Modeling Driver Characteristics

Driver Behavior In Traffic

Exploratory Advanced Research . . . Next Generation Transportation Solutions

Existing traffic analysis and simulation tools cannot effectively model drivers' ability to recognize and respond to their environment with behavior that varies depending upon the encountered driving situation. "Driver Behavior in Traffic," an Exploratory Advanced Research (EAR) Program project, aims to characterize driver behavior using naturalistic driving data and agent-based modeling techniques. This project was awarded by the Federal Highway Administration (FHWA) in 2009, and is being conducted by Virginia Tech University in partnership with PTV America and the Virginia Transportation Research Council.

A Behavioral Background

Current literature that has detailed the characterization of driver behavior is limited. The research that does exist is typically limited to specific locations and scope. The majority of traffic modeling and parameter calibration research assumes somewhat similar driving conditions and behavioral sets for all of the drivers' population; differences in drivers' actions are merely represented by drawing samples from statistical distributions assigned to each driver type. This approach does not capture or predict individual driver actions that reflect the effects of various situational and environmental factors.

The study aims to answer a number of questions related to driver and traffic performance:

- What are the driving rules during normal and abnormal driving conditions?
- What is the magnitude of difference in driving rules among different drivers?
- Do the rules change after certain experiences? For example, does a driver change the way he or she drives after being involved in an incident?
- What is the impact of an incident on the system performance? What is the effect of drivers' interaction during incidents?

Capturing Driver Behavior

This study is developing "intelligent agents" that can encapsulate individual driver decisions in response to varying traffic situations. The developed agents are designed to learn drivers' temporal actions for any given traffic state retrieved from a naturalistic driving database. These driving rules of the agents will be coded in a computer simulation environment to test and study the collective effects of the learned behaviors with multiple drivers and under different situations.

Learning Approach

As mathematical formulation alone is not adequate in predicting changes in acceleration rate, or the time it takes a driver to initiate the transformation from perception to reaction, this project uses artificial intelligence to model and predict driver behavior. The study uses reinforcement learning, a novel and successful area of artificial intelligence, to tackle how an independent agent that senses and acts on its environment can learn to choose logical actions to reach its long-term goals. This method allows the agent to keep learning from observations, actions conducted, and rewards received.

"A driver action at any time depends on their perception of the surrounding environment." says David Yang at FHWA. "A driver will initiate a sequence of actions, from acceleration and deceleration, to steering input, all of which are dependent on a given set of initial and final conditions, such

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as target speed, car following distance, or road geometry. This research will help us to better understand driver behavior so we can effectively predict the next driver action for a given situation."

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Example of a sudden lane change

Future Work

At the conclusion of this project, agents will be developed to mimic realistic driver behavior in various driving scenarios. After verification and validation of the developed agents, an abstraction of their learned "driving rules" will be embedded in a microscopic traffic simulation tool, VISSIM.

It is expected that analyzing trained agent characteristics will provide the transportation community with innovative methods for developing more accurate and sensitive traffic simulation models. It could also lead to future research developing new generations of traffic simulation tools that can accurately capture driver behavior in complex traffic situations.

Learn More

For more information on this EAR Program project, contact David Yang, FHWA Office of Operations Research and Development, at 202-493-3284 (email: david.yang@dot.gov).

EXPLORATORY ADVANCED **RESEARCH**

What Is the Exploratory Advanced Research Program?

FHWA's Exploratory Advanced Research (EAR) Program focuses on long-term, high-risk research with a high payoff potential. The program addresses underlying gaps faced by applied highway research programs, anticipates emerging issues with national implications, and reflects broad transportation industry goals and objectives.

To learn more about the EAR Program, visit the Exploratory Advanced Research Web site at www.fhwa.dot.gov/advancedresearch. The site features information on research solicitations, updates on ongoing research, links to published materials, summaries of past EAR Program events, and details on upcoming events. For additional information, contact David Kuehn at FHWA, 202-493-3414 (email: david.kuehn@fhwa.dot.gov), or Terry Halkyard at FHWA, 202-493-3467 (email: terry.halkyard@fhwa.dot.gov).

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