UNIVERSITY OF NEVADA LAS VEGAS
Department of Computer Science

CSC-758: Computational Geometry

Course Description

Computational geometry deals with the development and analysis of algorithms having geometric flavor. Knowledge of elementary data structures (arrays, heaps, balanced trees, etc) and algorithmic tools (asymptotic analysis, space time complexity, divide and conquer, dynamic programming, etc) are prerequisites for this course.

Student Learning Outcomes

The learning outcomes for the course.

- **Elementary geometric methods**: points, lines and polygons. Line segments intersection. Simple closed path, inclusion in a polygon, inclusion in a convex polygon, range search, point location in planar subdivision and duality.
- **Convex hull**: Graham's scan, Jarvin's march, divide and conquer approach, on-line algorithms, approximate algorithms, convex hull of simple polygons, lower bound proofs and diameter of a point set.
- **Proximity**: Closest pair, triangulation, divide and conquer approach for closest pair, Voronoi diagram and their properties, dual of Voronoi diagram, construction of Voronoi diagram, Euclidean minimum spanning tree, gaps and covers.
- **Intersections**: convex polygons, polygons, star polygons, line segments, half planes and plane sweep paradigm.
- Mesh generation algorithms: Delaunay triangulation, quad-trees, and Quadrangulations.
- **Visibility and path planning**: visibility properties of polygons, visibility graphs, applications of computational geometry in robotics, shortest s-t path inside a simple polygon, shortest s-t path amidst polygons, introduction to path planning in 3-d, decomposition of polygons.

Course Material

Textbook: Computational Geometry in C (Second Edition) by Joseph O'Rourke

Additional reading materials will be discussed in the class.

Course Schedule

	Lecture#: Topics	Materials
Week 1	**Martin Luther King Jr. Day recess**	
	L1: Elementary Geometric Objects and operations	Chapter 1

Week 2	L2: Visibility inside/outside polygons: Art Gallery Problem	Chapter 1
	L3: Triangulated polygons: 3 coloring	Chapter 1
Week 3	L4: Triangulation by ear removal	Chapter 1
	L5: Triangulating monotone polygons: top-down scan	Handouts
Week 4	L6: Convex decomposition – KM Algorithm	Chapter 2
	L7: Partitioning a polygon into trapezoids	Chapter 2
Week 5	**President Day Recess**	
	L9: Point inclusion in simple polygons	Chapter 7
Week 6	L10: Intersection between several line segments (plane sweep)	Chapter 7
	L11: Convex Hull - Introduction	Chapter 3
Week 7	L12: Jarvin's March Algorithm	Chapter 3
	L13: Quick hull and divide and conquer	Chapter 3
Week 8	L14: More on Convex Hull Algorithm	Chapter 3
	Mid Semester Exam	
Week 9	Spring Break Recess	
	Spring Break Recess	
Week 10	L15: Voronoi Diagram - Introduction	Chapter 5
	L16: Properties of Voronoi Diagram	Chapter 5
Week 11	L17: Delaunay triangulation	Chapter 5
	L18: Fortunes sweep-line algorithm for Voronoi Diagram	Handouts
Week 12	L19: Minimum spanning tree and Delaunay Triangulation	Chapter 5
	L20: Apprx Algorithm for Travelling Sales Person Problem	Chapter 5
Week 13	L21: Data Structure for Planar Straight Graphs	Chapter 4 and Handouts
	L22: Data Structure for Planar Straight Graphs … cntd	Chapter 4 and Handouts
Week 14	L23: Face routing algorithm	Handouts
	L24: 2D Path Planning – Visibility Graph	Chapter 8
Week 15	L25: More on 2D Path Planning	Chapter 8
	L26: Voronoi Diagram and Path Planning	Chapter 8 and Handouts
Week 16	**Study Week**	
	Final Exam (2 hours)	

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