Universidade de Aveiro

Mestrado em Engenharia Informática
Mestrado em Robótica e Sistemas Inteligentes

Simulação e Otimização

Simulation Mini-Projects

Academic year 2024/2025 — Nuno Lau/Amaro Sousa

1. City buses arrive to the maintenance facility with exponential interarrival times with mean 2 hours. The facility consists of a single inspection station and two identical repair stations; Every bus is inspected, and inspection times are distributed uniformly between 15 minutes and 1.05 hours; the inspection station is fed by a single FIFO queue. Historically, 30 percent of the buses have been found during inspection to need some repair. The two parallel repair stations are fed by a single FIFO queue, and repairs are distributed uniformly between 2.1 hours and 4.5 hours.

   1.1. Write a simulation program that runs the simulation for 160 hours and compute the average delay in each queue, the average length of each queue, the utilization of the inspection station, and the utilization of the repair station (defined to be half of the time-average number of busy repair stations, since there are two stations).

   1.2. Use the developed simulator to check which is the maximum bus arrival rate (minimum mean interarrival time) that can still be handled by this maintenance facility.

2. Consider a projectile moving through air. The evolution of the system is defined by the following variables:

   - *x(t)*: which represents the x position of a falling projectile
   - *z(t)*: which represents the z position of a falling projectile
   - *u*: which represents the air resistance

   The differential equations that govern this model are the following:

$$m.\frac{d^2x(t)}{dt^2} = -\,u.\left(\frac{dx(t)}{dt}\right)^2.sign\left(\frac{dx(t)}{dt}\right)$$

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

   2.1. Write a simulation program that can trace the evolution of $x(t)$, $z(t)$ and their speeds, using the Forward Euler method, when given the values of $x(0)$, $z(0)$, $vx(0)$, $vz(0)$, u, m, g, Δt and t_{final}. Initial values and parameters can be specified in the command line or in a file.

   2.2. Write a simulation program that can trace the evolution of $x(t)$, $z(t)$ and their speeds, using the Runge Kutta method, when given the values of $x(0)$, $z(0)$, $vx(0)$, $vz(0)$, u, m, g, Δt and t_{final}. Initial values and parameters can be specified in the command line or in a file.

   2.3. Compare the precision of the previous approaches.

Delivery

You should deliver:

- The source code of both 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; c) the experiments and results used to validate the solution.

Due dates

Materials (delivery using elearning platform): May 13, 2025

Bibliography

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