CMSC 754: Computational Geometry
Spring 1996

Course Information: *http://www.cs.umd.edu/ samir/754/754.html*

Instructor: Samir Khuller - Office: AVW 3217. Office phone: 405–6765.
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Office Hours: Tuesday 2:00–3:00, and Friday 11:00–12:00. If you cannot make these hours, please make an appointment to see me at a different time.

A few times during the semester, I would like to schedule some informal rump sessions during my office hours on friday. We will have to find a room where we can have these. We can use this session to discuss homeworks, other related questions that people have about the material being covered, or interesting research topics.

Class Time: Monday and Wednesday 11.00–12.15, Room: CLB 0109.

Teaching Assistant: Michael Murphy Office: AVW 3228. Office phone: 405–2717.
Email: murphy@cs.umd.edu.
Office Hours: Tuesday 9:00–10:30, Thursday 4:30–5:30. If you cannot make these hours, please make an appointment to see Michael at a different time.

Credits: 3

Course Overview: Introduction to algorithms and data structures for computational problems in discrete geometry (for points, lines, and polygons) primarily in 2 and 3 dimensions. Topics include triangulations and planar subdivisions, geometric search and intersection, convex hulls, Voronoi diagrams, Delaunay triangulations, line arrangements, visibility, and motion planning.

Text: We will use more than one book. The first one (O'Rourke) will be the main text for the course. We will also use the second one from time to time (Preparata and Shamos). The other two books are mostly for your entertainment.

Computational Geometry in C, Joseph O'Rourke, Cambridge University Press, 1994.

Computational Geometry: An Introduction, F. P. Preparata and M. I. Shamos, Springer-Verlag, 1985.

Algorithms in Combinatorial Geometry, H. Edelsbrunner Springer-Verlag, 1987.

Computational Geometry: An Introduction through Randomized Algorithms, by Ketan Mulmuley, Prentice Hall, 1994.

Prerequisites: CMSC 451 and CMSC 420 (or equivalent). More specifically: Knowledge of basic algorithm design techniques, such as divide-and-conquer, greedy algorithms, dynamic programming, and basic analysis techniques such as asymptotic notation, solving summations and recurrences. Knowledge of basic data structures (e.g. balanced binary trees and heaps).

Typical Course Work: There will be 6 homework assignments. We will have two examinations: One midterm and one final (midterm will be sometime in march). Homeworks are to be written neatly, stapled and turned in at the start of class on the due date. The homeworks should represent your own work, and not the work of anyone else. The only way to really learn the material is to do it yourself. Please keep this in mind while doing your homeworks. Attempting all problems on the homeworks is mandatory.

All homeworks will be kept on the home page for the class (/fs/www/users/samir/754/754.html). This is also accessible through my home page, or under the department's home page under "CMSC Class Pages".

It is your responsibility to make sure that you get all the handouts and homeworks.

Grading: Final grades will be based on homework assignments, the midterm exam, and the final exam. The relative weights of these will be 30% for the homework total, 30% for the midterm, and 40% for the final exam.

Suggested Syllabus: This is only a rough outline – we may do things in a different order.

Preliminaries: Mathematical and geometric review. Review of algorithm analysis techniques, mathematical models of computation, randomized algorithms and probabilistic analysis techniques, representation of basic geometric objects, convexity, polytopes.

Spatial decompositions: Planar subdivisions, triangulations, trapezoidal decompositions.

Geometric searching: Point location, interval and segment trees, data structures for nearest neighbors, range searching, multi-dimensional search trees.

Convex hulls: Geometric duality, deterministic and randomized algorithms for two and higher dimensional convex hulls, linear programming.

Proximity problems: Closest pair, Voronoi diagrams and Delaunay triangulations, relationship to convex hulls, and applications.

Arrangements: Line, hyperplane, and line segment arrangements, incremental construction techniques, complexity of lower envelopes, duality.

Visibility and motion planning: Visibility graphs, shortest paths, ray shooting.