DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Large-scale and Long-term Forecasting of Performance Measurement of Public

The main objective of this proposal is to develop a machine learning approach for large spatial scale and long-term performance measurement forecasting for public transportation systems.

Modal

DECEMBER 2022

Project Title:
Large-scale and Long-term Forecasting of Performance Measurement of Public Transportation Systems

Task Number: 3438

Start Date: August 16, 2020

Completion Date: August 15, 2021

Task Manager:
Bradley Mizuno
Transportation Engineer (Electrical)
bmizuno@dot.ca.gov

WHAT WAS THE NEED?

Reliable long-term forecasting of performance measurement for public transportation systems over a large area is essential for policymakers to achieve effective city planning as well as promotes ridership. For example, forecasting bus arrival time for the next day helps a rider to plan their commute early. Existing approaches typically rely on traffic simulation tools and models that require expert knowledge to execute and adjust parameters for various traffic scenarios. Previously under a Caltrans funded project, the researchers developed a data- driven, deep learning approach for traffic flow prediction and bus arrival time estimation. The researchers also built a system that uses the traffic predictions for forecasting various performance metrics for public transportations in Los Angeles (e.g., bus arrival times). The system demonstrates the overall approach in an area near downtown Los Angeles and shows that incorporating traffic flow predictions can help to forecast short-term bus arrival times accurately (e.g., in the next few hours).

WHAT WAS OUR GOAL?

To demonstrate the results from the proposed research, the researchers will develop a web application in which users can select the start time of a trip and access the predicted bus arrival times anywhere in the entire Los Angeles Metropolitan Area. This research will exploit real-world big traffic sensor data and California Highway Patrol accident logs collected from the Regional Integration of Intelligent Transportation Systems in the last nine years under our existing Archived Traffic Data Management System project.

Caltrans

DRISI provides solutions and knowledge that improves California's transportation system

WHAT DID WE DO?

First, we explore both spatial statistical methods and machine learning methods to estimate traffic flows for the road segments that do not have traffic sensors. Second, we develop methods to enable traffic forecasting with a deep learning model designed for small networks for the entire Los Angeles metropolitan area road network. Our methods split the large road network into multiple sub-networks and train a deep learning model for each sub-network. We also study various training strategies (e.g., teacher forcing) and deep learning architectures to enable accurate long-term forecasting of traffic flows and bus arrival times. Lastly, we develop an end-to-end deep learning approach that combines the estimation and forecasting of traffic flows with data imputation methods for estimating bus arrival time for each stop in individual bus routes in Los Angeles metropolitan area.

WHAT WAS THE OUTCOME?

Using the real-world freeway and arterial traffic data and bus location data in the USC Archived Transportation Data Management System, we show that the proposed approach and system are capable of predicting bus arrival times with a city-level spatial coverage and a route-level temporal forecasting horizon. Our distributed traffic forecasting model is capable of making city-level predictions on more than 10,000 road sensors. Image 1 shows our traffic forecasting experimental results compared with a baseline approach called "Historical Average" (taking the average speed at the same time from historical data). The comparison shows that our approach significantly outperformed the baseline approach. Our approach had small prediction errors for traffic forecasting at 15, 30, 45, and 60 minutes into the future, which enables accurate estimates of bus arrival times.

We also demonstrate the overall result of the bus arrival time estimation in a web dashboard (Figure 2). Using the dashboard in Image 2, a user can select a bus route, the starting and ending bus stops, and the time to leave to the bus arrival time estimation at each bus stop along the route. This dashboard enables users at all levels of technical skills to benefit from the developed machine learning approach and access to valuable information for trip planning, vehicle management, and policymaking.

WHAT IS THE BENEFIT?

Results from this project will help Caltrans' Transportation Planning Division and other policymakers by giving them a tool to improve transit planning. This tool will also assist Caltrans reaching its System Performance goals.

LEARN MORE

Metrans Web Dashboard: https://infolab.usc.edu/caltrans/index.html#/

IMAGES

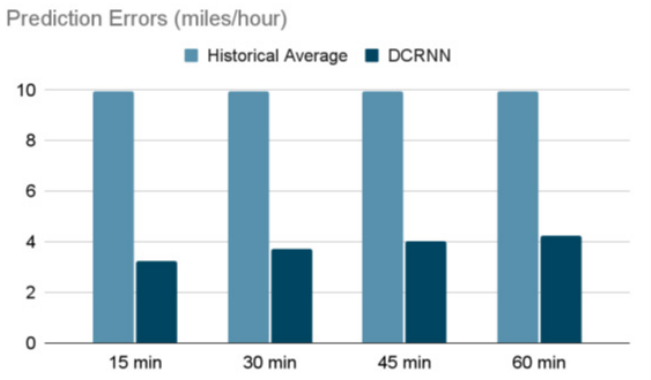

Image 1:Traffic Forecasting Performance

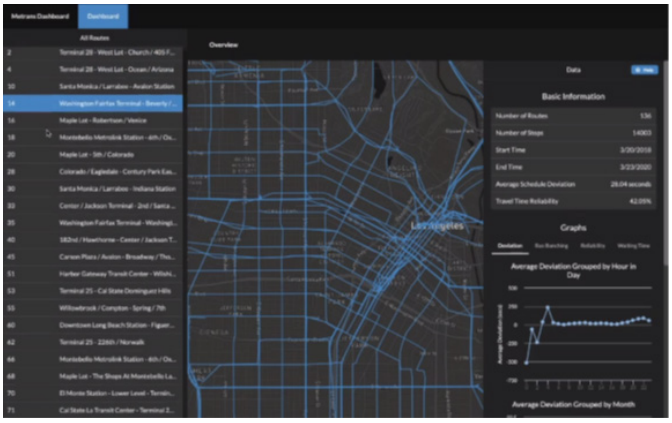

Image 2: Web Dashboard for Bus Arrival Time Estimation