Tech Xplore

Using deep learning algorithms to give bicyclists the 'green wave' at traffic signals

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Led by Dr. Stephen Fickas of the University of Oregon (UO), transportation researchers are working to give bicyclists smoother rides by allowing them to communicate with traffic signals via a mobile app.

The latest report to come out of this multi-project research effort introduces machine-learning algorithms to work with their mobile app FastTrack. Developed and tested in earlier phases of the project, the app allows cyclists to passively communicate with traffic signals along a busy bike corridor in Eugene, Oregon. Researchers hope to eventually make their app available in other cities.

"The overall goal is to give bicyclists a safer and more efficient use of a city's signaled intersections. The current project attempts to use two deep-learning algorithms, LSTM and 1D CNN, to tackle time-series forecasting. The goal is to predict the next phase of an upcoming, actuated traffic signal given a history of its prior phases in time-series format. We're encouraged by the results," Fickas said.

Their latest work builds on two prior projects, also funded by the National Institute for Transportation and Communities, in which Fickas and his team successfully built and deployed a hardware and software product called "Bike Connect" that allowed people on bikes to give hands-free advance information to an upcoming traffic signal, using their speed and direction of travel to increase the likelihood the signal would be green upon arrival.

The project V2X: Bringing Bikes into the Mix, completed in 2018, focused on giving bicyclists a virtual call button that they could use on their phones. During that project, researchers collected detailed real-time data from anactuated signal on the study corridor. The Fast Track: Allowing Bikes To Participate In A Smart-Transportation System project, completed in 2019 (featured in the May 2019 *ITE Journal*), developed a real-time display for non-actuated signals showing GLOSA (Green Light Optimized Speed Advisory) information—more often referred to as a "green wave." While a common technology available to drivers, GLOSA is not widely available for bicyclists. This real-time display (ideally mounted on handlebars for hands-free viewing) offered bicyclists real-time information on whether to slow down, speed up, or maintain speed in order to make a green light.

The 2021 project builds upon the prior studies:

1. It uses the data collected from the actuated signal in the first phase to train and test two machine-learning algorithms to forecast the signal phases.
2. It sets the groundwork to extend the FastTrack app to include both non-actuated and actuated signals, as bicyclists are likely to encounter both of these types of infrastructure while riding.

Incorporating machine learning

Researchers chose to explore two separate machine-learning algorithms. Both have a good track record with time-series forecasting: One-Dimensional Convolutional Neural Nets (1D CNN for short) and Long Short-Term Memory models (LSTM for short).

To measure the effectiveness of each algorithm, they used three metrics:

- Precision is concerned with "when the model does predict that the rider will arrive at a green light, how often is it correct?" A high Precision score says that the model is not prone to have the rider slamming on brakes, mistakenly told to expect a green.
- Recall asks "for all the actual green lights the rider encountered, how many did the model get correct?" A high Recall score says that the rider is not missing many greens.
- Finally, Accuracy is simply the number of correct predictions.

The LSTM and 1D CNN scored nearly identical results on all three metrics. Researchers were able to predict the next phase with roughly 85% accuracy, for each of the time-series forecasting algorithms.

"We believe we are in the ballpark of being acceptable in terms of adding a prediction component to our existing FastTrack app," Fickas said. This would open up green-wave capability for non-fixed-time intersections.

What's next: Increasing the complexity and size of the dataset

Based on what they learned, the researchers' plans for next steps are:

1. Gain access to a dataset with a larger range of days, perhaps an entire season. (Currently, the team has its eyes on "Better Naito" Parkway in Portland, Oregon, a bike-friendly corridor which contains multiple actuated intersections to draw data from.) Typically, more data leads to stronger results when looking at machine-learning algorithms.
2. Move to a multivariate dataset that includes date and time, and perhaps weather as well. This would not be a huge change to data preparation, and may allow a single model that covers all four seasons.

The FastTrack app requires a real-time feed from upcoming traffic signals on the bicyclist's path. Cities with older equipment or with older Traffic Management Systems (TMS) may not be able to provide this feed. However, Fickas and his team are optimistic. As cities replace older equipment and bring on a modern TMS, they will be fully capable of using a FastTrack app that is effective with both fixed and actuated intersections, giving their biking community green-wave opportunities.

The research team has made its exploration and results available in a Google Colab enabled Jupyter notebook. The authors welcome questions or comments.

More information: Green Waves, Machine Learning, and Predictive Analytics: Making Streets Better for People on Bikes: nitc.trec.pdx.edu/research/project/1299

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