

Leslie Brown
ECE 6730

Coffee Shop Project Checkpoint

For my term project I am creating a model of a coffee shop. The goal of the project is to use the coffee shop model to simulate a variety of various operational scenarios in order to evaluate resulting store performance metrics.

Customers arrive at the coffee shop with arrival rates drawn from an exponentially distributed random variable with piecewise constant mean μ . The mean will be dependent on time of day as seen below. Note that the coffee shop is closed between 6:00 am and 10:00 pm.

Time of Day	Start	End	μ
Early Morning	6:00 AM	7:30 AM	2 min
Peak Morning	7:30 AM	9:30 AM	1 min
Late Morning	9:30 AM	11:30 AM	1.5 min
Mid Day	11:30 AM	1:30 PM	2 min
Early Afternoon	1:30 PM	3:00 PM	3 min
Late Afternoon	3:00 PM	5:00 PM	6 min
Early Evening	5:00 PM	7:00 PM	3 min
Evening	7:00 PM	9:00 PM	2 min
Late Evening	9:00 PM	10:00 PM	6 min

Customers are randomly defined as “take-out” or “stay-in” customers upon their arrival. Upon arriving at the shop they enter a FCFS queue which splits off to a number of different cashiers (which will be varied as an operational parameter). Once a customer reaches a register, they process a transaction for an amount of time given by a random variable uniformly distributed between 1 and 2 minutes. They then wait to receive their order from one the coffee shop’s baristas (again, number of baristas will be varied). The amount of time it takes to make a drink is dependent upon the number of baristas.

Upon receipt of their order, if a customer is a “stay-in” type, and a table is available, they will sit down and stay for an amount of time given by a random variable uniformly distributed between 5 and 30 minutes. If there are no empty seats upon a stay-in customer’s drink receipt, the customer will leave. Take-out customers always leave immediately upon receipt of their order.

During their stay at a table, a stay-in customer may get up and order another beverage if they see that the register line contains less than 3 people. Alternatively, if they have been there for a while ($> .5$ hours), they might leave if the store gets too crowded (more than 10 people in the register and drink lines, combined). Also, if the register line contains more than 20 people, potential customers may balk at how busy the store is and leave.

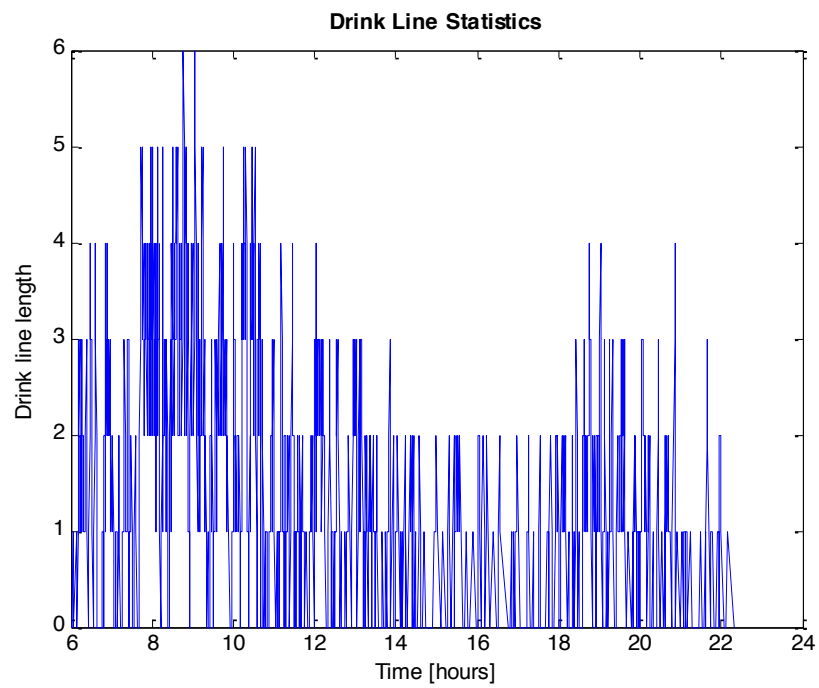
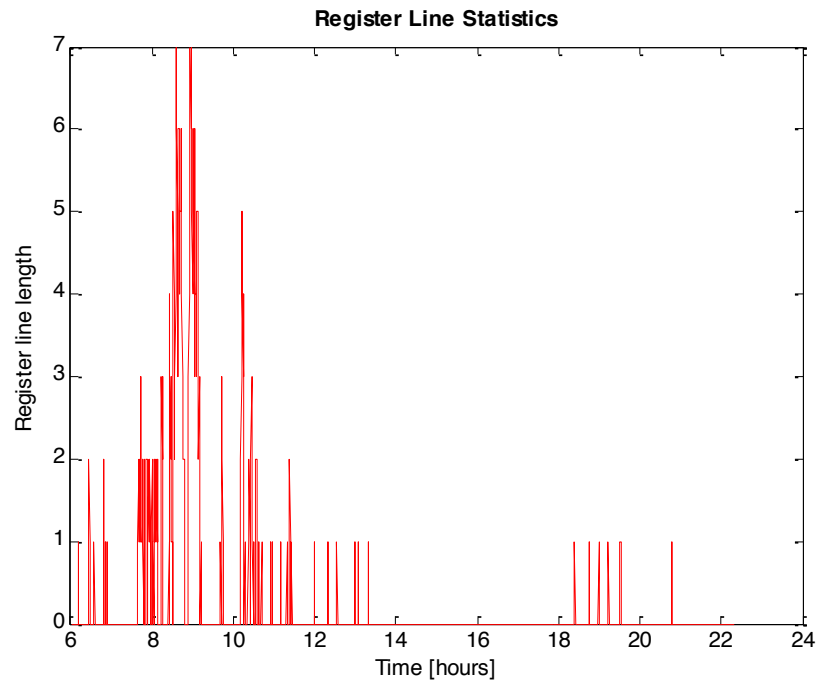
At this point, I have produced a piece of software which automatically generates the following performance metrics for user-specified operational parameters:

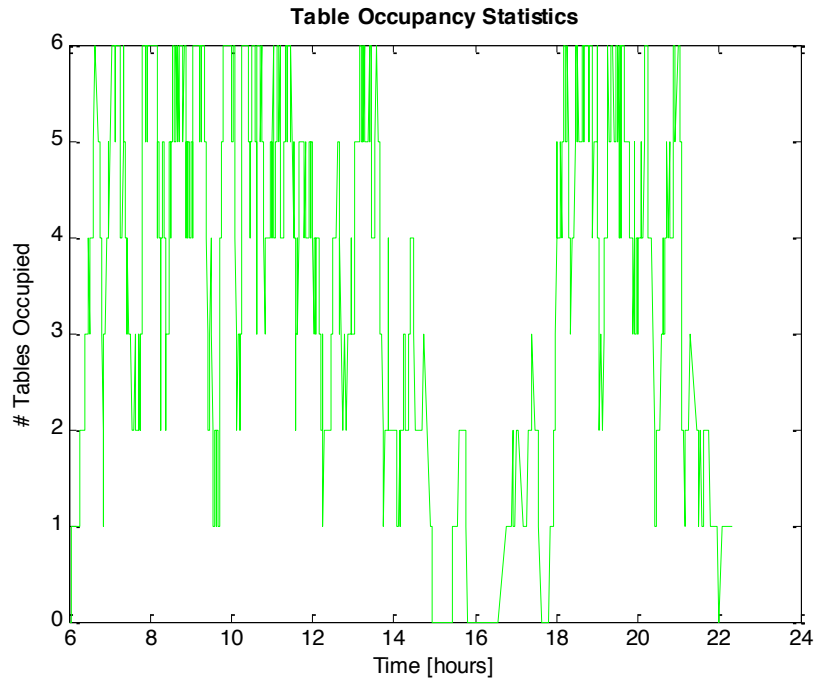
- Average customer wait time
- Average order to delivery time
- Peak register line length
- Number of lost customers

I have used the model to simulate day-long operational scenarios varying both number of cashiers and number of tables. The baseline was chosen to be a shop with 2 cashiers, 2 baristas, and 6 tables. A variety of performance analyses will be performed for cashiers varying from 1 to 3, baristas varying from 1 to 3, and tables varying from 4 to 10 (in increments of 2). So far I have computed the following statistics, all of which were computed for 2 baristas.

Cashiers	Tables	Avg Reg Wait [min]	Avg Drink Wait [min]	Longest Register Line	Lost customers
1	4	14.8	2.5	21	42
1	5	17.1	2.6	21	53
1	6	15.1	2.5	21	23
1	7	12.3	2.4	21	23
1	8	16	2.5	21	28
1	9	15.1	2.6	21	22
1	10	15.4	2.4	21	35
2	4	4.3	2.4	5	0
2	5	4.3	2.5	4	0
2	6	4.3	2.5	6	0
2	7	4.2	2.5	4	0
2	8	4.3	2.5	7	0
2	9	4.2	2.4	5	0
2	10	4.6	2.5	10	0
3	4	4.1	2.6	5	0
3	5	4	2.5	5	0
3	6	4	2.5	4	0
3	7	4.1	2.5	4	0
3	8	4.1	2.5	2	0
3	9	4.1	2.5	5	0
3	10	4	2.5	4	0

I have also computed some internal metrics to verify that the model is working correctly, such as the various line lengths and table occupancies over time, as shown below:





Work left to be done includes the following:

- Add the ability to compute the following performance metrics:
 - Percent idle time (cashiers)
 - Percent idle time (baristas)
- Make wait time for a drink dependent upon number of baristas
- Implement "staying at table" extended activity
- Run remainder of operational scenarios (using 1 and 3 baristas)
- Verify selected inter-arrival distribution times via research online or at a local shop
- Data analysis of performance metrics