**6.266 Network Algorithms**

4-0-8  Grad H

MW  11am-12:30pm  2-132

http://stellar.mit.edu/S/course/6/fa08/6.266/

**Course description.** This course will be geared towards teaching modern theory of networks from algorithmic perspective. It will emphasize the foundations of network theory in terms of modeling, performance analysis and design. The course will be broadly divided into three parts. The first part will focus on algorithms for communication networks. It will cover topics of scheduling, routing and congestion control for large, high-performance communication networks like the Internet. In the second part, algorithms for information processing and applications in networks will be discussed. It will cover topics including information dissemination for Peer-to-peer networks (e.g. BBCiPlayer), advertising and inference in social networks (e.g. Facebook, Orkut), data fusion and estimation in sensor networks and search algorithms in WWW. In the last part of the course, algorithms for data storage in networks will be described. This will cover topics like efficient storage of statistics for security in routers and distributed data storage for efficient retrieval.

This interdisciplinary course will borrow techniques from algorithms and data structures, stochastic modeling and theory of Markov chains, random graph model and graph theory and discrete probability.

**Pre-requisites.** We require two sets of pre-requisites: (1) 6.431 or 6.436 or 6.262, and (2) 6.255 or 6.251 or 6.854J; or Instructor’s consent.

**Course Staff.** The contact information of course staff:

- **Instructor.** Prof. Devavrat Shah, 32-D670, x34670, Email: devavrat@mit.edu.
- **TA.** Srikanth Jagabathula, 32-D672, x23968, Email: jskanth@mit.edu.
- **Admin.** Lynne Dell, 32-D664, x23679, Email: ldell@mit.edu.

**Grading Policy.** The grading policy is as follows:

- Final Exam (Nov. 20, 21, 2008; take home) — 45%.
- Project (presentation Dec. 11, 12, 2008) — 30%.
- Scribe — 5%.
- Homework (5 graded and 1 optional) — 20% in total.
Lecture Schedule. The following is a topic based lecture schedule. The course will be divided into three parts.

- **Part 0.** Introduction
  - [L1] Logistics and historical remarks; course overview and description of three parts; and a useful example.

- **Part I.** Algorithms for communication networks, e.g. the Internet.
  - A. Scheduling and routing
    - Examples include scheduling in routers, medium access in wireless mesh networks, routing in the Internet, circuit assignment in the Telephone networks
      - [L2] Network model, preliminaries on Markov chains
      - [L3-5] Maximum weight algorithm, its throughput property
      - [L6] Delay property of Maximum weight algorithm and fluid model
      - [L7] Extension for routing and overloaded network
      - [L8-9] Implementation of Maximum weight algorithm, randomization and Belief propagation
  
  - B. Congestion control
    - Examples include rate allocation in the Internet (ala TCP protocol)
      - [L10-12] Static resource allocation model, utility maximization and fairness, algorithms and the interpretation of TCP.
  
  - C. A complete network architecture
    - How should a large network like Internet be operated?
      - [L14] A complete network model (flows meet packets), algorithms and network stability property.
      - [L15] What if network does not co-operate: game theoretic model and a simple result.

- **Part II.** Algorithms for information processing and applications
  - Examples include algorithms operating in Peer-to-peer networks (e.g. BBCiPlayer), social networks (facebook, Orkut), sensor networks (for surveillance), the World-Wide-Web (WWW), etc.

  - A. Information dissemination
    - Examples include data dissemination through BBCiPlayer, file sharing in BitTorrent, virus or worm spreading in the Internet or society, advertising through an online social network
• [L18] Greedy information spreading and ‘small-world effect’

B. Information processing and computation

○ Examples include web-ranks for search, estimation in sensor networks, inference in social networks, consensus in multiagent systems


• Part III. Algorithms for data storage and applications

○ Examples include network security, router data structures and storage networks.

A. Data structure for network security


B. Distributed data storage

○ [L24-25] Luby codes and Raptor codes for efficient data retrieval, ‘soliton distribution’ and mean-field method.

C. Storage in high-speed network routers

○ [L26] Fast memory using combination of little expensive SRAM and majority of cheap DRAM; use of TCAM for packet classification.