**Queueing System** (Fast Food Restaurant)

The queuing system in a fast-food restaurant is a prime example of a process that can be modeled discretely, as it involves customers arriving, waiting, and being served at distinct intervals of time. In this system, customer arrivals and service completion occur at measurable intervals (every 5 minutes), making it suitable for discrete event modeling.

* Time Steps: **Every 5 minutes**
* State Variables:
  + **Number of Customers in Queue (Q):** The count of customers waiting in line to be served.
  + **Number of Customers Being Served (S)**: The count of customers currently being served.
  + **Number of New Customers Arriving (A)**: The count of new customers arriving at the restaurant.
  + **Service Rate (μ)**: The rate at which customers are served per unit time.
  + **Arrival Rate (λ)**: The rate at which new customers arrive per unit time.
* Rules or Equations:
  + **Customer Arrival:**

λ)

where ​ is the number of new customers arriving at time , and λ is the average arrival rate of customers per 5 minutes.

* + **Queue Dynamics:**

Where is the number of customers in the queue at the next time step, is the number of customers in the queue at the current time step, and is the number of customers being served at the current time step.

* + **Service Completion:**

whereis the number of customers being served at the next time step, and is the average service rate (customers served per 5 minutes).

* + **Queue Length Update:**

This equation accounts for customers who were served during the current time step and updates the queue length.

* Duration: 1 hour/60 mins (operation time), 5 mins every update = **12 times steps.**
* Assumptions:
  + **Arrival Rate (λ):** 3 customers per 5 minutes
  + **Service Rate (μ)**: 2 customers per 5 minutes
  + **Initial Queue Length (Q\_0)**: 0
  + **Initial Customers Being Served (S\_0)**: 0
* Step-by-Step Calculation: (how it evolves over time)

 New Customers Arriving (A): 3

 Customers Being Served (S): 0

 Customers in Queue (Q): max ( 0 + 3 – 0 , 0 ) = 3

* Representation:

|  |  |  |  |
| --- | --- | --- | --- |
| Time Step | New Customer Arriving (A) | Customer in Queue (Q) | Customer Being Served (S) |
| 0 | 3 | 3 | 0 |
| 1 | 4 | 5 | 2 |
| 2 | 2 | 5 | 2 |
| 3 | 3 | 6 | 2 |
| 4 | 2 | 6 | 2 |
| 5 | 3 | 7 | 2 |
| 6 | 4 | 9 | 2 |
| 7 | 1 | 8 | 2 |
| 8 | 3 | 9 | 2 |
| 9 | 2 | 9 | 2 |
| 10 | 2 | 9 | 2 |
| 11 | 4 | 11 | 2 |

**Conclusion:** Through the development of this model, it emerged regarding the behavior of a queueing system in a fast-food restaurant. The simulation above demonstrated how varying customer arrival and service rates directly affect the length of the queue. As expected, the queue tends to grow when the arrival rate exceeds the service rate, and shrinks when the service rate is higher. Refinements to the model could involve introducing more variables, such as customer patience, which would account for customers leaving the queue if their wait time is too long. Additionally, expanding the model to include multiple service counters or more complex customer behavior could provide deeper insights into optimizing staffing and service efficiency in the restaurant.