Computational Geometry

Introduction

Resources

- www.cs.brynmawr.edu/cs310
- ~dxu/handouts/cs310

Prerequisites

- Discrete Math (CS/MATH 231)
- Mathematical maturity
- Programming proficiency

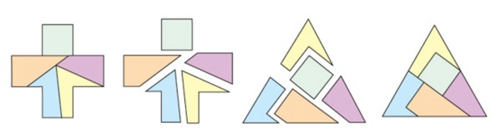
Requirements

- Class participation (10%)
- 6-7 assignments (40%)
  - individual or group
- Midterm (25%)
- Final project (25%)

Polygons

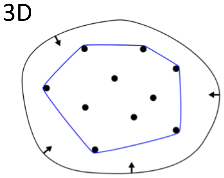
- Every polygon of *n* vertices may be guarded by *n*/3 vertex guards.
- Not every polyhedron of *n* vertices may be guarded with one guard at every vertex
- Any pair of polygons of the same area have a common dissection
- Not every pair of polyhedra of the same volume have a common dissection

Lindgren's Dissection of a Greek Cross to an Equilateral Triangle



Convex Hulls

- The convex hull of n points in 2D can be constructed as quickly as those n points can be sorted.
- The same complexity can be achieved for the convex hull of n points in 3D



Merging two 3D Hulls

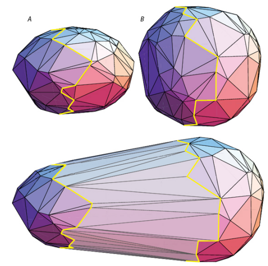


Figure 2.15. Two hulls A and B along with the hull of $A \cup B$. The shadow boundaries are marked.

Triangulations

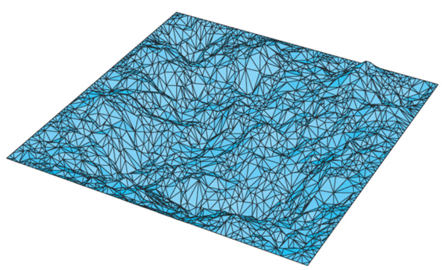
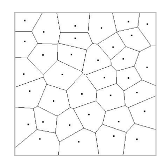


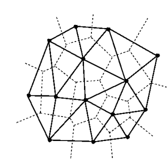
Figure 3.17. A piecewise-linear terrain reconstruction.

Voronoi Diagram

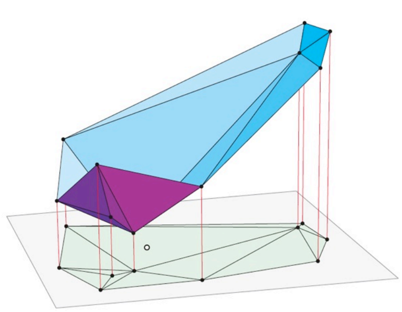
- Proximity diagram



- Delaunay Triangulation

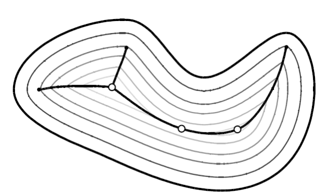


The Delaunay Triangulation is the projection of convex hulls in 3D



Curves

- Medial axis – a complete shape descriptor
- Generalization of the Voronoi diagram



Curve Shortening

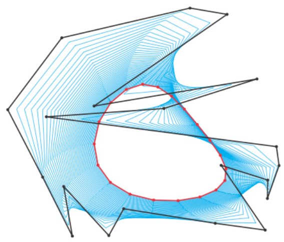


Figure 5.23. A discrete flow of a simple 20-gon (in black) with 40 iterations using $\delta = 1/10$.

Polyhedra

- Euler's formula
- Gauss-Bonnet Theorem: The total curvature on any polyhedron is a constant: 4π.
- Can any convex polyhedron be unfolded to a planar set?