MIE1613H: Stochastic Simulation (Winter 2023) – Project Assignment

The project assignment can be summarized as follows: define an Engineering problem related to your application area of interest and use simulation to answer it.

You should start by defining a decision making problem involving a stochastic dynamical system. The problem can be motivated by a research paper that you read, or be related to your own research topic, work experience, or be a topic of general interest to you. Regardless of the motivation for the problem, the project **must be based on academic research papers** (see below for further details and examples).

Examples of the type of problems to consider include:

- comparing different system designs or policies with respect to specific performance measures of the system (e.g., scheduling policies in queueing systems, replenishment policies for inventory systems, re-balancing policies for portfolio management.)
- applying simulation methodology covered in the course or from the simulation literature to your application area of interest (e.g., applying variance reduction techniques to a certain queueing problem, comparing different approaches for pricing American options, applying methods for estimating financial risk measures to real data).
- investigating / comparing various methodologies for a class of problems, e.g., comparing different simulation optimization methods for a class of difficult problems previously considered in the literature.

To find a paper in your area of interest, you can refer to journals and conference proceedings in the areas of Operations Research and Analytics, for example, *Operations Research, Management Science, IIE Transactions, Queueing Systems, European Journal of Operational Research*, *ACM Transactions on Modeling and Computer Simulation*, and the proceedings of the *Winter Simulation Conference* (https://informs-sim.org/). You can find a list of example papers from different areas at the end of this document. The papers do not have to be directly related to simulation or use simulation as the solution approach. For example, you may choose a paper that introduces a stochastic model and uses exact/numerical methods to analyze it (e.g., Wu et al. 2018 or Yom-Tov and Mandelbaum 2014). For your project, you can then consider reproducing the results of the paper and answering a new question that is not considered in the paper; consider extensions of the model (by relaxing one or more assumptions of the model in the paper), or a simplified version of the model (if it is too complex). Alternatively, the paper may introduce a new methodology or approach for analyzing a particular problem or class of problems using simulation (e.g., Ouyang and Nelson 2017 or Andersen and Broadie 2004). In that case, for your project you can consider applying the approach to a different stochastic model, or reproducing the results in the paper using data from another source. Be creative!

You are expected to complete this assignment **individually**. However, with the permission of the instructor you may work on a correspondingly larger project in a group of 2 students. This must be stated in your initial proposal (see below).

Deliverables and deadlines: The project will have two deliverables.

- A **proposal** to be submitted in PDF format on Quercus (due **March 9th**). The proposal length is limited to **maximum 3 double-spaced pages**. **The proposal must include the following three sections**: (1) Background: provide background information on the application area / topic you are considering and why; (2) Literature review: Provide a discussion of the paper (or papers) your project is based on and describe the scope and focus of the paper(s); (3) Proposal: provide a clear description of what you propose to do, including the question you are planning to answer; and an outline of the analysis that you are planning to perform. Feedback will be provided on the proposal.
- A **final report** to be submitted in PDF format on Quercus (due **April 27th**). The length of your final report must be a **maximum of 12 one-half spaced pages** (including figures, tables, and references) with an Appendix of unlimited size which must include the source code of your simulations. Since the project mark is a substantial part of your final mark, the amount of work (modelling and analysis) should be relatively substantial.

Evaluation is based on your creativity in defining the problem, correctness and thoroughness of the analysis, the extent to which you apply the learnings from the course in your project (e.g., controlling error, input modelling using real data, design of simulation experiments, and simulation optimization methods), as well as the quality of your written report and the presentation of the results. Your entire project must be very well explained, and must include (among possibly other sections) (*i*) an *Introduction* section where you provide background information on the application and provide an outline of the report; (*ii*) a *Problem Description* section where you clearly define the problem and the question(s) you are trying to answer; (*iii*) a *Model Description* section where you describe the simulation models that you have developed; and (*iv*) a *Results* section where you explain the experiments and output analysis that you have performed to answer the question, and discuss the results. If you make use of ideas, results, or methods from books, papers, or any other sources then this should be mentioned and the sources must be cited in the report.

You may (and are encouraged to) contact the instructor regarding your choice of the topic, the feedback you receive on the initial proposal, and additional questions during the project.

References

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- Inventory / supply chain management:
  - Diamant, A., Milner, J., Quereshy, F., & Xu, B. (2018). Inventory management of reusable surgical supplies. Health care management science, 21(3), 439-459.
  - Sarhangian, Vahid, et al. (2017) Threshold-based allocation policies for inventory management of red blood cells. Manufacturing & Service Operations Management 20(2), 347-362.
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  - Gilbert, K. (2005). An ARIMA supply chain model. Management Science, 51(2), 305-310.
- Integration of simulation with data analytics and machine learning:
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- Financial engineering:
  - Righi, M. B., & Borenstein, D. (2018). A simulation comparison of risk measures for portfolio optimization. Finance Research Letters, 24, 105-112.
  - Chen, Nan, and L. Jeff Hong. Monte Carlo simulation in financial engineering (2007) Winter Simulation Conference. IEEE, 2007.

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