



Caltrans Division of Research,  
Innovation and System Information

# Research

# Results

Transportation  
Safety and Mobility

**MAY 2019**

**Project Title:**  
UTC – 52 Travel Demand  
Nowcasting (UCCONNECT)

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**Task Manager:**  
Stan Chow  
Transportation Engineer  
[stan.chow@dot.ca.gov](mailto:stan.chow@dot.ca.gov)

## UTC – 52 Travel Demand Nowcasting (UCCONNECT)

Research into short-term forecasting of travel demand within the next few hours to one day for operational purposes.

### WHAT IS THE NEED?

The cities are getting more congested and less convenient. In 2011, delay is 38 hour/commuter, 61 in Bay Area. This caused congestion, excess greenhouse gas, and extra stress and damages on roads and bridges. Travel demand forecast becomes essential. With the capabilities built in prior work, California Department of Transportation (Caltrans) saw an opportunity within a travel demand framework using sequence prediction methods of machine learning. A range of the mechanism served to benefit from this nowcasting, includes ramp metering, changeable lanes, and traffic signals timing. This project was intended to build and demonstrate accurate predictions of travel demand from historical data and the observed travel.

### WHAT WAS OUR GOAL?

Goal was to deliver a report addressing IO-HMM (Input Output Hidden Markov Models) and LSTM (Long Short-Term Memory) method with nearest neighbor method as a baseline and validation of the agent-based simulation.

### WHAT DID WE DO?

Task 1: Nearest neighbor approach of matching a most similar sequence of activities from the past and used it as a forecast for the rest of the day was implemented as a baseline. IO-HMMs and LSTM structure was applied to produce the most likely second half of the activity sequence given the observed first half sequence of the day.

Task 2: The methods applied to forecast activity sequences on the large population and the predictive accuracy was evaluated across the range of forecast horizons in the range of 1 to 12



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integrated and efficient transportation  
system to enhance California's  
economy and livability.

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hours. Forecast activity sequences was upscale to the total pollution and imputed into a traffic microsimulation system. The accuracy of the simulated end of the day will be assessed with traffic data available for historical days.

**Task3:** The forecasting system implemented to produce the current day forecast within the San Francisco Bay Area.

## WHAT WAS THE OUTCOME?

The outcome of the experiment shows promising results for medium term forecast. Researchers concluded the project reached a Mean Average Percentage Error (MAPE) of less than 5% one hour ahead and 10% three hours ahead. For future projects, the results found here showed that we could improve the prediction accuracy by incorporating more of the observed data by the time of prediction. The researcher's AM-PM framework provided medium term travel demand prediction for the whole network, providing an actionable model to improve performance of the whole network, providing an actionable model to improve deducing negative impacts of congestions.

## WHAT IS THE BENEFIT?

**Goal Sustainability, Livability and Economy:** The framework provided actionable data to support sustainable “smarter, longer-lasting mobility decisions to improve the environment, support a vibrant economy and build communities”. The forecasting framework utilized new data sources and provided timely and cost-efficient travel demand information. It provided transparent structure revealing daily travel patterns and an interpretable set of parameters describing activity choices and transitions between them.

**Goal System Performance:** This goal was to understand the rapidly changing patterns and the impact of transportation network companies travel demand for the specific peak period. This opened opportunities for mitigation strategies and demand management and improvement of the overall system performance. Moreover, an opportunity to demonstrate the methods in near real-time and at scale. This made it an effective exploratory tool to observe changes induced by applied measures on the travel choices made by the travelers, and to assessing the long-term trends in system performance.