Algorithmic Foundations of Ad Hoc Networks

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An ad hoc network consists of a collection of geographically distributed nodes that communicate with one other over a wireless medium. An ad hoc network differs from both wired and cellular networks in that there is no wired infrastructure and the communication and computation capabilities of the network are limited by the battery power of the network nodes. In recent years, the rapid advent of mobile telephony, personal digital assistants, and the increasing deployment of diverse monitoring tools involving inexpensive wireless sensors and RFID tags has brought to the fore a number of commercial applications of ad hoc networks. Examples are disaster relief, conferencing, home networking, habitat monitoring, warehouse inventory monitoring, and personal area networks.

The lack of a fixed infrastructure in ad hoc networks implies that any computation on the network needs to be carried out in a decentralized manner. Thus, many of the important problems in ad hoc networking can be formulated as problems in distributed computing. However, there are several intrinsic characteristics of ad hoc networks -- e.g., energy limitations, the need for medium access control, limited computational power, mobility -- that makes this study different than traditional work in distributed computing.

In this tutorial, we will cover the algorithmic foundations of ad hoc networks. Our presentation will focus on the following topics, which are by no means exhaustive:

- Introduction: General overview, models, and routing paradigms
- Clustering: dominating sets, connected dominating sets, and clustering under mobility
- Geometric routing algorithms
- Medium access protocols (MAC) and their analyses
- Power and topology control: connectivity, energy-efficiency, and interference
- Fundamental limits of ad hoc network capacity
- Algorithms for sensor networks: MAC protocols, synchronization protocols, and query and stream processing

Instructors

Rajmohan Rajaraman is an Associate Professor of Computer Science at Northeastern University, Boston, where he is pursuing research in approximation algorithms, distributed computing and networks. His ongoing research projects include approximation algorithms for network design problems, protocols for ad hoc and sensor networks, data organization and retrieval in distributed networks, and competitive algorithms for scheduling. Prior to joining Northeastern, he was a postdoctoral fellow at DIMACS, an NSF Center for Discrete Mathematics and Theoretical Computer Science. He received his PhD from the University of Texas at Austin in December 1997. He has

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Andrea Richa is an Associate Professor of Computer Science at Arizona State University. Her broad research interests lie in the design and formal analysis of algorithms, with a primary focus on problems that arise in the context of distributed and parallel networks. Two of her main research projects include the data tracking (or name lookup) problem in distributed networks and development of theoretical foundations for mobile ad-hoc networks. She received a PhD in Algorithms, Combinatorics, and Optimization from Carnegie Mellon University in June 98. She has served on the program committees of several conferences in algorithms and parallel and distributed computing, and received the NSF Career award in 2000.