Universidade de Aveiro

Mestrado em Engenharia Informática
Mestrado em Robótica e Sistemas Inteligentes

Simulação e Otimização

Simulation Mini-Projects

Academic year 2023/2024 — Nuno Lau/Amaro Sousa

1. For the inventory system described in the class, and whose simulation was initiated in Lesson 2, consider the following changes:

   - If the inventory level I(t) at the beginning of a month is less than zero, the company places an express order to its supplier. (If $0 \leq I(t) < s$, the company still places a normal order). An express order for Z items costs the company 48 + 4.Z euros, but the delivery lag is now uniformly distributed on [0.25, 0.50] month.
   - The inventory is perishable, having a shelf life distributed uniformly between 1.5 and 2.5 months. That is, if an item has a shelf life of l months, then l months after it is placed in inventory it spoils and is of no value to the company (Note that different items in an order from the supplier will have different shelf lives). The company discovers that an item is spoiled only upon examination before a sale. If an item is determined to be spoiled, it is discarded and the next item in the inventory is examined. Assume that items in the inventory are processed in a FIFO manner.

   1.1. Write a simulation program that runs the simulation for all nine inventory (S,s) policies and estimate the expected average total cost per month, the expected proportion of time that there is a backlog, that is, $I(t) < 0$, and the expected number of express orders placed. Is express ordering worth it?

   1.2. Compute the proportion of items taken out of the inventory that are discarded due to being spoiled.

2. Consider the adapted Kermack-McKendrick model, also called SIR Model, for the evolution of an infectious disease in a population. The evolution is traced by keeping track of the the following metrics:

   - *s(t)*: which represents the fraction of the population that is susceptibe
   - *i(t)*: which represents the fraction of population that is infected
   - *r(t)*: which represents the fraction of population that is recovered (no longer infectious)

   The differential equations that govern this SIR model are the following:

$$\frac{ds(t)}{dt} = -\beta.s(t).i(t)$$

$$\frac{di(t)}{dt} = \beta.s(t).i(t) - k.i(t)$$

$$\frac{dr(t)}{dt} = k.i(t)$$

   2.1. Write a simulation program that can trace the evolution of s*(t)*, *i(t)* and *r(t)*, using the Forward Euler method, when given the values of *s(0)*, *i(0)*, *r(0)*, β, k, 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 s*(t)*, *i(t)* and *r(t)*, using the Runge Kutta method, when given the values of *s(0)*, *i(0)*, *r(0)*, β, *k*, 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;

Due dates

Materials (delivery using elearning platform): May 13, 2024

Bibliography

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

[2] W. O. Kermack, A. G. McKendrick and G. T. Walker, "Contribution to the mathematical theory of epidemics", Proc. R. Soc. Lond. A115, pp. 700–721, 1927