Advanced Algorithms

Course definition:

Advanced algorithms course introduces a number of algorithmic approaches and data structure techniques. It emphasizes to design and analyze of efficient algorithms using some advanced methods and data structures. This course covers usual techniques such as iterative methods, divide and conquer, dynamic programming and greedy algorithms applying on basic problems like sorting, median finding, scheduling and graph problems. Also, advanced algorithms course studies advanced methods for designing efficient algorithms like linear programming, computational geometry, approximation and randomized algorithms and probabilistic analysis. To successfully implement these approaches it is necessary apply efficient data structures such as Fibonacci heap and space partitioning data structures.

Class overview:

We start the advanced algorithm course by an introduction to the fundamental of algorithmic problem solving, complexity notations and recurrences. We briefly review iterative methods, divide and conquer, dynamic programming, greedy algorithms and linear programming technique. We apply, analyze and prove the correctness of these methods on some basic problems such as insertion, quick, merge, heap and linear sorts, selection and minimum spanning tree, shortest path, traveling salesman and knapsack problems. We also introduce some efficient data structures for designing efficient algorithms, and investigate trade-off between space and time, especially in query type problems like range searching and point location problems. We follow the class by geometric algorithms which have many applications in manipulation and robotics, facility location and computer graphic.

(***NOTE***: **1-**We will study the course of *Approximation Algorithms* separately in spring season.
2-We will study the course of *Randomized algorithms* separately in fall season.
3-The topics of geometric algorithms in this course do not overlap with the topics of *computational geometry* course.)

Resources:

- Text Books:
  - Introduction to Algorithms (by T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, 2nd 2002)
  - Randomized Algorithms (by Rajeev Motwani and Prabhakar Raghavan, 1995)
  - Computational Geometry: Algorithms and Applications (by M. de Berg, O. Cheong , M. van Kreveld, M. Overmans, 3nd 2008)
- Papers in topic of algorithms and applications.

Prerequisites:

Pseudo code for algorithm writing, Complexity notations (how to analyze algorithms), Solving recurrences, Elementary data structures (array, tree, link list, stack, queue), graph terminologies and basic algorithms on graphs (DFS, BFS, Shortest path), basic probability theory, standard programming languages (C and MATLAB are preferred).

Lectures: Sunday and Tuesday 9:30-11:00

Evaluating:

- 10% Implementing Project (which can done individually or in a couple joint group)
- 15% Mid-term Exam
- 25% Homework (which is done as some exercises individually)
- 50% Final exam

For further information about the course visit me in my office or send an email to mdmonfared@iasbs.ac.ir.