IMM - DTU

02443 Stochastic Simulation
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BFN/bfn

Queueing system with superposition of Interrupted Poisson Processes as input

Description/motivation

Traditionally the Poisson process has been a satisfactory model describing the arrivals of units requiring some sort of service at a service facility. However, modern computer and communication systems are characterised by automatically generated requests and other tasks. Many communication systems are packetised thus transmission units are divided and sent as a subsequent train of information frequently referred to as packets. The Poisson process is generally a poor model for these machine generated processes and novel more elaborate models has been introduced to cope with this challenge. The simplest, yet versatile and successful model is the Interrupted Poisson process. This is a simple two state Markovian model. The two model states are usually referred to as the "ON" and "OFF" states. Events are generated with constant Poisson intensity λ whenever the process visits the "ON" state while no events are generated in the "OFF" state.

The sojourn time in the "ON" and "OFF" states are described by exponential distributions with intensities ω_1 and ω_2. The transition mechanism could possibly be of more general type, but it is customary to reserve the term IPP for processes with independent exponentially distributed sojourn times.

The motivation for this model is a simplistic view of the environment of having two possible states. In one of these states there is a potential for some activity - the "ON" or active state, while no activity is possible in the "OFF" or passive state. The model could be a primitive model of a human working at a terminal with successive intervals of working and thinking modes.

The IPP is a renewal process. It can be shown that the inter-arrival times are hyper-exponentially distributed.

Primary task

Develop a simulation model of a single server queueing system with arrivals described by an IPP. Implement the model by writing a computer program in a language of choice and verify the function of the program.

Enhance the simulation model to cope with a superposition of a finite number of IPP's. Implement that model and verify function of the program.

Interesting quantities/primary performance measures

The performance quantities of primary interest are the queue length and waiting time distributions. In addition the output process from the queue and successive periods of server activity can be studied.

validation

verification

For special choices of the parameters the queueing system should have behaviour close to that of an M/M/1 system. Also marginally test the interarrival times of a single IPP, which are governed by a hyperexponential distribution.

Sensitivity analysis

Different load scenarios, that is the different levels of offered traffic.

Possible extensions

Enhance the program to queues of other types, like queues with finite or no waiting room. For a finite queue one should also investigate how blocking probabilities vary for different input combinations.