Course: EEE2020 Data Structure

Project   **Due date: 27 May 2014   before class starts**

Things you must do for this homework.

(1) **Upload *Report File* on YSCEC** (Report file should contain 'Flowchart', 'source code' and 'results')
(2) **Upload all *source codes* on YSCEC**.
(3) ***Print your Report File***, and ***hand it in*** before class

Late submissions will NOT be accepted.
This homework is a **group assignment**. You need to submit all text files which are used as inputs or outputs of your program.

Airport Control Simulation

We wish to simulate an airport landing and takeoff system. The airport has five runways, runway 1, runway 2, runway 3, runway 4, and runway 5. Arriving planes will enter an waiting queue, and the queue distributes planes to available runways. When a size of the queue exceed the maximum queue size, it denies the planes to enter. When a plane enters a holding queue, it is assigned an integer identification number and an integer giving the number of time units the plane can remain in the queue before it must land (because of low fuel level). There is also a queue for takeoffs. Planes arriving in a takeoff queue are also assigned an integer identification number. The takeoff queue should be kept approximately the same size.

At each time period, planes are arriving from outside. The number of arriving planes for each time period follows the Poisson distribution (see appendix A). The Poisson distribution parameter is 2. For takeoff queue, it follows uniform distribution, and it is up to 3.That is, $Pr(X=0)=Pr(X=1)=Pr(X=2)=Pr(X=3)=0.25$. Each runway can handle one takeoff or landing at each time period.
Runway 5 is to be used for takeoffs except when a plane is low on fuel or there is any plane to takeoff. At each time period, planes in either landing queue whose air time has reached zero must be given priority over other landings and takeoffs. If only one plane is in this category, runway 5 is to be used. If there is more than one, then the other runways are also used (at each time, at most five planes can be serviced in this way).

Use successive even (odd) integers for identification numbers of planes arriving at takeoff (landing) queues. At each time unit assume that arriving planes are entered into queues before takeoffs or landings occur. Try to design your algorithm so that neither landing nor takeoff queues grow excessively. However, arriving planes must be placed at the ends of queues, and the queues cannot be re-ordered.

The output should clearly indicate what occurs at each time unit. Show the output
(a) the contents of each queue;
(b) the average takeoff waiting time;
(c) the average landing waiting time;
(d) the average fuel levels that remains at landing time; and
(e) the number of landing airplanes with no fuel reserve.

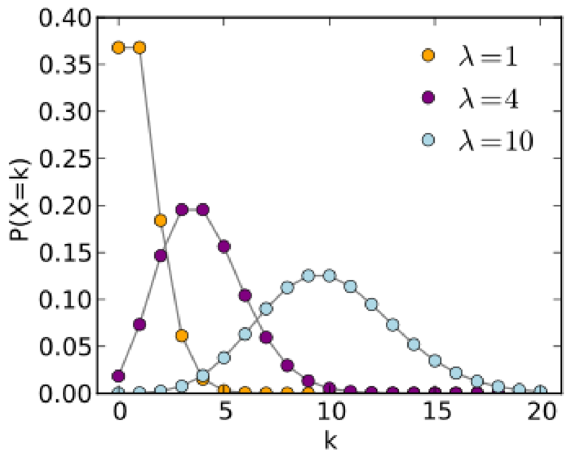
(b) and (c) are for planes that have taken off or landed, respectively. The output should be self-explanatory and easy to understand (and uncluttered).

For each time unit you need to find appropriately the number of planes arriving at takeoff queues, the number of planes arriving at landing queues, and the remaining fuel level for each plane arriving at a landing spot. The fuel level can be assigned randomly.

(f) The Poisson parameter decides a frequency of arriving planes. Vary this parameter to find the maximum value which does not cause a growth of size of waiting queue.

Appendix A. The Poisson distribution

The Poisson distribution is a discrete probability distribution that expresses the probability of a given number of events occurring in a fixed interval of time and/or space if these events occur with a known average rate and independently of the time since the last event. The Poisson distribution can also be used for the number of events in other specified intervals such as distance, area or volume.



Probability mass function of the Poisson distribution

For each time period, a probability that k planes are arriving is calculated as

$$f(k;\lambda) = \Pr(X = k) = \frac{\lambda^k e^{-\lambda}}{k!},$$

where λ is the Poisson distribution parameter. If all the probability for $k=0\ldots,10$ for $\lambda=1$ is accumulated, then it would be close to 1. *Pr(X=0)=Pr(X=1)=0.3679, Pr(X=2)=0.1839, Pr(X=3)=0.0613, Pr(X=4)=0.0153, Pr(X=5)=0.0031, …*

You can simulate the event depending on Possion probability for $\lambda=1$ as follows:
A random number can be generated in the range [0, 1]. If the number is smaller than the above propbability *Pr(X=0)*, then the event *X=0* can occur, that is, no airplane appears. If the random number is between *Pr(X=0)=0.3679* and *Pr(X<=1)=0.7358*, one airplane for landing or takeoff appears. If the random number is between *Pr(X<=1)=0.7358* and *Pr(X<=2)=0.9197*, two airplanes for landing or takeoff appear. In this way, you can simulate how many airplanes will appear for each time step. This simulation will be applied to takeoff and landing, respectively. You can assume that too many airplanes are not available.

Pr(X<=1)=Pr(X=0)+Pr(X=1)
Pr(X<=2)=Pr(X=0)+Pr(X=1)+Pr(X=2)
…

For a uniform distribution, *Pr(X=0)=Pr(X=1)=Pr(X=2)=Pr(X=3) = 0.25*. Each case has an equal probability.

Check list

- Creating the queues(landing queue, take off queue).
- Exception handling for Queue size
- Assigning identification number.
- Assigning and checking the remaining fuel level, and changing this as time passes.
- Exception handling for low-fuel planes and various runway situations
- Implementing the Poisson distribution.
- Producing arriving planes, take off planes.
- Showing outputs and runway situations as time goes on.