Simulation Project 1

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You will use CSIM as a simulation tool to solve the following problems. Also, if possible, verify with the theoretical result (if available). Last but not least, in all your result, you need to specifies *ALL* necessary parameters for your simulation.

1. Simulate a $M/M/1$ system. Plot the
   (a) average number of jobs for ρ, the system utilization, between 0.1 to 0.95 (with increment size of 0.05).
   (b) average response time of jobs for ρ, the system utilization, between 0.1 to 0.95 (with increment size of 0.05).

   In your simulation, you need to allow the user to input i) average arrival rate, ii) average service time, iii) number of jobs for the simulation.

2. Simulate a $M/E_3/1$ system. The density function of the service time is:

$$b(x) = \frac{3\mu(3\mu x)^2 e^{-3\mu x}}{2!} \qquad x \geq 0$$

   Plot the
   (a) average number of jobs for ρ, the system utilization, between 0.1 to 0.95 (with increment size of 0.05).
   (b) average response time of jobs for ρ, the system utilization, between 0.1 to 0.95 (with increment size of 0.05).

   In your simulation, you need to allow the user to input i) average arrival rate, ii) average service time, iii) number of jobs for the simulation.

3. Simulate a bulk arrival system (e.g., the one that we discussed in class). Let the bulk arrival process be Poisson and the service time of each job be exponentially distributed. Let g_i be the probability that the arrival bulk size is i. We have:

$$g_1 = 0.5; g_2 = 0.25, g_3 = 0.25$$

   Plot the
   (a) average number of jobs for ρ, the system utilization, between 0.1 to 0.95 (with increment size of 0.05).
   (b) average response time of jobs for ρ, the system utilization, between 0.1 to 0.95 (with increment size of 0.05).

   In your simulation, you need to allow the user to input i) average bulk arrival rate, ii) average service time, iii) number of jobs for the simulation. (Warning: be careful of stability).

4. Simulate a *Fork-Join* (FJ) queueing system. A K-servers FJ system has $K > 0$ servers. A job, upon arrival, will generate K sub-tasks, t_i, where $i = 1, 2, \ldots, K$. Sub-task t_i will join the queue at the i^{th} server. Each sub-task t_i will have a service time which is exponentially distributed with parameter μ_i. A job is considered finished when all its sub-tasks complete the service requirement. Let $\mu_i = i\mu$ for $i = 1, 2, \ldots, K$. Find the response time of the K-servers FJ system for $\rho = 0.1$ to 0.95. What is the condition of system stability?