# Gossip Algorithms: Design, Analysis and Applications

*S. Boyd, A. Ghosh, B. Prabhakar, D. Shah (listed in alphabetical order)*

- [gossip_infocom.pdf](#)

- [Journal version.](#)

Motivated by applications to sensor, peer-to-peer and ad hoc networks, we study distributed asynchronous algorithms, also known as gossip algorithms, for computation and information exchange in an arbitrarily connected network of nodes. Nodes in such networks operate under limited computational, communication and energy resources. These constraints naturally give rise to "gossip" algorithms: schemes which distribute the computational burden and in which a node communicates with a randomly chosen neighbor. We analyze the averaging problem under the gossip constraint for an arbitrary network, and find that the averaging time of a gossip algorithm depends on the second largest eigenvalue of a doubly stochastic matrix characterizing the algorithm. Using recent results of Boyd, Diaconis and Xiao (2003), we show that minimizing this quantity to design the fastest averaging algorithm on the network is a semi-definite program (SDP). In general, SDPs cannot be solved distributedly; however, exploiting problem structure, we propose a subgradient method that distributedly solves the optimization problem over the network. The relation of averaging time to the second largest eigenvalue naturally relates it to the mixing time of a random walk with

transition probabilities that are derived from the gossip algorithm. We use this connection to study the performance of gossip algorithms on two popular networks: Wireless Sensor Networks, which are modeled as Geometric Random Graphs, and the Internet graph under the so-called Preferential Connectivity Model.

---