Modeling and prediction of congestion patterns using deep learning

Master‘s Thesis of Mohamed Azzam

Mentoring:
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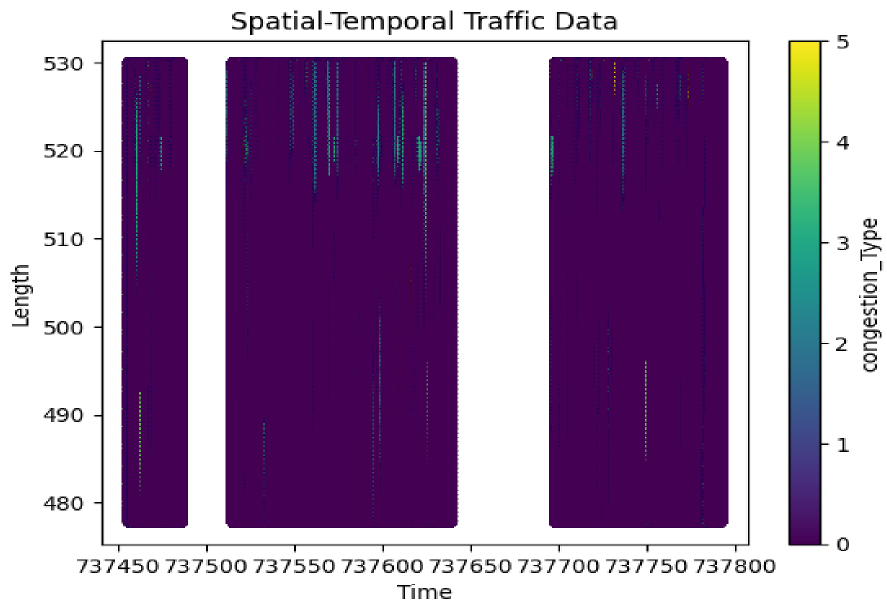


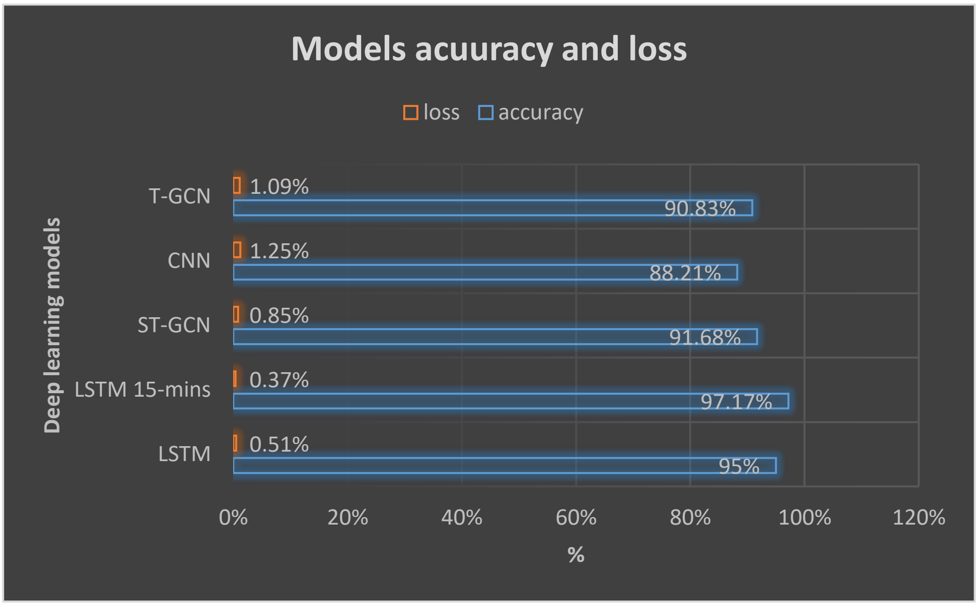
Short-term traffic congestion forecasting is one of the most vital problems in transportation research because it provides a solid foundation for minimizing traffic congestion and pollution. Forecasting is critical for both traffic management and commuters. Travelers may quickly obtain information about traffic congestion and make trip plans by taking detours to their destination without additional waiting time. Traffic managers may employ timely management measures to ease traffic congestion.

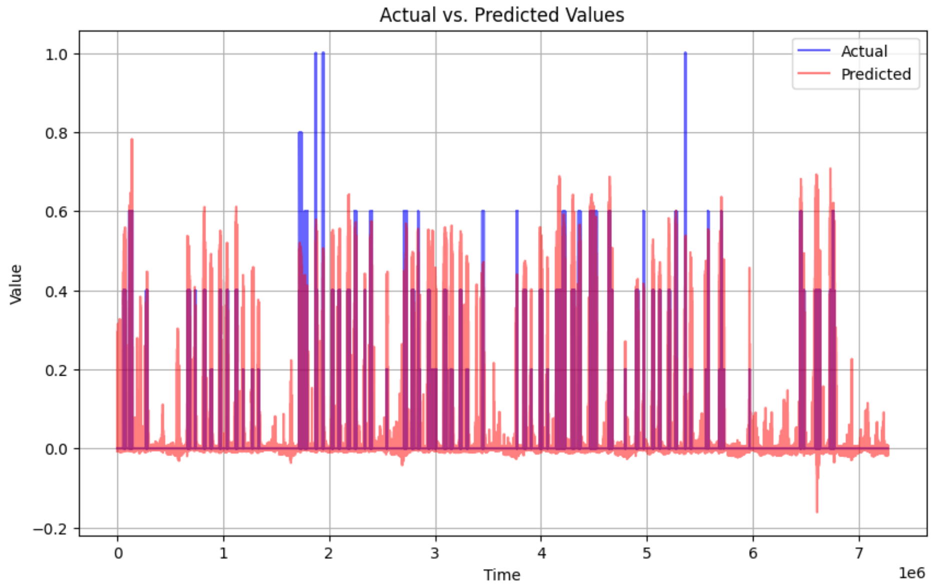
The thesis focuses on short-term predicting congestion patterns on the A9 highway using deep learning algorithms implemented in a high-level, general-purpose programming language. The model uses a given data set of congestion patterns recorded in 2019 to train it and validate its predictions.

The aim is to develop an algorithm based on a method of deep learning to predict the five congestion patterns found on the highway (preferably with an accuracy higher than 80%).

The most well-fitted models for the spatial-temporal traffic data are those four models (T-GCN, CNN, ST-GCN, and LSTM) are ideal for managing spatial and temporal data because they can extract information from the order and sequencing of the dataset of different timestamps from the data by using historical data to make short term predictions about traffic congestions in the future, many experimental trials were conducted on the four models and see how the model's performance react.

As a result of the results of the trials, LSTM with a 15-minute sequencing in specific because the model can read the data and connect with other timestamps within the 15-minute sequencing, and the ST-GCN model are the two chosen models as they have higher accuracy and less chance of percentage of losing the data while training the model with an accuracy of 97.17% and 91.68 % respectively.





The visualization of the LSTM 15-minute model's performance shows how close the predicted model's prediction values are to the actual values given in the data. Some lines perfectly match each other (overlapping), which means the model's predictions are aligned closely with the actual values, indicating good performance results. On the other hand, there are predicated lines that match the first half of the actual values, and the actual line values keep on without overlapping with the predicated lines anymore; that model's predictions are not able to give an entirely correct prediction and the actual values differ from what was predicted, mainly because of errors like (MAE, RMSE, and MAPE) related to model outcomes. There are also a few of the prediction line values that do not overlap with any of the actual line values, and this is because the given dataset was eight months long in 2019, which leaves four months without any given ground truth value data, so that is the model's congestion forecasting prediction in those four months due to the training behavior of the other eight months.

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