PROBABILISTIC OPERATIONS RESEARCH MODELS

MATH/CSCI 4310/8316

Project 3 – Queueing and Simulation Models

Disclaimer

I have the right to slightly modify the wording to match my intention of the description of this project. You may ask questions at any time if you do not understand the wording of the project.

Coding Instructions

If you know how to code, then you can skip this part and go to Project Description. If you never coded before (or are not good at coding), then this project is a good reason for you to start. I recommend that you start with Python, but you may choose whatever programming language you like. You can find thousands of Python tutorials online. One that I recommend is https://www.learnpython.org/. Doing the "Learn the Basics" chapters should be sufficient for this project. I also recommend using Anaconda to manage your Python packages. You can visit the Web address https://www.anaconda.com/distribution/ to install the Anaconda Distribution. The open-source Anaconda Distribution is the easiest way to perform Python/R data science and machine learning on Linux, Windows, and Mac OS X. With the Anaconda Distribution, you can download thousands of Python/R packages and manage libraries, dependencies, and environments with Conda. I recommend using the Python 3.10 version. If you are not familiar with Anaconda, then I recommend that you watch the following quick tutorial to start: https://www.youtube.com/watch?v=5mDYijMfSzs. Anaconda comes with Spyder and Jupyter Notebook. Both are good environments for you to write and compile your code.

Project Description

Using some programming language (Python, C/C++, Java, R, MATLAB, Maple, Mathematica, etc.), simulate an M/M/1 queue model for 500 hours. For this model, the interarrival time follows an exponential distribution with a rate of 3 per hour. The service time is exponentially distributed with a rate of 4 per hour. You should run the simulation for 30, 100, and 1,000 replications. For each set of replications, you should perform the following output analysis.

(a) Compute the expected time in queue, expected time in the system, expected queue length, expected number in the system, and expected portion of time that the server is busy (utilization).
(b) For each parameter computed in part (a), find a 95% confidence interval.
(c) Statistically compare the results from part (a) with the theoretical values.
(d) Statistically compare the results from part (a) with the results produced by a similar simulation model using AnyLogic.

You may use any generic random number generator to create your random numbers. I believe that in less than 5 minutes you can easily find another person's code online to perform these simulations. However, you should remind that copying someone else's work is a violation of UNO's academic integrity policy, and such an action may result in academic sanctions.

Graduate Students Only

In addition to the M/M/1 queue, simulate a G/M/1 queue model for 500 hours. For this model, the interarrival time occurs according to the following general distribution $f(x)$. The service time is exponentially distributed with a rate of 4 per hour. You should run the simulation for 30, 100, and 1,000 replications. For each set of replications, you should repeat the output analysis of parts (a) and (b) described for the M/M/1 queue.

$$f(x) = \begin{cases} \frac{1}{2}x & \text{if } 0 \le x \le 2 \\ 0 & \text{else} \end{cases}$$

Report

You need to prepare a technical report describing your implementation and the results obtained. Standard format, margins, and appropriate grammar are expected. This report has no page limit. The technical report should include an introduction, any relevant assumptions made, computer implementation, results obtained by the simulation, analysis of results, and conclusion. This document must be well-written and formatted professionally. **No need for an executive summary**.

Grading

40% to the technical report and 60% to the correctness of your solutions.