COSC 311 Programming Project #1 Winter 2010

Queuing, probabilities and customer satisfaction

Distributed: 26 January 2010
Due: 11 February 2010

Synopsis: Al owns a small walk-up lunch stand on the main floor of a large classroom building called "Al's Place." He has come to your small computer consulting firm, Good Answer Computer Solutions (GACS) for a simulation in order to make a decision to maximize his profit.

Al says, "my business has been growing lately, and I've noticed the customers are standing in line longer. I'm sure they don't like that. But my profit margin, out of which I pay my employees, is extremely small. I'm not sure whether or not to add another employee. Also, I could change my inventory to provide less tasty, shorter prep sandwiches. I'd like the computer to give me some advice."

Here are the facts:
- With the current menu and current single employee
  * the time to service a customer is 2 minutes (120 seconds) and
  * the profit per customer is $1.00 = 100 cents
- A different menu that Al has mind would give
  * the service time of 100 seconds/customer, and
  * the profit per customer of $0.50

Currently Al has one employee. Al estimates that adding a second employee would reduce the service time per customer 50% (e.g. from 120 seconds to 60 seconds (120 - 0.5 * 120 = 60)).

Al pays his employees $10.00 / hour.

After consultation with Al, he agrees that the average customer wait time is an obvious factor for customer satisfaction. In fact, if a customer waits more than 10 minutes, he abandons the queue.

Then after a second, longer discussion with Al, he agrees that customers that get served a tasty sandwich (current menu) leave with satisfaction = (10 - waitTime (in minutes)); customers that get served a not-so-tasty sandwich leave with satisfaction = (5 - waitTime (in minutes)).

Program specification:
(1) Write a simulations of the above four scenarios:
  Single employee, tasty menu
  Single employee, not-so-tasty menu
  Two employees, tasty menu

Two employees, not-so-tasty menu.

The simulation should last four hours simulated time. You will collect data on:

Number of arrivals
Number served
Number remaining in queue at end of simulation
Average wait time (include those remaining in queue at the end)
Average customer satisfaction

(2) Output:

The key factors in the simulation, e.g.

```
Al's Place     GACS 4 hour simulation   1/29/2010
     Arrivals per minute: 0.25
     Menu: tasty
```

The result of the simulation

```
totalArrived: 58
totalServed: 55
final queue length: 3
average wait in minutes: 1.60
average customer satisfaction: 7.3
```

(3) Include code that will output the entire state of the system after each time step. The state of the system at each time is:

number of arrivals
server is busy or idle
status of currently served customer (if any) -- i.e., how many seconds left for service
list of queue nodes (all data in nodes)

Obviously, the state of the system should be nicely formatted. This code will be turned off during actual 4 hour simulations.

The experiment
Collect data for the four different conditions above. Each condition should be run on the following 6 different arrival rates (# arrivals / minute): 0.125, 0.25, 0.375, 0.5, 0.75, 1.0 . Arrivals follow a Poisson distribution (see `http://www.emunix.emich.edu/~haynes/Papers/ProbabilityDistributions/probabilityDistributions.html`)

The report

Write a report for Al. The report includes:

Title page:

Title
Customer information
Current date
Your company information

Executive summary:
Maximum 250 word summary, in non-technical language, of your recommendation and why.

Data:
Tabulated results, arrival rates given column-wise, conditions given row-wise.
Graphed results.
English language description of results (500 words or less)

Analysis: Analyze the data to answer the question: which scenario (condition) gives Al the best profit. Your analysis must include a statement of how confident you are in your recommendation and why you have that confidence level.

Turn in:
(1) On 2/2/10 at beginning of class, initial program and run: queue management, calculate total wait, with sufficient output to prove you're doing those two things correctly.
(2) Program listing
(3) Hardcopy of simulation results
(4) Hardcopy of simulation with debugging output statements turned on: run for 20 minutes simulated time, tasty menu, single employee.
(5) Report

NB: Notice the style standards given on the course website.
Grammar and spelling and other readability factors are very important.

Grade based on:

Initial program:	10%
Program satisfies specification:	65%
Program style and elegance:	10%
Hard copy output:	5%
Report:	10%