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In Session: Variance reduction techniques for rare events, organized by Nadhir Ben Rached

Speaker: Bruno Tuffin

Bounds, Assessment and Confidence Intervals for Exponential Approximations

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Geometric sums can often be approximated by an exponential random variable when the number of summands is large [3], simplifying estimations in many rare contexts. It is typically the case when estimating the distribution of the waiting time in an M/G/1 queue or the hitting time to a rare set for a regenerative process [1, 2]. One of the main advantages of the approximation is to reduce the estimation of the whole distribution to the estimation of its mean, for which efficient (rare event) simulation are usually available in the literature.

Though, the approximation error introduces a bias to the estimation which needs to be assessed and ensured to be negligible with respect to the statistical error, or included in the overall estimation error. This presentation contributes to solve this issue: it provides deterministic approximation bounds when parameters are known, which can be used to control the validity of the estimation and to propose thresholds on the mean of the geometric number of summands for which the approximation is advised to be used.

- [1] P.W. Glynn, M.K. Nakayama, B. Tuffin (2018) Using simulation to calibrate exponential approximations to tail-distribution measures of hitting times to rarely visited sets. *Proceedings of the 2018 Winter Simulation Conference* (Piscataway, NJ: Institute of Electrical and Electronics Engineers).
- [2] P.W. Glynn, M.K. Nakayama, B. Tuffin (2020) Comparing regenerative-simulation-based estimators of the distribution of the hitting time to a rarely visited set. Bae KH, Feng B, Kim S, Lazarova-Molnar S, Zheng Z, Roeder T, Thiesing R, eds., *Proceedings of the 2020 Winter Simulation Conference* (Piscataway, New Jersey: IEEE).
- [3] V. Kalashnikov (1997) *Geometric Sums: Bounds for Rare Events with Applications* (Dordrecht, The Netherlands: Kluwer Academic Publishers).