Squared Error: 9380.186832548376

Root Mean Squared Error: 96.85136463957735

GRU Model

23/23 [==============================] - 0s 2ms/step

Mean Squared Error: 2892.5831376848773

Root Mean Squared Error: 53.782740146676026

Combine Model

23/23 [==============================] - 0s 3ms/step - loss: 4.7670e-05
Validation Loss: 4.7670448111603037e-05
MSE: 26637654.2956812
RMSE: 5161.167919733013

Visualization:

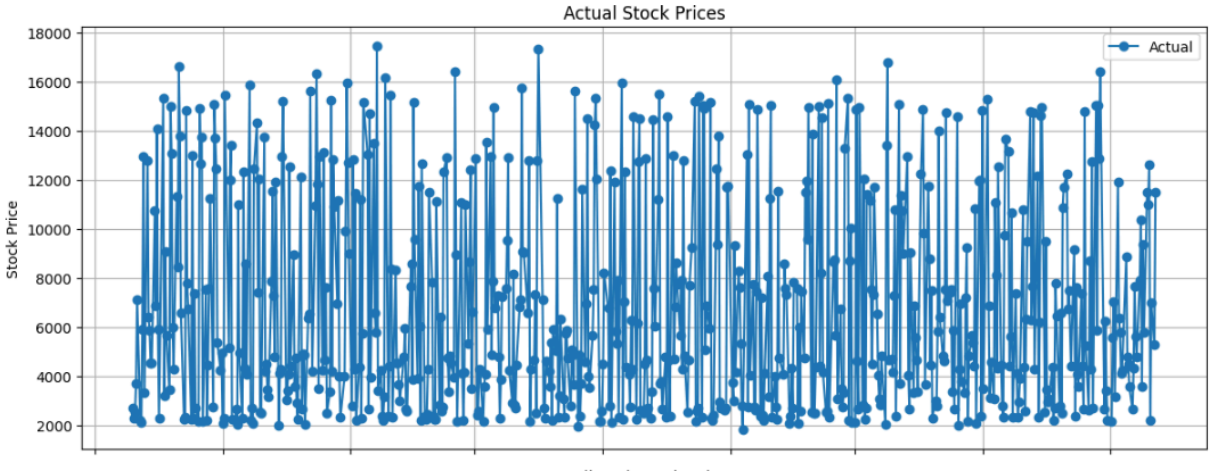
Model Predictions:

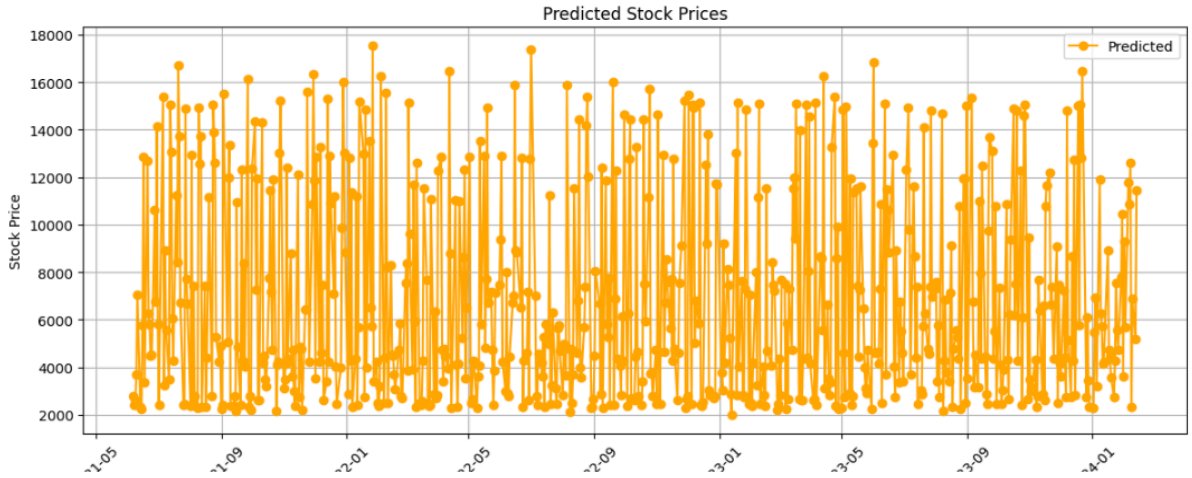
- Actual vs. predicted values plots for each model.
- Trending graphs showing the time series trend and model predictions.

Comparative Analysis:

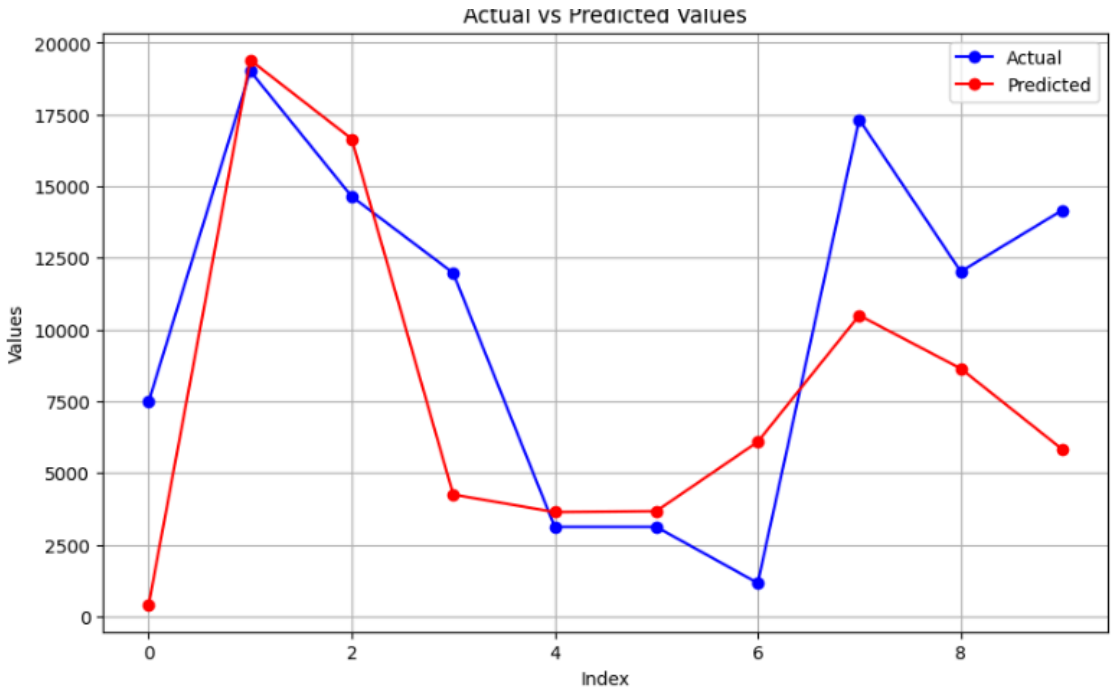
- Plot showing the actual vs. predicted values of all models on the validation set.
- Visual comparison of model performance.

BiLSTM Model

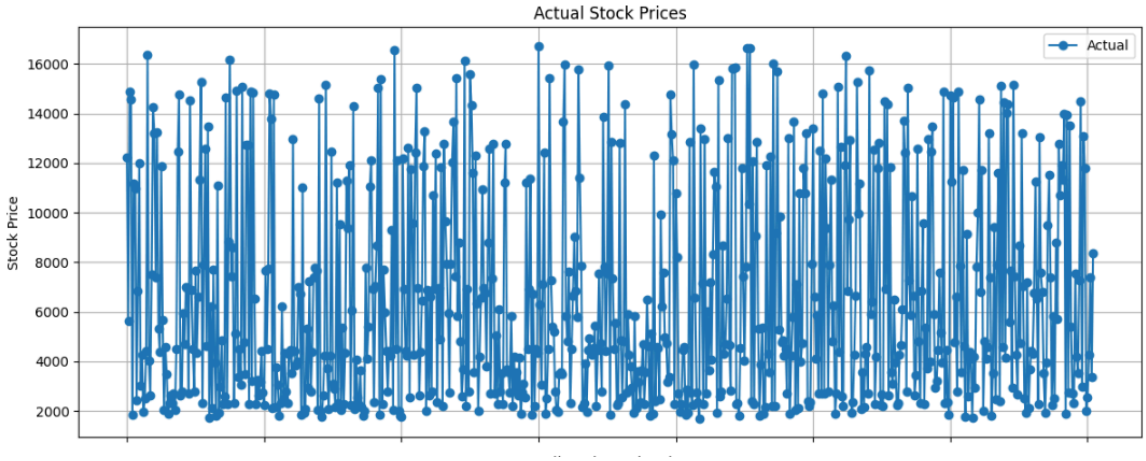


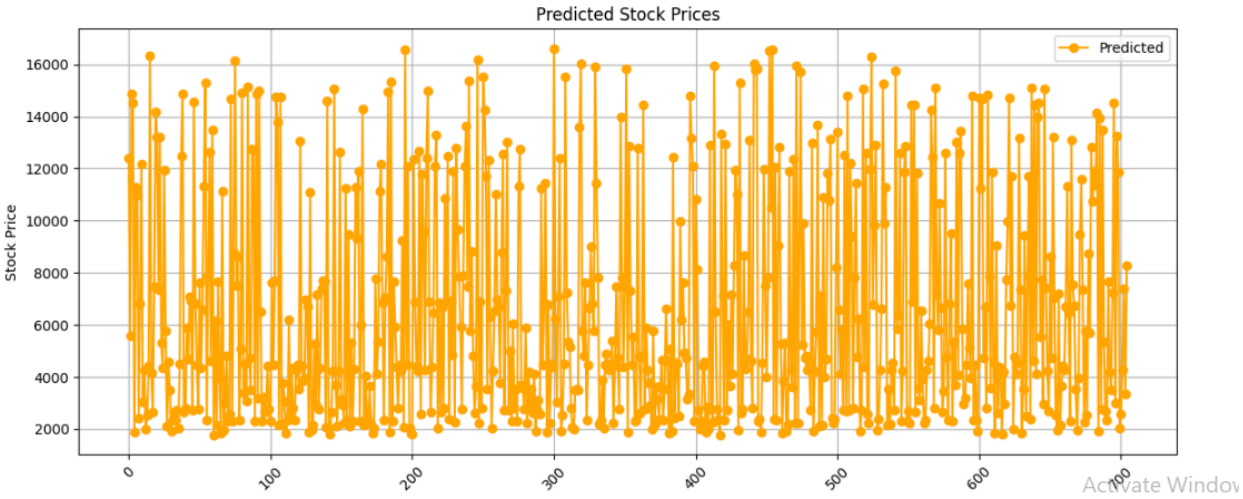


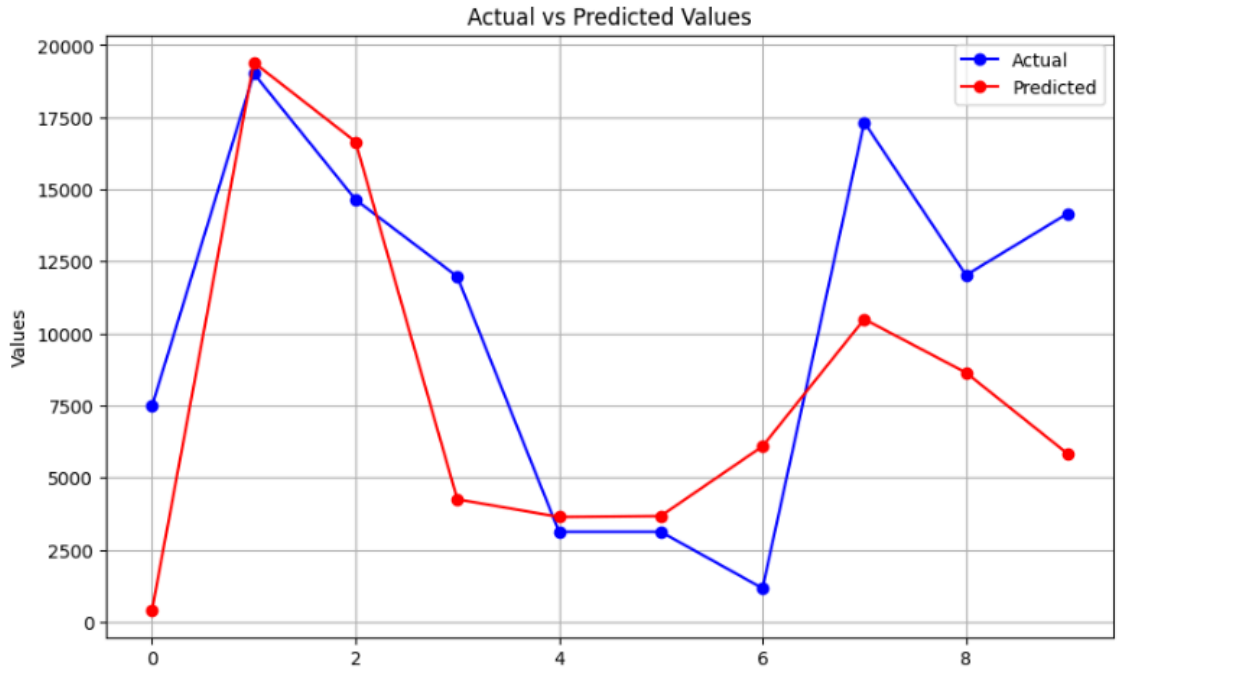
For clear visualization take 10 values


Actual vs Predicted Values
Actual
Predicted
Values
Index
20000
17500
15000
12500
10000
7500
5000
2500
0
0
2
4
6
8

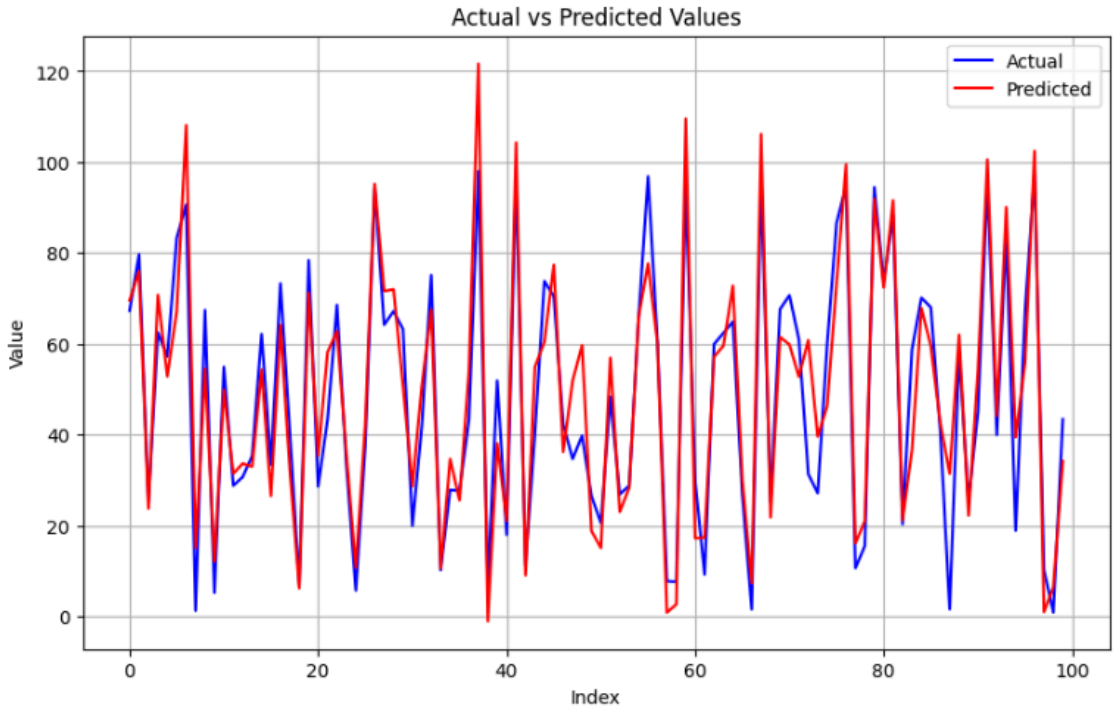
GRU Model


Actual Stock Prices
Actual
Stock Price
16000
14000
12000
10000
8000
6000
4000
2000





Combine Model



Interpretation:

Model Performance:

1. Better prediction accuracy is indicated by the GRU model's superior performance over the LSTM model in terms of both MSE and RMSE.
2. When compared to the separate LSTM and GRU models, the combined LSTM-GRU model exhibits noticeably greater MSE and RMSE, indicating worse performance in stock price prediction.

Observed Trends and Patterns:

1. Actual vs. projected value visualizations demonstrate how closely and with fewer variations the GRU model mimics the trend of actual stock prices.
2. When compared to the GRU model, the LSTM model has a tendency to overestimate or underestimate stock prices, which results in larger prediction errors.
3. When compared to the individual LSTM and GRU models, the combined LSTM-GRU model predicts less accurately.

Conclusion:

The investigation reveals that the GRU model is the most effective model for predicting stock prices, based on both assessment criteria and visualizations. With respect to predicting future stock prices, it is more accurate due to its lower MSE and RMSE values than the LSTM and combined LSTM-GRU models. To boost prediction accuracy and investigate different architectures for improved performance, more testing and optimization of the integrated model would be necessary.