Simulation Analysis & Optimization (2023)
Projects

Below are suggestions for a simulation project. You may propose your own project, discuss this with the teachers.

You work in teams of 3 people. Enroll your teams via Canvas → People → SAOgroup. During the lecture / tutorial hours we can discuss questions that you may have, and hear your progress. The output of the project consists of (i) a written report, and (ii) a presentation. The report is to be handed in ultimately Sunday 2 April (23:59 hr) via Canvas. Requirements of the report are listed at the last page of this document. The presentations will be held on Monday 3 April (12:30-14:00).

Project Guidelines

The projects concern networks, logistic systems, or business processes in which certain actions impact the performance, the profits, or the efficiency, although with uncertainty. To study these impacts, you develop a simulation model of the system, implement the model in computer program written in Python, R, or Matlab/Octave, and then execute the program in order to obtain estimations. The next step is to implement several strategies of actions in order to find an optimal solution.

For each project a reference paper is provided in which the details of the system are described, what the ingredients are, and what the objectives are. Your task is to study the paper, and understand the system. Then you develop the conceptual, or mathematical model of the system, meaning what are the variables, what are the probability distributions, what are the relations between the variables, what are the output variables, the objective function, etc. Next step is to describe these in a simulation model, and write the simulation program.

You need to model the random input variables of the system with probability distributions from which you can sample. When data are available, you might try to find a fit by statistical procedures and tests. But, since the course is about simulation and not data analysis, we do not provide you with data. It is fine when you consider theoretical distributions that are appropriate for the system.

1 Traffic Lights

In this project you are asked to model and simulate an intersection of two roads with automobile traffic regulated by traffic lights. The purpose is to experiment with several traffic light policies, and optimize with respect to waiting times.

References

[1] M.A. Kamran et al (2017). Traffic light signal timing using simulation. Communications on Advanced Computational Science with Applications 2017 (1), 1-11. Link

`https://www.researchgate.net/publication/314288631_Traffic_Light_Signal_Timing_Using_Simulation`

2 Elevator

In this project you are asked to model and simulate a multi-floor elevator system. The purpose is to experiment with several elevator policies, and optimize with respect to waiting times.

References

[1] M. Henriques (2019). Analysis of an elevator system using discrete event simulation: case study. *International Journal for Quality Research* 13(4), 823-836. Link

`https://www.researchgate.net/publication/337498024_ANALYSIS_OF_AN_ELEVATOR_SYSTEM_USING_DISCRETE_EVENT_SIMULATION_CASE_STUDY`

3 Boarding a Plane

In this project you are asked to model and simulate the boarding process of an airplane. The purpose is to experiment with several boarding policies, and optimize with respect to total boarding time.

References

[1] S. Jafer & W. Mi (2017). Comparative study of aircraft boarding strategies using cellular discrete event simulation. *Aerospace* 4(4), 57. Link

`https://www.researchgate.net/publication/321349696_Comparative_Study_of_Aircraft_Boarding_Strategies_Using_Cellular_Discrete_Event_Simulation`

4 Healthcare Logistics

Many logistical issues in healthcare are studied by simulation. For instance, capacity planning: how many resources are required to offer good quality of long-term care.

References

[1] K-H. Bae et al (2019). Simulation modelling of patient flow and capacity planning for regional long-term care needs: a case study. *Health Systems* 8(1), 1-16. Link

`https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6508013/`

5 Social Network

Several network issues could be modelled and analysed by computer simulation.

- In this project you are asked to model and simulate a virtual social network. The purpose is to experiment with several methods to generate social networks (as random graphs), and to assess these by their dynamics, and by metrics such as density, clustering, and centralization.

References

[1] Y. Meleshko (2019). Computer model of virtual social network with recommendation system. *Innovative Technologies and Scientific Solutions for Industries* 2(8), 80-85. Link

`https://www.researchgate.net/publication/334075858_COMPUTER_MODEL_OF_VIRTUAL_SOCIAL_NETWORK_WITH_RECOMMENDATION_SYSTEM`

- In this project you model and analyse the impact of misinformation in social networks.

References

[1] M. Azzimonti, and M. Fernandes (2018). Social media networks, fake news, and polarization. Working paper w24462. National Bureau of Economic Research. Link

`https://www.nber.org/papers/w24462`

Project Report

The report is a group project. The report should include: (i) abstract, (ii) content, (iii) introduction (description of the investigated system, objective of the study), (iv) description of the conceptual model(s) of the system, (v) description of the simulation program, (vi) validation and verification, (vii) results, (viii) interpretation of your findings, (ix) conclusion, (x) references.

Title Title of the report. The names of all group members, the class and university names, the date (month & year).

Abstract Provides a condensed and concentrated version of the full text. Can be understood without reading the report.

Content A list of the sections and subsections, and their page numbers.

Introduction Describe the (real-world) system that originates your study. What kind of problems in this system are interesting to study? What are your objectives to investigate in your study? Is there related scientific literature? Illustrate with figures.

Conceptual model Describe your conceptual model of the real-world system. This means to introduce notation, variables, and parameters. Next come the state process and some other mathematics, such as probability distributions, relations, etc. What kind of simplifications did you make? Mention the parameters you will estimate, and the policies that you consider (if applicable).

Simulation model Clearly summarize the design of the (discrete-event) simulation program. Typically you might use flow diagrams.

Validation and verification In case you have collected data of the real system you need to check whether the conceptual model is a correct representation.

Always, you need to describe the methods you applied to verify the correctness of the simulation program.

Results Display the results in graphical form and some tables. When you report estimates, mention sample sizes or the number of replications to compute these, and give confidence intervals.

Discussion Correctly interpret your results. Constructively address sources of error and methodological difficulties. Place your results in context and draw implications from them.

Conclusion Conclude with a short summary of your work, and an outlook on issues that could be studied in the future.

References A list of papers, and/or reports from literature, and websites that you have consulted.