Queueing System Design

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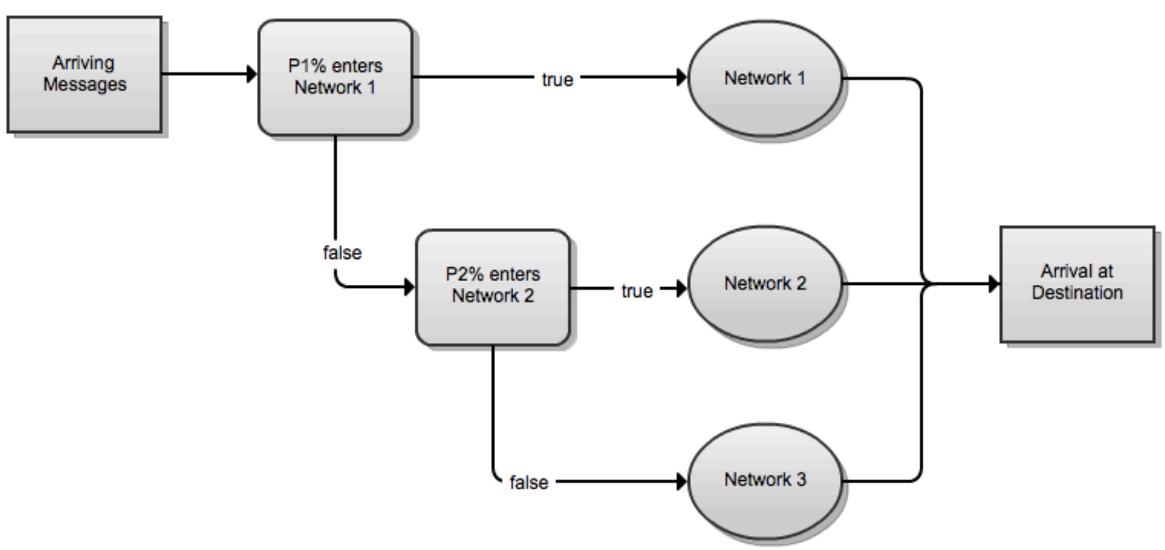
(Continuous variables, constrained, unknown if it is smooth or not)

Problem Statement:

Let's consider the optimization of a communication system where you choose routing percentages to route random arriving messages through a network. There are N random messages that arrive that need to go to a particular destination and there are n networks available to process these messages. The per message processing cost is $c_1, c_2, \ldots, c_n$ depending on which network the message is routed through. It also takes time for a message to go through a network. This transit time is denoted by S_i for each network i and S_i follows a triangular distribution with mean $E(S_i)$ and limits =/- .5. There is a cost for the length of time a message spends in a network measured by c per each unit of time.

The decision variables are the routing percentages $P_1, \ldots, P_{n-1} \in [0, 100]$ which are the probabilities that a message will go through a particular network. When a message is in front of network i there is a P_i% chance that it will processed by network i. If the message packet is not processed by that network, then it will go to network i + 1, and will be processed with probability P_{i+1}%, and so on. All messages arrive at network 1 with an exponentially distributed interarrival time with a mean of $1/\lambda$. The objective is to minimize total costs.

An example with n=3 networks looks like the following:



Recommended Parameter Settings: N = 1000, c = \$0.005, n = 10, c_i = \$1/i for each i, λ = 1, $E(S_i)$ = i for each i
Starting Solutions: $P_i = 100/(n-i+1)$ for each i
Measurement of Time: Number of realizations of the entire routing process for N message packets
Optimal Solutions: Unknown
Known Structure: None

References

Barton, R. R., & Meckesheimer, M. (2006). *Metamodel-Based Simulation Optimization.* S.G. Henderson and B.L. Nelson (Eds.), *Handbook in OR & MS, Vol. 13*