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Major Research Interests: **Design and Analysis of Algorithms, Randomization, Network Algorithms, Distributed Computing, Communication Networks**

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My current research interests are in network algorithms, distributed computing, and communication networks. With the emergence of the Internet and other networking technologies such as peer-to-peer networks, overlay networks, ad hoc wireless and sensor networks, it has become all the more important to design and analyze efficient distributed algorithms for solving various networking problems. My research goal is to design and analyze scalable algorithms that will work efficiently on large-scale networks. Efficient distributed and decentralized computation is key to this research as it leads to scalable algorithms. Another key is coming up with models that capture these networks (which are typically dynamic) and designing provably efficient algorithms that work well on such models. Randomization and probabilistic analysis plays an important role in both these aspects and is a unifying theme underlying my research.

Operation of a distributed communication network (e.g., the Internet) requires solving fundamental network optimization problems such as minimum spanning tree, shortest paths, Steiner tree, etc. For example, in the Internet, computing shortest paths is necessary for shortest-path routing. My research focus is to design highly efficient distributed algorithms for these problems, even possibly at the cost of a reduced quality of solution --- called distributed approximation. Such algorithms have low communication and time complexity and may output sub-optimal solutions. My research has resulted in the design of the first, provably-efficient distributed approximation algorithms for a number of important network optimization problems including minimum spanning tree (MST), minimum Steiner tree, generalized Steiner forest, and the shortest paths problem. Another key focus is to develop efficient algorithms for dynamic networks --- networks with dynamically changing characteristics e.g., topology or bandwidth. Dynamic networks are becoming increasingly important with the rise of peer-to-peer networks and ad hoc wireless, mobile, and sensor networks. Much of the traditional distributed computing theory focuses on static networks and thus there is an urgent need to develop a solid distributed algorithmic foundation for dynamic networks.

Designing energy-efficient algorithms is an important task for energy-constrained wireless and sensor networks. Another facet of my research has focused on designing energy-efficient distributed algorithms and developing a framework for rigorous analysis of such algorithms. In addition to the traditional complexity measures of time and number of messages, we have developed an algorithmic theory that addresses the energy complexity which accounts for the total energy associated with the messages exchanged among the nodes in a distributed algorithm.

I am also interested in other areas in algorithms and theoretical computer science including randomized algorithms and random graphs, online algorithms, information theory, and computational biology.

Selected Publications:

1. Atish Das Sharma, Danupon Nanongkai, and Gopal Pandurangan. Fast Distributed Random Walks, Proceedings of the 28th ACM Symposium on Principles of Distributed Computing (PODC), 2009, 161-170.
2. Maleq Khan, V.S. Anil Kumar, Madhav Marathe, Gopal Pandurangan, and S.S. Ravi. Bi-criteria Approximation Algorithms for Power-Efficient and Low-Interference Topology Control in Unreliable Ad hoc Networks, in Proceedings of the 28th IEEE Conference on Computer Communications (INFOCOM), April 2009.
3. Maleq Khan, Fabian Kuhn, Dahlia Malkhi, Gopal Pandurangan, and Kunal Talwar. Efficient Distributed Approximation Algorithms via Probabilistic Tree Embeddings, Proceedings of the 27th Annual ACM Symposium on Principles of Distributed Computing (PODC), 2008, 263-272.
4. Yongwook Choi, Maleq Khan, V. S. Anil Kumar, and Gopal Pandurangan. Energy-Optimal Distributed Algorithms for Minimum Spanning Trees, IEEE Journal on Selected Areas in Communications, Issue on Stochastic Geometry and Random Graphs in Wireless Networks, 27(7), Sept. 2009. Conference version: Proceedings of the 20th ACM Symposium on Parallelism in Algorithms and Architectures (SPAA), 2008, 188-190.
5. Maleq Khan, Gopal Pandurangan, and V.S. Anil Kumar. Distributed Algorithms for Constructing Approximate Minimum Spanning Trees in Wireless Sensor Networks, IEEE Transactions on Parallel and Distributed Systems, 20(1), 2009, 124-139.
6. Alessandro Ferrante, Gopal Pandurangan,and Kihong Park. On the Hardness of Optimization in Power-Law Graphs, Theoretical Computer Science, 393, 2008, 220-230.
7. Maleq Khan and Gopal Pandurangan. A Fast Distributed Approximation Algorithm for Minimum Spanning Trees, Distributed Computing, 20, 2008, 391-402. Conference version: Proceedings of the 20th International Symposium on Distributed Computing (DISC), LNCS 4167, Springer-Verlag, 2006, 355-369. Best Student Paper Award.
8. Maleq Khan, Gopal Pandurangan, and V.S. Anil Kumar. A Simple Randomized Scheme for Constructing Low-Weight k-Connected Spanning Subgraphs with Applications to Distributed Algorithms, Theoretical Computer Science, 385(1-3), 2007, 101-114.
9. Gopal Pandurangan and Gahyun Park. Analysis of Randomized Protocols for Conflict-Free Distributed Access, Algorithmica, 49(2), 2007, 109-126.
10. Jen-Yeu Chen, Gopal Pandurangan, and Dongyan Xu. Robust Computation of Aggregates in Wireless Sensor Networks: Distributed Randomized Algorithms and Analysis, IEEE Transactions on Parallel and Distributed Systems, 17(9), 2006, 987-1000.
11. S. Muthukrishnan and Gopal Pandurangan. The Bin-Covering Technique for Thresholding Random Geometric Graph Properties, Proceedings of the ACM-SIAM Symposium on Discrete Algorithms (SODA), 2005, 989-998.