COMP9334 Capacity Planning
Assignment 2, Session 1, 2016

March 24, 2016

Instructions

(1) There are two (2) questions in this assignment. Answer all parts of all the questions.

(2) The total mark for this assignment is 10 marks.

(3) In answering the questions, it is important for you to show us your intermediate steps and tell us what arguments you have made to obtain the results. You need to note that both the intermediate steps and the arguments carry marks. Please note that we are **not** just interested in whether you can get the final numerical answer right, but we are **more** interested to find out whether you understand the subject matter. We do that by looking at your intermediate steps and the arguments that you have made to obtain the answer. Thus, if you can show us the perfect intermediate steps and the in-between arguments but get the numerical values wrong for some reason, we will still award you marks for having understood the subject matter.

If you use a computer program to perform any part of your work, you are also required to submit the program.

(4) The submission deadline is 11:59pm 26 April 2016. Late submissions up to 5 days late will be accepted. Late submission will cap the maximum mark that you receive.

(5) Submit your work via *give* command. We will only accept Acrobat pdf file with the name **assign2.pdf**. Log onto a CSE machine and make sure you're in the same directory as your work, then do the following:

(a) When you're ready to submit, at the bash prompt type 9334

(b) Next, type: give cs9334 assign2 assign2.pdf (You should receive a message stating the result of your submission).

Note that you can submit as many times as you wish before the deadline. A later submission will over-write the earlier one(s).

Question 1 (4 marks)

A company has 5 external connections that it can use for video calls. These connections can be used to support either high-quality or standard-quality video calls. A standard-quality video call requires only one external connection but a high-quality video call requires two simultaneous external connections.

Employees in the company can make requests to use these external connections at the time that they want to use them. If there are sufficient number external connections to meet the employees request, the request will be granted immediately and the connection will be available to the user for the duration requested by the user, which we will refer to as holding time. In the case where insufficient number of connections is available, the request will be turned down.

You are given that:

- The company has N employees.
- One employee can make at most one video call (of either high- or standard-quality) at a given time.
- The request rate from an employee for high-quality video calls is a requests per hour.
- The request rate from an employee for standard-quality video calls is b requests per hour.
- High-quality video calls have an average holding time of $\frac{1}{n}$ hours.
- Standard-quality video calls have an average holding time of $\frac{1}{m}$ hours.

You can assume both the inter-arrival time distribution for the requests and the holding time distribution obey exponential distribution.

Derived a Markov Model for this scenario using (p, q) as the state where p is the number of active standard-quality video calls and q is the number of active high-quality video calls. For example, for the state (2,1), two standard-quality video calls and one high-quality video call are active.

For this question, you are asked to

(a) Draw the state transition diagram for the Markov chain that describes the above problem. You need to define the state and specify the transition rates.

(b) Write down the flow balance equations for any two states of this model. (Note: You have the liberty to choose which two states you want to use.)

Question 2 (6 marks)

A data centre has 4 machines and one repair staff.

The time to the next failure of a machine is exponentially distributed. The mean-time-to-failure (MTTF) depends on the number of machines that have failed, as follows:

- If two or less machines have failed, the MTTF is 600 minutes.
- When three machines have failed, due to the additional workload imposed on the remaining working machine, the MTTF of the last working machine is 400 minutes.

The actual time required by the repair staff to repair a machine is exponentially distributed. The time required depends on the number of failed machines, as follows:

- When two or less machines have failed, the repair staff will do the work alone and it takes on average 70 minutes to repair a machine.
- When there are three or more machine failures, the repair staff will get an assistant to help with the repair work. The repair staff and the assistant will work together so that it will only take them 50 minutes on average to repair a machine together. You may assume that it takes negligible delay for this assistant to arrive, i.e. you can assume that the assistant will start working once the third machine has failed. You can also assume that once the number of failed machine is two or less, this assistant will instantly not be available.

Answer the following questions:

(a) Draw the state transition diagram for the Markov chain that describes the above problem. You need to define the state and specify the transition rates.

(b) Determine the steady state probability of all the states of the Markov chain.

(c) Compute the mean-time-to-repair (MTTR) for this data centre.

$---$ End of assignment $---$