Performance Evaluation -- Exam Question Samples
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At the oral exam, you first pick one set of questions and have 20 mn to prepare your answer, with documents.
After the preparation phase comes the presentation phase, during which you present your solution on the board to the examiner and the expert. During the presentation phase documents are not allowed except for the notes you wrote during the preparation phase. After you have presented your solution you may be asked additional short questions on other topics of the course or on your solution to the homeworks.

Below are some samples of questions that were drawn in the past years. The solutions will be posted soon.

Set 1

1. You perform simulations in order to compute the throughput of a communication protocol. You do 10 independent runs. Explain how you obtain a confidence interval for your results. Give the exact formulas you will use.

2. A sensor alternates between two states 0 and 1. The time spent in state i is independent of the past and is distributed according to an exponential distribution with parameter $\lambda_i$. Give the pseudo code of a program for the perfect simulation of one sensor.

3. Same question if the distributions are Pareto($p = 2.5$) instead of exponential.

Set 2

1. You want to estimate the probability that a sensor fails to provide a measurement. You make simulations of the sensor and its operating conditions. You perform 100 independent runs and find no failure. Give your estimate of the failure probability, with a confidence interval.

2. The autolib company has a fleet of electric cars and one single charging station. Every car visits the charging station to charge its batteries. Only one car can be charged at a time, other cars wait in a queue. The charging time is 30 mn. Every car spends in average 2 hours when it is charged before returning to the charging station. There are $N$ cars in total. Can you approximately plot the (1) average waiting time at the charging station (2) the intensity of the number of visits to the charging station as a function of $N$? (3) Can you estimate the worst case waiting time?

Set 3

1. The following data shows the amount of memory claimed by a server process, in percent of the total physical memory, as a function of times in seconds since last reboot. The server should be rebooted 10 seconds before the used memory reaches the threshold $\theta = 90\%$ (of the physical memory). Explain a method for deciding when to reboot.

2. A sensor sends measurements to a base station once in a while. The time intervals between sending events are iid and distributed according to a Pareto distribution with shape parameter $p$. We simulate the sensor. Does our simulation have a stationary regime?
Set 4

1. We have the job of simulating a random point \((X, Y)\) in the unit disk, whose PDF is

\[ f_{X,Y}(x, y) = \eta \sqrt{x^2 + y^2} 1_{x^2 + y^2 \leq 1} \]

where \(\eta\) is a normalizing constant. Give the pseudo code of a program that produces a sample of \((X, Y)\).

2. When a sensor receives an event, it sets its state to 1 and starts a timer of fixed duration \(\alpha\). The timer is restarted whenever an event is sensed. When the timer expires, the sensor goes to state 0. Events arrive according to a Poisson process of rate \(\lambda\). What is the probability that an arriving event sees the sensor in state 0?

An inspector arrives and reads the sensor state. What is the probability that she finds the sensor in state 0?