Graph and Network Algorithms: Theory and Practice

CS 69000-GNA, 3 Credits, Fall 2011

Tues, Thurs 3:00 - 4:15 P.M., Recitation 113

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This is an advanced course in graph and network algorithms for graduate students in computer science, computer engineering, mathematics, statistics, computational life sciences, and related fields. Students are expected to have a graduate course in Algorithms prior to taking the course. We will discuss the design of exact or approximation algorithms for each problem. This course is suitable as a foundational course for students planning to do research in topics where graph algorithms play an important role. It is also suitable for those who wish to acquire some breadth during graduate study and learn about important developments in graph algorithms. I anticipate making this course a regular course offering if there is sufficient student interest.

Graph algorithms have been central to computer science, and their importance has increased in recent years as the internet, social networks, and bioinformatics, have become more significant in our lives and in research. Here are a few examples. In what order should the results of a web search be presented to a user to be most useful? How should ads be ordered on such a page to maximize likely revenue to the search company? Graph algorithms play an important role in answering these questions. Who should be the first group of people in a community to be vaccinated to prevent the spread of a highly infectious and fatal disease? Algorithms for computing centrality measures in a network provide helpful answers. How can the human protein-protein interaction network be compared to that in the mouse? Graph alignment algorithms that compute matchings provide solutions.

A list of the topics to be discussed include:

- Basic graph concepts and graph models
- Shortest paths
- Spanning trees
- Greedy algorithms and matroids

- Network flows
- Strong connectivity and directed graphs
- Colorings
- Matchings
- Weighted matchings
- Approximation algorithms for graph problems
- Large scale graph computations

Since this is an advanced course, I will expect students to participate actively in the class discussions, and to be willing to read topics beyond the material covered in class. I will encourage the students to present some topics in class, and will be glad to discuss topics based on students' interests.

Grades will be based on regular homework problems, programming assignments, and a project (e.g., implement an algorithm, explore a research problem, or present a report and a lecture on a topic related to the course).

The textbook for the course is
Dieter Jungnickel, *Graphs, Networks, and Algorithms*, Third Edition, Springer, 2010.

The area of graph algorithms is rich in books. A few books that provide background material include
Reinhard Diestel, *Graph Theory*, Springer, 2000.
J. A. Bondy and U.S.R. Murty, *Graph Theory with Applications*, Springer, 2008.
Douglas B. West, *Introduction to Graph Theory*, Second edition, Prentice Hall, 2001.
Alexander Schrijver, *Combinatorial Optimization: Polyhedra and Efficiency*, Volume A, Springer, 2003.

Recent books on networks and approximation algorithms include
M. E. J. Newman, *Networks: An Introduction*, Oxford University Press, 2010.
David Williamson and David Shmoys, *The Design of Approximation Algorithms*, 2011.

You do not need to purchase any book other than the text book. You could read the others books from the library or borrow it from me.