Computational geometry

Olivier Devillers
Marc Pouget
Computational geometry

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Marc Pouget

Gamble team in Nancy

Geometric Algorithms and Models Beyond the Linear and Euclidean realm
Computational geometry

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Interns welcome

Geometric Algorithms and Models Beyond the Linear and Euclidean realm
Computational geometry

7 lectures of 3 hours

21-09 • Intro: what is computational geometry.
Convex hull: definitions, classical algorithms.

24-09 • Delaunay Triangulation: definitions, motivations
First properties and classical algorithms.

05-10 • Randomized algorithms.
Poisson Delaunay triangulation.

08-10 • Numerical issues and algorithmic robustness.
Degenerate cases and perturbation techniques.

19-10 • Reconstruction. Meshing.

09-11 • Triangulations in the CGAL library.

12-11 • Periodic triangulations. Hyperbolic triangulations.
Computational geometry

Evaluation

Your grade will be in two pieces:

- Homework: exercises after each lecture.
- Presentation of a research paper

10-12 Defense: 20 minutes ? (how many students ?)
Computational geometry
Computational geometry

Design geometric algorithms
Computational geometry

Design geometric algorithms

Study complexity
Computational geometry

Design geometric algorithms

Study complexity

Model of computation
Worst-case or random analysis
Lower bound
Asymptotic analysis
Computational geometry problems
Computational geometry problems

Convex hull
Computational geometry problems

Convex hull
Computational geometry problems

Convex hull

Convex hull lecture
Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams
Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams
Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams
Computational geometry problems
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Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams
Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams

Arrangement of curves
Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams

Arrangement of curves
Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams

Arrangement of curves

Lower envelopes
Computational geometry problems

Convex hull
Delaunay triangulation / Voronoi diagrams
Arrangement of curves
Lower envelopes
Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams

Arrangement of curves

Lower envelopes

Visibility
Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams

Arrangement of curves

Lower envelopes

Visibility
Computational geometry usage
Computational geometry usage

Points to shape

\[4 - 2\]
Computational geometry usage

Points to shape

Reconstruction lecture
Computational geometry usage

Points to shape

Reconstruction lecture

Use Delaunay
Computational geometry usage
Computational geometry usage

Shape to mesh
Computational geometry usage

Shape to mesh

Meshing lecture
Computational geometry usage

Shape to mesh

Meshing lecture

Use Delaunay
Computational geometry usage
Computational geometry usage

Motion planning

Robot

Obstacles
Computational geometry usage

Motion planning

Obstacles

Robot
Computational geometry usage

Motion planning

Obstacles

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Computational geometry usage

Motion planning

Obstacles

Robot
Computational geometry usage

Motion planning

Robot

Obstacles

Use arrangements, lower envelopes
Computational geometry, 1975-1985

Complicated algorithms
Worst case complexities
Asymptotic complexities
Real RAM model
Lower bounds
General position hypothesis
Computational geometry, 1975-1985

- Complicated algorithms
- Worst case complexities
- Asymptotic complexities
- Real RAM model
- Lower bounds
- General position hypothesis

- Fit real life data
- For $n$ big enough
- Does it exist
- Real life data
- Don’t degeneracies exist
Computational geometry, 1975-1985

- Complicated algorithms
- Worst case complexities
- Asymptotic complexities
- Real RAM model
- Lower bounds
- General position hypothesis

- Fit real life data
- For \( n \) big enough
- Does it exist
- Real life data
- Don’t degeneracies exist
Computational geometry, 1975-1985

- Complicated algorithms
  - Not used in practice
- Worst case complexities
- Asymptotic complexities
- Real RAM model
- Lower bounds
- General position hypothesis

- Fit real life data
- For $n$ big enough
- Does it exist
- Real life data
- Don’t degeneracies exist

$7 - 4$
Computational geometry, 1985-2000

Complicated algorithms

Worst case complexities

Asymptotic complexities

Real RAM model

Lower bounds

General position hypothesis
Computational geometry, 1985-2000

Simpler
Complicated algorithms

Worst case complexities

Asymptotic complexities

Real RAM model

Lower bounds

General position hypothesis
Computational geometry, 1985-2000

- Simpler
- Complicated algorithms
- Worst case complexities
- Asymptotic complexities
- Real RAM model
- Lower bounds
- General position hypothesis

randomized
Computational geometry, 1985-2000

- Simpler
- Complicated algorithms
- Worst case complexities
- Asymptotic complexities
- Real RAM model
- Lower bounds
- General position hypothesis

Randomization lecture
Computational geometry, 1985-2000

- Complicated algorithms
- Worst case complexities
- Asymptotic complexities
- Real RAM model: address robustness issues
- Lower bounds
- General position hypothesis: solve degeneracies
Computational geometry, 1985-2000

- Complicated algorithms
- Worst case complexities
- Asymptotic complexities
- Real RAM model: address robustness issues
- Lower bounds
- General position hypothesis: solve degeneracies
Computational geometry, 1985-2000

Complicated algorithms

Worst case complexities

Asymptotic complexities

Real RAM model

Lower bounds

General position hypothesis

Just really code it
Computational geometry, 1985-2000

Complicated algorithms
Worst case complexities
Asymptotic complexities
Real RAM model
Lower bounds
General position hypothesis

Just really code it
Computational geometry, 2000-

Complicated algorithms

Worst case complexities

Asymptotic complexities

Real RAM model

Lower bounds

General position hypothesis
Computational geometry, 2000-

- Complicated algorithms
- Worst case complexities
- Asymptotic complexities
- Real RAM model
- Lower bounds
- General position hypothesis

Probabilistic hypotheses
Computational geometry, 2000-

- Complicated algorithms
- Worst case complexities
- Asymptotic complexities
- Real RAM model
- Lower bounds
- General position hypothesis
- Probabilistic hypotheses
- Old (and recent) math literature
Computational geometry, 2000-

- Complicated algorithms
- Worst case complexities
- Asymptotic complexities
- Real RAM model
- Lower bounds
- General position hypothesis
- Probabilistic hypotheses
- Old (and recent) math literature
- Poisson Delaunay lecture
Computational geometry, 2000-

Complicated algorithms

Worst case complexities

Asymptotic complexities

Real RAM model

Lower bounds

General position hypothesis

Beyond the Euclidean realm
Computational geometry, 2000-

Bone scaffolding

Periodic Delaunay lecture
Computational geometry, 2000-

Periodic Delaunay lecture

Cosmic web
Computational geometry, 2000-

Periodic Delaunay lecture

Photonic crystal
Computational geometry, 2000-

Complicated algorithms
Worst case complexities
Asymptotic complexities
Real RAM model
Lower bounds
General position hypothesis

Beyond the Euclidean realm

Hyperbolic Delaunay lecture
Computational geometry, 2000-

Hyperbolic Delaunay lecture
Computational geometry, 2000-

Hyperbolic Delaunay lecture