ROYAL INSTITUTE
OF TECHNOLOGY

AH2174 Traffic Simulation Modeling and Applications

Project II Assignment

23rd Nov, 2023

Objectives

This project assignment is to motivate the students by computational experiments to i) grasp the essential car-following models in microscopic traffic simulation ii) understand the concepts and modelling aspects of macroscopic traffic flow iii) comprehend the mesoscopic traffic modelling approaches.

1 Introduction

The work in Lab 2 has equipped all students with basic knowledge on how to use SUMO, a flexiable microscopic traffic simulation tool, for building traffic simulation model and carrying out traffic analysis in applications. This lab enables to analyze macroscopic traffic flow characteristics using microscopic simulation outputs. All students may further explore the simulation model especially on how to obtain and analyze various types of output data in SUMO. For the modelling part, it is required to implement, evalaute and analyze car-following models numerically.

In addition, you shall report the experiment you did with the mesoscipic traffic simulation model, Mezzo, in lab 3 and answer the questions that have been raised in the final project report.

2 Assignments

2.1 Numerical experiments of car-following models (3p)

Car following models are the most important representatives of microscopic traffic flow models. They describe traffic dynamics from the perspective of individual drivers i.e. driver-vehicle units (DVU) in simulation. The tasks in this problem are to implement and analyze car following models in a scenario of acceleration - running - deceleartion process. The initial condition $(t = 0)$ is that a platoon of 8 vehicles start with an equal inter-vehicle space of 10 meters. The leading vehicle will accelerate constantly for 20 seconds with an acceleration rate of 0.9 m/s^2, run with constant speed for 20 seconds after the acceleration, and then decelerate constantly with deceleration rate of 1.5 m/s^2 until it stops.

- Implement the Intelligent Driver Model (11.14) in Ch11 (page 188) of the "Traffic Flow Dynamics" book and analyzing the model performance by starting with the parameters of Table 11.2 (Both Scenarios).
- If some parameters of the model are randomized, e.g. ,the safe time gap is randomized by uniform distribution between 0.8 sec and 1.5 sec, analyze the car following patterns for both scenarios.

2.2 Analysis of macroscopic characteristics of multi-lane traffic flow (5p)

In the previous project, you have already built a simulation model of a highway section with five edges (edge 1 to edge 5) composed of three lanes with speed limit 70 km/h. In this project, you have the opportunity to investigate the fundimental diagram of a road stretch that is assumed to have homogenous traffic flow characteristics. Let us focus on a road section, edge 4, in the simulation model you have created. Consider that the loop detectors are deployed at the boundaries of edge 4 so that you can measure inflow and outflow per lane. You can also obtain traffic speed estimation using detector data.

- The first task is to estimate traffic densities of edge 4 per 5 minutes during simulated one hour period using traffic flow data from detectors at both boundaries. Hint: virtual loop detectors can be added in SUMO model to simulate loop detector data; the density can be estimated continuously using the conservation law i.e. the variation rate of density of a road section is compensated by the flow change in a road section i.e. $\rho_k(t + \Delta t) = \rho_k(t) + \frac{1}{\Delta x_k}(Q_k^0 - Q_k^1)\Delta t$.

- Compare the time mean speed with the harmonic mean speed at the entry of edge 4 using simulated data of half an hour (after simulation warmup). How are they different from the space mean speed of edge 4 that you can obtained from vehicle trajectories?

- Explore by simulation the speed-density relation $V_e(\rho)$ (an equilibrum function between traffic speed and density) of edge 4 using speed and density measured from the loop detectors of the edge. Fit the density and speed data with an analytical model. (Hint: to sample sufficient data to model the fudimental diagram, you might need to variate the upstream demand and reduce downstream supply, e.g. closing one or two lanes of edge 5, in order to simulate traffic flow of higher densities.)

2.3 Network traffic analysis by mesoscopic simulation model (4p)

TBD

2.4 Bonus project questions

TBD

Examination

For all assignments, motivate your answer/solution to the raised problems, including graphic plots and decriptive analysis. Also, please send your source codes (.zip) along with the report (.pdf). Please submit all files before the deadline - Dec 20, 2023 - through the CANVAS system.

This project II assignment requires a minimum of 7 points for master student and 10 points for doctoral student to pass The grading level for this project is

- $\geq$7 $\rightarrow$ D
- $\geq$8 $\rightarrow$ C
- $\geq$9 $\rightarrow$ B
- $\geq$10 $\rightarrow$ A.