Red Light Green Light Method for Solving Large Markov Chains

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September 8, 2020

Abstract

Discrete-time discrete-state finite Markov chains are versatile mathematical models for a wide range of real-life stochastic processes. One of most common tasks in studies of Markov chains is computation of the stationary distribution. Without loss of generality, and drawing our motivation from applications to large networks, we interpret this problem as one of computing the stationary distribution of a random walk on a graph. We propose a new controlled, easily distributed algorithm for this task, briefly summarized as follows: at the beginning, each node receives a fixed amount of cash (positive or negative), and at each iteration, some nodes receive 'green light' to distribute their wealth or debt proportionally to the transition probabilities of the Markov chain; the stationary probability of a node is computed as a ratio of the cash distributed by this a node to the total cash distributed by all nodes together. Our method includes as special cases a wide range of known, very different, and previously disconnected methods including power iterations, Gauss-Southwell, and online distributed algorithms. We prove exponential convergence of our method, demonstrate its high efficiency, and derive scheduling strategies for the green-light, that achieve convergence rate faster than state-of-the-art algorithms.

For details, see the preprint: `https://arxiv.org/pdf/2008.02710.pdf`

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