Fluid Heuristics, Lyapunov Bounds, and Efficient Importance Sampling for a Heavy-tailed G/G/1 Queue

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We develop a strongly efficient rare-event simulation algorithm for computing the tail of the steady-state waiting time in a single server queue with regularly varying service times. Our algorithm is based on a state-dependent importance sampling strategy that is constructed so as to be straightforward to implement. The construction of the algorithm and its asymptotic optimality rely on a Lyapunov-type inequality that is used to bound the second moment of the estimator. The solution to the Lyapunov inequality is constructed using fluid heuristics. Our approach takes advantage of the regenerative ratio formula for the steady-state distribution—and does not use the first passage time representation that is particular to the delay in the G/G/1 queue. Hence, the strategy has the potential to be applied in more general queueing models.