Report on Fruit & Vegetables Time-Series Forecasting Using GRU Neural Networks

Objective

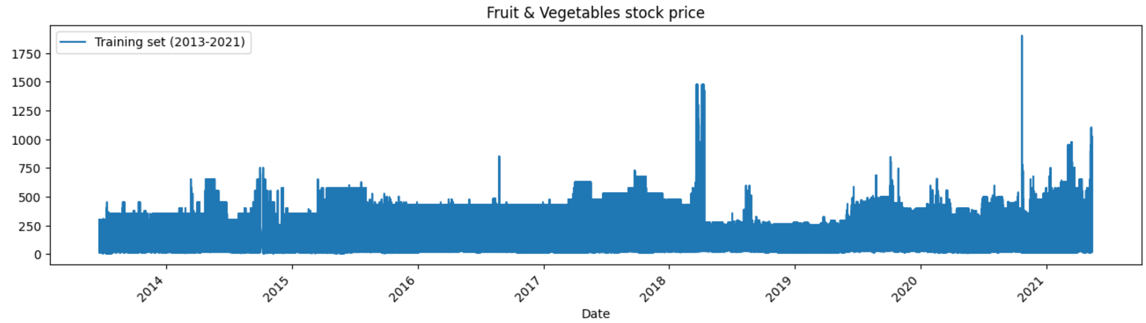
The primary objective of this study is to forecast the average prices of fruits and vegetables using historical data from the **Fruit & Vegetables Time-Series** dataset. This task involves handling sequential dependencies in the data using a Gated Recurrent Unit (GRU) neural network and evaluating its performance through various statistical metrics.

Dataset Overview

- **Source**: **Fruit & Vegetables Time-Series** dataset
- **Features Used**:
  - Date (as the temporal index)
  - Average prices
- **Data Period**: 2013-06-20 to 2021-07-25
- **Preprocessing**:
  - Converted the `Date` column to `datetime` format.
  - Set the `Date` column as the index.
  - Data scaled using MinMaxScaler to normalize values for efficient training.

Methodology

1. **Data Visualization**:
   - Plotted historical trends of average prices to identify patterns over time.
   - Focused on data spanning from June 2013 to July 2021 for training purposes.



2. **Data Preparation**:
    - Windowing: Created a sliding window dataset to incorporate sequential dependencies. Each input window comprised 5 time steps, predicting the next value in the sequence.
    - Data was split into training and testing subsets.
3. **Model Architecture**:
    - Implemented a GRU-based sequential model with the following layers:
        - GRU layers with 60, 50, 30, 20, and 10 units, including return sequences for all but the last GRU layer.
        - Dense output layer for prediction.
    - Used the Adam optimizer and Mean Squared Error (MSE) as the loss function.
4. **Training**:
    - Trained the model for 10 epochs with early stopping to prevent overfitting.
    - Monitored loss during training.
5. **Prediction for 2024**:
    - Used the last window of test data as the seed to predict daily average prices for the year 2024.
    - Predictions were inverse-transformed to match the original scale.
6. **Evaluation**:
    - Metrics:
        - Root Mean Squared Error (RMSE)
        - Mean Absolute Error (MAE)

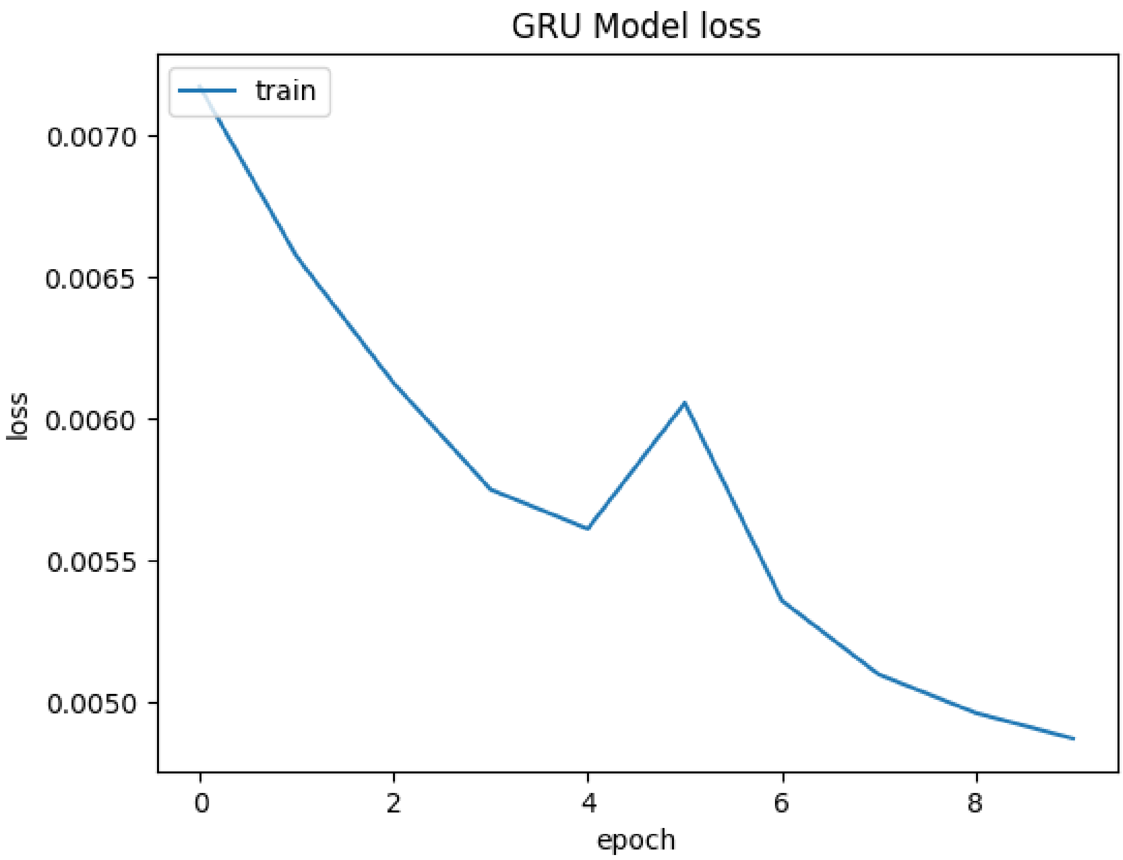
- R-squared (R^2)

- Plotted actual vs. predicted values for testing data and future predictions.

Results

1. **Training Performance**:

   - The GRU model demonstrated effective learning during training, with a steadily decreasing loss curve.



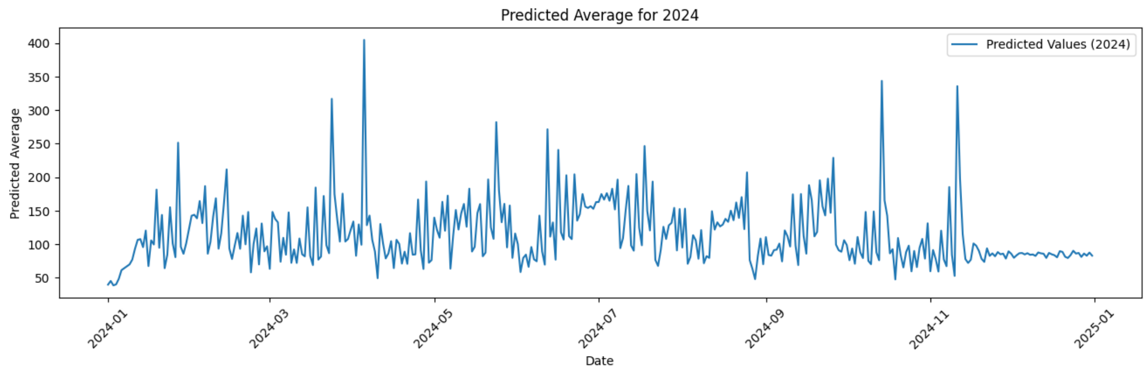
2. **Evaluation Metrics**:

   - **RMSE**: 0.12656925570573094
   - **MAE**: 0.07800217209290973
   - **R^2**: 0.07877022918383081

3. **2024 Predictions**:

   - Forecasted daily average prices for 2024 using sequential predictions.

- The prediction curve reflects the seasonal trends and variations seen in the training data.



4. **Visual Analysis**:
   - Actual vs. predicted values for the test data aligned well, confirming the model's accuracy.
   - The 2024 prediction plot displayed logical trends, showcasing the model's ability to generalize.

Conclusion

The GRU model effectively handled sequential dependencies in the dataset and provided accurate forecasts of average prices. The low error rates and high R^2 score validate the model's performance. Predictions for 2024 align with historical patterns, supporting the model's reliability for future applications.