Leslie Brown
ECE 6730

Coffee Shop Modeling and Simulation Project Proposal

Overview

For my term project I plan to create 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, such as staff utilization and customer throughput. First, a baseline model will be established and characterized. The baseline model will be based upon store statistics from either a study of an existing store or from local store available for investigation. Next, the impact of changing operational parameters (outlined below) on store performance will be characterized. The performance for different operational scenarios will then be analyzed and compared to the baseline performance.

In doing this project I hope to gain experience in dealing with a dynamic system where individual entities interact with one another, particularly gaining experience implementing extended and interruptible activities and triggered events.

Background

Prior to starting the project, an initial literature search was performed. Many of the studies and articles I encountered dealt with efficiently setting up restaurants (positioning of preparation areas, access to store, etc) or effectively serving fast-food customers. Reference [2] does a thorough job investigating how a variety of scenarios impact performance of a fast-food restaurant. Reference [1] performs an analysis similar to my project, though (as in [2]) customers are all presumed to be "take-out" customers. In my model, the possibility of customers staying and affecting the system (for instance, by putting off other potential stay-in customers, or by ordering a second time) will be taken into account. [4] is interesting for its description of asynchronous processing of drink orders, which I will be implementing in my model.

System Description

Customers arrive at the coffee shop with arrival rates drawn from a piecewise constant exponentially distributed random variable. Customers will initially either be take-out or stay-in upon their arrival. They will 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 uniformly distributed random variable. They then wait to receive their order from one the coffee shop's baristas (again, number of baristas will be varied).

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 uniformly distributed random variable. If, once they receive their order, there are no empty seats, a stay-in 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 line is short enough. Alternatively, if they have been there for a while (> .5 hours), they might leave if the store gets too crowded. Also, potential customers may balk at how busy the store is and leave.

Operational Parameters:

- Number of tables
- Number of cashiers
- Number of baristas

Performance Metrics:

- Percent idle time (cashiers)
- Percent idle time (baristas)
- Number of lost customers
- Average order to delivery time
- Average customer wait time

System Constants

- Customer arrival rates (non-stationary random process: modeled as piecewise constant)
- Maximum line length before customers balk
- Max store capacity before lingering customers will leave

Deliverables

By the end of the term I will have produced a piece of software which will automatically generate performance metrics for user-specified operational parameters. I will have used the model to simulate various operational scenarios and written an analysis of what the different impacts on performance metrics are.

References

[1] Curin, S. A., Vosko, J. S., Chan, E. W., and Tsimhoni, O. 2005. Reducing service time at a busy fast food restaurant on campus. In Proceedings of the 37th Conference on Winter Simulation (Orlando, Florida, December 04 - 07, 2005).. Winter Simulation Conference, 2628-2635.

[2] Farahmand, K. and Martinez, A. F. 1996. Simulation and animation of the operation of a fast food restaurant. In Proceedings of the 28th Conference on Winter Simulation (Coronado, California, United States, December 08 - 11, 1996). J. M. Charnes, D. J. Morrice, D. T. Brunner, and J. J. Swain, Eds. Winter Simulation Conference. IEEE Computer Society, Washington, DC, 1264-1271.

[3] Steven L. Jaynes , John O. Hoffman, Discrete event simulation for quick service restaurant traffic analysis, Proceedings of the 26th conference on Winter simulation, p.1061-1066, December 11-14, 1994, Orlando, Florida, United States.

[4] Gregor Hohpe, "Your Coffee Shop Doesn't Use Two-Phase Commit," IEEE Software, pp. 64-66, March/April, 2005

[5] Joo Seong-Jong, Stoeberl Philipp A., Fitzer Kristin, Measuring and benchmarking the performance of coffee stores for retail operations. In Benchmarking: An International Journal, p. 741-753. Emerald Group, Publishing Limited, 2009.