On Some Regenerative Approaches of Queuing Network Simulation

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The aim of this work is to develop regenerative approaches based on discrete time events simulation and framework of general semi-markov processes (GSMP). It's expanding field of classic methods for research of queuing networks, which are simulated ineffective (or impossible at all) with classical regeneration. We suggest that multidimensional markov process describe system. It consist of discrete (for example, vector of number of customers in a network) and ???-continuous components. Continuous components mean time counters (clocks) - remained time until next discrete components transformation. Discrete components change at moments of occurring some events (for example, arrival/depature customers). Also, at such moments, recalculating of several (or all) continuous components proceeded.

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At present time, simulation based on classic regeneration is not applicable for getting reliable estimates during reasonable time in modern communication networks (for example, network with great number of nodes or high load of nodes). As result, new methods was suggested to expand facilities of regenerative approach, [1, 2, 3]. One of them - method of *weak regeneration* - allows to construct confidence interval with accounting of covariations between adjacent regeneration cycles. This approach makes available to use special technics for decreasing estimate dispersion (so-called equal and opposite random values, and other), [1].

Method *quasi regeneration* is some kind of generalization of weak regeneration which allows effective information using during simulation, [2]. Moments of quasi-regeneration derive from moments of departure from network group of *dependent customers* - customers "collide" (meet each other, stand together) in queue of some node). Confidence estimation, in this case, based on mechanism of *windows*, which covers conception of renewal event thorough abdicate of fixed values (non-random) of barriers that can be inserted between independent customers.

Among experiential approach we can eliminate method of A-cycle that can be mentioned in regenerative terms.

In this case, A-regeneration moments occur when process achieves some compact set. Our modification of A-cycle method consist of requirement that during A-cycle renewal of all process components is necessary. This method is easy to implement and have high frequency of regeneration points, but there are a few difficulties: absence of clear criterion of choosing the set A and unpredictable dependence between consequent cycles, that's make hard to apply central limit theorem. We are working to prove confidence estimation of network characteristics based on A-cycle method.

Our experiments at present consist of confidence estimation of average network workload at 3-nodes network with dendroid structure. Technic of GSMP and DES (discrete event simulation) used in realization of simulation algorithms, distribution functions of arrival times and services are Pareto and exponential. As result we can say that confidence intervals derived on different approaches (classic, weak, quasi, A-regeneration) are asymptotically equivalent. However, in different cases some regenerative approaches more effective.

References

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