

Bonus assignment Simulation and Statistical Analysis 2021/2022

Setting

Given is a supermarket where there are six cash registers available. Five of these cash registers are regular ones, the other one combined cash register/service desk. The customers arriving at the cash registers decide where they are going to queue up by looking at how many customers are waiting in line at each of the cash registers. Obviously, service desk customers (e.g. cigarettes, lottery, stamps, etc.) can only line up for the service desk. For that reason, the service desk has two queues: one for the regular customers and one for service desk customers and will give priority to the latter one. When returning the total queue length, this service desk will return the sum of the lengths of both queues such that customers can properly decide on where to line up (shortest queue).

Regular customers arrive according to a Poisson process at a rate of 1 per minute. Service times are normally distributed with mean 2.6 minutes and a standard deviation of 1.1 minutes, where the smallest service time is 1 second.

Service desk customers arrive according to a Poisson process with mean interarrival time 5 minutes and a normally distributed service time of on average 4.1 minutes and a standard deviation of 1.1 minutes, where again the minimum service time is 1 second.

The combination desk is always open and at minimum two additional cash registers are. But if for all open cash registers there are at least 4 people in queue, an additional cash register will open (where the maximum cannot be exceeded). If a cash register faces an empty queue, it will try to close down (where we cannot go below the minimum. Try to be pragmatic here concerning the implementation)

Implement this setting in java, using the engine provided and modifying it where necessary, but don't start making large modifications and optimizations.

The output measures of interest are the mean delay of customers, this being the mean delay of regular customers, the mean delay for service desk customers and the delay overall, as well as average queue length. Provide for these four measures a 95% t-confidence interval. Ensure that you can do proper statistics, thus ensuring that all assumptions of such confidence interval are satisfied. The statistical analysis can be performed in Matlab.

For PR reasons the supermarket wants to make some promises to the customers. More specifically for each type of customer (regular and service desk), the supermarket wants to promise a maximum delay and a maximum queue length that can be guaranteed 95% of the time. Provide this and explain how you guarantee this.

What you must produce

- A Java 11 project that can run the complete simulation
- A Matlab/Java software bundle that does the data analysis on collected data (could be combined with previous)
- A report (max 5 pages) showing, visualizing and discussing the results and drawing conclusions, describing your model and describing your choices. Those page numbers are a maximum since we don't know how many pictures you want to include.
- A clip in mp4 format (h.264) with narrations of maximal 5 minutes where you take us through your code, demo your product and tell us what nice features are in there. You e.g. can use the open source OBS studio for that.
- In the report/clip be sure to highlight
 - What your model is
 - How you implemented the service desk
 - The confidence intervals
 - How you found the performance guarantees
- You are allowed to work in groups of 3 to 6 students. If you work in smaller groups then this does not change the grading rubrics. Obviously, you are allowed to collaborate within your group, but not with other groups.

What you should not be doing is

- Using add-on libraries to do things
 - You can use the built-in random number generator, but for generating random variates other than $U(0,1)$ or $N(0,1)$, you must demonstrate that you master techniques for generating random variates.
 - For tests that we discussed in class: use your own code. If you want to do fancier stuff e.g. the Wilcoxon rank sum test or signed rank test, you can use the Matlab functions for that even though they are in toolboxes. You are also free to use the `tinv` function to find values from the t-distribution.
- Using an alternative engine
- Using Matlab toolboxes, unless explicitly allowed
- Copying code from the internet. That's plagiarism
- Having others write code. That's plagiarism
- List personal information in your code like name, student number. Your code will be off-site plagiarism checked
- Waste time making a GUI

What you should be doing is

- Start early; I really mean this!
- Exploit the fact that you learn things during the labs
- Contribute homogeneously to the project group
- Use the project to show that you master the course material
- Motivate the choices in your report

Timeline for the project MS

- By 12 April 2022: Indicate your group composition (or lack thereof) via Canvas
- Before 23 May 2022, 11:00 Maastricht time: hand in all deliverables through Canvas

External packages that you may use

- <https://github.com/bastibe/Violinplot-Matlab>

FAQ

- Can I use Python? -> NO