E244 JAN 3:1

Computational Geometry and Topology

Instructor

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Department: Computer Science and Automation

Course Time:

Lecture venue: CSA Rm 252

Detailed Course Page:

Announcements

Brief description of the course

Computational geometry deals with the design and analysis of algorithms for geometric problems. Topology is a abstraction of geometry obtained by focusing on the connectedness of space. Computational topology deals with the study of algorithms for topological problems. Many of the algorithmic tools employed in computational topology have origins in computational geometry. This course will serve as an introduction to both computational geometry and computational topology. Further, it will explore the links between the two fields. The course content will be a combination of mathematical and algorithmic topics. The mathematical topics will include epsilon nets, geometric intersection graphs, geometric discrepancy, topology of cell complexes, simplicial homology, persistent homology, and Morse theory. The algorithmic topics will include efficient methods for computing geometric structures such as the Voronoi diagram and Delaunay triangulation, geometric optimization, efficient computation of topological structures and invariants, clustering, and approximation and fixed parameter algorithms for geometric problems. Results

from computational geometry and topology have been applied in various fields including computer graphics, computer vision, geographic information systems (GIS), molecular biology, robotics and scientific visualization.

This course is targeted at graduate students of Computer Science, Mathematics, and related disciplines.

Prerequisites

A graduate level course in algorithms and data structures.

Syllabus

Voronoi diagram, Delaunay triangulation, Geometric Data Structures â€" Interval tree, Range tree, Segment tree. Complexes â€" simplicial complex, Rips complex, alpha complex, homology, Betti numbers, persistence homology, Morse functions, Reeb graph, approximation and fixed parameter algorithms for geometric problems - hitting set and set cover, epsilon nets, epsilon approximations, geometric intersection graphs, geometric discrepancy, clustering.

Course outcomes

Students taking this course will be introduced to a new class of problems and algorithms that involve the study of geometry and topology. The course will also introduce various algorithmic paradigms and hence help students improve their algorithmic skills. After successful completion of the course, a student will be able to effectively apply the techniques to specific application domains of interest or pursue independent research in this area.

Grading policy

Midterm exam 35%

Assignments 35%

Final project 30%

Assignments

Resources

Computational Geometry: Algorithms and Applications, Mark de Berg et al., Third Edition, Springer, 2011.

Computational Topology : An Introduction, Herbert Edelsbrunner and John L. Harer, Indian Edition, 2010.

Recent literature