Technische Universität München
Informatik VIII
Netzarchitekturen und Netzdienste
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Tutorial – Discrete Event Simulation

Assignment 3, SS 2011

Submission **until Wed, 15th of June 2011, 14:10** via e-mail to `klein@net.in.tum.de`
with subject: `DES Blatt 3,` *Surname_1st_group_member*`,` *Surname_2nd*`,` *Surname_3rd*

Up to three students may submit their exercise together.

Exercise 1 — Evaluation of waiting queues

In this exercise you will simulate a modified M/M/1 waiting system. Assume that some waiting slots $(s > 0)$ are more preferable than others, which is in contrast to an ordinary waiting system. Imagine a bar during the Munich Tollwood festival on a cold rainy day, where only a certain number of people (s) are able to queue without getting wet. Obviously, customers will less likely want to queue for a Mass Helles if they have to wait outside in the rain. Therefore, the arrival rate decreases by 50 % as soon as the waiting queue becomes larger than s customers, since additional customers would have to wait outside. The arrival rate increases again to its original value when the waiting queue becomes smaller than $s + 1$.

Extend your simulator so that it allows to simulate this behaviour. Then compare the performance of the following systems in terms of average waiting time, average waiting queue length, and utilization depending on the number of preferable waiting slots s. Use a simulation duration of $T = 10^7$s.

a) System A: M / M / 1 – ∞, Arrival rate(dry) = 10/s, Arrival rate(wet) = 5/s,
Service rate = 10/s, Number of dry waiting slots $s = 1$

b) System B: M / M / 1 – ∞, Arrival rate(dry) = 10/s, Arrival rate(wet) = 5/s,
Service rate = 10/s, Number of dry waiting slots $s = 5$

c) System V: M / M / 1 – ∞, Arrival rate(dry) = 10/s, Arrival rate(wet) = 5/s,
Service rate = 10/s, Number of dry waiting slots $s = 10$

d) Interpret the results (two to three sentences).

Exercise 2 — Impact of deadlines on customer satisfaction

Customers do not like to wait for a long time until they are served. Typically, customers leave the waiting queue if the waiting time exceeds a certain duration (deadline). In the following, customers who leave the waiting queue due to an exceeded dealine are referred to as unsatisfied customers, whereas customers that have to wait for less than the deadline are satisfied customers.

Extend our simulator by adding a deadline attribute to the class `Customer`. This attribute will be used to compare customers in the waiting queue. In this exercise you will evaluate a GI/GI/1 waiting system: Customers arrive with a uniformly distributed inter-arrival time between $[10; 200]$ s. The service completion time is uniformly distributed between $[30; 150]s$. Evaluate the average waiting time, waiting queue length, utilization, and percentage of satisfied and unsatisfied customers depending on the deadline. Use a simulation duration of $T = 10^7$ s.

a) System A: Customers have no deadline

b) System B: Customers have a constant deadline of 200 s

c) System C: Customers have a uniform distributed deadline between $[200; 600]$ s

d) Interpret the results (two to three sentences).

Exercise 3 — Impact of queueing strategies on the system performance

The processing unit in our simulator serves the customers according to the First-In-First-Out (FIFO) principle. In communication networks, data packets may have different deadlines, e.g. voice and http traffic. Therefore, some network devices apply priority-based queuing strategies in order to satisfy the needs of the different traffic types.

Modify our simulator such that the processing unit always chooses the customer from the waiting queue who has the nearest deadline. This kind of queuing strategy is also known as *earliest deadline first* (EDF).

a) Compare the performance of System C from Exercise 2c for the two different queueing strategies FIFO and EDF. Evaluate the average waiting time, waiting queue length, utilization, and percentage of satisfied and unsatisfied customers. Use a simulation duration of $T = 10^7$s.

b) Interpret the results (two to three sentences).