11 Computational Geometry

CGAL
fab modules

11.1 MESHES

triangulation
FEM, STL, GL


maximize minimum angle


closest points
voting, ecology, networking
dual
simplices with no vertex in circumsphere


start arbitrary bounding simplex
add point, delete intersecting circumspheres, create simplices from polytope faces
not unique, perturb
construct tree from subdivisions
11.2 Shapes


randomized incremental
N log N

guayon


ear-clipping, diagonal contained

volume
CT, sim, frep

marchine cubes


decimation


11.2 SHAPES

mesh
NURB
brep
CSG
frep


Boolean
distance metric
interval arithmetic
octree


Pion, Sylvain. "Interval arithmetic: An efficient implementation and an application to computational geometry." Workshop on Applications of Interval Analysis to systems and Control (MISC). 1999.


ASDF


Hierarchical Volumetric Object Representations for Digital Fabrication Workflows, Matthew Keeter (May 2013)

folding


11.3 DISTANCES

offset

biarc


discretize
thicken, thin, fill
distance transform

naive $O(N^2)$


pixel $p_{ij}$ zero interior nonzero exterior

\[ f_{ij} = \min_{x \in \text{interior}} (i-x)^2 \]  

(11.1)

sweep left, right
every point assigned

\[ g_{ij} = \min_{y \in \text{interior}} f_{iy} + (j-y)^2 \]  

(11.2)

sweep up, down

\[ g_{ij} = \min_{y \in \text{interior}} f_{iy} + (j-y)^2 \]
\[ = \min_{y \in \text{interior}} \min_{x \in \text{interior}} (i-x)^2 + (j-y)^2 = 0 \]  

(11.3)

bound distance by $f$
higher dimensions

photogrammetry
triangulation
structured light
Gray code


11.4 ROTATIONS

quaternions


Lie groups


Berry’s phase


11.5 GRAPHS

types
linked lists

routing
shortest path

Dijkstra’s algorithm


dynamic programing
mathematical programing

Bellman-Ford


Hamiltonian path, TSP
NP complete
relaxations

11.6 SELECTED REFERENCES


Old and new classics.

11.7 PROBLEMS

(11.1) frep
(11.2) 720 rotation
(11.3) mesh routing