

Performance Analysis of Telephone Call Centers: Bayesian Inference Combined with Domain Knowledge

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Telephone call centers, as the primary contact interface between customers and their service providers, have become an integral part of today's economy and their importance is still growing. From the managerial perspective, it is critical to evaluate the performance of the call center in order to develop an efficient staffing/scheduling scheme, since the labor cost accounts for up to 70% of the overall operating expense of a call center. In practice, one of the most widely used approaches to assess the system performance is to apply the so-called Erlang-A model, which models the inter-arrival time between successive calls, the service time, and the patience time (the time a customer is willing to wait before hang-up) as independent exponential random variables. Under the Erlang-A model, the typical performance measures such as mean customer waiting time and the probability of customer waiting have closed-form formulas. However, recent empirical studies show that the above assumptions are not valid and the Erlang-A formulas may be significantly off the chart. Other more sophisticated models have been proposed, which unfortunately do not yield closed-form formula for the performance measures. In this paper, we build a semi-parametric framework to assess the performance of a call center, which combines statistical learning techniques with the domain knowledge from the existing queueing theory. We also develop a Bayesian inference approach, which utilizes both "input data" (i.e. inter-arrival times, service times, patience times) and "output data" (observed performances). Empirical results show that our approach significantly reduces the error in performance assessment while retaining flexibility and analytical tractability.

Key Words: Call centers, Bayesian inference, Erlang-A model, semi-parametric