

Tue, Thu
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LSRC D243

Computational Geometry

Course CPS234 Fall 2005

Instructor	Instructor
Overview	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Lecturer: <u>Pankaj K. Agarwal</u> LSRC D315 660-6548 pankaj@cs.duke.edu</p> </div> <div style="width: 45%;"> <p>Teaching Assistant: <u>Amit Patel</u> LSRC D103 660-6501 akpatel@cs.duke.edu</p> </div> </div>
Grading	
Assignments	
Lectures	
Reading	
Links	
Participants	

Overview

Computational geometry studies the design, analysis, and implementation of algorithms and data structures for geometric problems. These problems arise in a wide range of areas, including CAD/CAM, robotics, computer graphics, molecular biology, GIS, spatial databases, sensor networks, and machine learning. In addition to the tools developed in computer science, the study of geometric algorithms also requires ideas from various mathematical disciplines, e.g., combinatorics, topology, algebra, and differential geometry. This close interaction between various mathematical and practical areas has had a beneficial impact on both basic and applied research in computational geometry.

The goal of this course is to provide an overview of the techniques developed in computational geometry as well as some of its application areas. The topics covered in the course will include:

- 1. Geometric Fundamentals:** Models of computation, lower bound techniques, geometric primitives, geometric transforms
- 2. Convex hulls:** Planar convex hulls, higher dimensional convex hulls, randomized, output-sensitive, and dynamic algorithms, applications of convex hull
- 3. Intersection detection:** segment intersection, line sweep, map overlay, halfspace intersection, polyhedra intersection
- 4. Geometric searching:** segment, interval, and priority-search trees, point location, persistent data structure, fractional cascading, range searching, nearest-neighbor searching
- 5. Proximity problems:** closest pair, Voronoi diagram, Delaunay triangulation and their subgraphs, spanners, well separated pair decomposition
- 6. Arrangements:** Arrangements of lines and hyperplanes, sweep-line and incremental algorithms, lower envelopes, levels, and zones, applications of arrangements
- 7. Triangulations:** monotone and simple polygon triangulations, point-set triangulations, optimization criteria, Steiner triangulation, Delaunay refinement
- 8. Geometric sampling:** random sampling and ϵ -nets, ϵ -approximation and discrepancy, cuttings, coresets

9. Geometric optimization: linear programming, LP-type problems, parametric searching, approximation techniques

10. Robust geometric computation: perturbation techniques, floating-point filters, rounding techniques

Textbook

M. de Berg, M. van Kreveld, M. Overmars, and O. Schwarzkopf.
Computational Geometry: Algorithms and Applications. Springer-Verlag, 2nd edition, 2000.

Grading

Assignments: 30% weight

Four assignments will be given during the semester, which each student has to complete individually.

Scribe: 30% weight

Each student has to scribe roughly two lectures. Scribed notes should be completed individually, but you can certainly ask your peers to clarify any point that your notes leave unclear.

Research Project: 40% weight

The intention is to produce a work of publishable or near-publishable quality. It will consist of a comprehensive survey on a topic plus new research work.

Assignments

Homework 1 due October 6

Homework 2 due October 27 (Solution)

Homework 3 due November 18

[Top of Page](#)

Web site by Celeste Hodges