CX 4230 Spring 2021 Project Proposal

Members:

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Project Description:

The project aims to construct an event-driven system that simulates checkout lines in grocery stores. Grocery stores usually have a large number of customers in certain time intervals of a day, while in other time intervals, they may have much fewer customers. This makes it inefficient to keep a fixed number of checkout lines open regardless of the number of customers because each open line adds to the total operation cost, such as the hourly pay for cashiers, so it is expensive to keep all lanes open when there are few customers. However, if there are few open lines during peak hours, the customers may get dissatisfied and may not continue to visit the store as frequently, which also leads to a potential loss in revenue. Our project will simplify such situations into an event-driven simulation system for a grocery store that focuses on the most important factors. Our model assumes customers can use three types of checkout lines including regular cashier, express and even self-serve lines and provides a possible way to give an economically optimal combination of each type of lines with respect to the number of customers who are ready to check out.

Goals:

We would like to investigate

1. for a varying number of checkout lines and amount of traffic in the grocery store,
    a. What is the expected (average) queue length?
    b. What is the maximum/average waiting time for a customer?
    c. How many lines need to be opened to avoid congestion?
    d. How many lines need to be opened to maximize utility but minimize cost if both are quantifiable with reasonable data?
2. If the introduction of the following types of lines increases the throughput of the system.
    a. regular/cashier-checkout
    b. Express-checkout
    c. Self-checkout
3. If the customer behavior, namely different criteria for selecting a line, affects the performance metrics of the system.
    a. Pure random
    b. Least person
    c. Least item
4. The possibility of developing an adaptive algorithm for opening and closing lines depending on the amount of traffic.

More goals can be defined as we start building our project ...

Assumptions and Key System Behaviors:

- The system boundary is limited to the checkout zone of a grocery store: picking up groceries from the shelf is not simulated.
- Each customer performs the following activities while in the system:
    - Arrive at checkout zone
    - Pick a checkout line
    - Wait in that checkout line
    - Scan Items (by the cashier or themself)
    - Pay for the grocery purchase
    - Leave the checkout zone
- Grocery items are generic. We count their quantities but ignore their types.
- Unless the line is closed, customers do not leave or switch lines once they pick one.
- Customers may use express-checkout only if they strictly have no more than 10 items.
- Customers arrive at the checkout zone at uniformly distributed intervals.
- The traffic to the checkout zone (customer arriving rate) can vary with the hour in a day.
- The time to scan a grocery item is normally distributed (?)
- The time to complete grocery payment is normally distributed.