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IPA Derivatives Can Serve as a Foundation for Research on Design Optimization

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Introduction

Formulas for random gradients (derivatives) of performance measures in relation to parameters of interest, calculated from sample paths of stochastic systems, are provided by infinitesimal perturbation analysis (IPA).When the formulas are nonparametric, empirical field data or simulation runs can be used to calculate IPA derivatives in practice. For the loss volume and time average of buffer occupancy in fluid-flow queues, nonparametric IPA derivatives of buffer size, arrival-rate, or service-rate parameters have recently been derived. In addition, it has been demonstrated that these IPA derivatives are impartial due to the fact that their differentiation and expectation operators coexist, whereas their conventional discrete counterparts have long been known to be generally biased. In addition, recent research has demonstrated a method for mapping the computation of IPA derivatives from a fluid-flow queue to a compatible discrete counterpart without significantly affecting performance measures' accuracy. As a result, this work shows promise for using IPA derivatives in a queuing network context for gradient-based optimization of objective functions with performance metrics parameterized by settable parameters.

Description

Last but not least, the findings serve as the foundation and the impetus for IPA-based applications to the improvement of the design of telecommunications networks as well as for potential new open-loop protocols that make use of IPA data. When conventional analytical approaches are unable to provide closed-form or numerical solutions for complex queueing networks, dynamic Monte Carlo simulation techniques are frequently used. The vast majority of queueing systems have traditionally been represented as discrete workload units that enter and exit queue buffers "abruptly." The fluid-flow variety of queueing systems, on the other hand, consider workload to be fluid that “gradually” enters and exits queue buffers at various (possibly random) rates. The first type of queueing system will be referred to as discrete or traditional, while the second type will be referred to as continuous or fluid-flow (sometimes abbreviated as fluid).Throughout the remainder of the paper, the terms gradient and derivative will be used interchangeably. For telecommunications networks with specific protocols, fluid models have been proposed in addition to fluid-flow analytical models for queueing networks.

An empirical investigation of IPA derivatives of individual queues in queueing systems that simulate telecommunications networks and some of their protocols is the focus of this paper. We used HNS (Hybrid Network Simulator), a hybrid Java simulator of queueing networks with traffic streams subject to multiple telecom protocols, as our tested. More specifically, the hybrid feature of HNS allows for models that combine discrete (packet) and continuous (fluid) flows, as well as collects comprehensive statistics and IPA derivatives for each flow type. The accuracy of IPA derivatives in compatible fluid and packet queueing models as well as the stabilization of their values over time are the subjects of this study, which also examines the mapping of IPA derivatives from the fluid domain to the packet domain as implemented in HNS. The hypothesis that IPA derivatives can be accurately computed using a fluid-flow view from discrete versions is empirically supported by our experimental findings. Furthermore, it is empirically demonstrated that the long-run values of various IPA derivatives stabilize quite quickly.

A fluid event-driven ATM network simulator with fluid leaky buckets, fluid bandwidth schedulers, and Markov-modulated fluid models for the sources is outlined in this model. Fluid versions of four common workload-processing schedulers are included in the overview of fluid-flow network modelling found in .non-work-conserving idle schedulers, FIFO schedulers, and priority schedulers are all examples of work-conserving schedulers. In, a fluid-flow model of the TCP protocol is suggested. Acknowledgments, lost traffic, timeouts, and retransmissions are all captured in this model, which is applicable to both slow start and congestion avoidance modes. Lastly, contrasts the complexity of fluid-based and packet-based simulations. Buffer occupancy, lost workload, and job sojourn times are all standard queueing processes of interest, and associated performance measures typically take the form of time averages and means. Sensitivity information is added to these statistics by infinitesimal perturbation analysis (IPA).More specifically; IPA is a sample-path method for calculating performance metric gradients in relation to important design/ control parameters like buffer size and service and arrival process parameters. Formally, let be a random variable with real values that is affected by a real parameter, where is a real set. The parameter-dependent expectation function is next. The random variable is the IPA derivative (gradient), provided that it exists.

Since simulation-based mean-derivative estimates can be used to optimize objective functions formulated in terms of performance metrics of interest, IPA derivatives can theoretically serve as a foundation for research on design optimization and control applications for simulated systems. Cost functions that are linked to performance metrics, such as the link loss rate and the time average of link buffer occupancy (or, equivalently, the mean waiting time, according to Little's formula), are frequently used to express these objective functions. After that, simulation-based gradient-driven methods can make use of IPA derivatives to improve system performance. Furthermore, the aforementioned methods can be applied to real-world systems if the IPA derivatives are nonparametric—that is, they can be derived without making distributional assumptions about the underlying random processes. A telecom router that calculates IPA derivatives and updates them at packet arrival times is one example [1-5].

Conclusion

A control policy that adjusts network parameters like source arrival rate (for access control), link buffer size (for buffer size allocation), and link service rate (for bandwidth allocation) may try to use the observed values of performance metrics and their IPA derivatives for an online management and control application. Unfortunately, traditional queueing systems' IPA gradient estimators are frequently biased due to the discontinuous nature of their sample paths, which results in flawed IPA.As a result, fluid queueing systems,

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whose continuous sample paths produce impartial IPA gradients, have recently received more attention,

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Conflict of Interest

The Author declares there is no conflict of interest associated with this manuscript.

References

1. Lew, Susie Q and Neal Sikka. “Operationalizing telehealth for home dialysis patients in the United States.” *J Telecommun Syst Manage* 74 (2019) 95-100.

2. Feijóo, Claudio, José Luis Gómez-Barroso and Sergio Ramos. “Techno-economic implications of the mass-market uptake of mobile data services: Requirements for next generation mobile networks." *J Telecommun Syst Manage* 33 (2016): 600-612.

3. Panwar, Nisha, Shantanu Sharma and Awadhesh Kumar Singh. “A survey on 5G: The next generation of mobile communication." *J Telecommun Syst Manage* 18 (2016): 64-84.

4. J. S. Metcalfe. "Technology systems and technology policy in an evolutionary framework." *Cambridge J Econ* 19 (1995): 25–46.

5. Siljak, Harui, Irene Macaluso and Nicola Marchetti. “Artificial Intelligence for Dynamical Systems in Wireless Communications: Modeling for the Future.” *J Telecommun Syst Manage* 7 (2021): 13-33.

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