Robust Model Checking for Urban Traffic Simulations

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traffic21
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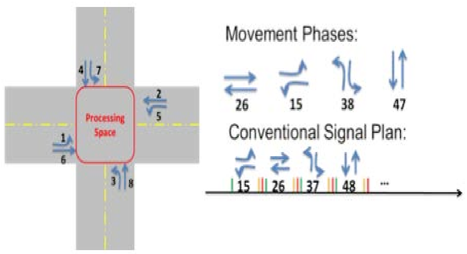
Overview

- Frequency of adaptive traffic control system deployment is increasing
- These systems typically require significant upfront investment
- It is worth evaluating the efficacy of an adaptive system in the simulation before deployment
- Most commercially available simulators (eg. VISSIM) are targeted to simulate conventional timing plans
- ICLL research team developed a distributed software architecture (VISCO) to simulate Surtrac adaptive control system in VISSIM
- My work focuses on model checking aspects involved in simulating this system

Background



- Conventional signal systems use pre-programmed timing plans, sometimes with simple actuation
- Adaptive signal systems (eg. Surtrac) sense approaching traffic flows and dynamically adjust timing plans in real-time

More Details on Surtrac

- Surtrac (Scalable URban TRAffic Control) treats signal control problem as a decentralized, schedule driven process
- Each intersection is controlled by a local scheduler (schedules are built on a rolling horizon basis)
- Neighboring intersections exchange information to achieve network level coordination

Problem Description

Pre-Checks on Simulation Model

•Network topology information is encoded into the configuration files

•Local Surtrac processes build schedules based on the information contained in the configuration files

•Configuration files also contain information to be communicated to the neighboring intersections

•Configuration files are built from the simulation model of the network

•There are assumptions made about how this information is included in the simulation model

•The simulation model needs to be built in accordance with these assumptions

Model Checking During Simulation

•Shadow RBC (Ring Barrier controller) module keeps track of signal timing plans, current signal state for each intersection

•This module also serves the left turn movements (when needed)

•Left turn movement service decisions are based on the detector actuation information

•It is necessary to ensure that left turn movements are serviced in a manner that they are expected to

•Second, Surtrac makes control decisions concerning when to serve the next phase within a time window (between min and max green)

•If it fails to make a decision within the specified time window, phase is forced to end automatically

•Model checking is incorporated to ensure that the local scheduler is building efficient schedules

Model Assumptions Checked

- Each link is connected to other links with a unique connection
- Each link is named according to convention
- Links do not "cross" intersections, only connections can do that
- Links are not "split" at an intersection
- Connections do not contain detectors or signal heads
- Connections are unnamed
- Detectors follow naming conventions
- Each link contains three types of detectors: advance, stopbar, and occupancy

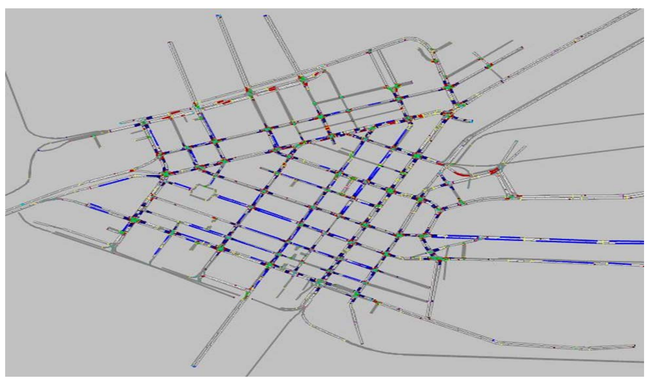


Figure 2. Simulation model of downtown Pittsburgh network

Figure 1. Under name, the detector on the right has a typo: a "+" where an "_" should be. The detector on the left follows proper naming conventions.

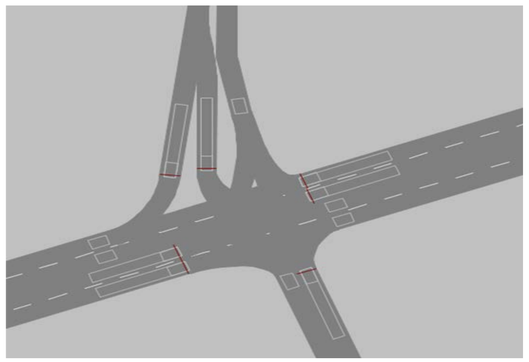


Figure 3. An example of a "split" intersection, where two lanes in the same direction approach the intersection separately. This would be flagged.

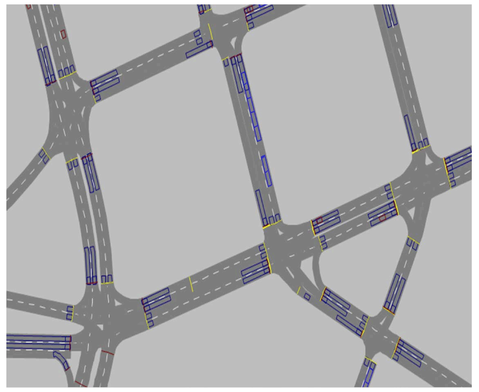


Figure 4. A subsection of the simulation model of downtown Pittsburgh. Each blue box is a detector, and every lane should have one of each type (advance, stopbar, occupancy).

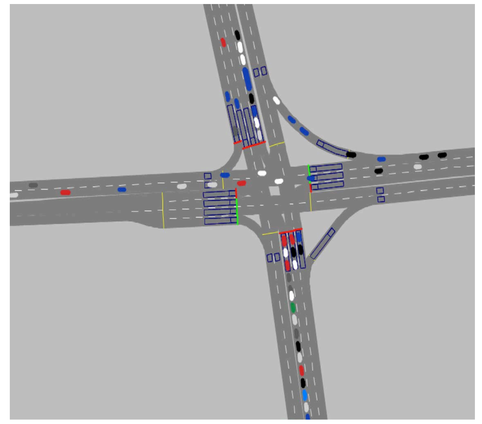


Figure 5. Cars waiting in simulation for a protected left while the opposite phase is green. The next change of the light will be to allow these cars to turn.

Acknowledgments

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