M.Sc. in Mathematics (Finance)

2017/2018, 1º semester

Computational Methods

Project 1 – Study of the Quality of a Web Service Provider

1. Introduction

The manager of a web service provider is interested in measuring the quality of the service provided to its clients. To do so, she asked you to simulate the behaviour of the system, taking into account the following observed characteristics of the functioning of the supermarket:

a) Requests arrive at the company servers, according to an exponential distribution (with $\lambda = 1\ \mathbf{min}^{-1}$).
b) The servers process the client requests with a service time that is well modelled by an Erlang distribution (with parameters `k = 3`, λ `= 1 min`$^{-1}$).
c) There are **`n_serv`** servers, operating in a single queue. Whenever any server becomes idle, the first request in the queue is processed by an idle server (if there are more than one idle server, one of them is chosen arbitrarily);
d) The buffer that stores the pending requests has capacity for at most **`max_ql`** requests. Requests arriving when the buffer is full are rejected.

2. Objective

To study the performance of the payment sector, you were asked to the system for **`max_tw`** time units and, from this simulation, answer the following questions:

1. What was the percentage of time each server was busy (**`av_bp`**)?
2. What is the average length of the queue (**`av_ql`**)?
3. What was the average waiting time of the accepted requests (**`av_wt`**)?
4. What was the percentage of requests that were rejected (**`p_rj`**)?

From the simulation, you should also provide an array, **`wt_hist,`** with an histogram of the waiting times, i.e. **`wt_hist(i)`** is the number of requests that waited in the list between **`i-1`** and **`i`** minutes.

3. Implementation Notes

a. Use a function with the signature below

```
function res = study_queue(n_serv, max_ql, max_tw)
```

where the result **`res`**, is a record with fields **`av_bp, av_ql, av_wt, p_rj, wt_hist,`** as explained above. The input paramenters, the parameters are as explained above are also as

For debugging purposes, you should try with different values for the input parameters **`n_serv, max_ql, max_tw`**. In your report, you may focus on the case with 3 servers (**`n_serv = 3`**), max queue length of 4 messages (**`max_ql = 4`**) and simulate the system in a time window of 1000 minutes (**`max_tw = 1000`**).

b. To implement the Erlang distribution, you can use **`T = 12`**, and **`M = 0.3`** (cf. slides 7-9 from class 8).
c. Adapt the simulation function outlined in the slides, but adopt a representation of the states that allows to answer all the above questions with the information kept in the representation of the (last) state.

4. Final Report

You should write a small report explaining how you carried out your simulation, namely:

- The data structures that you used to model the state of the system and their sequence;
- The events and transitions that you considered;
- The functions you used to simulate the timing of the events;
- The functions you used to model the whole system;

The report, as well as the files with your code and results must be sent by email to the lecturer (pb@fct.unl.pt) with subject **Project_MC_1_by_XXXXX+YYYYY** (where XXXXX and YYYYY are the numbers of the students - max 2 per group), **no later than** Friday, 22 December at 23:59.