Department of Systems Engineering & Operation Research
George Mason University

OR 335 / SYS 335 Discrete Systems Simulation Modeling

Prof. Chun-Hung Chen Spring 2009

Homework Assignment #4

due 1:30 PM, Wednesday, April 8

****** No collaboration is allowed on HW***

****** Due time will be strictly enforced. Late HW is subject to at least 25% penalty***

1. Suppose we conduct 10 independent simulation runs to estimate the mean throughput of a network system. The observed throughputs from these 10 simulation runs are 7.3, 6.1, 3.8, 8.4, 6.9, 7.1, 5.3, 8.2, 4.9 and 5.8.

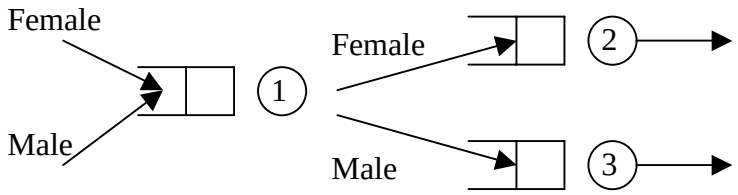
   (a) (5 points) What is the 95% confidence interval if we use the Normal distribution model?
   (b) (5 points) What is the 95% confidence interval if we use the t-distribution model?
   (c) (5 points) What is the 99% confidence interval if we use the t-distribution model?

2. Continue Question 1. Now we are interested in estimating P(System Throughput > 8.0).
   (a) (5 points) What is a good estimator for P(System Throughput > 8.0)?
   (b) (10 points) What is the 80% confidence interval if we use the Normal-distribution model?
   (c) (10 points) What is the 80% confidence interval if we use the t-distribution model?

****** For Questions 3 and 4,***

- ***TA and the instructor will answer only questions about problem clarification before HW due date***
- ***In addition to the printout requested below, please turn in a floppy disk or CD-ROM containing all of your Arena models***

3. Apply Arena for the following three-node system. There are two types of arriving customers: Male and Female. The inter-arrival times for Male customers are exponentially distributed with rate 0.5 (so the mean is 2.0), and the inter-arrival times for Female customers are also exponentially distributed with rate 0.5. After arriving at the system, some preliminary process has to be performed at Node 1. There is one worker to perform this work. The service time is Triangular(0.5, 0.8, 1.5). After the service at Node 1, Female customers are sent to Node 2 and Male customers are sent to Node 3 for further service. There is one worker at Node 2 and another worker at Node 3 to perform the services. The service times at Node 2 are Uniform(0.5, 3.0), and the service times at Node 3 are also Uniform(0.5, 3.0).



Have the following simulation setup:

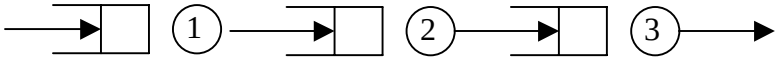
Number of Replications:	**1**
Length of Replication	**5000**
Beginning Time:	**0**

(a) (10 points) Print your Arena model and a single page of your output report showing the average system times for Male and Female customers (please mark these two numbers).

(b) (10 points) Repeat Part (a). But we want to make a change about where Female customers are sent after the service at Node 1. Each Female customers will check the length of the queue at Node 2 to decide to where to go next. If the queue length of Node 2 is 0 or 1, this Female customer will go to Node 2. Otherwise, she goes to Node 3 instead.

(c) (10 points) Consider a different scenario from Part (a). Suppose we hire an additional worker (say number 4) to help the further service for Female customers. After the preliminary process at Node 1, each Female customer check the queue length of Node 2. If the queue length is 0 or 1, this Female customer will go to Node 2. Otherwise, she goes to Server 4 instead. Assume the service time by Server 4 is the same as that at Node 2, i.e., Uniform(0.5, 3.0).

4. Consider the following three-stage service system:



Each customer will be served by a SAME worker through all 3 stages. There are 5 workers to provide service. Suppose the interarrival times are exponentially distributed with **rate** 0.8 (the mean is 1.25), the service time distributions are:

Stage 1: Unif[0.5, 1.5),

Stage 2: Triangular(0.5, 1, 1.5)

Stage 3: Unif[0.6, 1.4)

Use ARENA to simulate this system. Have the following simulation setup:

Number of Replications: **1**

Length of Replication **5000**

Beginning Time: **0**

(a) (10 points) Print your Arena model and a single page of your output report showing the average system times (please mark this number).

(b) (5 points) Repeat Part (a). Suppose there are only 4 workers to perform the service.

(c) (10 points) Continue Part (b) for a different scenario that each customer will be served by a SAME worker at Stages 1 and 2 only. At Stage 3, the service will be performed by a different worker. Now we allocate 3 workers to provide service at Nodes 1 and 2. And there is only one worker to perform service at Node 3.