Road Traffic Simulation

CSE6730

SPRING 2015

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Problem Description

When modeling traffic flows along a busy, congested street, minimizing average travel time to traverse portions of streets becomes key. The objective of this project is to compare the average travel time for vehicles traveling along a portion of Peachtree Street in midtown Atlanta between a model using synchronized traffic lights versus unsynchronized traffic lights.

Conceptual Model

Objectives

- Measure impact of synchronization on traffic signals on output parameters of a simulation of traversing a portion of Peachtree Street in midtown Atlanta

Input Parameters

- Signal timings for each intersection
- Total simulation time
- Global inter-arrival time
- Vehicle length
- Safety distance while driving and queuing up

Outputs

- Average travel time between origin and destination per vehicle
- Average waiting time at traffic signal

Assumptions

- No pedestrians/bikers
- No road construction
- No weather
- No vehicle accidents

Content

- Entitles (vehicle, intersections and street section, queues)
- Activities (vehicle waiting in queue, traveling through street, etc)

Simplifications

- No u-turns
- Constant vehicle speed
- Identical vehicles

References

Implementation

Signal Lights & Phases:

Each intersection structure contains a pre-calculated array containing the various stages of each light during each phase, and the current phase is kept track of as well as the total number of phases (see Fig. 1).

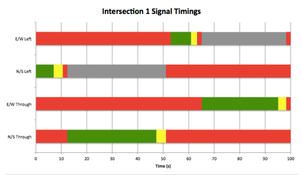

Fig. 1

Vehicle Queues & Lanes:

Each lane is modeled as a queue and each queue is a linked list of events (where the object of the event is a vehicle); when the vehicle arrives at a particular intersection, it is placed in the appropriate lane queue. Each lane also has a *flag* associated with it, to be used for vehicles entering the portion of the lane entering the intersection. Finally, each lane has an associated *lane counter* indicating how many vehicles are entering and crossing the Intersection on this particular lane.

Intersection Event Handlers:

When the simulation enters the signal event handler, to simulate the switching of traffic lights, the current phase is incremented by 1. The next signal change will be scheduled using the current simulation time plus the time for the current phase as timestamp. When arriving at an intersection, the vehicle is put into the corresponding lane queue. If the vehicle is first in this queue and allowed to enter, the entering event is scheduled directly, and the vehicle velocity remains unchanged. In all other cases, the entering event will not yet be scheduled and the vehicle velocity is set to 0. The entering event sets the corresponding lane flag to 1, indicating no other vehicle may enter the intersection on this lane. The following crossing event is scheduled depending on on the vehicle acceleration, current and maximum velocity, length and safety distance parameters. When the vehicle starts crossing the Intersection, the corresponding lane flag is set to 0 so that the next vehicle may enter the Intersection and the Intersection departure is scheduled (again, dependent on the parameters mentioned above, as well as the Intersection crossing distance for this particular lane).

The Intersection departure schedules either a new arrival at the following Intersection or a global departure in case the vehicle is leaving the simulated roadway network.

Input/Output Analysis

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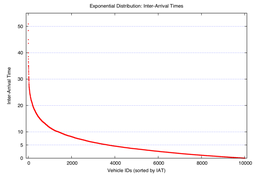
Random Variables

The C standard library *rand()* function is assumed to return uniformly distributed random values in the *(0, R)* interval such that rand()/R is uniform in *(0,1)*, where *R* is an integral constant defined in the library. All input parameters were mapped to a uniform distribution except the inter-arrival time between vehicles, where an exponential distribution was used.



Plot of the inter-arrival time for a sample size of *n=10,000* and expected mean $\mu = 5$, sorted in decreasing order

Results