CECS 552 Programming Assignment 3, Fall 2016

Dr. Todd Ebert

Due Date: 6:30pm on Tuesday, November 29th

Presenting Your Work.

Submit a **hard copy** of the exercise solutions at the beginning of class. Include in an appendix all source code that you authored in order to solve the exercises.

Plagiarism

Plagiarism is defined for this assignment as the practice of taking someone else's code and passing it off as one's own. However, you are welcome to use the functions in the posted R-scripts as starting points for developing your own functions. Although it is OK to discuss this assignment with other students, in the end each student must implement his or her own source code based on his or her own coding style, and way of seeing the solution. Students suspected of plagiarism will receive an automatic course grade of "F".

Wolf Communications

One-way radio-transmitted messages arrive at Wolf Communications according to a Poisson process having a rate of 2 per hour. The facility has three dedicated channels for handling the messages. When a message arrives, it goes through one of three possible available channels. If all channels are busy, then the message is lost. The amount of time required for a message to pass through a channel depends on the weather condition. If the weather is in a `good` state, then the processing time has CDF $F(x) = x$, where $0 \le x \le 1$ is measured in hours. Otherwise, if the weather state is `bad`, the processing time follows $F(x) = x^3$, $0 \le x \le 1$. The duration of a `good` weather state is normally distributed with mean 90 minutes and a standard deviation of 10 minutes, while the duration of a `bad` weather state is normally distributed with mean 1 hour and a standard deviation of 20 minutes.

By implementiing the ESTA algorithm using a general-purpose programming language of your choice, write a program that performs a discrete-event simulation of the Wolf-Communications message processing system over the time interval of $[0, 100]$, where time is measured in hours.. Assume the following kinds of events.

Good Weather The weather has changed from `bad` to `good`.

Bad Weather The weather has changed from `good` to `bad`.

Message Arrival A message has arrived to Wolf Communications.

Message Processed A message has been processed by one of the channels.

Assume the initial events are i) a `Good Weather` event always occurs at $T = 0$, and ii) a sequence $E_1, \ldots, E_n$ of all `Message Arrival` events that occur during the simulation. Also, i) a `Good Weather` event triggers a `Bad Weather` future event, ii) a `Bad Weather` event triggers a `Good Weather` future event, and iii) a `Message Arrival` event triggers a `Message Processed` future event provided there is an available channel when it arrives; otherwise the message is recorded as lost.

Exercises

1. Display your source code that represents the main `while` loop of the ESTA algorithm. Make sure that each line is commented. Refer to the Discrete-Event Simulation lecture.
2. Perform 10,000 simulations of the system to estimate i) the average number of messages that get lost, and ii) the probability that a sent message gets lost. Include a 0.90-confidence interval for both estimates.
3. Repeat the previous exercise, but now use M, the number of sent messages during the interval $[0, 100]$, as a control variable. Use 1000 additional preprocessing samples to compute control constant c.
4. Suppose that Alice is aware of your simulation results (from Exercise 2). If (p_1, p_2) denotes the 0.90-confidence interval for the probability of a message being lost, then Alice wishes to cut the probability that her message is lost down from p_2 to $p_2/2$. To accomplish this she uses the following strategy. Whenever she sends a message at time t, she re-sends $k \geq 1$ copies of the message at times $t + 1, \ldots, t + k$. Then her message is only lost when the original and all its copies are lost. Otherwise the message is successfully sent. Determine the least k needed so that, in 10,000 simulation trials of the strategy, the percentage of lost messages is no greater than $(p_2/2) \times 100$. For each trial, perform a simulation of the communication system over the time interval $[0, 200]$, and assume she sends her original message at time $T = 100$. For example, if you are testing $k = 3$, then each simulation trial should schedule Alice to send messages at

times 100,101,102, and 103. Note that Alices's messages are in addition to the sequence of arriving messages that follow a Poisson process. Note also that, by sending her message at time 100, we know that the system has already been in operation for a long time, and so the long-run behavior of the system is guaranteed.

Appendix

Include as an appendix a copy of the source code that you wrote in order to complete this assignment. Make sure there are sufficient comments.