MSc/PGDip Data Analytics

Modelling, Simulation and Optimisation (H9MSO)

Project

DEADLINE: 25th April 2021
WEIGHT: 60% of overall marks

Project Outline

The "Future Cities" Project in Trinity College Dublin investigates a "Self-Organising Motorway" as a possible approach to reduce congestion on motorways. Your task is to replicate aspects of this research using a simulation model implemented in SimPy v.4.

Create a simulation for a 3km segment of motorway that reduces after 2km from 3 lanes to 2 lanes, as shown below on a screen shot from the TCD website.

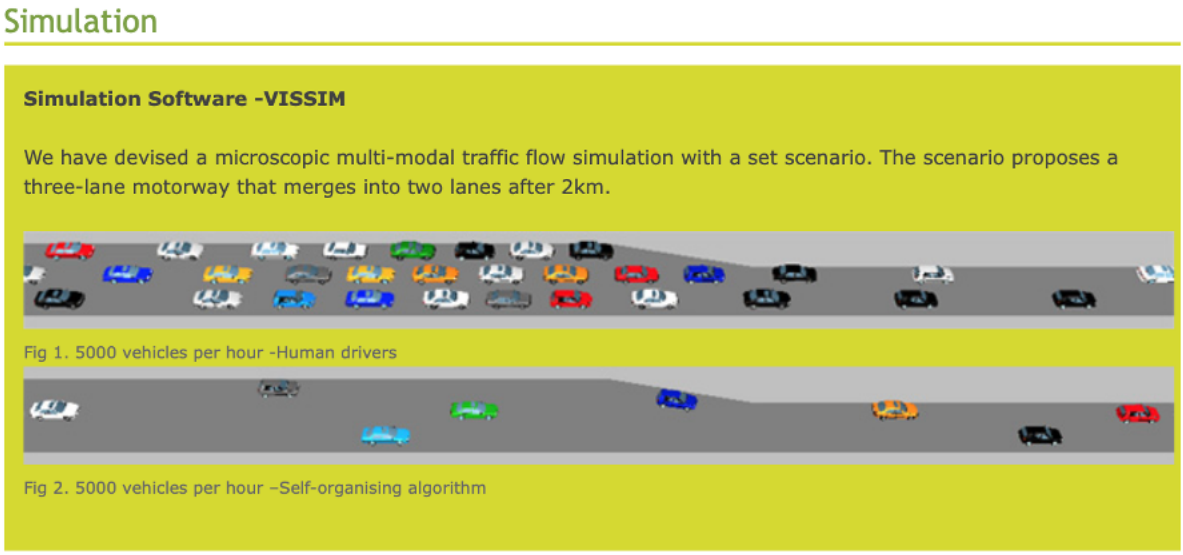

Fig. 1: Model Visualisation as shown on the TCD Project Website

Answer the following questions:

1. What is the as optimal average traveling time t_{opt} in free flowing, non-congested traffic?
2. What is the optimum throughput N_{opt} in cars/hours when the average traveling time is 20% longer than t_{opt}. (The Trinity Study seems to indicate a value of N_{opt}=4000 cars/hours, see Fig.2 below)
3. What is the maximum throughput N_{cong} in cars/hours when the motorway is heavily congested, but the traffic is still flowing? We define traffic as congested, when the average travelling time t_{cong} is twice the optimal average travelling time t_{opt}. (The Trinity study seems to indicate a value of N_{cong}=5000 cars/hours, see Fig.2 below)

Figure 2: Simulation Results as shown on the [TCD Project Website]

Note: The travelling time t_{opt} and t_{cong} as well as the throughput figures N_{opt} and N_{cong} depend of course on your assumptions about the traffic mix, i.e. the distribution of vehicle types and drivers behaviour that you have considered as given. Make sure that you clearly document your assumptions.

We are facing two major changes:

- An increase in the number of fully electrical vehicles (with a different acceleration / deceleration factors), and
- An increase in the number of autonomous or partially automated cars (both electrical and conventional) following an improved driving strategy.

The aim of the simulation study is to investigate the influence of these two parameters on N_{opt} and N_{cong}.

You may use components from the Motorway Simulation Study presented in class. When re-using code or design elements, refer to the version uploaded on Moodle.

Deliverables

The project has two deliverables:

1. A final report in .pdf format describing your simulation study should have maximal 6 pages in IEEE conference format and follow the outline structure given below

2. A .zip file with the code as (one or more) Jupyter Notebook files and any additional data files and documentation that may be required. Each Jupyter Notebook file (in .ipynb format) should be accompanied by a text document (in .pdf format) that describes the Notebook file.

The final report will be uploaded through the Turn-it-in link provided on Moodle.

For evaluation criteria please check the Rubrics given at the end of this project outline.

The Structure of the Final Report

Abstract with Keywords

1. Introduction
   In this section you introduce the problem you intend to investigate and articulate the research question you intend to answer.

2. Literature Review
   To the extend you have referred to the literature for model parameters give a summary of your sources and the parameter values you have extracted. When you refer to data provided in class use as reference the material provided on Moodle.

3. Methodology
   Describe the sequence and possibly intermediate stages of your development and give references to the relevant section of code in the Jupyter Notebook file.

4. The Simulation Model
   This section should give a clear description of the key components of the simulation model. There is an interaction between vehicle types, driver behaviour and the overall traffic generation model. Explain the choices you have made. When your study is based on particular parameter settings include them clearly readable in tabular format. Subsections should cover the following aspects:

   4.1. Model for vehicles
   4.2. Model for the behaviour of human drivers
   3.3. Model for autonomous or computer assisted driving
   3.4. Model for the Motorway section
   3.5. Model for Traffic Generation
   3.6. Data Collection

5. Results and Interpretation
   Report the results of your simulation study and give an interpretation of the same. In particular check if your results are consistent with data published in the literature and/or common sense. Should there be major deviations, discuss possible reasons for the same.

6. Conclusions and Future Work
   Discuss how your research could be improved and suggest problems for future research.

7. References

Rubrics

Grade Criterion	Solid H1 > 80%	H1 > 70%	H2.1 > 60%	H2.2 > 50%	PASS > 40%	FAIL < 40%
Methodology (10%)	All elements of project requirements have been thoroughly addressed.	All elements of the project requirements have been thoroughly addressed.	Some minor requirements missing from project.	Multiple omissions from the project. The project may contain parts that are not relevant.	Major parts of the project are missing. The project may contain parts that are not relevant.	The solution bears no resemblance to the project requirements at all.
Simulation (40%)	An excellent, thorough simulation was carried out. Effort exceeds the requirements.	An excellent, fully complete simulation was carried out. The results go beyond the minimal requirement.	A very good and largely complete simulation was carried out.	A good and largely complete simulation was carried out.	An adequate simulation was carried out. Some logical errors exist.	Little or no simulation carried out.
Code Format/Style (20%)	Code is elegant and fully commented. There are no syntax or logic errors, and no excess code used. The implementation significantly exceeds the module requirements	Code is fully commented. There are no syntax or logic errors, and no excess code used. The code executes without problems	Code is partially commented. There are few syntax or logic errors, and a minimal amount of excess code used.	Code is partially commented. There are several syntax or logic errors, and use of excess code.	Code is poorly commented. There are many syntax or logic errors, and excess use of unnecessary code.	Code is barely commented. There are many syntax or logic errors, and excess use of much unnecessary code.
Evaluation & Results (20%)	Models are fully evaluated. Results are thoroughly discussed. There is significant reflection on the challenges faced in this project and possible resolution to remaining problems	Models are fully evaluated. Results are presented and thoroughly discussed. There is significant reflection on the challenges faced in this project.	Models are evaluated. Results are presented and thoroughly discussed. There is very good reflection on the challenges faced in this project.	Models and results are presented and appropriately discussed. There is good reflection on the challenges faced in this project.	Cursory evaluation of models. Cursory discussion of results. There is some reflection on the challenges faced in this project.	Little to no evaluation of model. Little to no discussion of results. There is no reflection on the challenges faced in this project
Quality of Writing (10%)	Very well written, with no language errors. All figures are well conceived and read-able. The IEEE template is strictly adhered to. Report does not exceed the length limits. References are appropriately and correctly used.	Well written, with no (large) language errors. All figures are well conceived and read-able. The IEEE template is adhered to. Report does not exceed the length limits. References are appropriately and correctly used.	Main document has a few language and/or style errors. Figures are well presented. IEEE template and length limit are adhered to. References are complete, and correctly used.	Main document has a few language and/or style errors. Some figures are may be hard to read. IEEE template and length limit are largely adhered to. References are complete, and correctly used.	Main document is readable with some language and/or style errors. Figures may be hard to read or presented in a suboptimal manner IEEE template may have been broken. References are mostly complete and correctly used.	Littered with typos, and/or poor use of English. IEEE template not used. Figures may be hard to read. References (if any) are probably incomplete.