

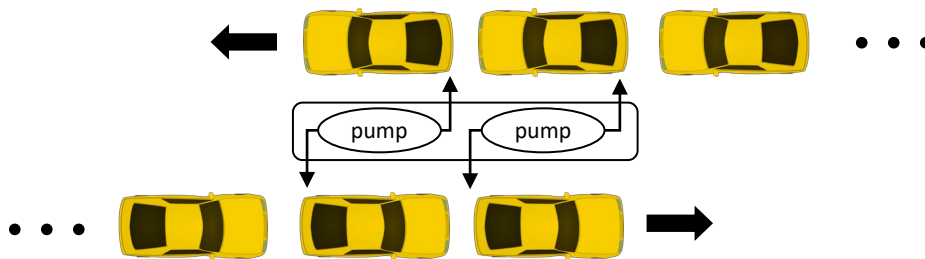
CS 4830 / 6830
Midterm Examination

1) (25 pts / 5 pts each) Simulation Concepts

Provide short answer (a few sentences or a brief paragraph) addressing a-e.

- a) Briefly discuss the distinction between a real system, a model, and a simulation.
- b) Describe how the concepts of a system state, state transition function, state variables and descriptive variables are related to a model-simulation.
- c) Describe the distinction between model validation and verification of a simulation.
- d) Discuss the levels of validity that can exist between a real system and a model.
- e) Discuss the difference between a continuous state/time system simulation and a discrete state/time simulation.

2) (45 pts) Suppose we want to simulate the behavior of a small gas station that has one island containing two gasoline pumps as shown below:



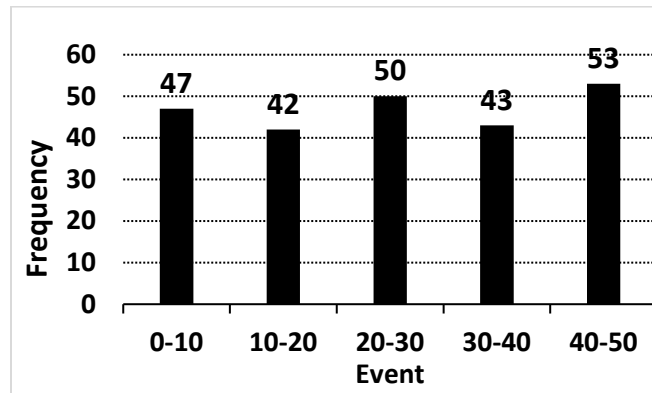
Assume the gas station is opened from 6 AM to 11 PM. Customer arrivals are modeled using an exponentially distributed random variable with a mean interarrival time of 5 minutes. Assume the transaction time (pay and pump gas) for customers is modeled using lognormal distribution with a scale value of 1.5 and a shape parameter of 0.5. A lognormal with a scale and shape of these values produces a mean of approximately 5 minutes (see the discussion of the Lognormal distribution in chapter 6 of your textbook). Once the transaction is complete the customer exits the gas station.

Provide the sections of a SimPy program listed below to simulate this system. You do not need to include any extra statements or comments in your solution.

- a) (5 pts) List the import statements
- b) (15 pts) Provide code to create appropriate processes and resource. Also provide code to initialize the simulation, launch processes and start the execution of the simulation.
- c) (10 pts) Provide code to implement a customer generator process.
- d) (15 pts) Provide code to implement a customer simulation process.

3) (30 pts) Input Distributions

(a) (10 pts) Suppose you have been asked to model a system's input behavior. After observing the system, you form the histogram shown below. You have decided to fit a standard distribution to the data. Select the "best" distribution to describe this input and sketch a plot of the corresponding probability density function. What is the mean of your chosen distribution. Make sure to clearly state why you selected the specific distribution and rejected the others.



(b) (10 pts) Suppose a simulation study was conducted of a grocery store that had several checkout stations. In the report of the simulation results, it was noted to save cost, the analyst decided to collect data on only one checkout station and recorded the number of stations open. To estimate the true arrival rate, they decided to multiply the observed arrival times by the number of checkout stations. For example, if the analyst observed an arrival time 10 and three checkouts were open, they assume there were three arrivals at time 10. This results in the following type of input data: observed: 10, 12, 17, 25, 32, ... that was simply tripled to form an augmented data set: (10, 10, 10, 12, 12, 12, 17, 17, 17, 25, 25, 25, 32, 32, 32, ...). Finally, the augmented data set was used to make a histogram, generated parameters (e.g. sample mean and variance) and select a theoretical distribution.

What is the flaw in this approach to selecting an input distribution? Do you suspect that this approach overestimates or underestimates the arrival rate? What would you do to improve the quality of this simulation?

(c) (10 pts) Suppose you are given the following histogram of interarrival times for a small shop. Hypothesize a theoretical distribution for this data and estimate the parameter(s) for the chosen distribution. Use the midpoint of the interval defining each bin to represent the typical value. Explain why you believe your chosen distribution is appropriate. Also describe how you would perform a Chi-Square test for the quality of the fit of your chosen distribution to the sample data (undergraduate students do not perform the test – graduate students perform the goodness of fit test).

