

CS5234 : Combinatorial and Graph Algorithms

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Fall 2002 (Jul-Oct 2002)
Leong Hon Wai, S16 06-01

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Web-Site: <http://www.comp.nus.edu.sg/~cs5234/2002/>

Objectives:

This course presents **advanced** material on the design and analysis of combinatorial algorithms with emphasis on efficient algorithms and data structures. It also provides practical experience of re-using a C++ library of advanced data structures and algorithms in software development. This course is meant for students who intend to do (i) research work in computer science in general, and algorithm design in particular, or (ii) advanced application/software development in other areas of computer science.

Target Students: Advanced Undergraduate students;
Beginning graduate students;
Those doing research in algorithm design;

Pre-requisites: CS3230 Design and Analysis of Algorithms
(See more pre-req. info on this on course web-site)

Main TextBook:

[CLRS] *Introduction to Algorithms, (2nd edition)* (Linc:SC-RBRx2)
Cormen, Leiserson, Rivest, and Stein MIT Press, (2001)

References:

[Tar83] *Data Structures and Network Algorithms,* (Linc: SC-RBRx1)
Robert E. Tarjan, SIAM Press, (1983).

[SKD83] *Discrete Optimization Algorithms,* (Linc: SC-MSx2)
Syslo, Kowalik & Deo, Prentice-Hall, (1983)

[RND77] *Combinatorial Algorithms: Theory & Practice,* (Linc: SC-MSx1)
Reingold, Nievergelt & Deo, Prentice-Hall, (1977)

[PS82] *Combinatorial Optimization: Alg & Complexity* (Linc: SC-RBRx1)
Papadimitriou & Steiglitz, Prentice-Hall, (1982)

[PS85] *Computational Geometry: An Introduction,* (Linc: SC-RBRx1)
Preparata & Shamos, Springer-Verlag, (1985)

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Tentative Course Outline (Fall 2002)

A. ADVANCED DATA STRUCTURES AND ALGORITHMS

Priority Queues and Graph Algorithms
Leftist Heaps and $O(n \lg \lg n)$ MST Algorithm
Amortized Complexity and Binomial Heaps
Fibonacci Heaps and Fast Shortest Path Algorithm
LEDA Software Library

B. ADVANCED GRAPH ALGORITHMS

Bipartite Matching – Algorithms and Applications
General Matching
Knapsack Problem – Problem, Algorithms and Applications

C. NP-COMPLETENESS

Introduction and Proof of Cook's Theorem
Proving NP-Completeness
Approximation Algorithms
Local Search Methods

D. SPECIAL TOPICS (a subset of these)

Resource Scheduling, Network Flows, Graph Partitioning,

Assessment: (30%) Homework
(20%) Programming Project -- using C++ and LEDA
(50%) Final Exam [Open Book]

Homework: (30%)

There will be 4-5 homework sets in the course (roughly one every 2-3 weeks). Homework is a very important part of this course – they force you to learn the material. Please read the important “Remarks on Homework” on course web-site.

Project Work:

For project work, each student is expected to do a C++ programming project using LEDA to solve a combinatorial optimization problem -- to be announced later. LEDA is a powerful C++ library of data structures and algorithms that can be reused to implement advanced algorithms covered in the course. To help learn LEDA and realize the power of LEDA, one or two simpler implementation exercises will also be included.