1) What questions lead you to this simulator extension?

The questions that led to the extension of the simulator were primarily focused on exploring the behavior of more complex queueing systems than the classic M/M/1 model. The central question was: "How does the M/M/n queue model with Supermarket scheduling perform under different load conditions, and how does it compare with the traditional queueing models in terms of efficiency and service time?"

2) Why do you think they are relevant?

These questions are highly relevant in both academic and practical domains. The traditional M/M/1 queue is a basic model that doesn't account for real-world scenarios where multiple servers are common. For instance, supermarkets, call centers, and network routers often employ multiple servers. Understanding the dynamics of such systems can lead to more efficient designs and better customer service. Moreover, the Supermarket scheduling algorithm, which dispatches jobs to the least loaded server, can be an effective strategy for load balancing and is thus worthy of detailed study.

3) How did you do that?

The extension involved implementing additional classes and methods within the existing simulator framework to support the M/M/n queueing logic and Supermarket scheduling algorithm. The following modifications were made:

- A new `Server` class was created to represent individual service channels in an M/M/n system.
- The scheduling algorithm was enhanced to allocate jobs to the server with the shortest queue.
- Simulation parameters were refined to allow varying the number of servers (n) and adjusting the arrival and service rates.

During the implementation, a surprising behavior was observed where, under certain conditions, adding more servers did not significantly reduce the average waiting time, indicating a point of diminishing returns. Additionally, the Supermarket scheduling algorithm sometimes led to uneven server utilization, an interesting phenomenon that warranted further investigation.

4) What is the answer to the original questions you asked? Why is that? What is your interpretation of the results you obtained?

The answer to the original question is that the M/M/n queue with Supermarket scheduling demonstrates better performance than the M/M/1 queue as expected, but with notable nuances. The efficiency gain from adding more servers tapers off beyond a certain point, which suggests that there is an optimal number of servers beyond which additional resources do not proportionately benefit the system. The uneven server utilization observed with Supermarket

scheduling hints at the complexity of load balancing and suggests that while it can reduce wait times, it may introduce new challenges in server load distribution.

My interpretation of these results is that while Supermarket scheduling can improve system performance, its effectiveness is highly dependent on the specific parameters of the system, such as arrival rates and the number of servers. The results underscore the importance of a tailored approach when designing and managing complex queueing systems.