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On the statistical analysis of the response time of some databases modeled as a queueing systems

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Abstract

Our paper investigates the statistical analysis of database response time by modeling databases as queueing systems of increasing generality. Starting from the classical M/M/1 model as a reference framework, the study extends the analysis to M/G/1 and GI/G/1 systems in order to better capture the variability and structural complexity of real database operations. The main contribution consists in the development of an algorithm for determining the minimum number of Monte Carlo simulation runs required to ensure, with a prescribed confidence level, that the sample mean of key performance indicators approximates their theoretical values within a given absolute error. The considered performance metrics include traffic intensity and response time, defined as the total time spent by a request in the system. The statistical analysis is based on samples of interarrival and service times, and includes the estimation of mean values, dispersion, and cumulative distribution functions. The proposed approach is validated through simulation experiments, which demonstrate a very good agreement between theoretical characteristics and their statistical estimates, including the empirical cumulative distribution function. The results highlight that the proposed methodology provides a reliable framework for performance evaluation not only for analytically tractable models, but also for more general queueing systems where explicit solutions are unavailable or expressed only in transform form. This makes the approach particularly suitable for the analysis of modern database systems with complex service structures.

Keywords: *databases; dispersion; mean value; queueing systems; statistical analysis*

References:

1. A. O. Allen, ***Probability, Statistics and Queueing Theory With Computer Science***

Applications, 2nd ed., Academic Press, New York, 1990, pp. 747. ISBN: 978-0120510504.
Google Scholar

2. U. N. Bhat, *An Introduction to Queueing Theory: Modeling and Analysis in Applications*, Birkhäuser, Boston, 2008, pp. 268. doi: 10.1007/978-0-8176-4725-4.
CrossRef Google Scholar

3. L. Kleinrock, *Queueing Systems, Vol. I: Theory*, John Wiley & Sons, New York, 1975, pp. 417. ISBN: 0-471-49110-1.
Google Scholar

4. L. Kleinrock, *Queueing Systems, Vol. II: Computer Applications*, John Wiley & Sons, New York, 1976, pp. 549. ISBN: 0-471-49111-X.
Google Scholar

5. J. F. Shortle, J. M. Thompson, D. Gross, and C. M. Harris, *Fundamentals of Queueing Theory*, 5th ed., John Wiley & Sons, Hoboken, NJ, 2018, pp. 576. doi: 10.1002/9781119453765.
CrossRef Google Scholar

6. N. K. Jaiswal, *Priority Queues*, Academic Press, New York, 1968, pp. 240. ISBN: 9780080955582.
Google Scholar

7. G. P. Klimov, *Stochastic Service Systems*, Nauka, Moscow, 1966, pp. 247. (in Russian)
Google Scholar

8. M. Harchol-Balter, *Performance Modeling and Design of Computer Systems: Queueing Theory in Action*, Cambridge University Press, 2013, pp. 548. ISBN: 978-1-107-02750-3.
CrossRef Google Scholar

9. S. M. Ross, *Simulation*, 5th ed., Academic Press, Oxford, 2013, pp. 312. ISBN: 978-0-12-415825-2.
Google Scholar

10. A. M. Law, *Simulation Modeling and Analysis*, 5th ed., McGraw-Hill, New York, 2014, pp. 800. ISBN: 978-0-07-340132-4.
Google Scholar

11. M. A. Carlton and J. L. Devore, *Probability with Applications in Engineering, Science, and Technology*, 2nd ed., Springer, New York, 2017, pp. 776. doi: 10.1007/978-3-319-52401-6.
CrossRef Google Scholar

12. C. R. Rao, *Linear Statistical Inference and Its Applications*, 2nd ed., Wiley-Interscience, New York, 1973, pp. 630. ISBN: 0-471-21857-8.
CrossRef Google Scholar

13. A. T. Martinsek, "Two-stage and fully sequential determination of estimator as well as sample size," *Journal of Statistical Planning and Inference*, vol. 17, pp. 11–20, Jan. 1987, doi: 10.1016/0378-3758(87)90098-X.
CrossRef Google Scholar

14. B. Grigelionis, "On the convergence of sums of random step processes to a Poisson

process," *Theory of Probability & Its Applications*, vol. 8, no. 2, pp. 177–182, 1963. doi: 10.1137/1108017.
CrossRef Google Scholar

15. G. P. Klimov, A. K. Leahu, and V. F. Matveev, *Mathematical Models of Time-Sharing Systems*, Știința, Chișinău, 1983, pp. 110. (in Russian)
Google Scholar