Problem 3 (Queues): Analysis

1. How does the static compare to the random?

- **1.** Static (Non-Randomized) Servicing:
  - ⇒ Each clerk serves customers at a fixed, consistent rate. For example, if the rate is "1 customer per minute," every customer takes exactly one minute.
  - ⇒ Predictable service times ensure steady customer handling, keeping the line moving and minimizing wait times. That's the way Queue behavior determine.
  - ⇒ For load balancing, clerks handle work consistently; matching arrival and service rates keeps the system efficient.
  - ⇒ customers don't face unexpected delays, so their wait time is shorter.
  - ⇒ Queue length is steady as the service is uniform and the line stays manageable without sudden spikes.

- **2.** Randomized servicing:
  - ⇒ unlike static serving, clerk service time varies. For instance, it potentially being 50% faster or slower than expected rate, causing unpredictability.
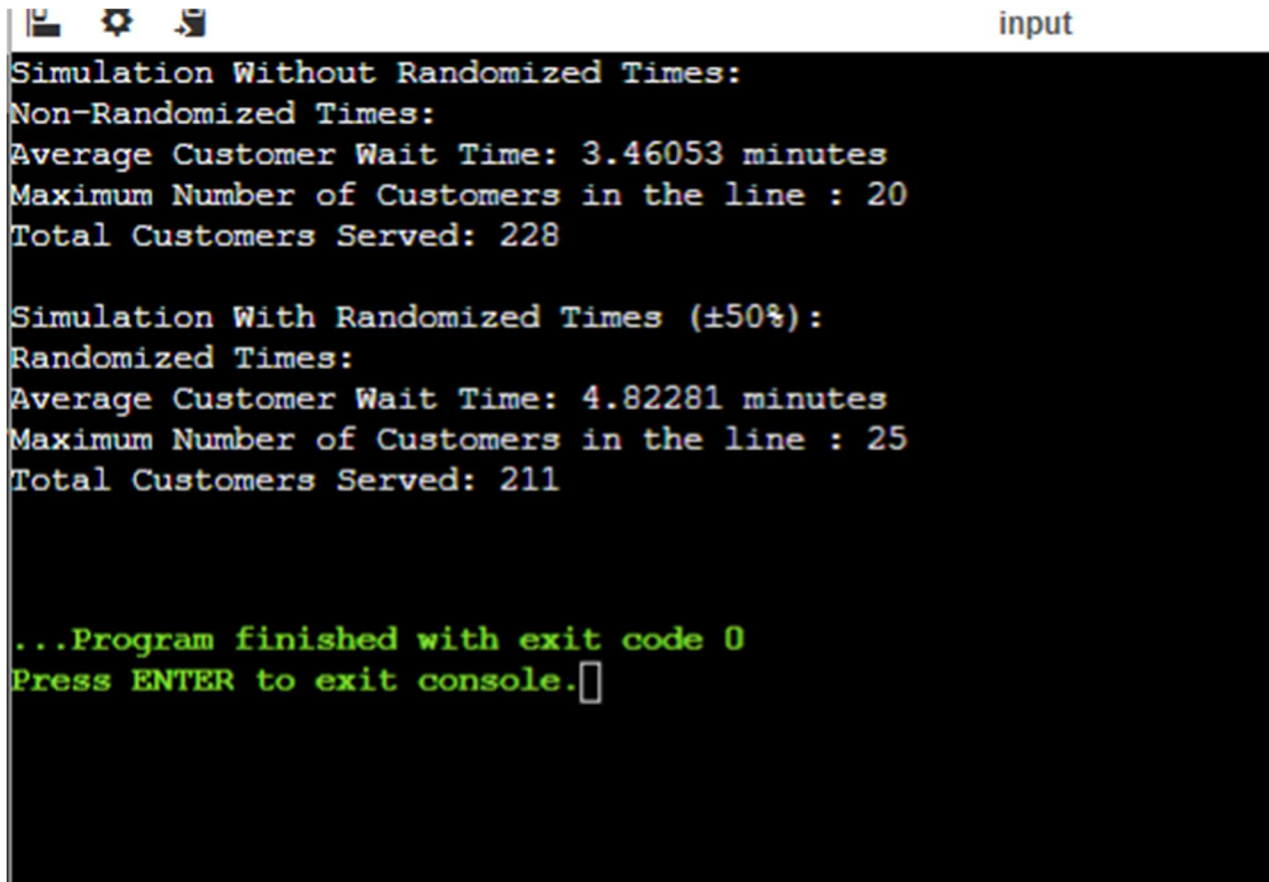 - ⇒ Random service times can delay some clerks, causing longer lines and influence on Queue behavior.

⇒ If one clerk is delayed, others can't always help right away, causing system bottlenecks in case of lead balancing.

⇒ Unpredictability makes some customers wait longer.

⇒ Delays cause the line to grow, lead to longer queue.

⇒ Dynamic adjustments may need to add or remove clerk based on queue length.

Why Are They So Different?

⇒ Static servicing runs smothly due to predictability, while randomized servicing can cause delays and bottlenecks due to unpredictability

⇒ Random servicing is chaotic due to unpredictable customer arrivals and service times, making system adjustment harder.

⇒ If a clerk is slow, delays build up, causing longer wait time and bigger queues.

Here is the output of the Queues program:

```
Simulation Without Randomized Times:
Non-Randomized Times:
Average Customer Wait Time: 3.46053 minutes
Maximum Number of Customers in the line : 20
Total Customers Served: 228

Simulation With Randomized Times (±50%):
Randomized Times:
Average Customer Wait Time: 4.82281 minutes
Maximum Number of Customers in the line : 25
Total Customers Served: 211




...Program finished with exit code 0
Press ENTER to exit console.
```

What is my average customer wait time?
= Average customer wait time: **3.46053 minutes**

What is the max number of customers in the line?
= The max number of customers in the line **: 20**

If you randomize servicing and arrival times by +-50% how does this change the results?
= Average customer wait time: ≈ **4.82281 minutes**
= The max number of customers in the line : **25**