Combining the adaptive and heuristic approach
for simulation of overflows in queueing models

For the estimation of the probability of rare events, such as buffer overflows in queueing models of telecommunication networks or failures in complicated critical systems, standard simulation techniques require too much CPU time. One technique for speeding up such simulations is importance sampling; in this technique, the model's probability distributions are modified such that the rare event becomes more frequent. Then the main challenge is finding a good way to change the probability distributions such that the simulation speed indeed improves. Three approaches have been used for this: mathematical calculation (leading to a provably good simulation, but limited to simple models), adaptive techniques (where in the course of several iterations a good simulation is approximated) and heuristic approaches (where based on some rough theoretical understanding, a simulation scheme is proposed). In the present assignment, the goal is to combine the latter two approaches.

To be more precise, we want to combine some recently proposed heuristics with the adaptive "cross-entropy" method, in the hope of largely eliminating the weaknesses of both methods. The heuristic has the weakness that it depends on a parameter, which is typically chosen by trying many values and see which one works best (but that wastes much computational effort). The adaptive method on the other hand initially leaves very much freedom to the new probability distributions, and consequently needs a lot of computational effort to converge to a single optimal solution. Combining the two would mean that the adaptive approach only searches within the parameter space of the heuristic approach, thus needing less effort to converge to the optimal value of the heuristic's parameter.

The work to be done includes the following:

- Study literature on both the adaptive and the heuristic approaches.

- Mathematically "connect" the two methods, i.e., derive the adaptive update equations for the heuristic's parameter.

- Implement this in a simulation program, either an existing one or one written specifically for this experiment.

- Experiment with the resulting simulation program, to judge how well it works.

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