

A Multigrid Solver for Graph Laplacian Linear Systems on Power-Law Graphs

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1 Abstract

The Laplacian matrix, L , of a graph, G , contains degree and edge information of a given network. Solving a Laplacian linear system $Lx = b$ provides information about flow through the network, and in specific cases, how that information orders the nodes in the network. I propose a novel way to solve this linear system by first partitioning G into its maximum locally connected subgraph and a small subgraph of the remaining teleportation edges. I then apply optimal multigrid solves to the locally connected subgraph, and linear algebra and a solve on the so-called "teleportation" subgraph to solve the original linear system. I show results for this method on real-world graphs from the biological systems of the *C. Elegans* worm, Facebook friend networks, and the power grid of the Western United States.