Business Decision Analytics under Uncertainty
Spring 2017, Professor Eckstein
Homework 10, Due Monday, May 1

Q1: Spending Time at the DMV (Little's Law)

On Tuesdays, an average of 1,200 customers use the Winwood County branch of the state Department of Motor Vehicles (DMV). This facility is open 8 hours per day on weekdays. Analyzing a random sample of security camera photos taken on Tuesdays shows an average of 80 customers occupying the facility (either in service areas or waiting areas). On average, how many minutes do Tuesday visitors to the DMV spend in the facility? Show your work.

Q2: A Security Scanner at a Small Airport (Pollaczek-Khinchin)

Outer Moosewood Regional Airport, a relatively small rural facility, has a single body scanner for security checks. During the airport's busy hours, outgoing passengers arrive at the scanner facility in a memoryless manner at an average rate of 3 per minute (or 0.05 passengers per second). They line up to pass through the body scanner.

The current scanner must be replaced with one of two possible models, called "A" and "B". Model A takes 12 seconds to scan a passenger and has a 32% chance of referring passengers for manual screening. Model B takes 15 seconds to scan a passenger but has only an 8% chance of referring passengers for manual screening. We model this system as an M/G/1 queue in which the service facility is the scanner plus the manual screening (if needed). Assume that every manual screening takes exactly 15 seconds and a customer cannot enter the scanner until the previous customer's manual screening (when needed) is complete.

Find each of the following, showing your work:

(a) For each kind of scanner, what is the expected service time E[*S*]?

(b) For each kind of scanner, what is the server loading factor ρ?

(c) For each kind of scanner, what is the variance σ^2 of the service time?

(d) For each kind of scanner, use the Pollaczek-Khinchin formula to predict the average number of customers L_q waiting to enter the scanner during the airport's busy hours.

(e) For each kind of scanner, what is the average number of seconds each busy-hour customer will spend passing through security (including the line, the scan, and manual screening if that is necessary)?

Q3: A More Complicated Taxi Repair Facility (Arena)

You operate the repair facility for a large urban taxi corporation. The average time between arrival of taxis at the facility is ½ hour. You model its operation as follows:

1. After a taxi arrives, it goes into the main repair facility to be worked on by a single regular mechanic. If no mechanics are available, the taxi waits in queue until one is available. Once a mechanic is available to work on the taxi, the repair time has a triangular distribution with a minimum value of ½ hour, a most likely value of 1 hours, and maximum time of 5 hours.

2. After undergoing repair, there is a 15% chance that the taxi will need to be seen by a transmission specialist. Otherwise it goes directly to the final safety check (step 4).

3. Taxis needing a transmission specialist wait in queue until a transmission specialist becomes available. After one becomes available, the transmission service time has a triangular distribution with a minimum value of 3 hours, a most likely value of 4 hours, and maximum value of 6 hours.

4. Next, all taxis undergo a final safety check. This check requires one regular mechanic (from the same pool of mechanics as used in step 1) and takes time uniformly distributed between ¼ hour and ½ hour.

5. There is a 90% chance that a taxi passes the final safety check. Taxis that pass are returned to service immediately. If a taxi fails the check, it returns to step 1 of the process.

You estimate an opportunity cost of $50 per hour that a taxi waits for service. Whether or not they are busy, regular mechanics cost $60 per hour and transmission specialists cost $75 per hour. Suppose that the facility has 7 regular mechanics and 2 transmission specialists.

Simulate this system using Arena, using a run length of 1000 hours and a warm-up time of 6 hours.

(a) Hand in a screen shot or printout of your graphical model.

(b) Hand in a printout of all parts of the "Category Overview" report from your Arena model.

(c) Submit a copy of your .doe file to BlackBoard under the assignments tab, and "Homework assignment 10, Q3 Arena model".

(d) Answer the following questions from the Category Overview report:
   i. What is the total cost over the length of the simulation
   ii. What is the average time a taxi spends between entering the repair facility and returning to service?
   iii. What is the average wait time for transmission service?
   iv. What is the average wait time for the final safety check?
   v. What is the average number of taxis waiting for the main repair facility?
   vi. What percent of the time are regular mechanics busy?
   vii. What percent of the time are transmission specialists busy?