# Homework 7

# $\mathrm{CS}~547$

## Due Friday, Mar. 30, in class

Turn in your answers and copies of your code for all of these problems.

#### MVA Warm-Up: Scherr's Model

Recall Scherr's original model of the Compatible Time-Sharing System: users alternate between thinking at their terminals and submitting requests to a mainframe. The mainframe processes requests in FCFS order with service times that are approximately exponentially distributed.



Figure 1: Scherr's model

Use mean-value analysis to solve Scherr's model when N = 400,  $\overline{s} = 2$  ms, and  $\overline{Z} = 1$  second. Report the average response time of a user request at the mainframe, the system throughput, and the mainframe's utilization.

# Improving a Closed System

Consider the following closed network with two queues in parallel.



Both queues have the same average service time  $\bar{s}_{top} = \bar{s}_{bot} = 1$  with exponentially distributed service times. A customer has an equal chance of routing to either queue. The number of customers in the closed system is fixed at N = 20. Note that there is no think node. Suppose we improve the top queue's service time to  $\overline{s}_{top} = \frac{1}{2}$ . What is the effect on the system's throughput?

Before doing any work on this problem, write down what you *think* will happen. There's no right or wrong answer here – just honestly state the effect you think the improvement will have on throughput.

Now use mean-value analysis to solve the closed model, once with the original service times, then with the improved service time at the top queue. What effect does improving one queueing center have on overall throughput?

Can you explain this result?

## First Amalgamated Widget

First Amalgamated Widget is a world-leader in the manufacture of precision widgets for the global widgeting industry. You've been hired as a consultant to help improve aspects of their production processes.

First Amalgamated's factory operates as a closed system. Only N widgets are under construction at any moment. When one widget is finished, construction begins on a new widget, with no delay.

The factory contains four major stations for widget production. Production is somewhat customized, so each widget does not have to visit every station. Each station processes jobs in FCFS order.

All widgets begin at the foundry, where they are cast into their basic shape. The casting process takes an average of 1 hour, with a variance of 1.5 hours.

30% of widgets require chemical treatment. This step takes an average of 3 hours, with a variance of 9 hours.

Finally all widgets are tested for quality. This takes only 15 minutes for every widget with negligible variance. Widgets that fail their quality inspection must be investigated and repaired before shipping. Repairing a defective widget takes an average of 5 hours, with a variance of 50 hours. 30% of widgets currently fail their inspections.

Develop an MVA model for the production process and solve it for N = 10.

Which of these two choices will yield a greater improvement in throughput: doubling the number of jobs in the system, or halving the defect rate?