Math 324 Fall 2004
Assignment 3
Due: Oct 27, 2004

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This goal of this assignment is to give you a chance to use some of the probability distributions that have been discussed in class as part of a simulation of a real life situation. You should submit your solutions to this assignment as a written report. In other words, it is not enough to submit pages of computer output with no interpretation. If you wish to submit your analysis code, please attach it as an appendix to your report.

Simulating a queue

In this assignment you will simulate some queuing situations. Consider a supermarket with only one checkout stand. When a customer arrives at the checkout and there is no other customers there then they will be served immediately. Other wise they form a queue and wait their turn. A customers total time T is the sum of the amount of time where they are actually being served S and the time they spend waiting in the line W. Assume that a customer does not leave the queue until after they have been served (ie no giving up because the line is too long). If there is no customer to serve the the server is idle.

You should assume

1. The queue starts off empty so that the first customer may be served immediately upon arrival.

2. Customers arrive randomly according to a Poisson distribution at a rate of 25 per hour. (hint you should simulate inter-arrival times using the exponential distribution)

3. Service times S for each customer are independent and have normal distribution with mean 1.8 minutes, standard deviation 0.25 minutes.

4. 1000 customers arrivals should be simulated.

In your write-up you should explain briefly how you carried out your simulation and what you observed. Some questions to be answered include

1. What happens to total waiting times T as time goes on? Does it stabilize at some level or keep growing? Also look at the distribution of T both graphically and using summary statistics.

2. What happens to the distribution of W? What is the mean time spent waiting to be served? What is the the standard deviation?

3. What is the longest length of the queue? And when did it happen?

4. Was the server ever idle? If so, what proportion of the time was the server idle

5. Consider increasing the rate at which customers arrive to 35 an hour and answer 1, 2, 3 and 4.

6. Decrease the rate at which customers arrive to 15 customers an hour and answer 1, 2, 3 and 4.

To reduce some of your computational/programming burden some sample scripts will be available on the website. Your final report should include some charts and tables showing your results. Try to make your plots look nicer by accurately labeling the axes and using clear titles.

Note the supermarket is not the only situation you could think of as being modeled here. Queuing situations arrive in many real life situations. For instance you could think of it as being a batch processing computer, and instead of customers you would have jobs arriving at the CPU waiting to be processed.