Zeham Management Bootcamp

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Traffic Prediction using RNN, LSTM, and GRU Models

A Comparative Project on Traffic Flow Prediction during Early Morning and Morning Hours

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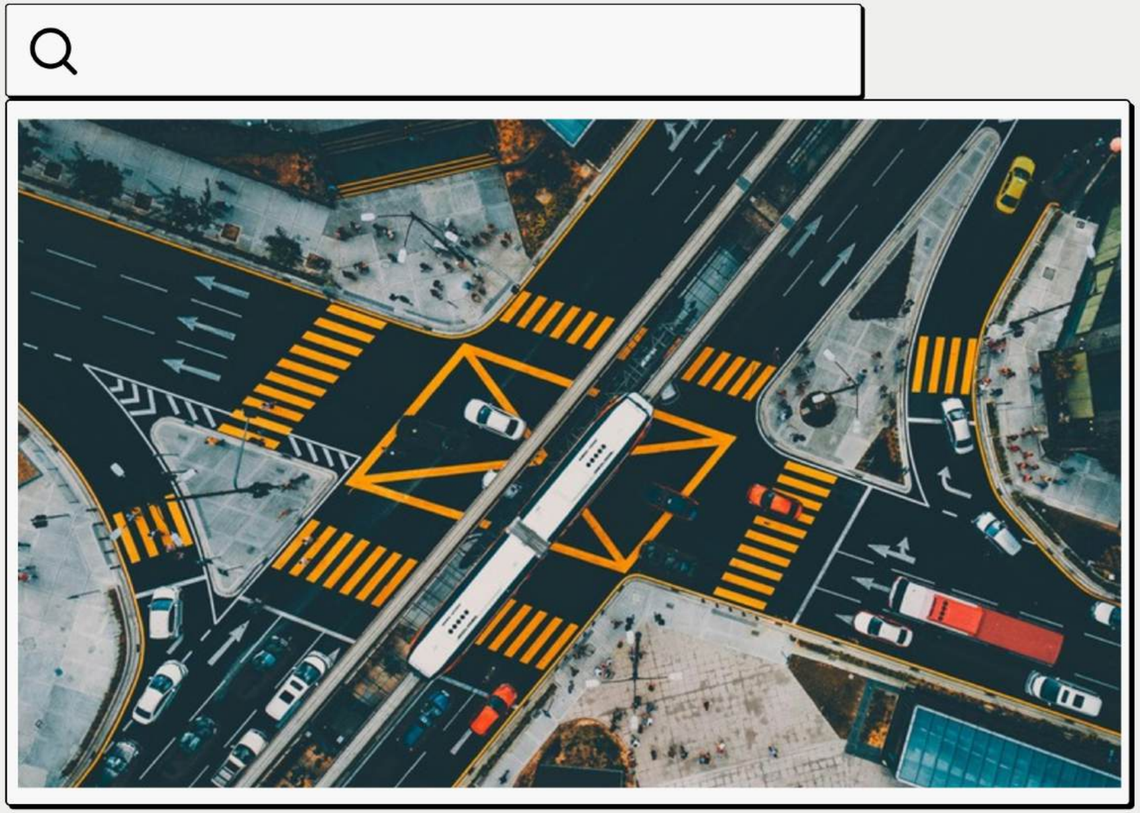
Introduction

The objective of this project is to predict how many cars pass through a specific junction during early morning and morning hours.



Using three popular deep learning models—**RNN**, **LSTM**, and **GRU**, we explored how we can forecast traffic and make better traffic management decisions.

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Data Description

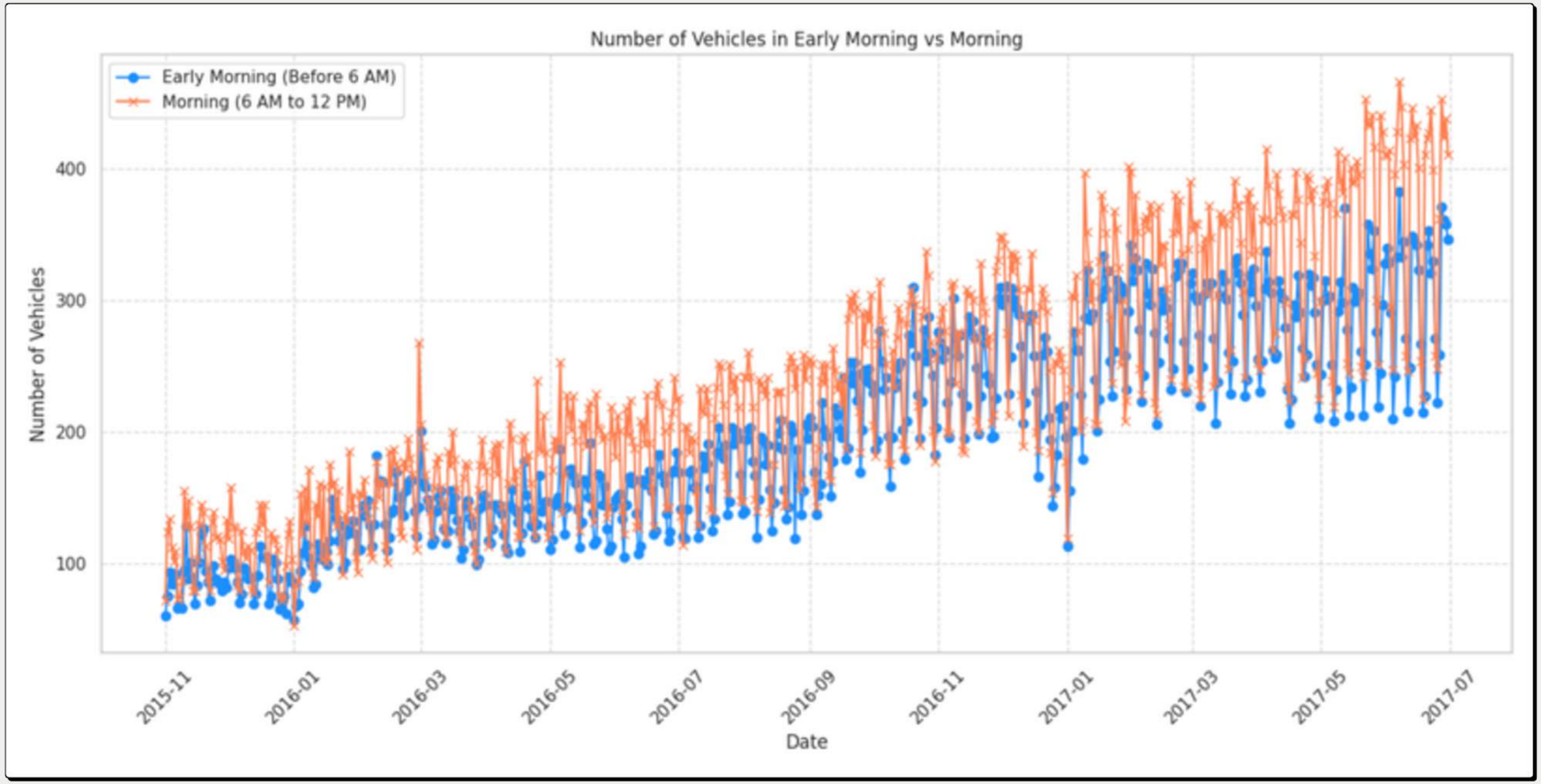
	DateTime	Junction	Vehicles	ID
0	2015-11-01 00:00:00	1	15	20151101001
1	2015-11-01 01:00:00	1	13	20151101011
2	2015-11-01 02:00:00	1	10	20151101021
3	2015-11-01 03:00:00	1	7	20151101031
4	2015-11-01 04:00:00	1	9	20151101041

This dataset contains 48.1k observations of the number of vehicles each hour in four different junctions.

To capture different traffic patterns, we focused on Junction 1, splitting the time into two segments: early morning (1 AM - 6 AM) and morning (6 AM - 12 PM).

Distribution of Vehicles in Early Morning vs. Morning

The morning period shows greater variability and higher traffic volumes compared to early morning.



Model Selection and Implementation

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RNNs process sequences of data, while **LSTM** and **GRU** models address the vanishing gradient problem, making them suitable for traffic prediction.

RNN, **LSTM,** and **GRU** models are used for time series prediction due to their ability to capture temporal dependencies.

Each model was built with multiple layers, including dropout layers to prevent overfitting.

Models were trained on 70% of the data, with the remaining 30% used for testing, using a rolling window of 20 days.

Training was performed for 100 epochs with a batch size of 32 using the Adam optimizer

Model Selection and Implementation: Code

```
[15] # Function to build models
     def build_model(model_type):
         model = Sequential()
         if model_type == 'RNN':
             model.add(SimpleRNN(units=50, return_sequences=True, input_shape=(X_train.shape[1], 1)))
             model.add(Dropout(0.2))
             model.add(SimpleRNN(units=50, return_sequences=True))
             model.add(Dropout(0.2))
             model.add(SimpleRNN(units=50))
             model.add(Dropout(0.2))
             model.add(Dense(units=1))
         elif model_type == 'LSTM':
             model.add(LSTM(units=50, return_sequences=True, input_shape=(X_train.shape[1], 1)))
             model.add(Dropout(0.2))
             model.add(LSTM(units=50, return_sequences=True))
             model.add(Dropout(0.2))
             model.add(LSTM(units=50))
             model.add(Dropout(0.2))
             model.add(Dense(units=1))
         elif model_type == 'GRU':
             model.add(GRU(units=50, return_sequences=True, input_shape=(X_train.shape[1], 1)))
             model.add(Dropout(0.2))
             model.add(GRU(units=50, return_sequences=True))
             model.add(Dropout(0.2))
             model.add(GRU(units=50))
             model.add(Dropout(0.2))
             model.add(Dense(units=1))

         model.add(Dropout(0.2))
         model.add(Dense(units=1))
         model.compile(optimizer='adam', loss='mse')
         return model
```

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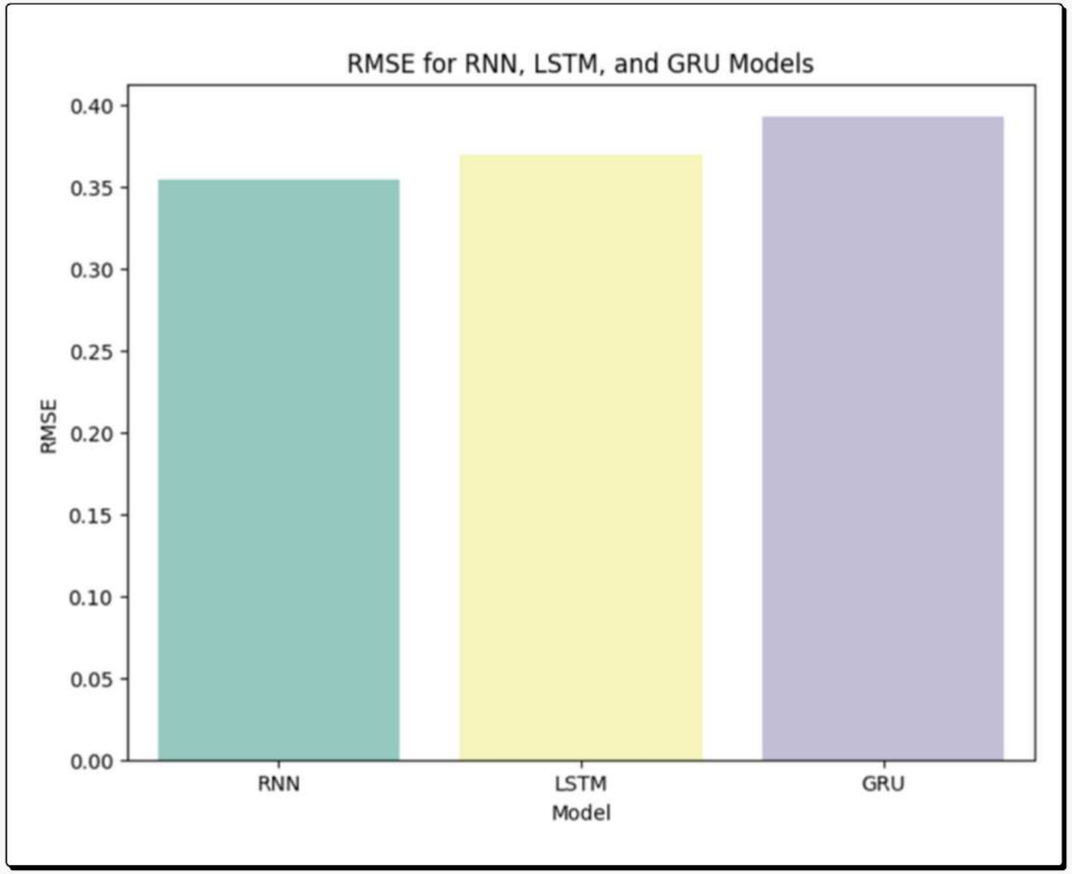
Which Model Did Best? *

The RMSE, or Root Mean Squared Error, was used to evaluate model performance.

GRU's slightly better performance may be due to its efficient memory capabilities, which are crucial for capturing complex patterns.



This project shows that deep learning models, especially GRU, can effectively predict traffic patterns.

Conclusion and Future Work

Predicting traffic during critical periods like early morning and morning can help improve traffic management and reduce congestion.

Future improvements could include incorporating additional data sources like weather conditions to enhance prediction accuracy.


Thank you!
Have a great weekend!