Universidade de Aveiro

Mestrado em Engenharia Informática

Mestrado em Robótica e Sistemas Inteligentes

Simulação e Otimização

Simulation Mini-Projects

Academic year 2021/2022 Nuno Lau/Amaro Sousa

1. A service facility consists of two servers in series (tandem), each with its own FIFO queue. A customer completing service at server 1 proceeds to server 2, while a customer completing service at server 2 leaves the facility. Assume that the interarrival times of customers to server 1 are IID exponential random variables with mean 1 minute. Service times of customers at server 1 are IID exponential random variables with mean 0.7 minute, and at server 2 are IID exponential random variables with mean 0.9 minute.

   1.1. Simulate the facility for exactly 1000 minutes and estimate for each server the expected average delay in queue of a customer, the expected time average number of customers in queue, and the expected utilization.

   1.2. Suppose that there is a travel time from the exit from server 1 to the arrival to queue 2 (or to server 2). Assume that this travel time is distributed uniformly between 0 and 2 minutes. Modify the simulation and rerun it under the same conditions to obtain the same performance measures. What is the required dimension (i.e., length) of the event list?

   1.3. Suppose now that no queueing is allowed for server 2. That is, if a customer completing service at server 1 sees that server 2 is idle, she proceeds directly to server 2, as before. However, a customer completing service at server 1 when server 2 is busy with another customer must stay at server 1 until server 2 gets done; this is called *blocking*. While a customer is blocked from entering server 2, she receives no additional service from server 1, but prevents server 1 from taking the first customer, if any, from queue 1. Furthermore, "fresh" customers continue to arrive to queue 1 during a period of blocking. Modify the simulation and rerun it under the same conditions to compute the same six performance measures.

2. Consider the problem of simulating a projectile under gravity and wind resistance, where:

   - *z(t)*: which represents the position (height) of the projectile

   The differential equation that governs this model is the following:

   $$m.\frac{d^2z(t)}{dt^2} = -m.g + u.\left(\frac{dz(t)}{dt}\right)^2$$

   2.1. Write a simulation program that can trace the evolution of z*(t)* and its derivative using the Forward Euler method, when given all initial conditions (*z(0)* and *dz/dt(0)*) and all parameters (m, g, u, Δt and t_{final}).

   2.2. Write a simulation program that can trace the evolution of z*(t)* and its derivative using the Runge Kutta RK4 method, when given all initial conditions (*z(0)* and *dz/dt(0)*) and all parameters (m, g, u, Δt and t_{final}).

Delivery

You should deliver:

- The source code of all simulation programs;
- A report that presents: a) the answers to the questions raised in this document; b) briefly presents the strategy followed for the resolution of the various implementation tasks;
- The pdf of the slides of your presentation.

Due dates

Materials (delivery using elearning platform):	May 17, 2022
Presentation of the work:	TBD

Bibliography

[1] "Simulation Modeling & Analysis", 5th edition, Averill M. Law, McGraw-Hill