Deep learning coupled with existing sensors based multiresolution traffic data and future connected technologies has immense potential to improve traffic operation and management. But to deal with complex transportation problems, we need efficient modeling frameworks for deep learning models. In this study, we propose two different modeling frameworks using Deep Long Short-Term Memory Neural Network (LSTM NN) model to predict future traffic state (speed and signal queue length).

In our first problem, we present a modeling framework using deep LSTM NN model to predict traffic speeds in freeways during regular traffic condition as well as under extreme traffic demand, such as a hurricane evacuation. The approach is tested using real-world traffic data collected during hurricane Irma's evacuation for the interstate 75 (I-75), a major evacuation route in Florida. We perform several experiments for predicting speeds for 5 min, 10 min, and 15 min ahead of current time. The results are compared against other traditional prediction models such as K-Nearest Neighbor, Analytic Neural Network (ANN), Auto-Regressive Integrated Moving Average (ARIMA). We find that LSTM-NN performs better than these parametric and non-parametric models. Apart from the improvement in traffic operation, the proposed method can be integrated with evacuation traffic management systems for a better evacuation operation.

In our second problem, we develop a data-driven real-time queue length prediction technique using deep LSTM NN model. We consider a connected corridor where information from vehicle detectors (located at the intersection) will be shared to consecutive intersections. We assume that the queue length of an intersection in the next cycle will depend on the queue length of the target and two upstream intersections in the current cycle. We use InSync Adaptive Traffic Control System (ATCS) data to train a Long Short-Term Memory Neural Network model capturing time-dependent patterns of a queue of a signal. To select the best combination of hyperparameters, we use sequential model-based optimization (SMBO) technique. Our experiment results show that the proposed modeling framework performs very well to predict the queue length. Although we run our experiments predicting the queue length for a single movement, the proposed method can be applied for other movements as well. Queue length prediction is a crucial part of an ATCS to optimize control parameters and this method can improve the existing signal optimization technique for ATCS.