Network algorithms

Motivation and goals

- A networked world
  - Social networks; networks of economic agents
  - Web; internet; wide area networks; data-centers; power networks; electrical networks; transport networks
  - Networks as models to solve problems
- Goals of the course
  - Learn the main techniques for the analysis and design of network algorithms
  - Build a repertory of basic algorithmic solutions to network problems
  - Learn the main techniques and predictions of game theory

Schedule

- Period
  - Monday, September 8, to Wednesday, October 22.
- Lectures
  - Monday, from 13:30 to 15:30, room F3.
  - Wednesday, from 13:30 to 15:30, room F4.
- Labs
  - Tuesday from 14:00 to 15:30 and Thursday 14:00 to 15:30; or
  - Tuesday from 15:30 to 17:00 and Thursday from 15:30 to 17.00
  - All labs in room LT5

Grading

- Three MAPs of 45 minutes, each worth 20% of the grade, minimum 7/20 over the three MAPs
  - Wednesday, September 24
  - Wednesday, October 8
  - Wednesday, October 22
- Project worth 40% of the grade, minimum 7/20
  - Deadline Friday, October 10, 23:59
  - Oral discussions on Tuesday, October 21, and Thursday, October 23
- Appeal exam in substitution of MAPs (worth 60% of the grade)
  - Friday, October 31, 8:00

Substitution

- Lecture of Wednesday, September 10, and Labs of Thursday, September 11 will be delivered by PhD student Miguel Alves Ferreira.

- Lectures and Labs of the week from Monday, September 22, through Thursday, September 25 will be delivered by PhD student Miguel Alves Ferreira

Project

- Two students per group
- Problem statement published today, September 8
- Evaluation
  - Report of no more than 5 pages
  - Running code
  - Oral discussions of 20 minutes per group

Bibliography

- Primary
  - “Algorithm Design,” Jon Kleinberg and Eva Tardos, Pearson Education, 2006
  - “Networks, Crowds and Markets,” David Easley and Jon Kleinberg, Cambridge University Press, 2010 (Part II)
- Slides
- The Web

Syllabus - I

- Introduction to networks
- Structural problems
  - Bipartition, biconnectivity, strong connectivity
  - Breadth-first search and depth-first search
- Shortest paths
  - From one node to another, from one node to all, from all to all
  - Dijkstra’s, Bellman-Ford, Johnson’s, Floyd-Warshall algorithms

Syllabus - II

- Optimal-path routing and stable destination-based routing
  - Routing algebras, left-inflation, and left-isotonicity
  - Generalized Dijkstra's algorithm and Bellman-Ford algorithm
  - Applications
- Routing protocols
  - Chandy-Misra, distance-vector/path-vector
- Minimum weight spanning trees
  - Prim and Kruskal algorithms

Syllabus - III

- Maximum flow problem
  - Duality maximum flow - minimum cut
  - Ford-Fulkerson method and Edmonds-Karp algorithm
  - Applications
- Game theory
  - Games, players, strategies and payoffs, dominant and dominated strategies, Nash equilibria
  - Static games, dynamic games, and mixed games
  - Applications