Computational geometry

Olivier Devillers
Monique Teillaud

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Gamble team in Nancy

Geometric Algorithms and Models Beyond the Linear and Euclidean realm

Computational geometry

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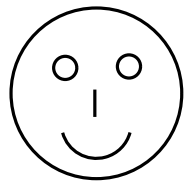
Interns welcome



Geometric Algorithms and Models Beyond the Linear and Euclidean realm

Computational geometry

7 lectures of 3 hours

9-10 • Intro: what is computational geometry.
Convex hull: definitions, classical algorithms.

10-11 • Delaunay Triangulation: definitions, motivations
First properties and classical algorithms.

13-11 • Randomized algorithms.
Poisson Delaunay triangulation.

17-11 • Numerical issues and algorithmic robustness.
Degenerate cases and perturbation techniques.

20-11 • Triangulations in the CGAL library.

24-11 • Reconstruction. Meshing.

27-11 • Periodic triangulations. Hyperbolic triangulations.

Computational geometry

Evaluation

Your grade will be in two pieces:

- Homework: exercises after each lecture.
- – Presentation of a research paper
  – or coding project using CGAL

8-12 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

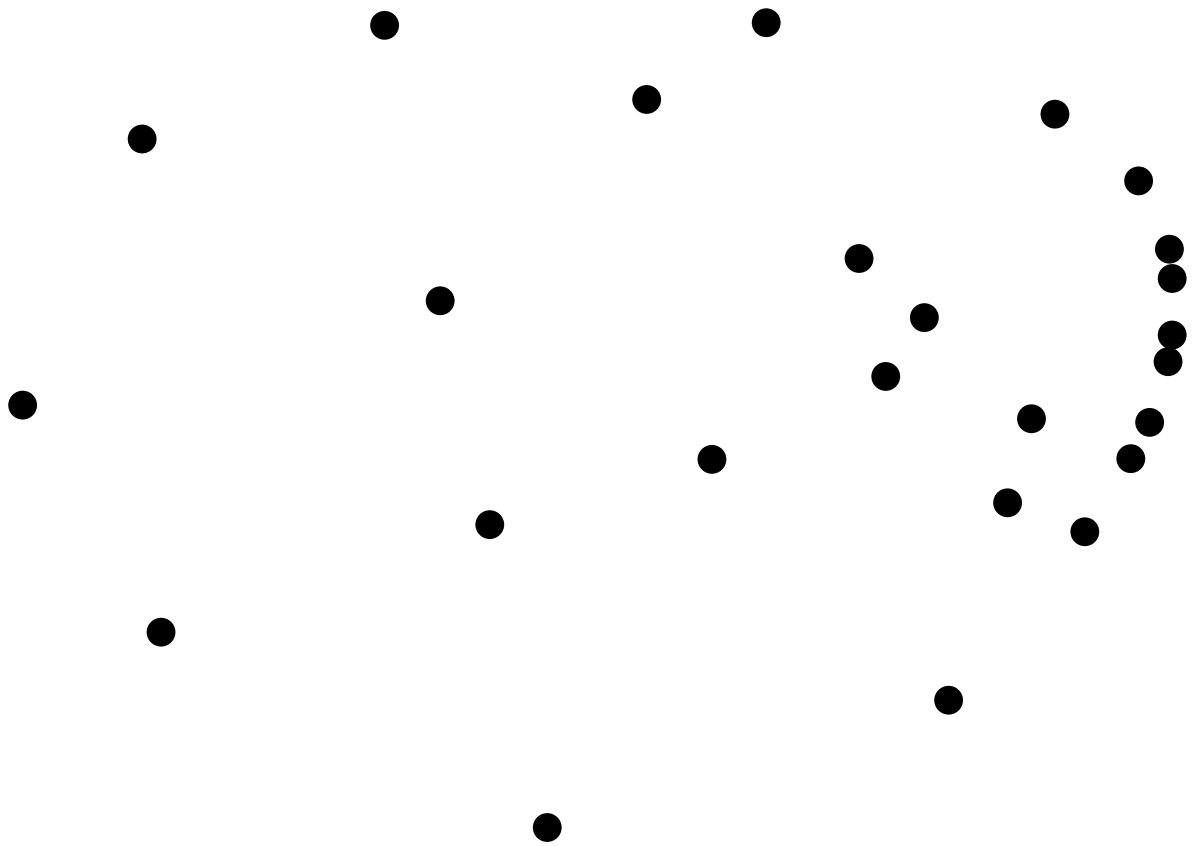
Study complexity

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

Computational geometry problems

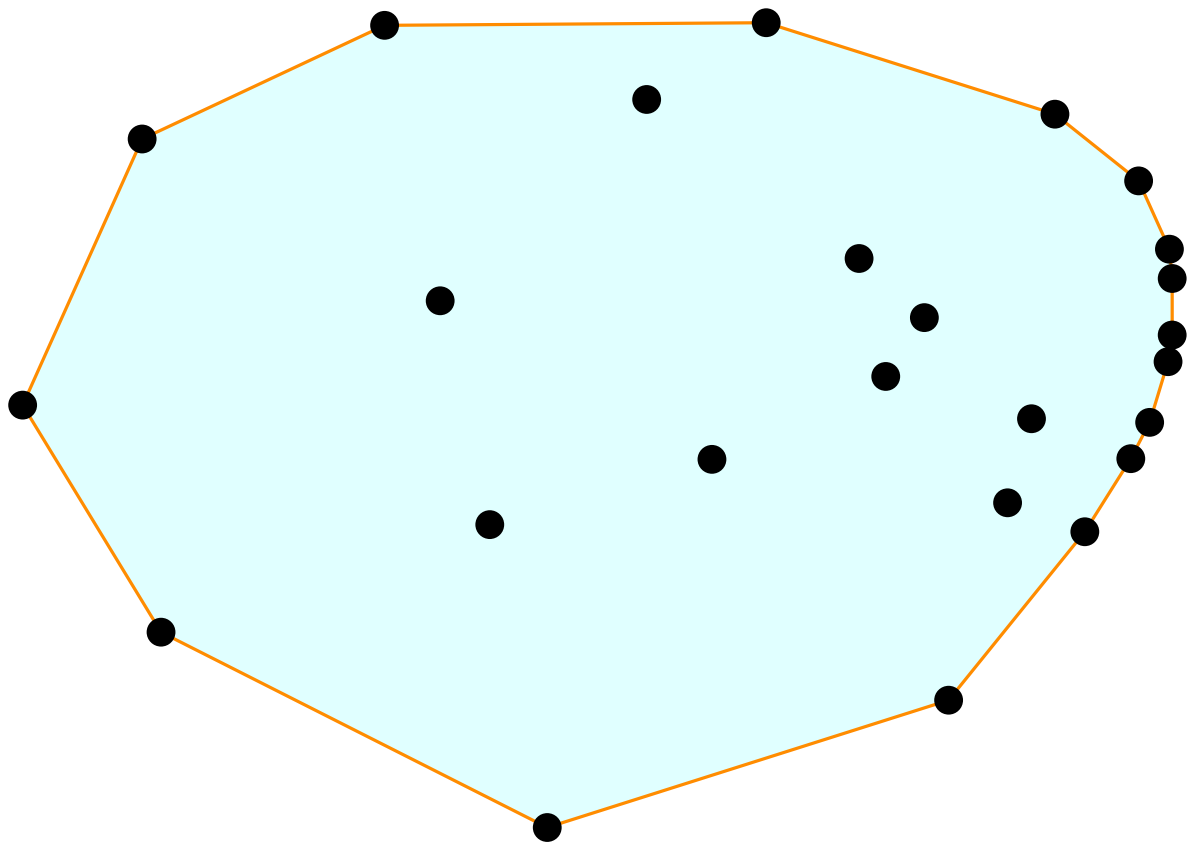
Computational geometry problems

Convex hull



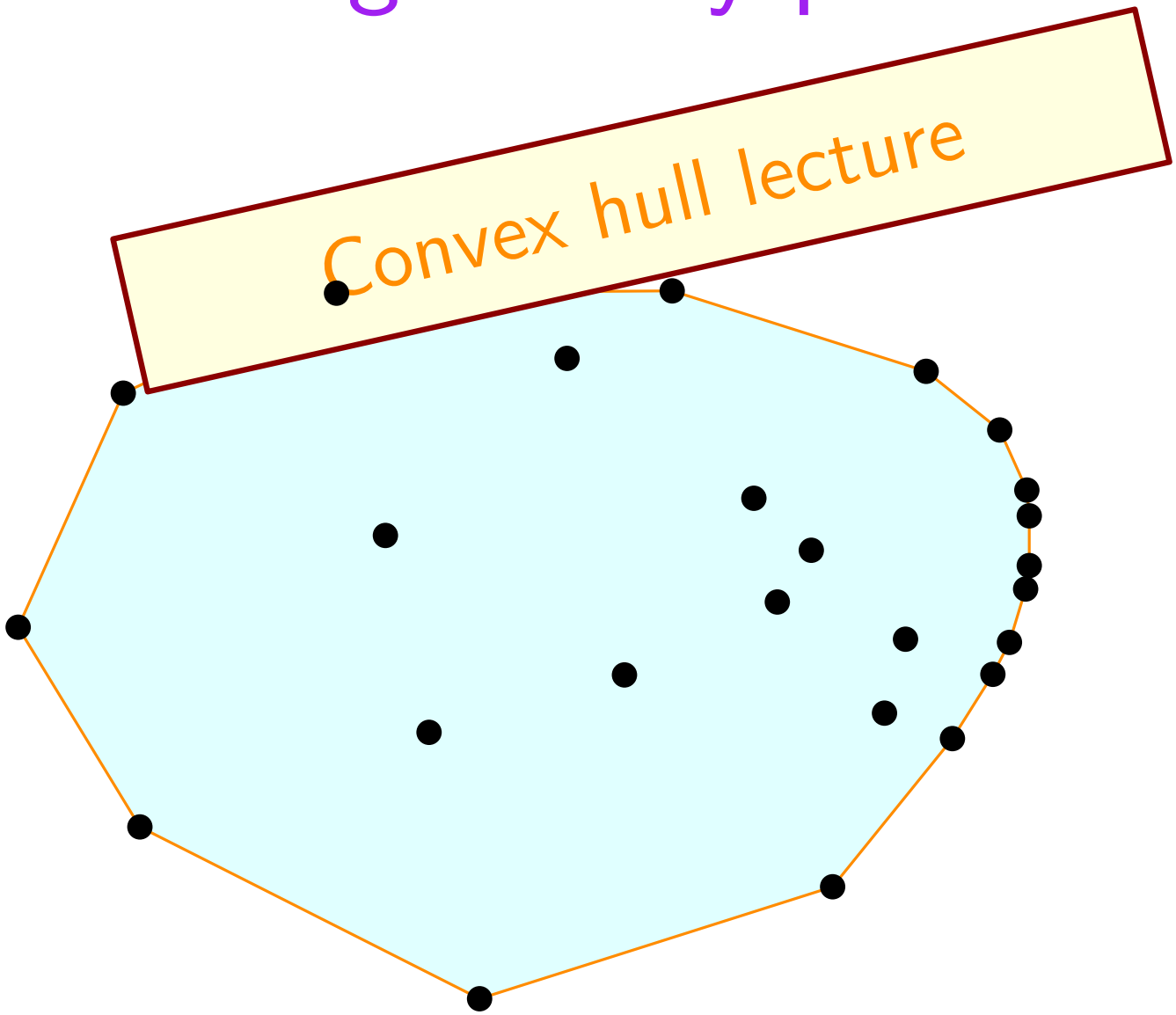
Computational geometry problems

Convex hull



Computational geometry problems

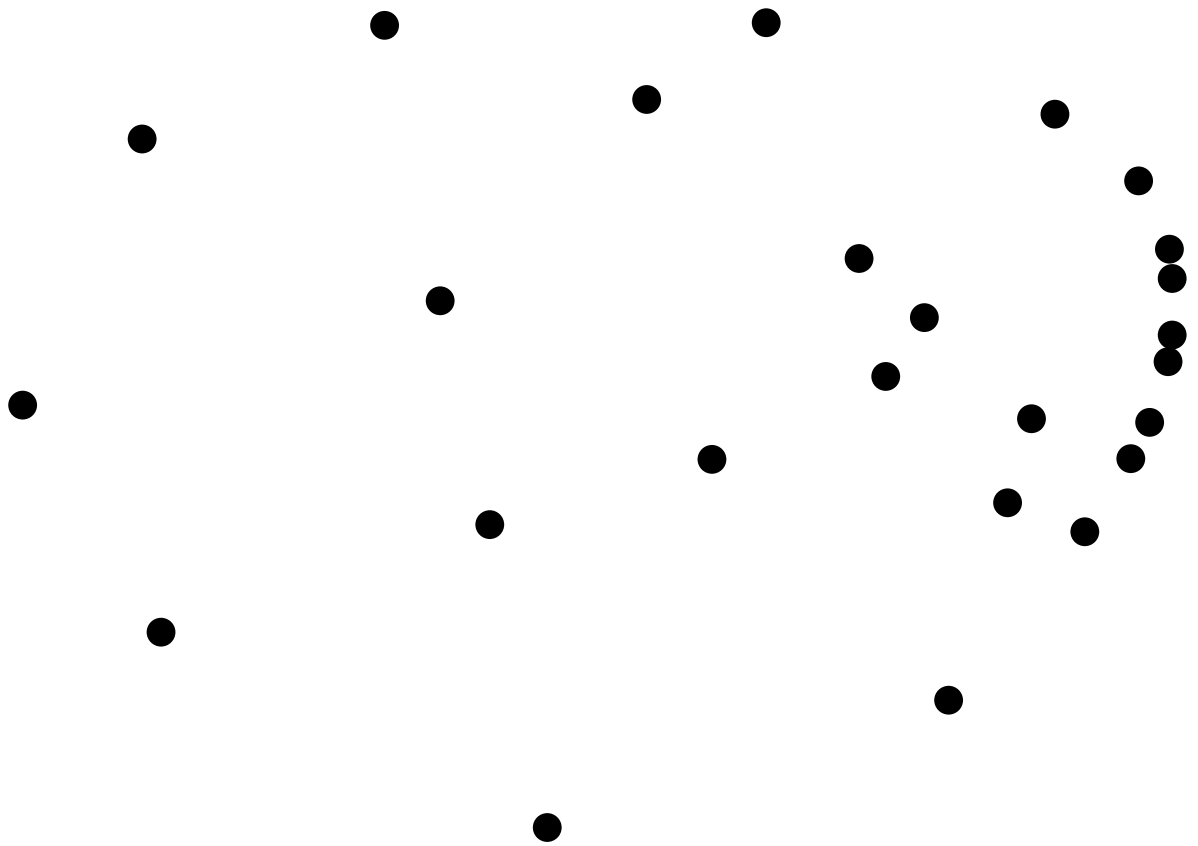
Convex hull



Computational geometry problems

Convex hull

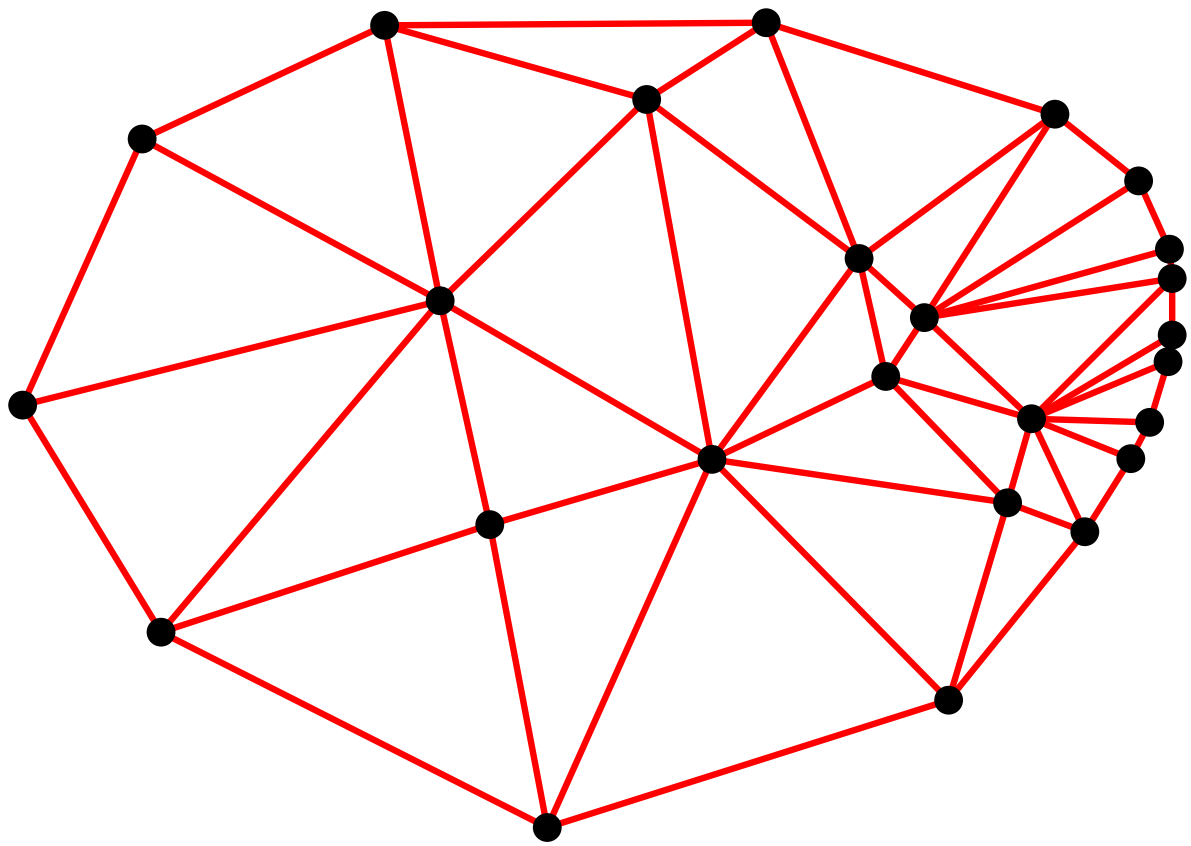
Delaunay triangulation / Voronoi diagrams



Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams



Computational geometry problems

Convex hull

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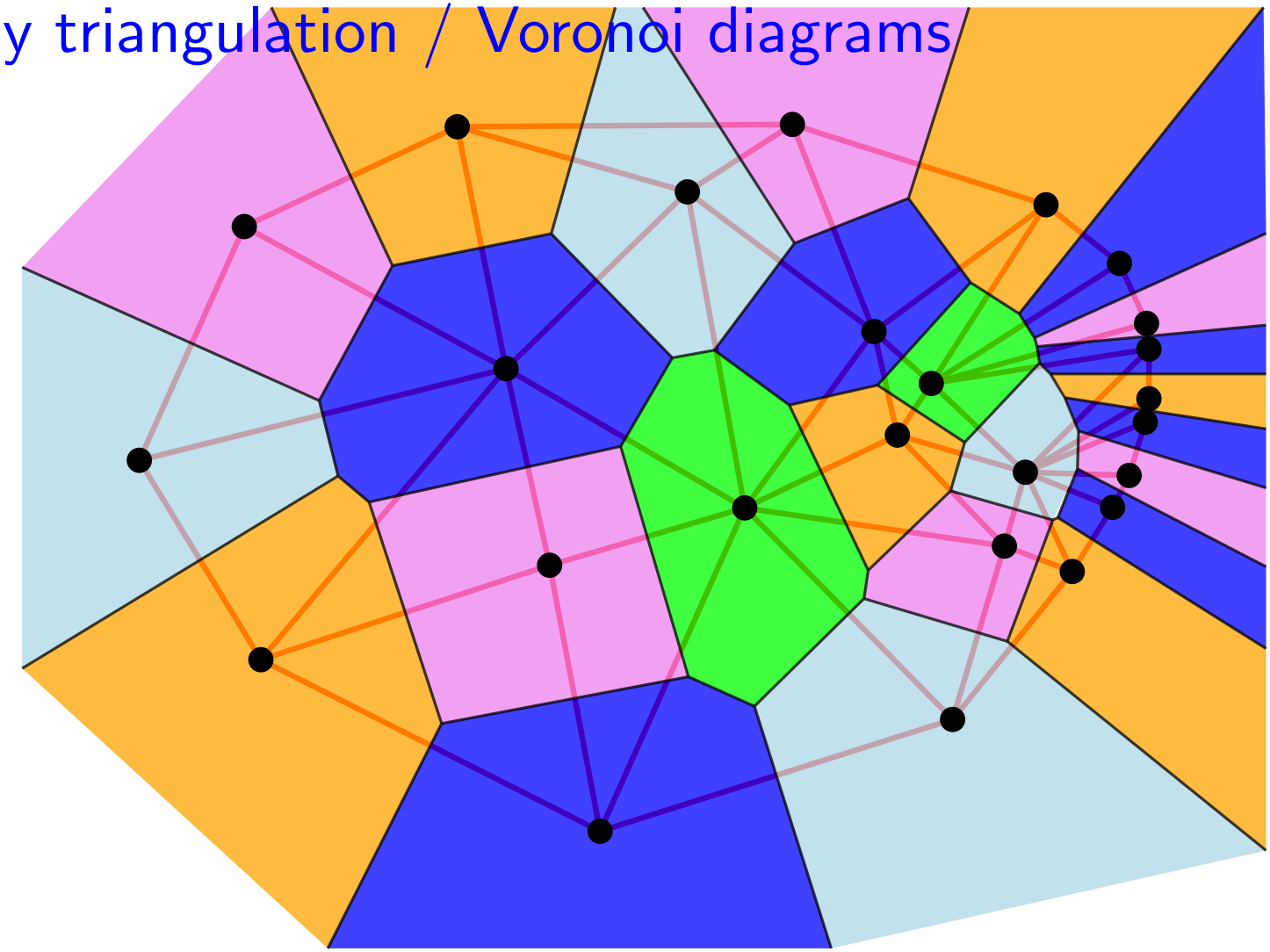
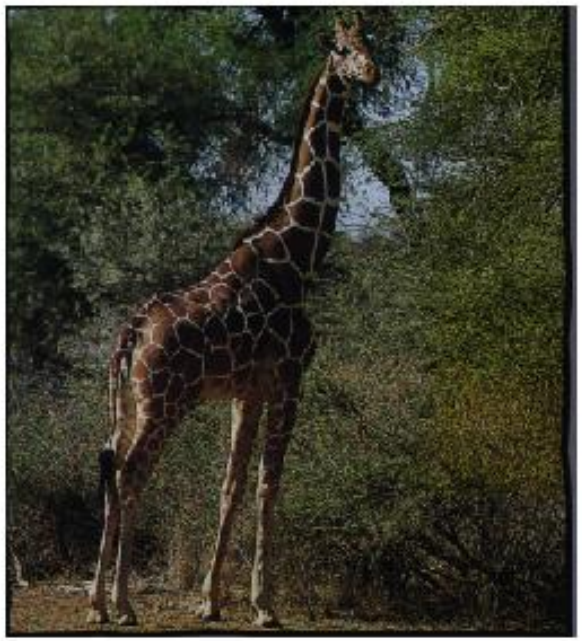
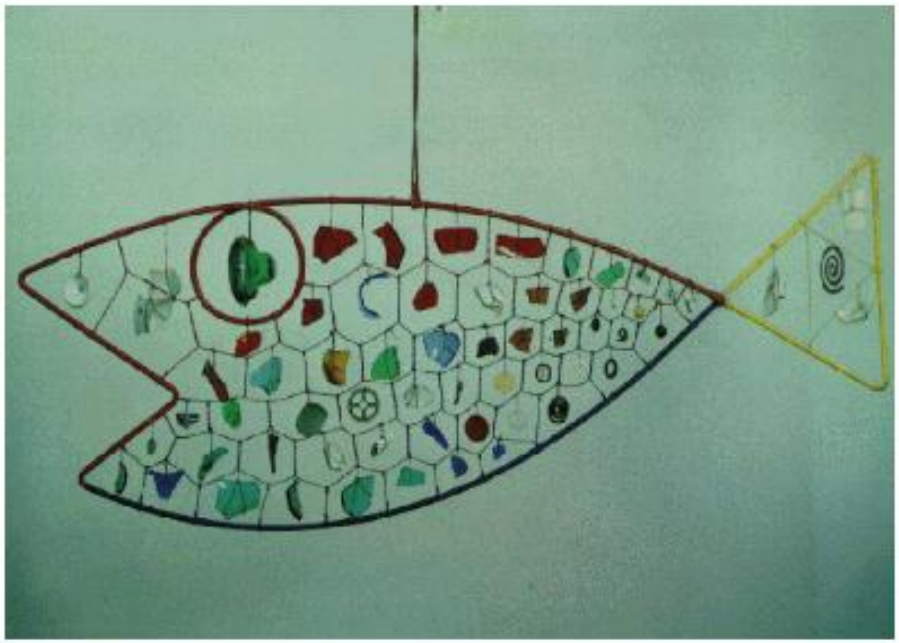


Computational geometry problems





Computational geometry problems

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Convex hull

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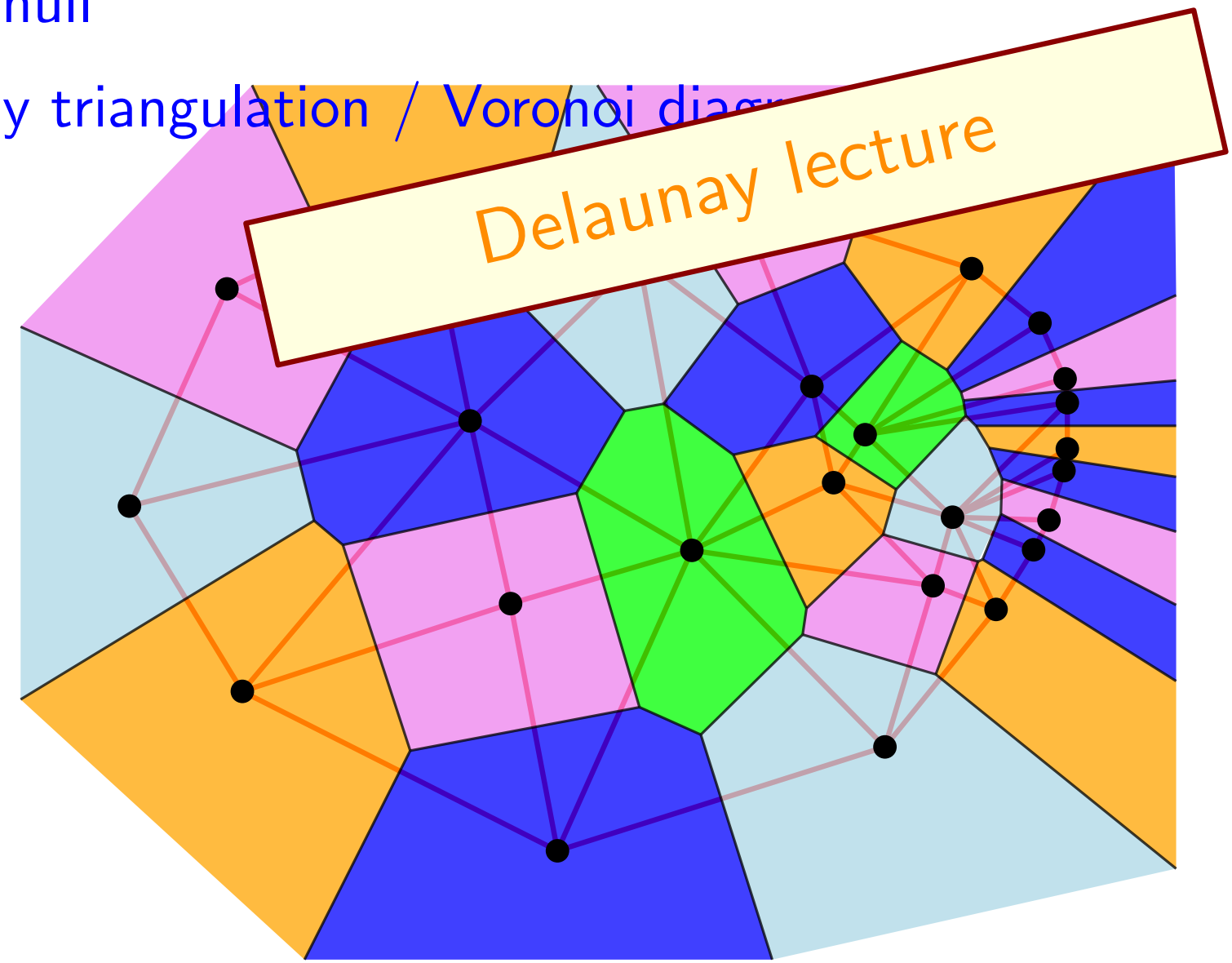
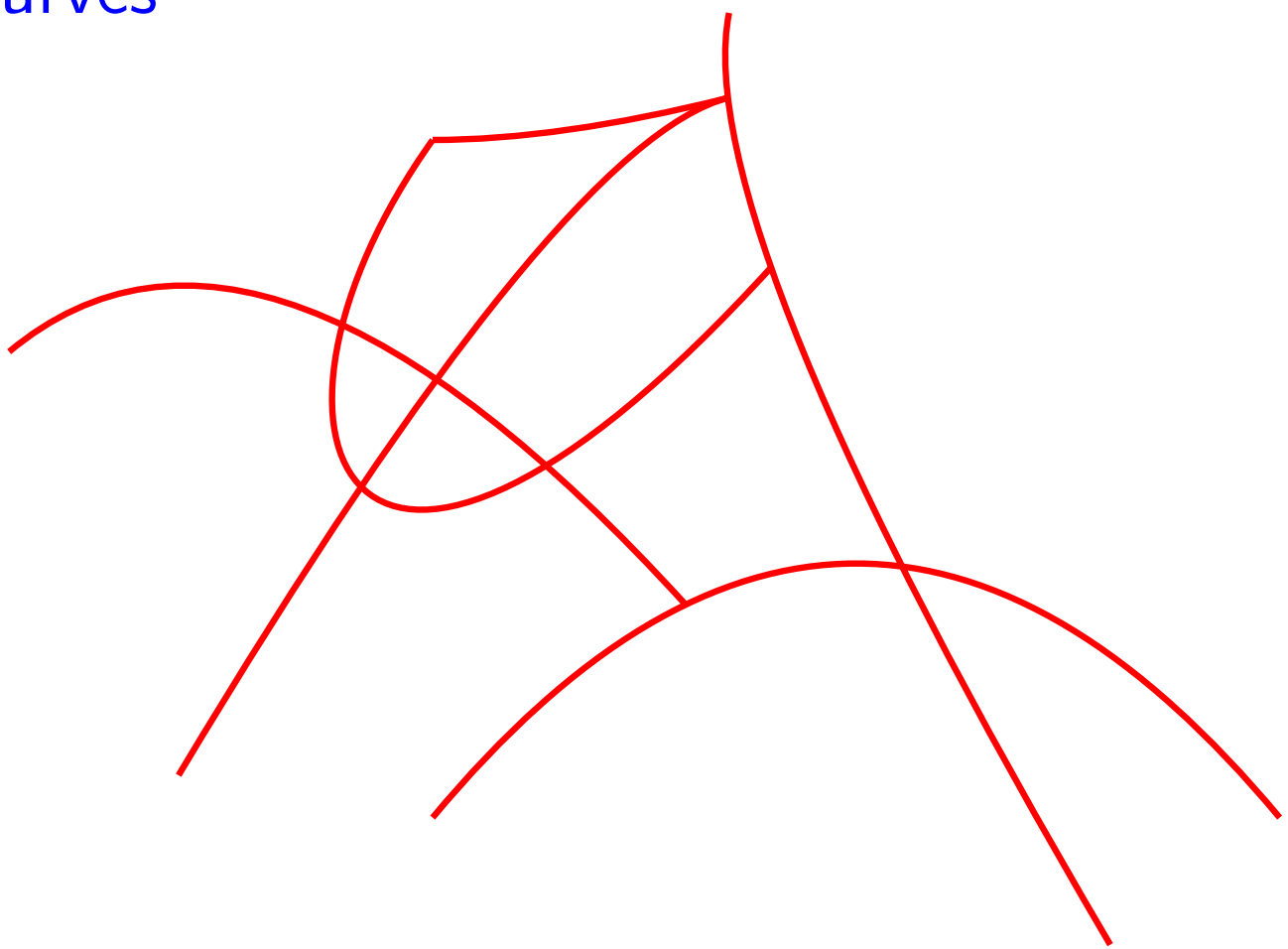


Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams

Arrangement of curves



Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams

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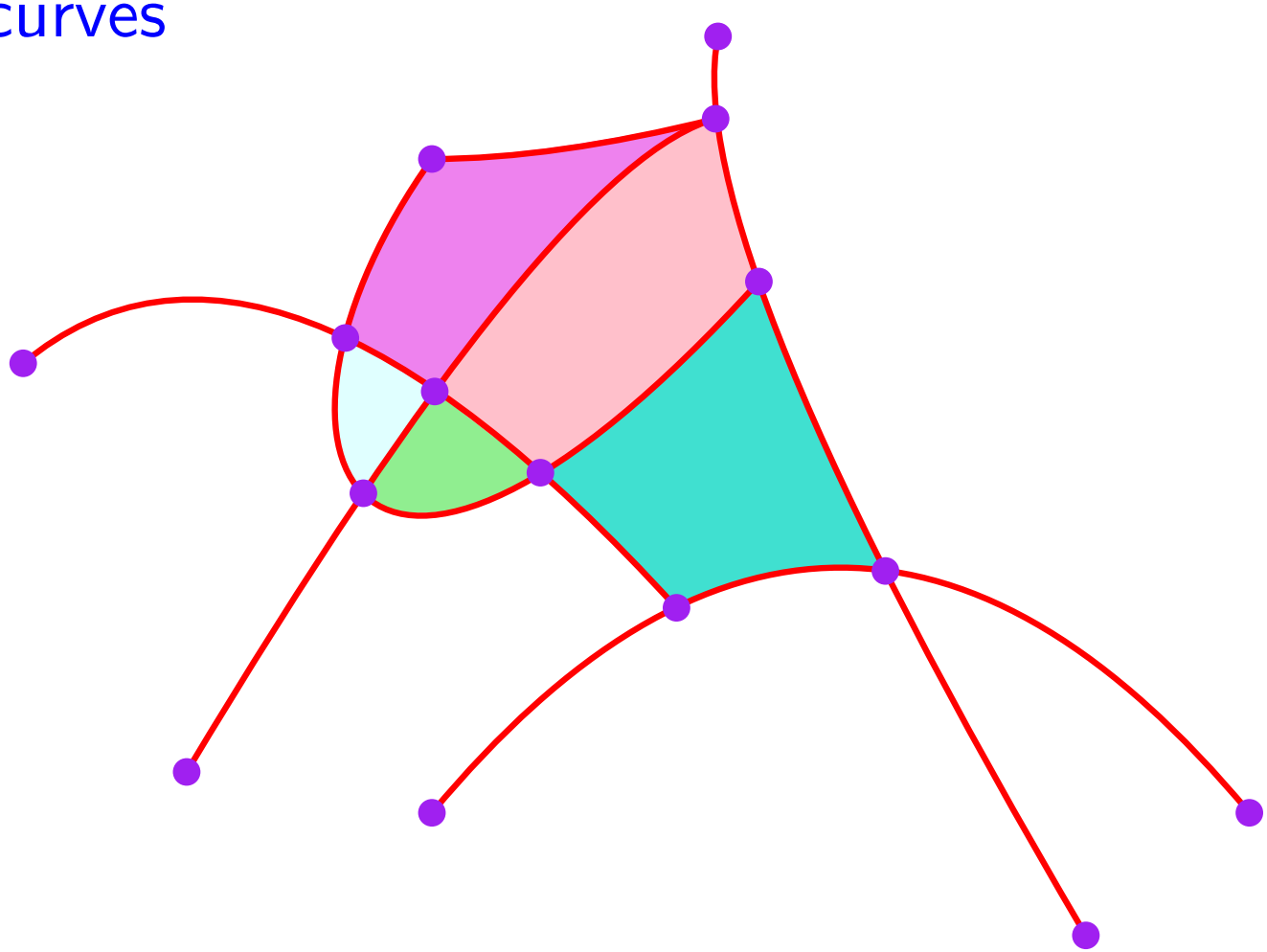


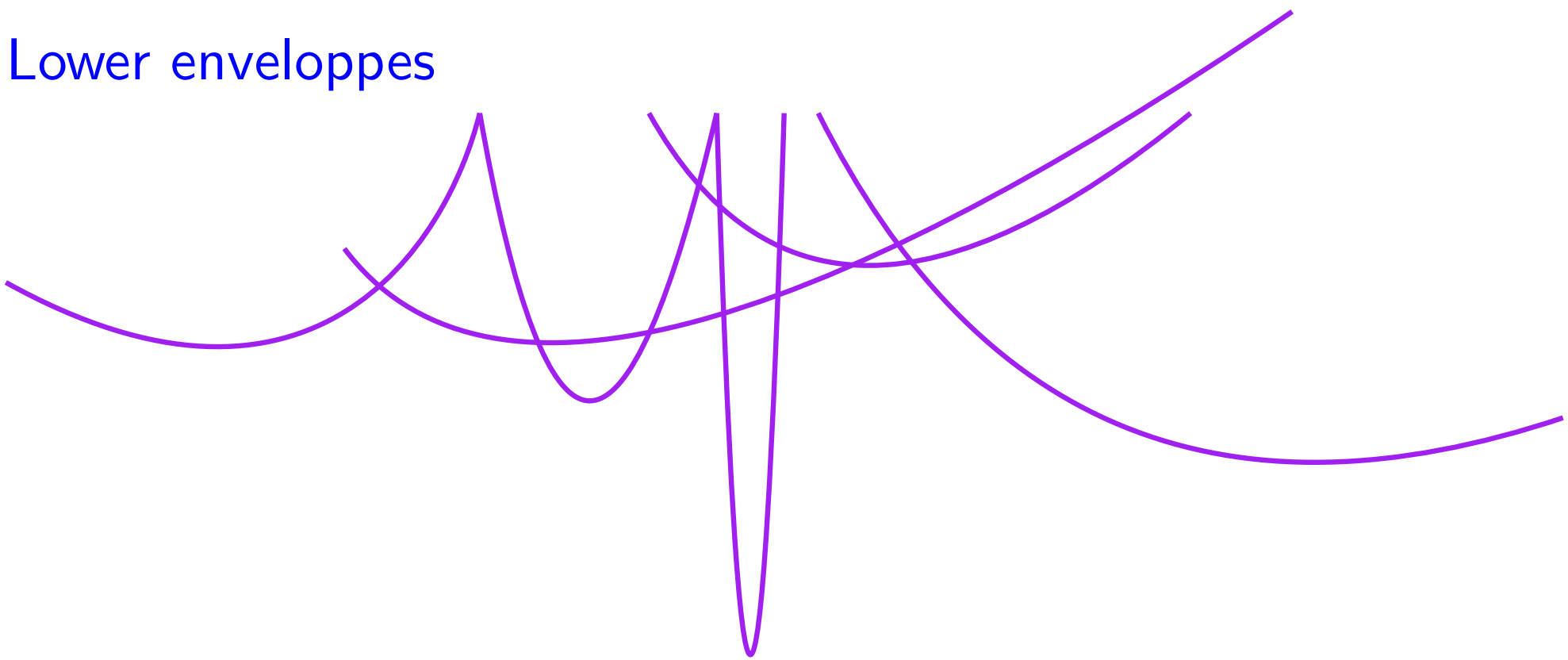
Computational geometry problems

Convex hull

Delaunay triangulation / Voronoi diagrams

Arrangement of curves

Lower enveloppes



Computational geometry problems

Convex hull

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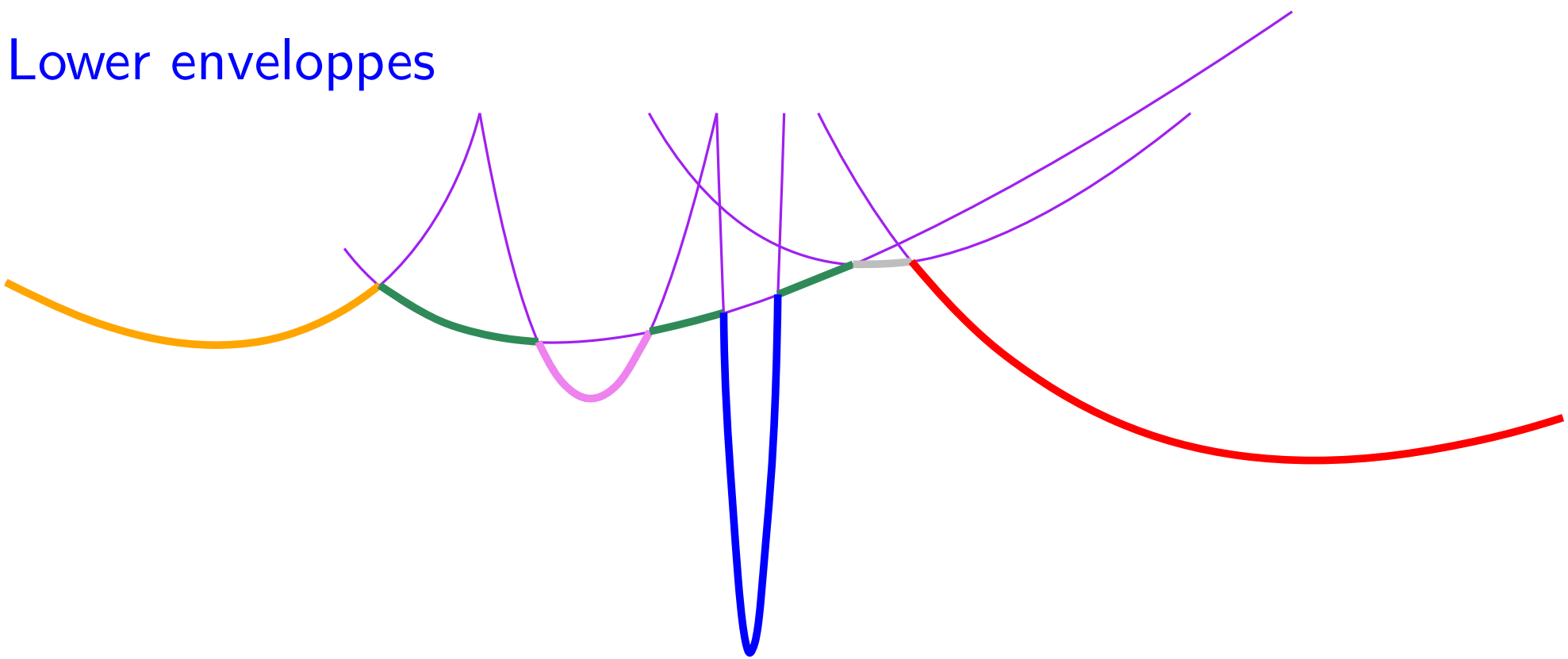
Arrangement of curves

Lower enveloppes



Computational geometry problems

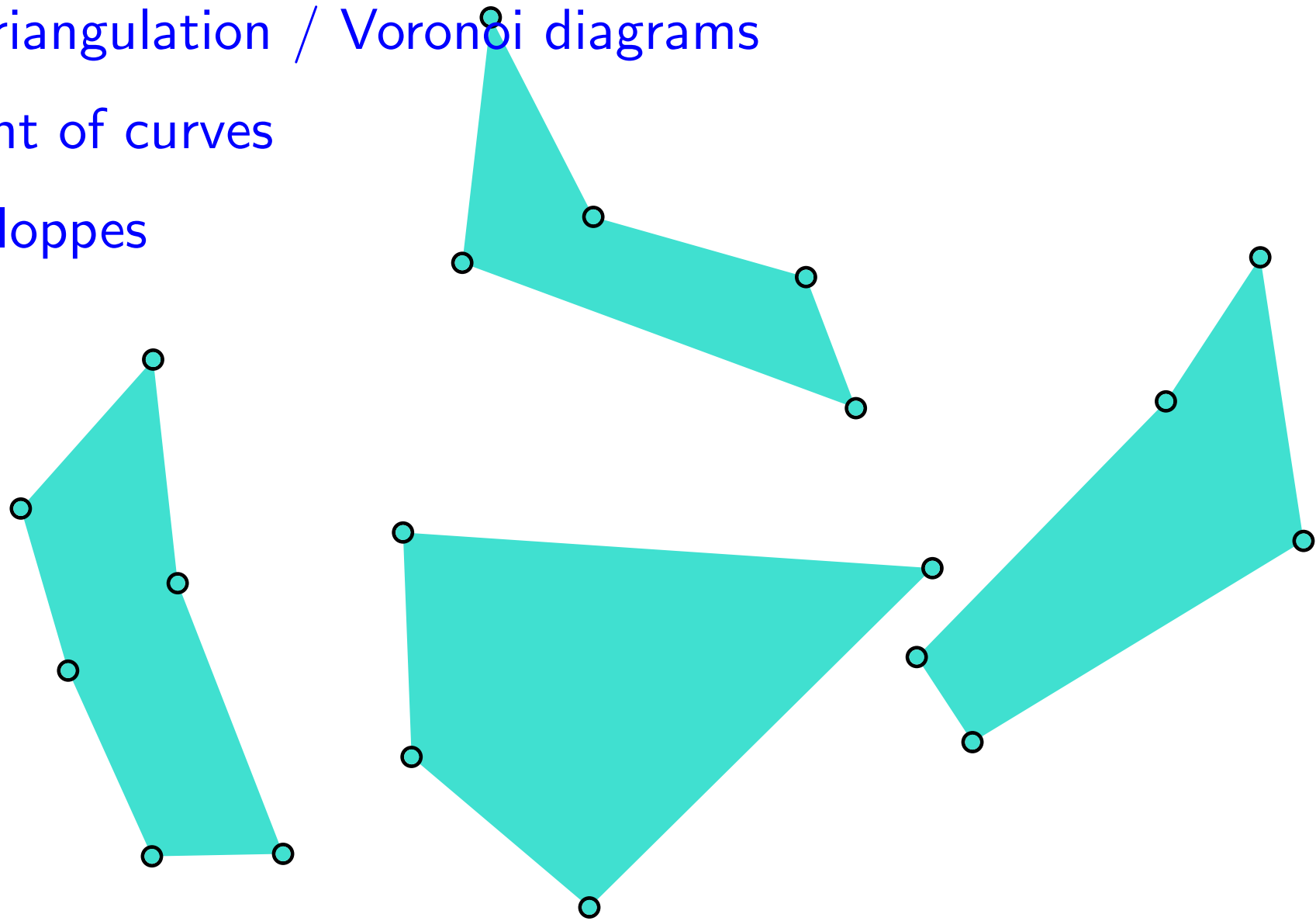
Convex hull

Delaunay triangulation / Voronoi diagrams

Arrangement of curves

Lower enveloppes

Visibility



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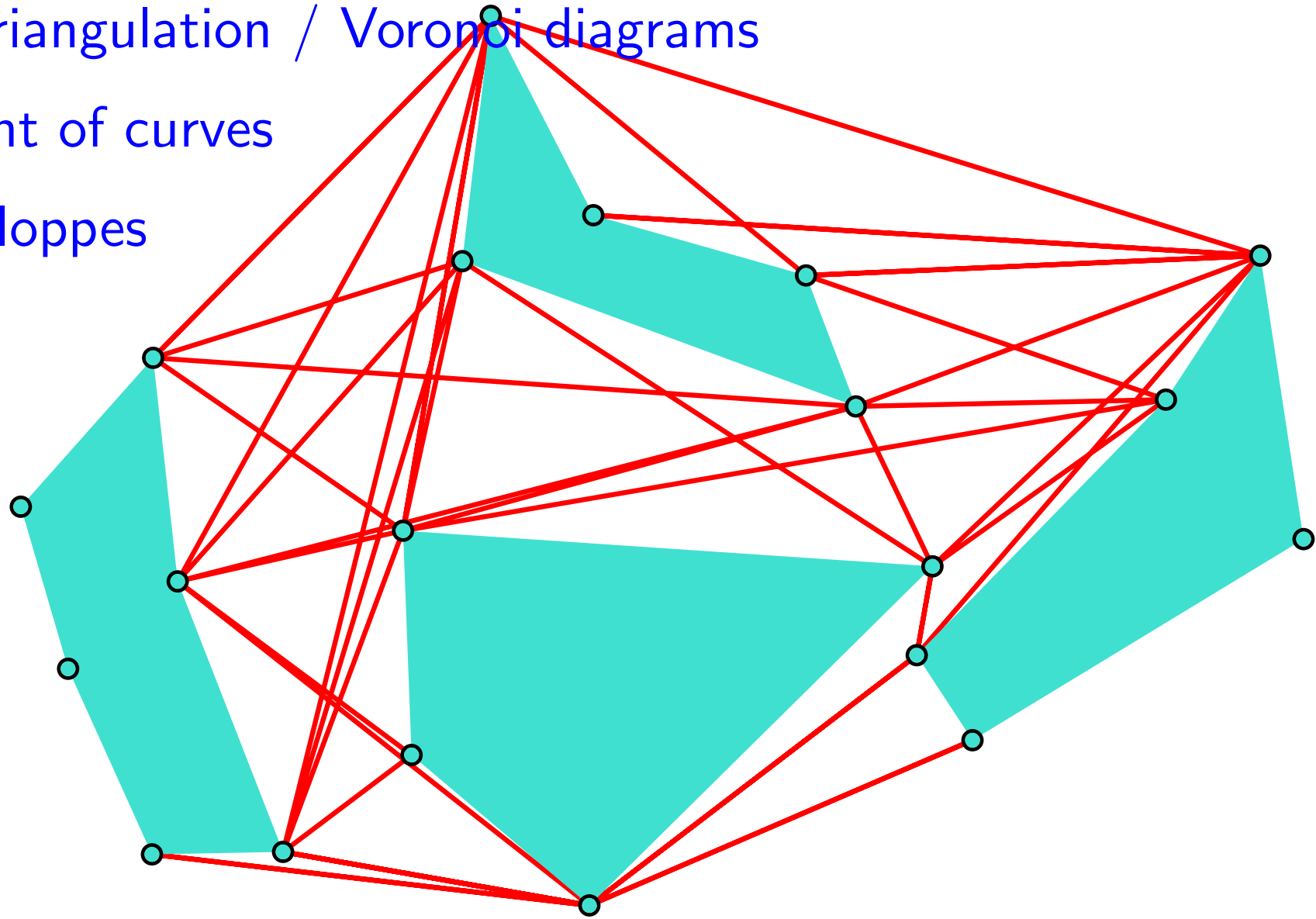
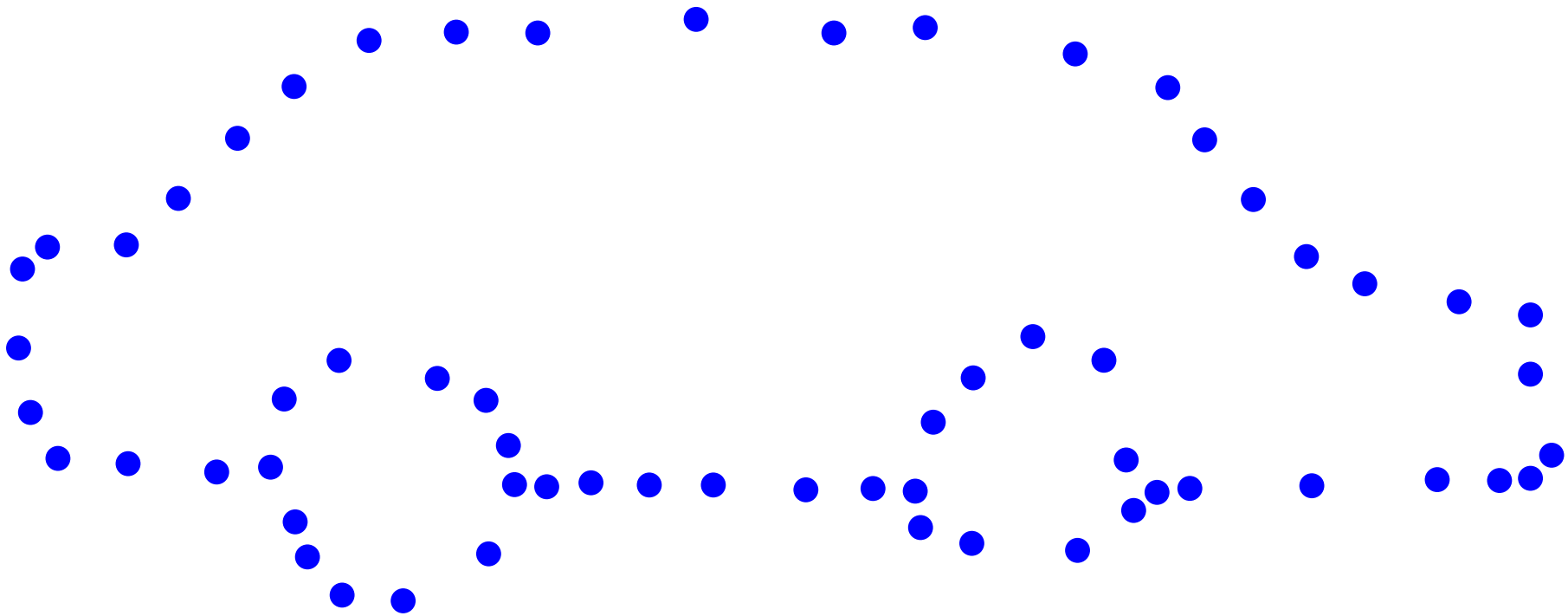
Visibility



Computational geometry usage

Computational geometry usage

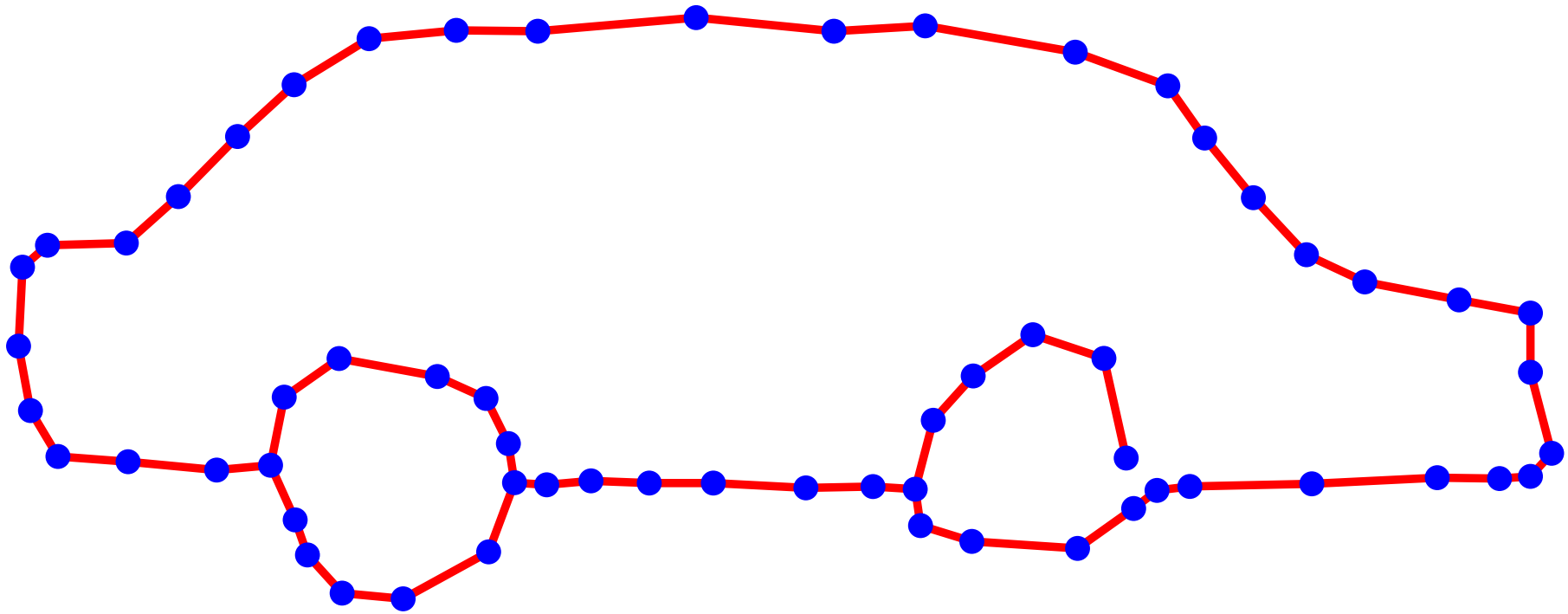
Points to shape



Computational geometry usage

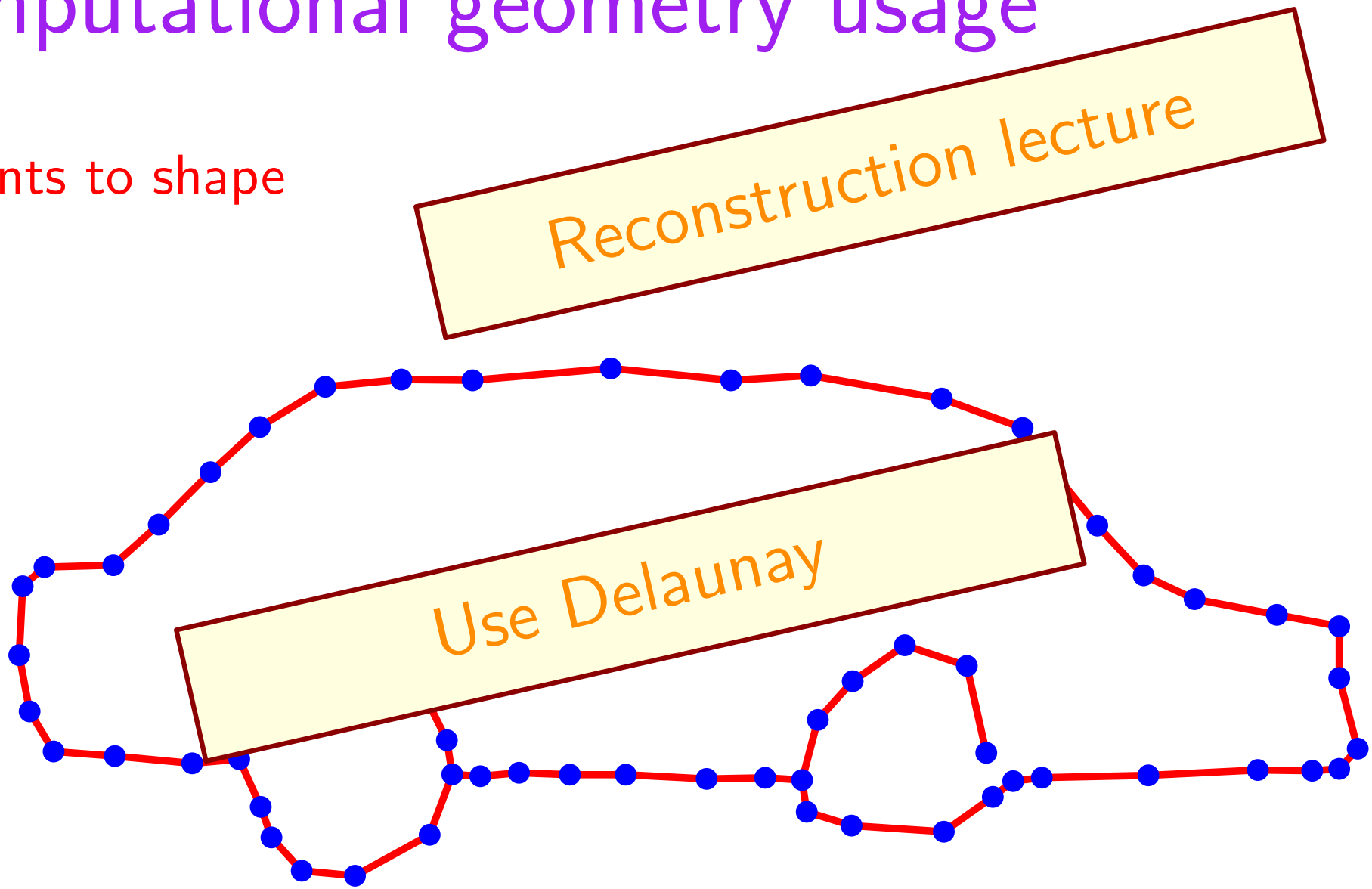
Points to shape

Reconstruction lecture



Computational geometry usage

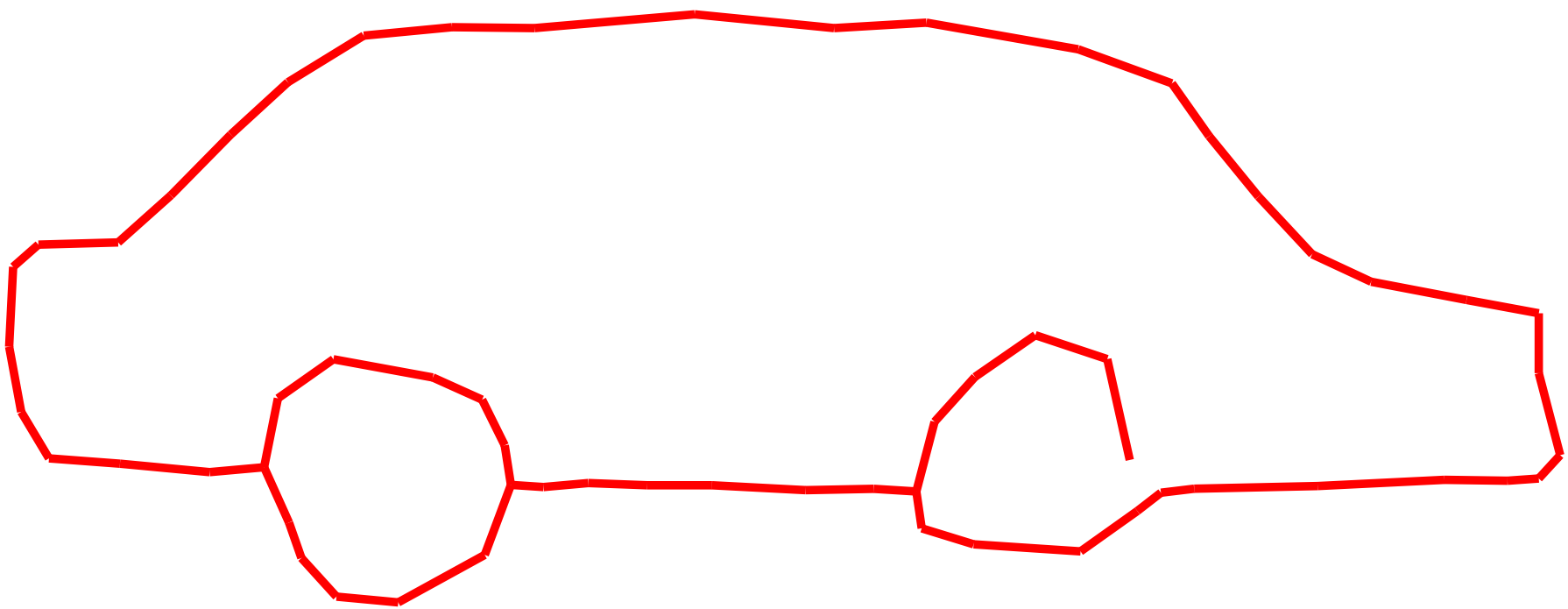
Points to shape



Computational geometry usage

Computational geometry usage

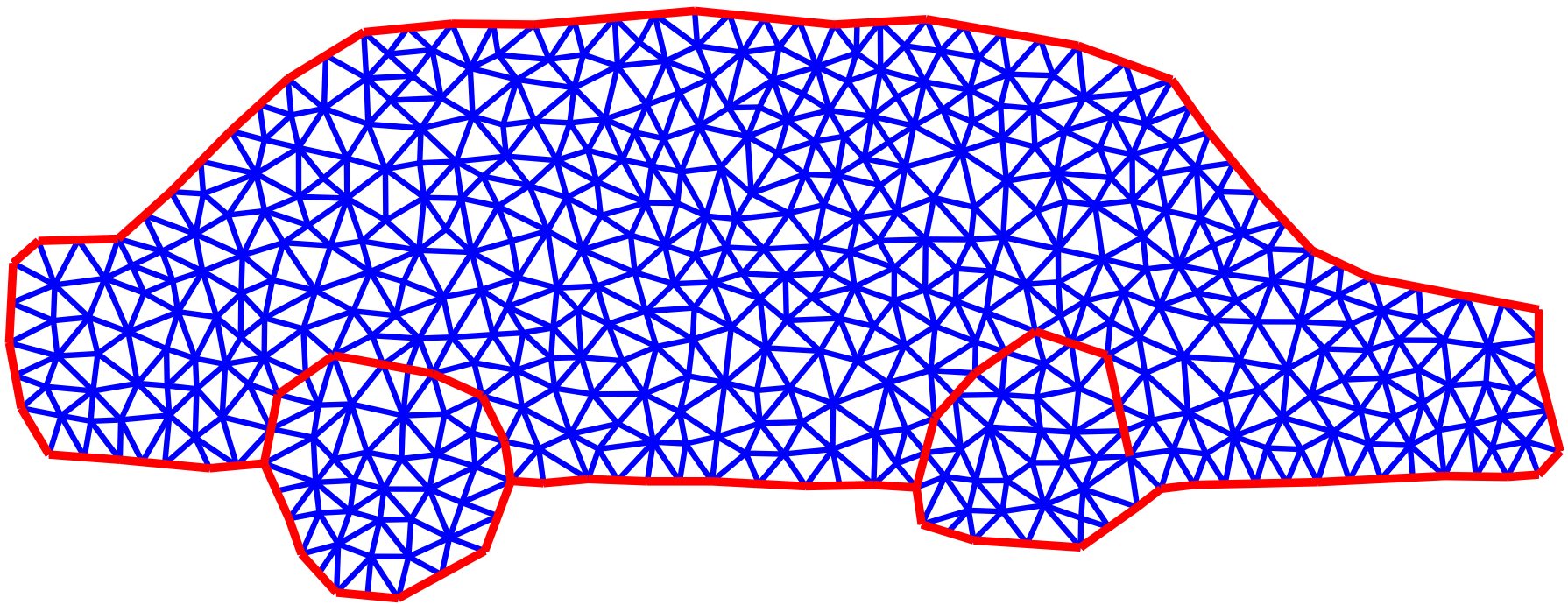
Shape to mesh



Computational geometry usage

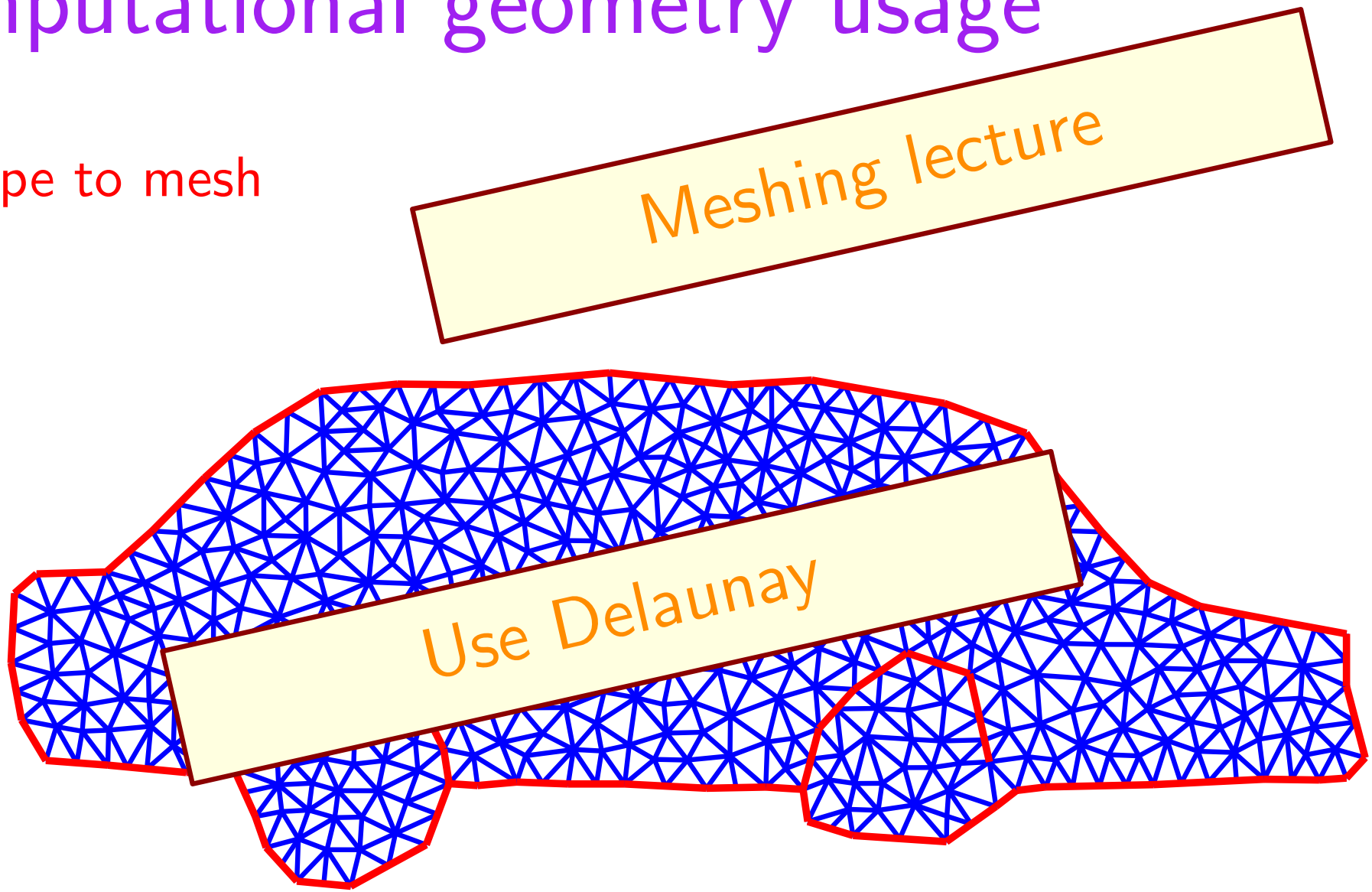
Shape to mesh

Meshing lecture



Computational geometry usage

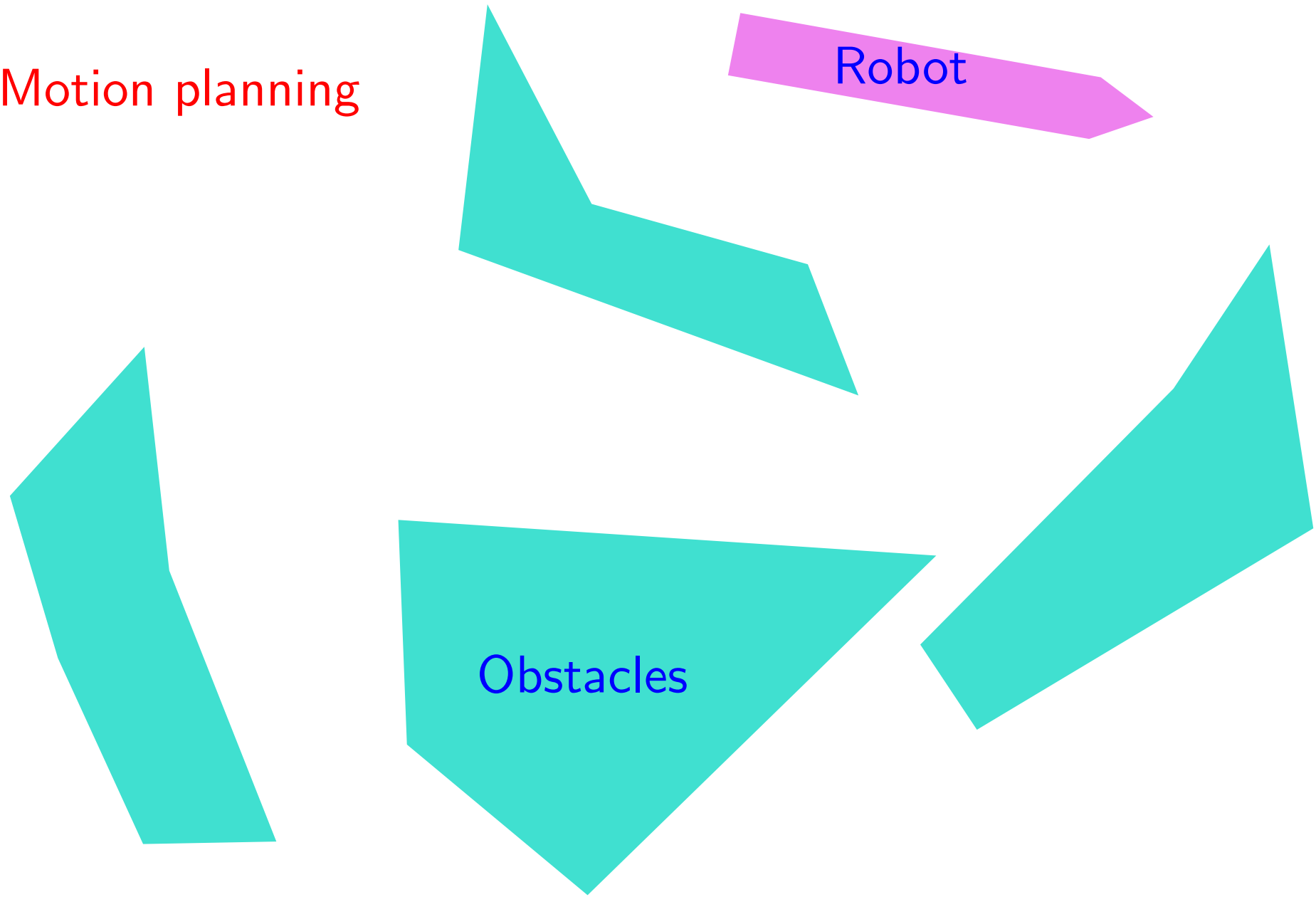
Shape to mesh



Computational geometry usage

Computational geometry usage

Motion planning



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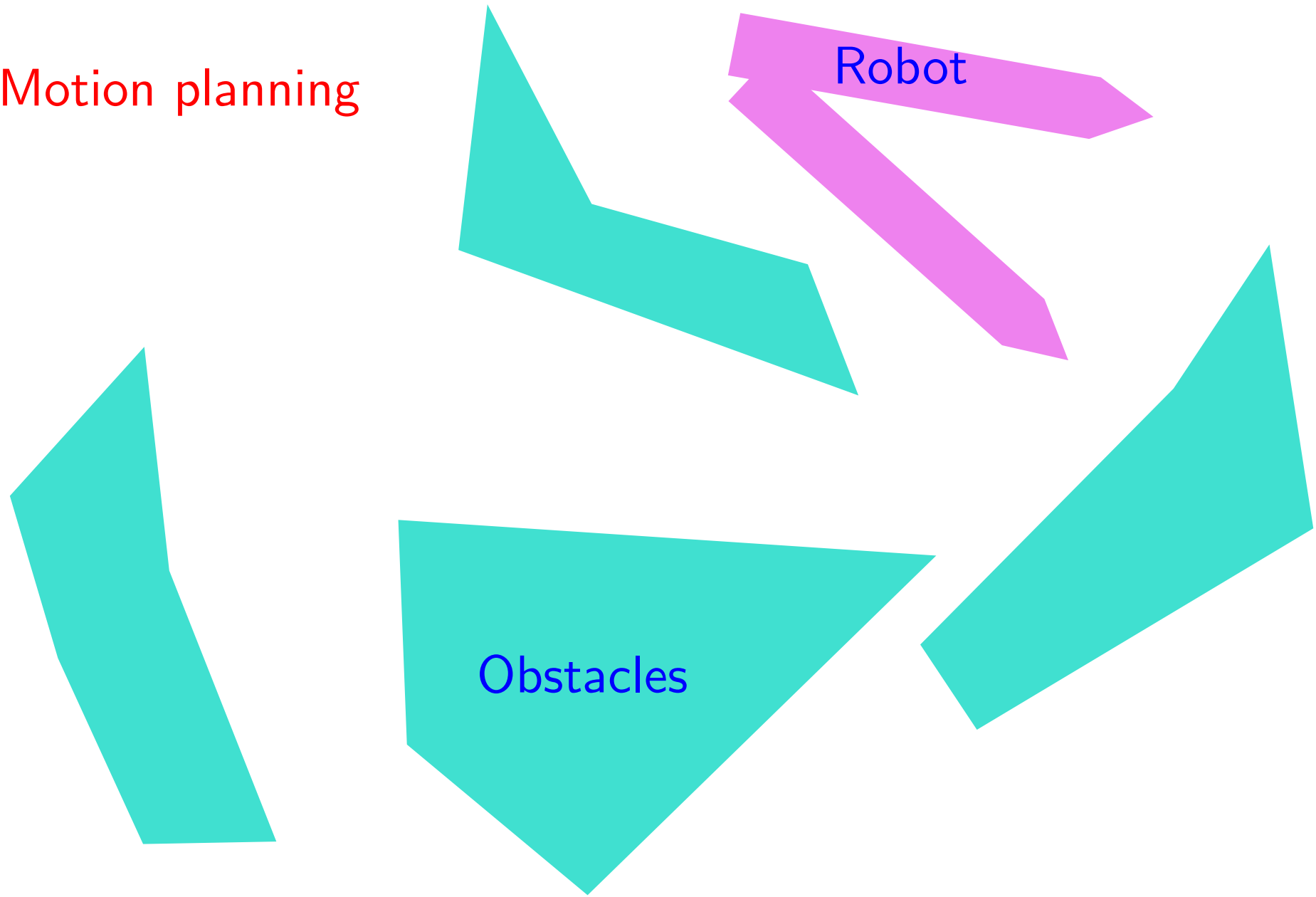

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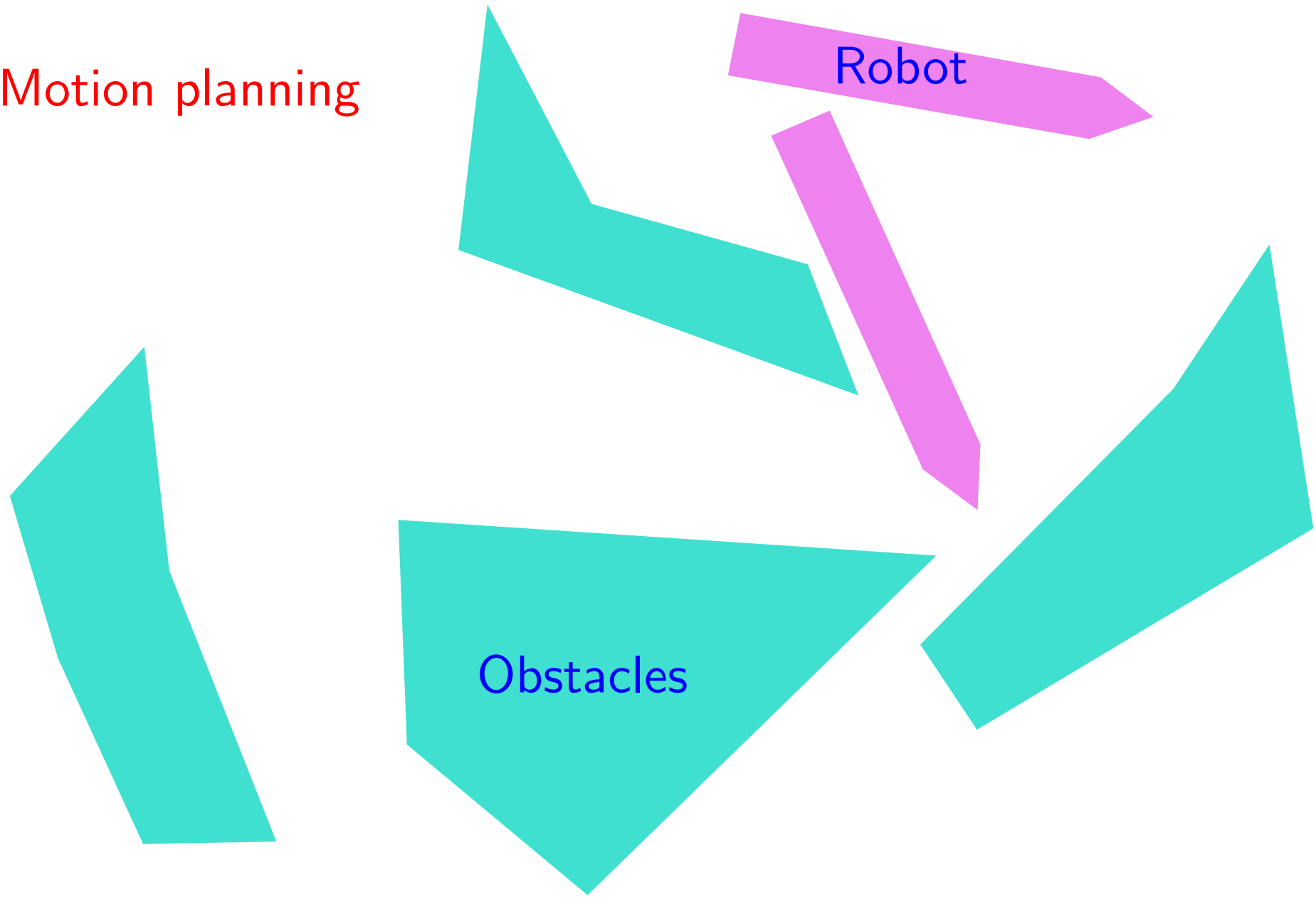

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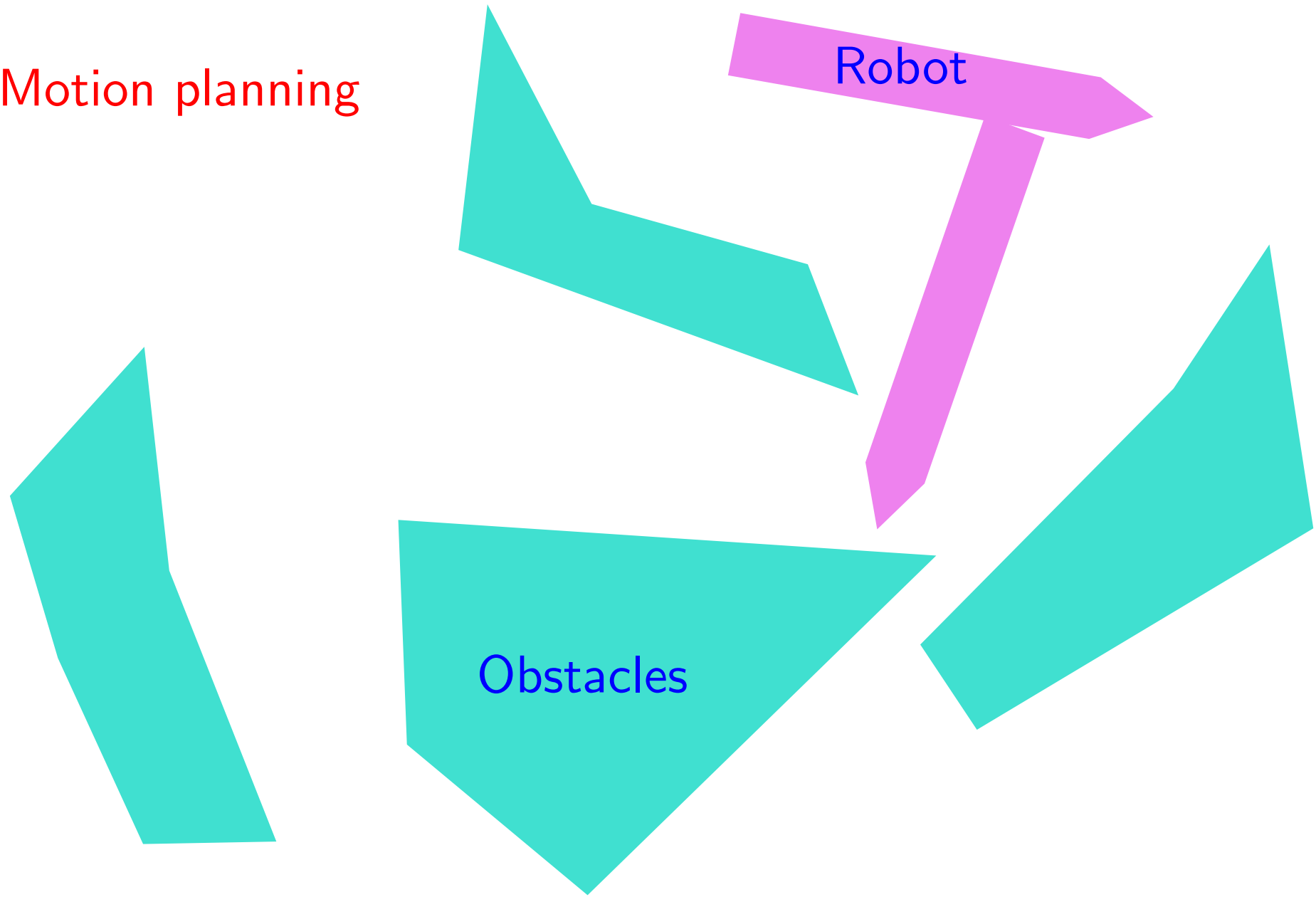

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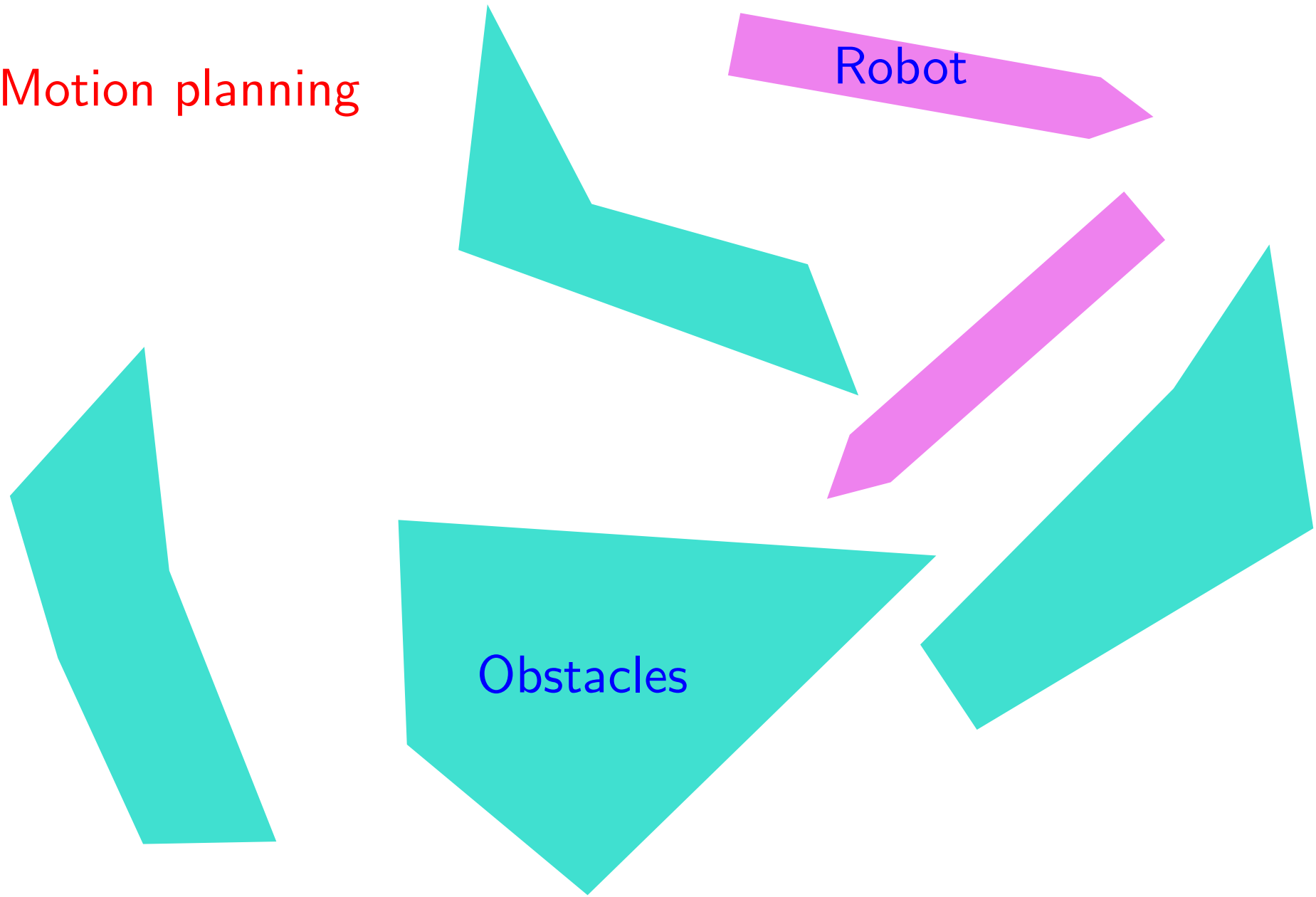

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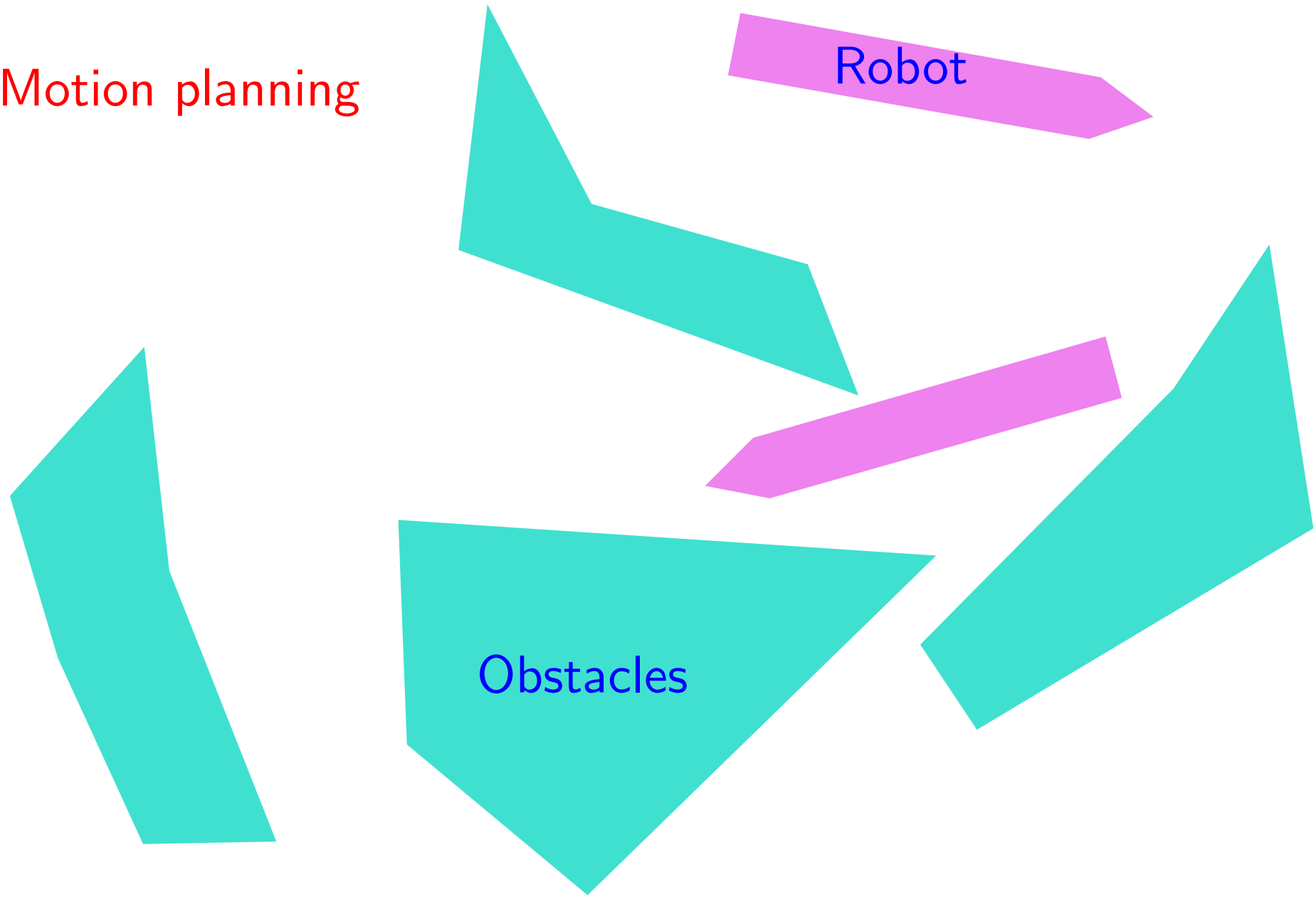

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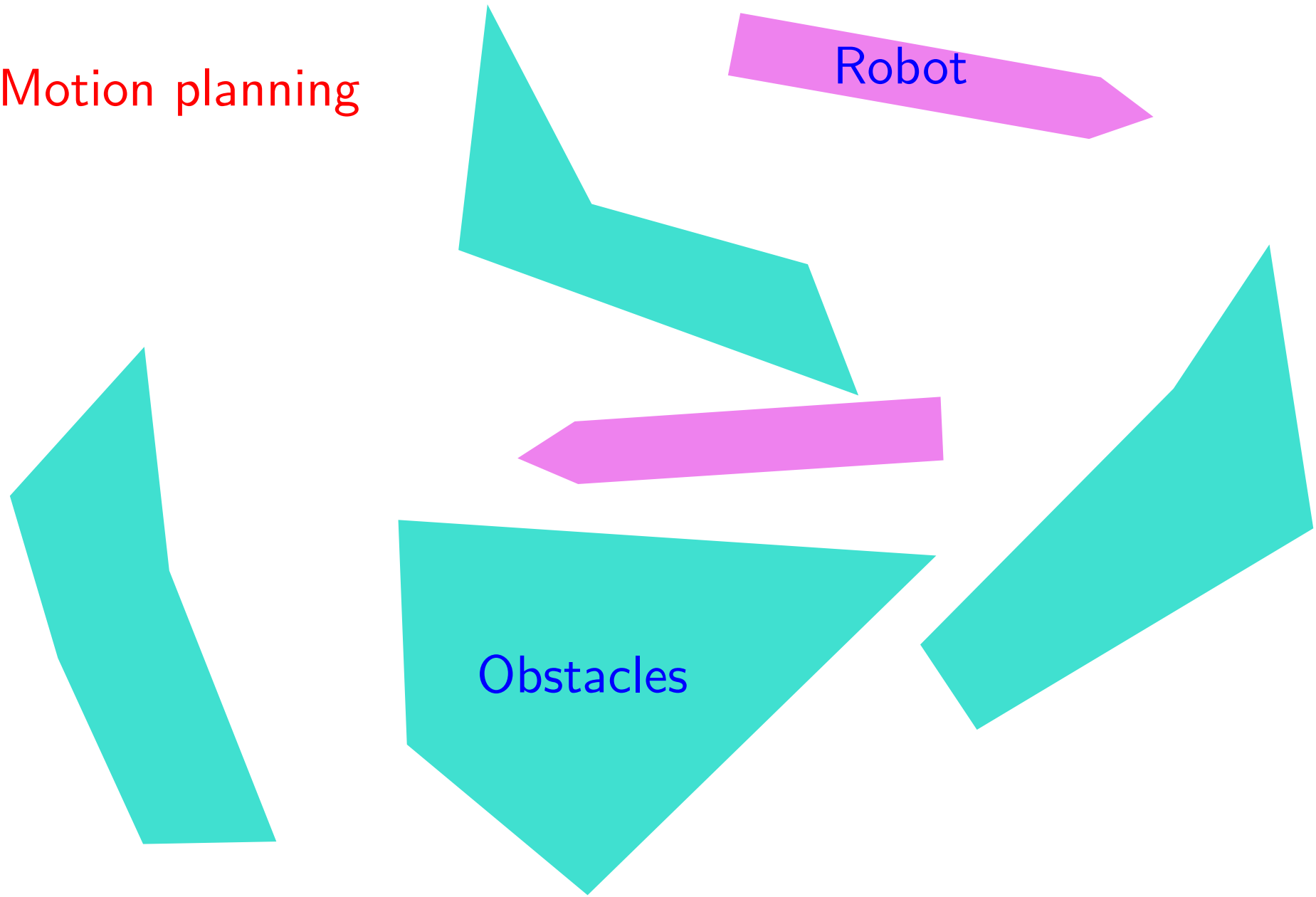

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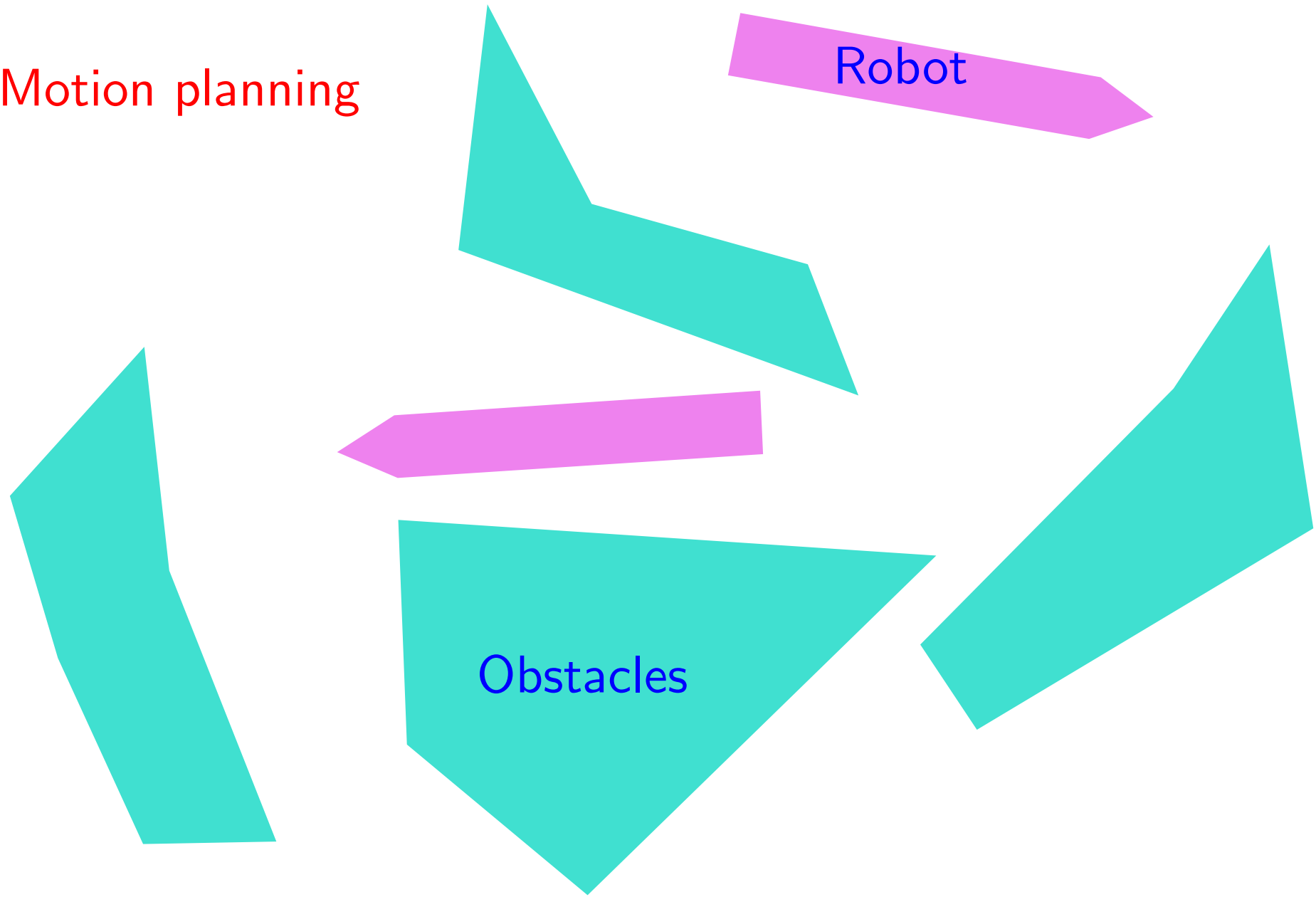

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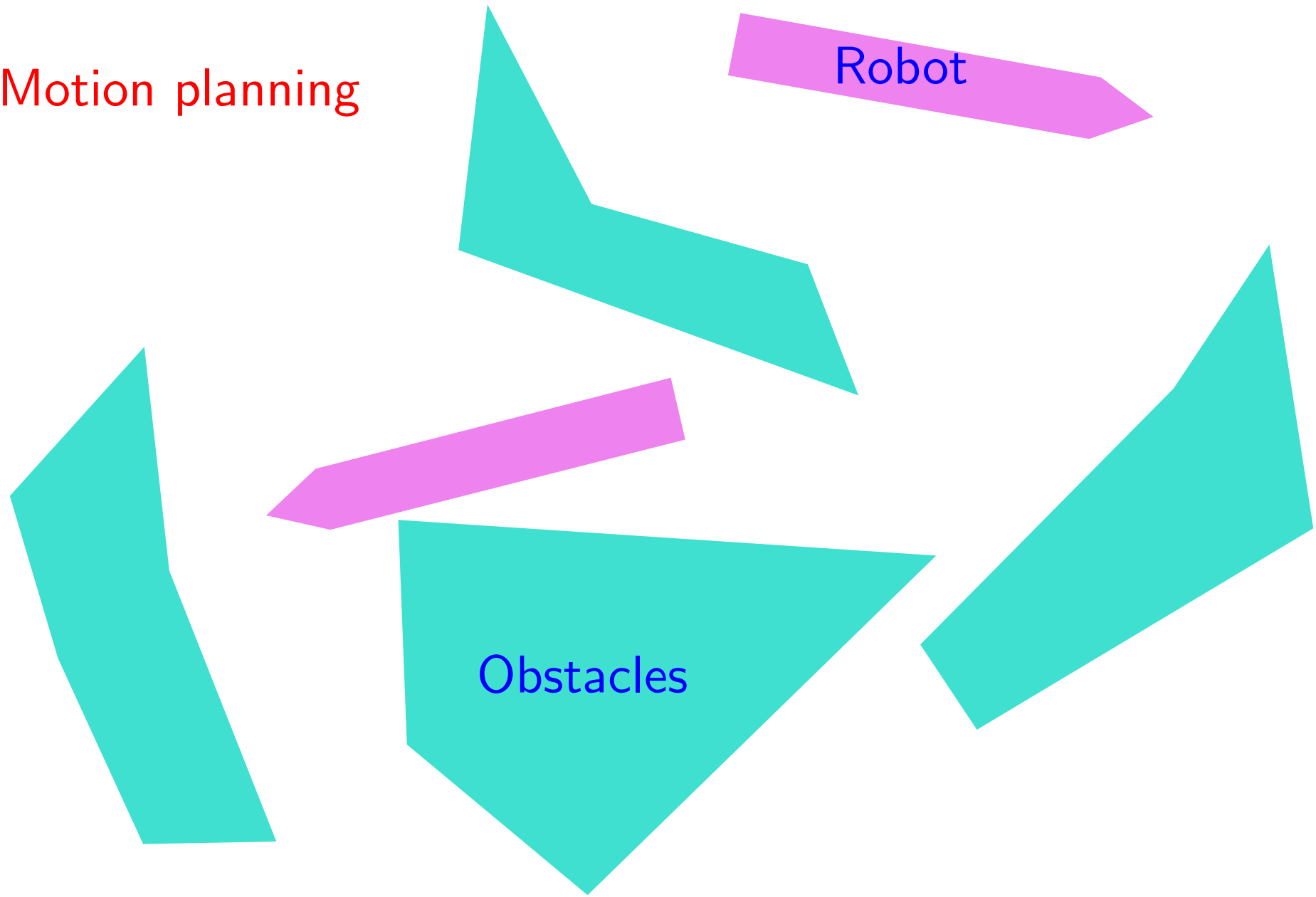
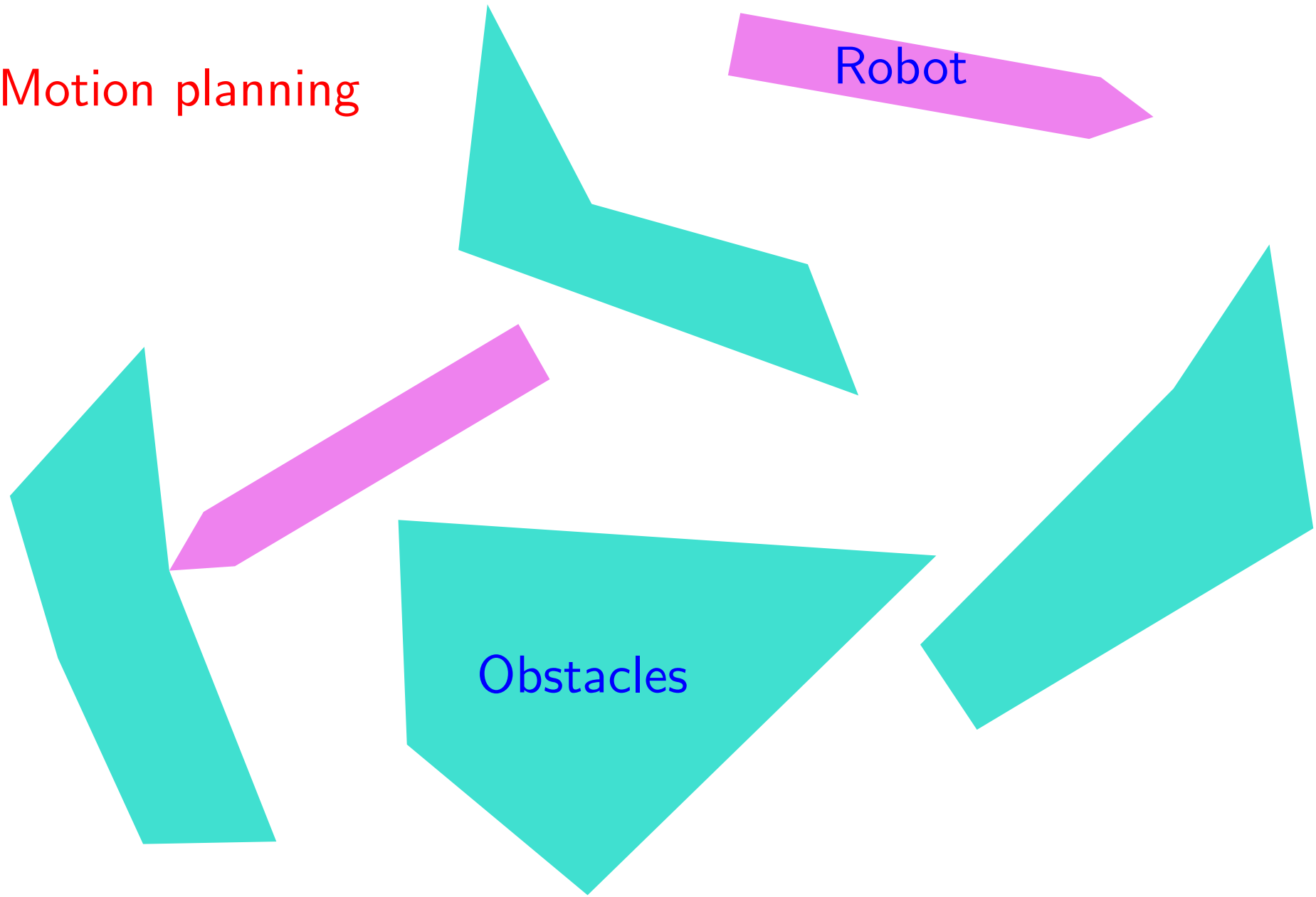


Computational geometry usage

Motion planning



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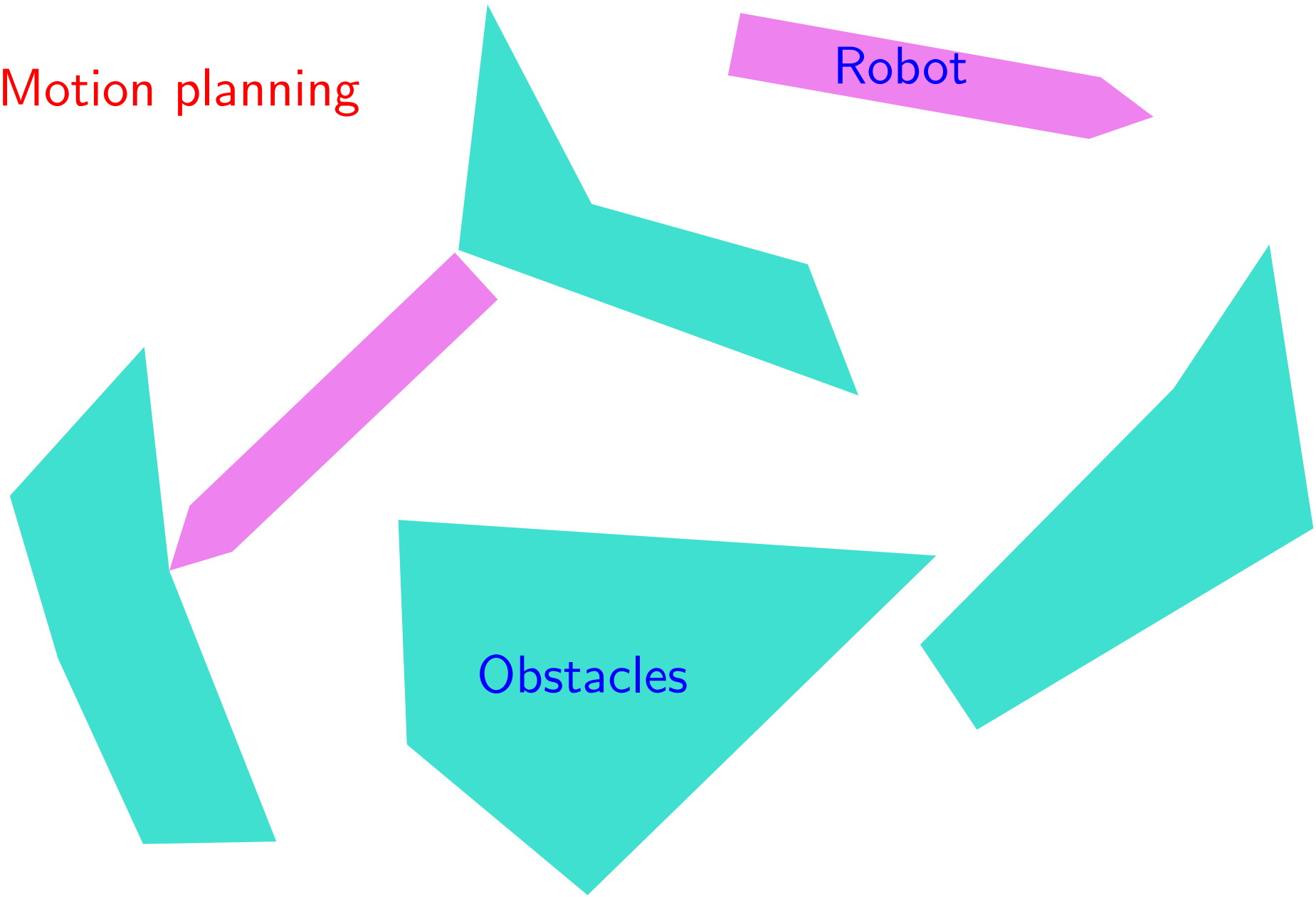

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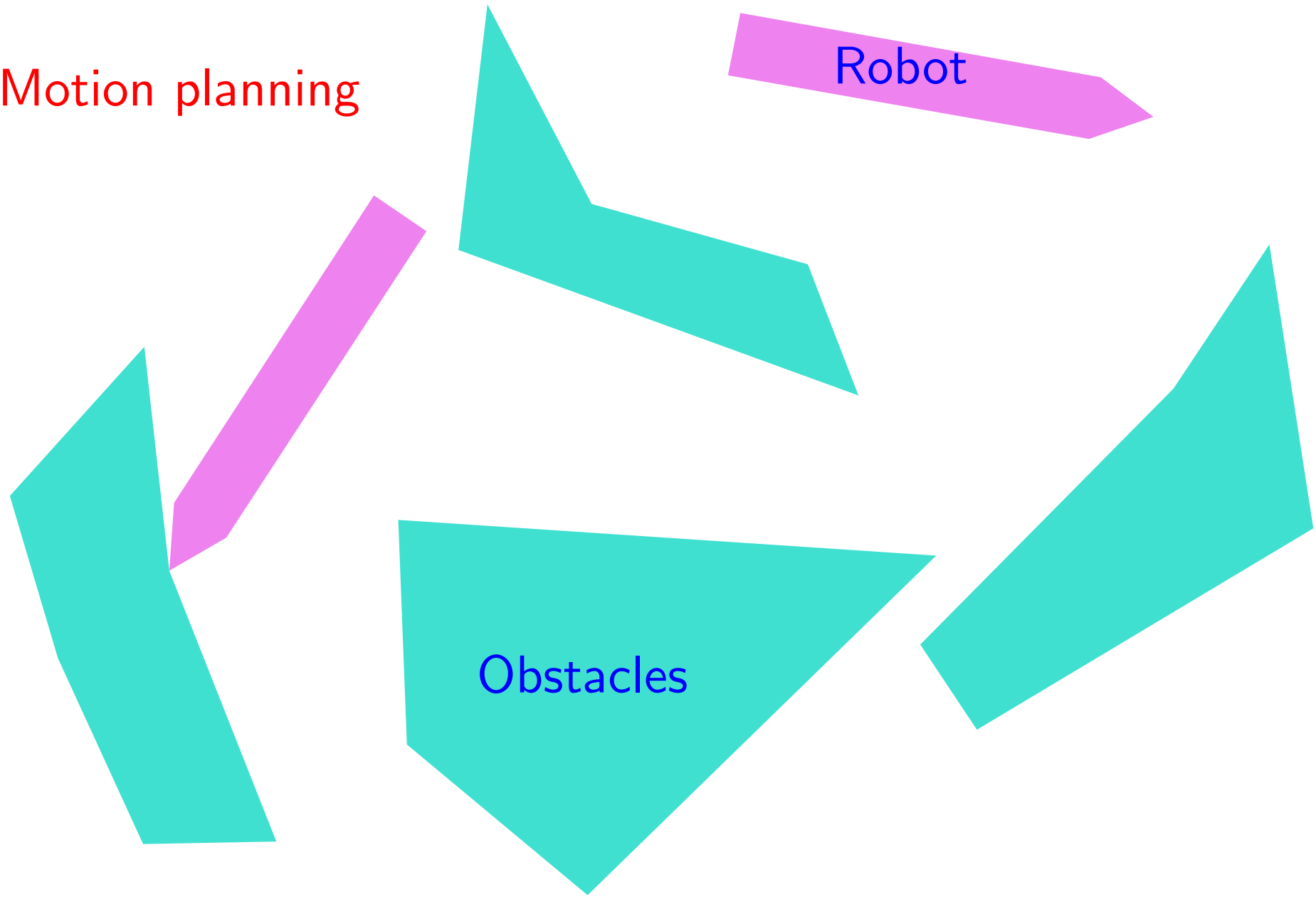

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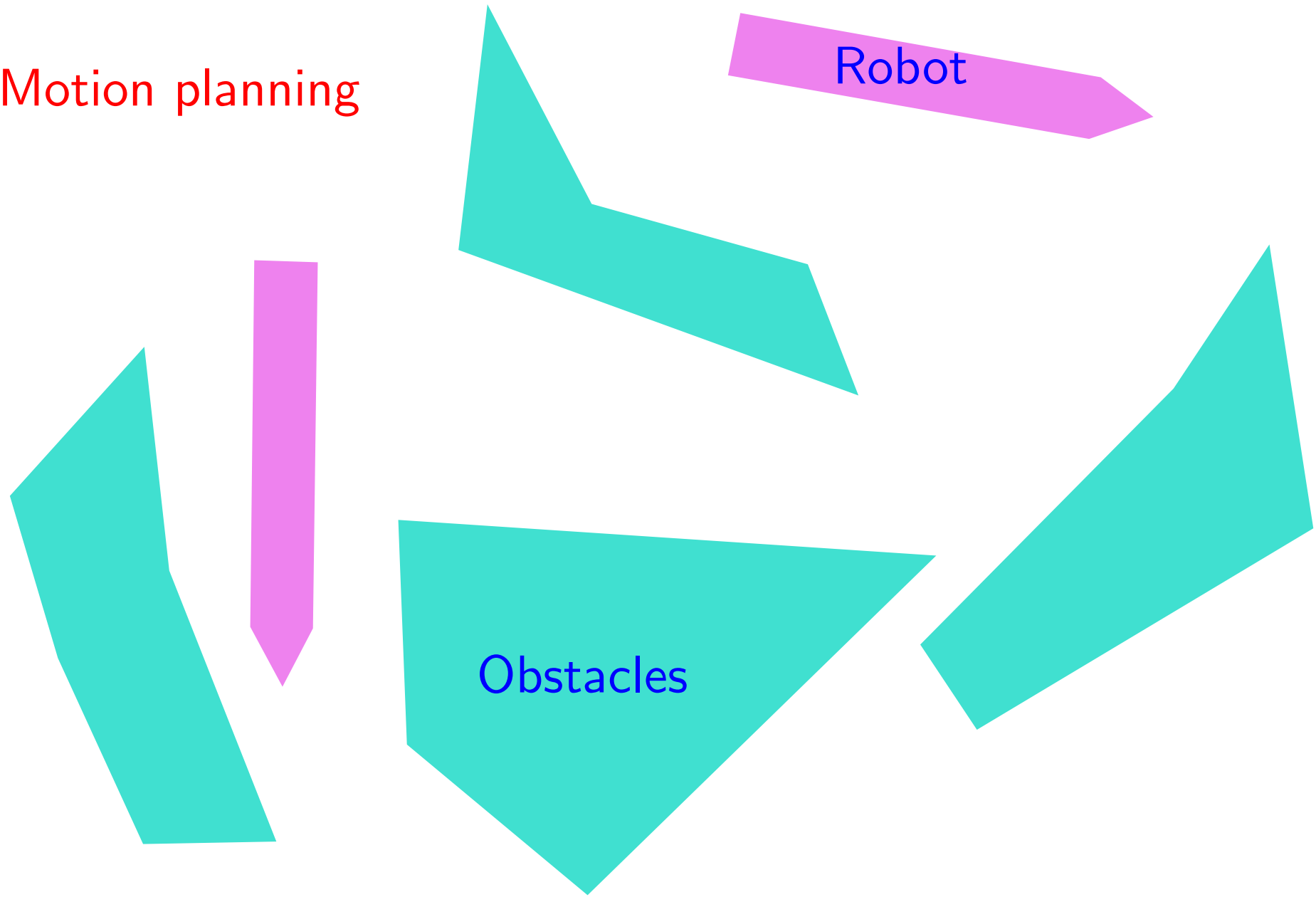

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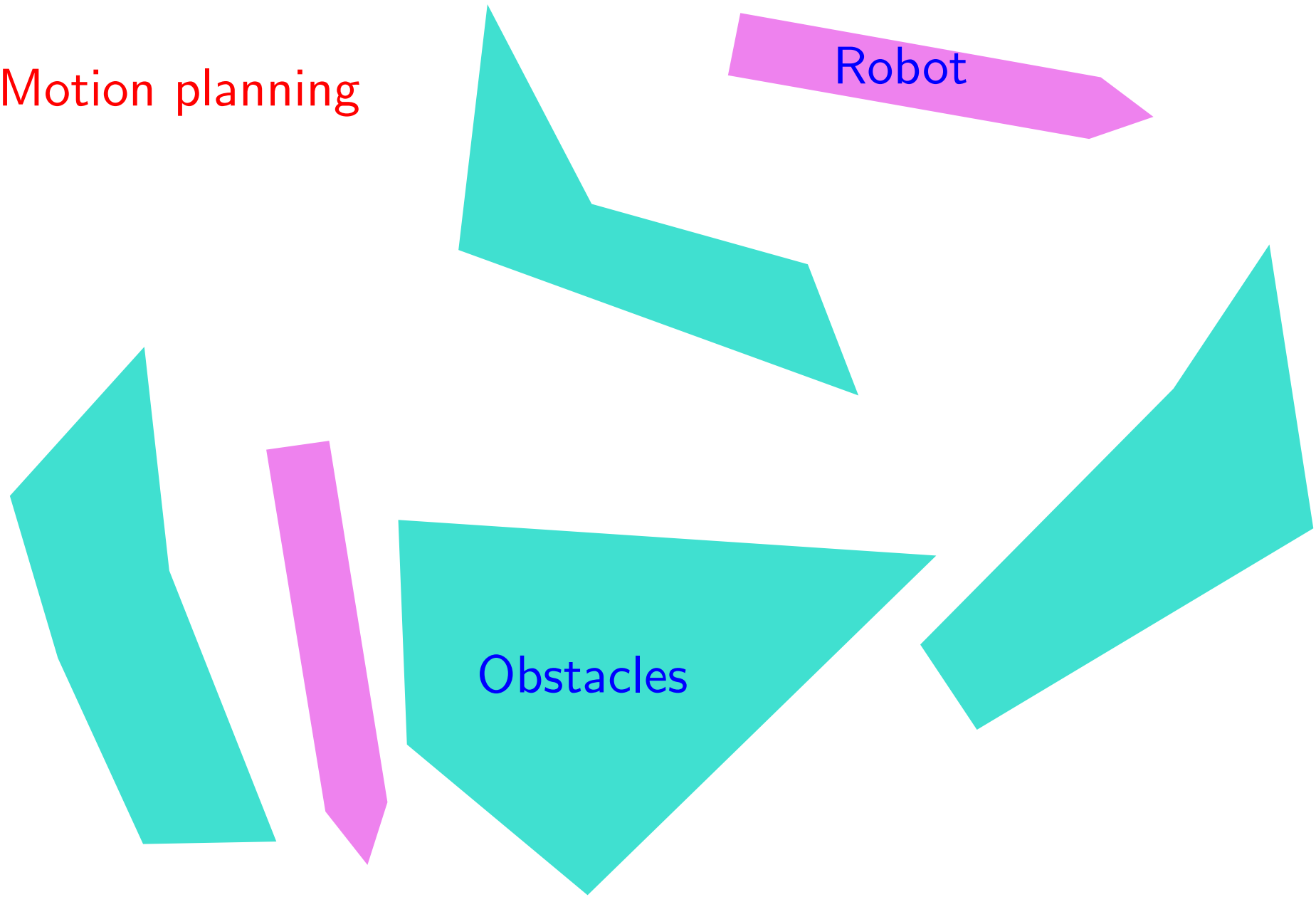

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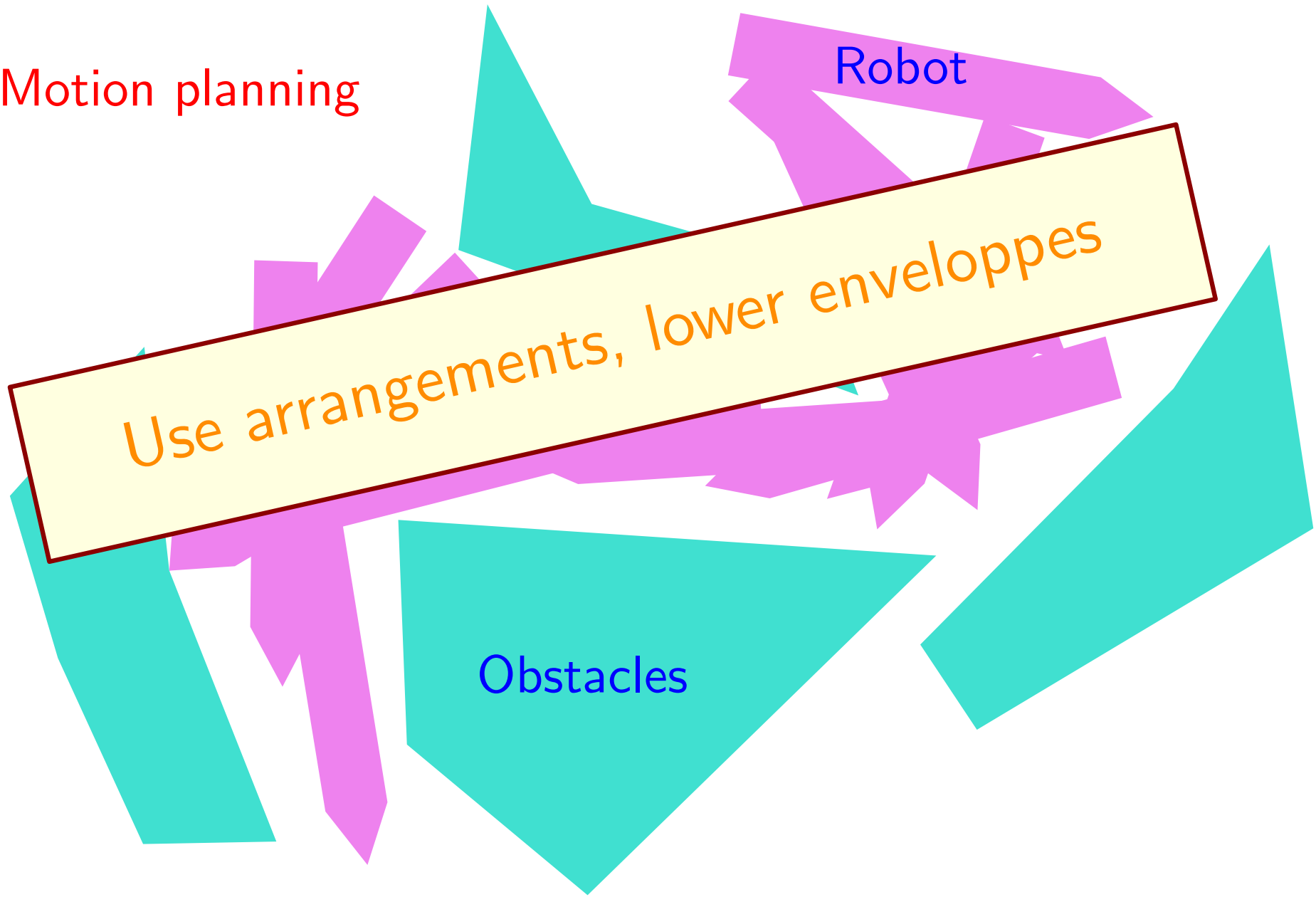


Computational geometry, 1975-1985

Complicated algorithms

Worst case complexities

Asymptotic complexities

Real RAM model

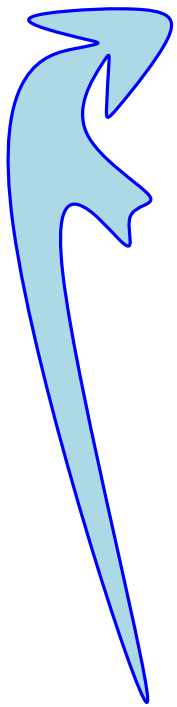
Lower bounds

General position hypothesis

Computational geometry, 1975-1985

Complicated algorithms	
Worst case complexities	Fit real life data
Asymptotic complexities	For n big enough
Real RAM model	Does it exist
Lower bounds	Real life data
General position hypothesis	Don't degeneracies exist

Computational geometry, 1975-1985



Complicated algorithms

Worst case complexities — Fit real life data

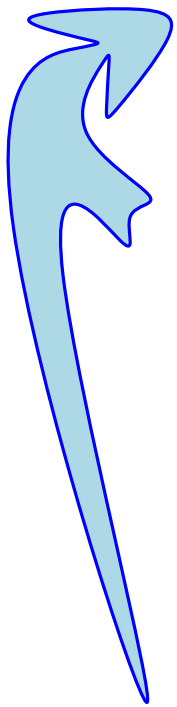
Asymptotic complexities — For n big enough

Real RAM model — Does it exist

Lower bounds — Real life data

General position hypothesis — Don't degeneracies exist

Computational geometry, 1975-1985



Complicated algorithms

Worst case complexities

Asymptotic complexities

Real RAM model

Lower bounds

General position hypothesis

Not used in practice

Fit real life data

For n big enough

Does it exist

Real life data

Don't degeneracies exist

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

Asymptotic complexities

Real RAM model

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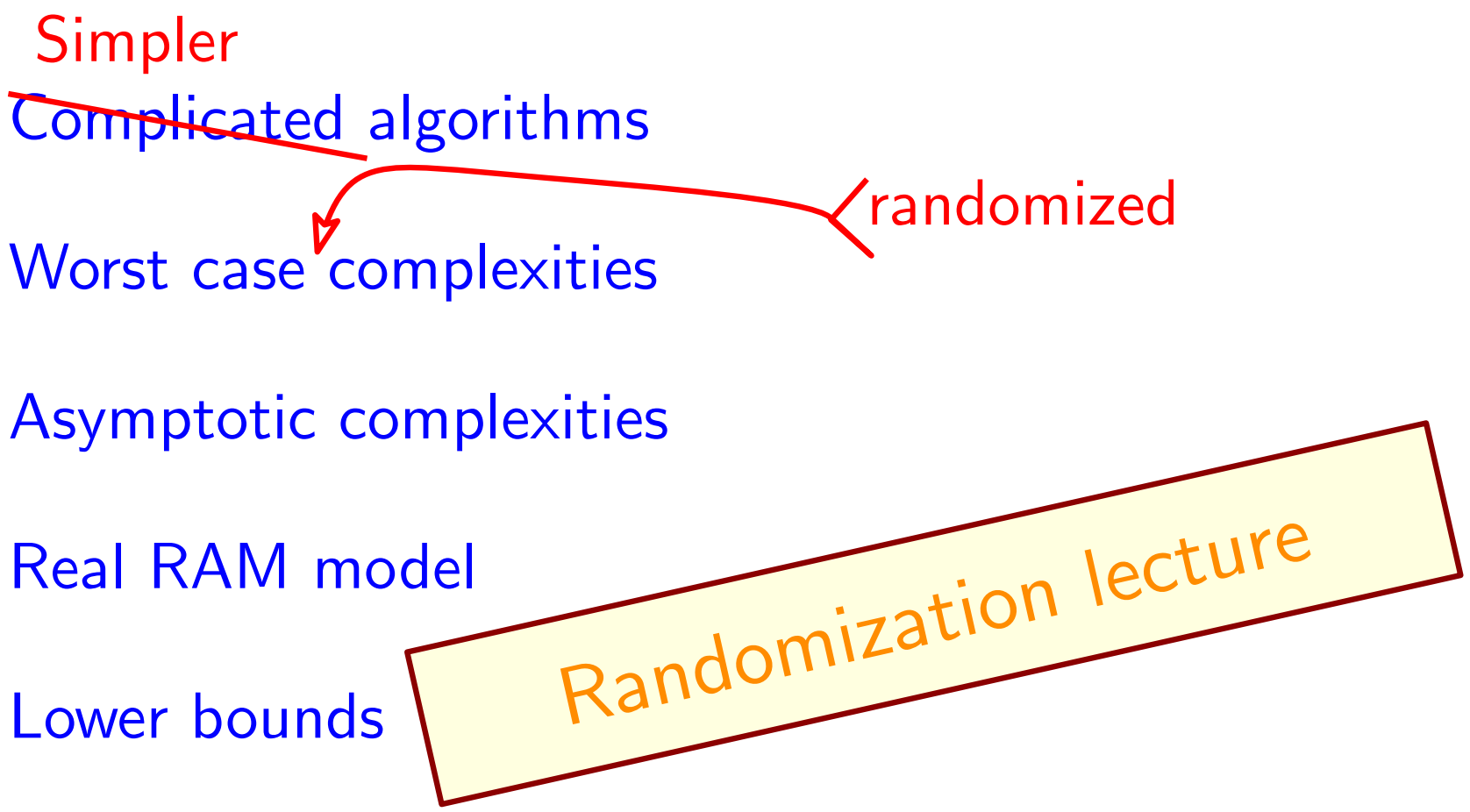
Computational geometry, 1985-2000



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

Real RAM model — address robustness issues

Lower bounds

General position hypothesis — solve degeneracies

Robustness lecture

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

Probabilistic hypotheses

Old (and recent) math literature

Asymptotic complexities

Real RAM model

Lower bounds

General position hypothesis

Computational geometry, 2000-

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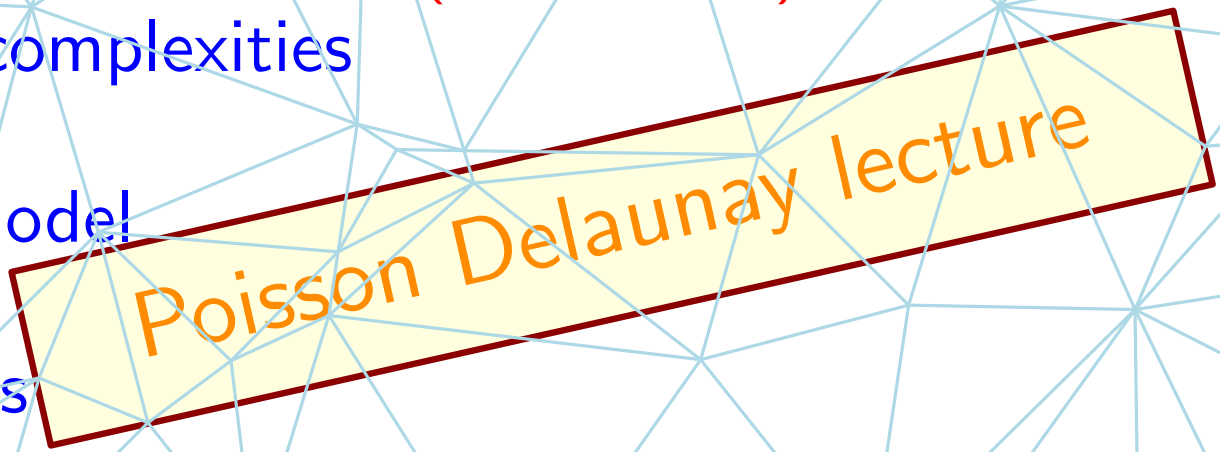


Computational geometry, 2000-

Complicated algorithms

Beyond the Euclidean realm

Worst case complexities

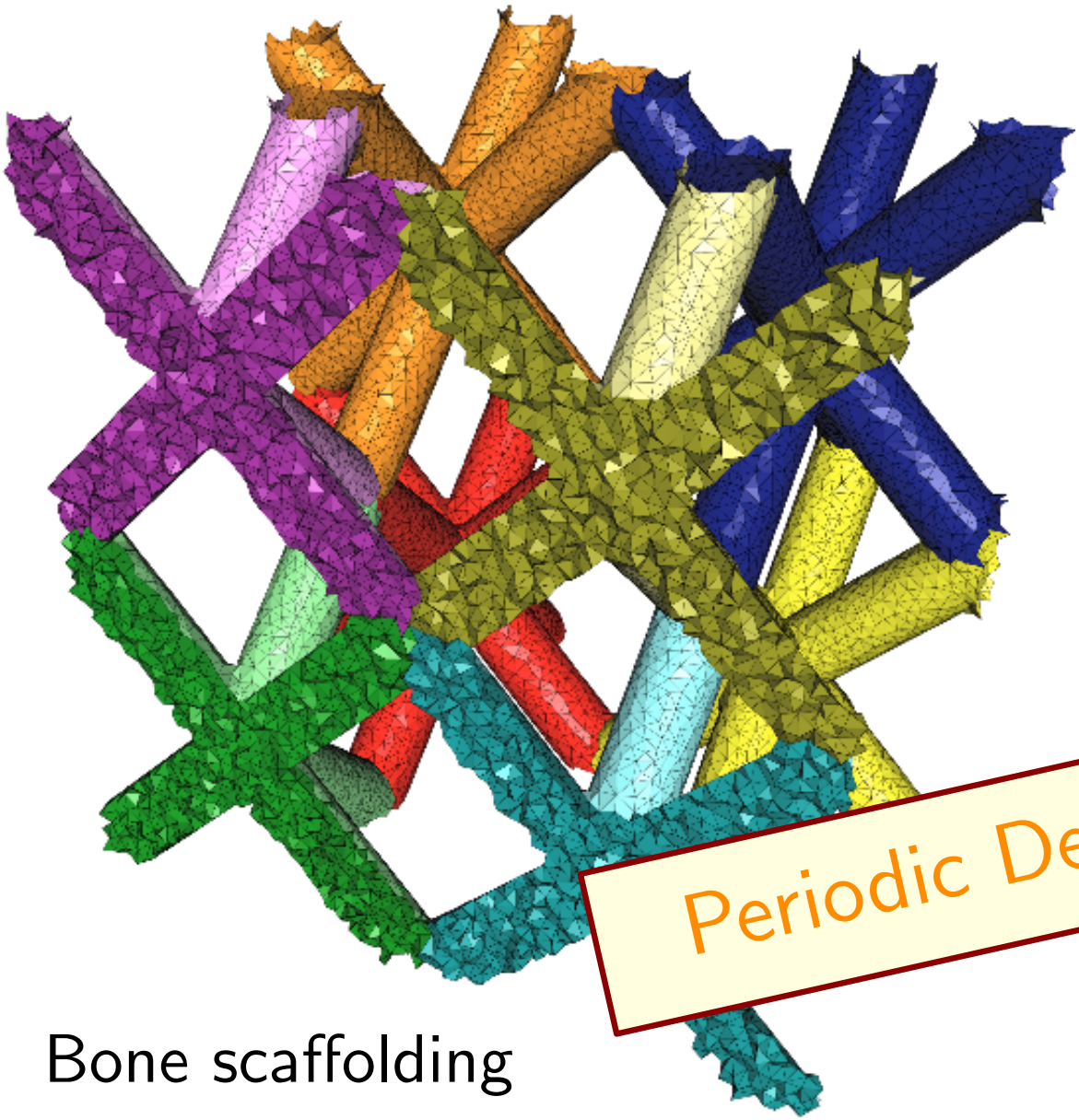
Asymptotic complexities

Real RAM model

Lower bounds

General position hypothesis

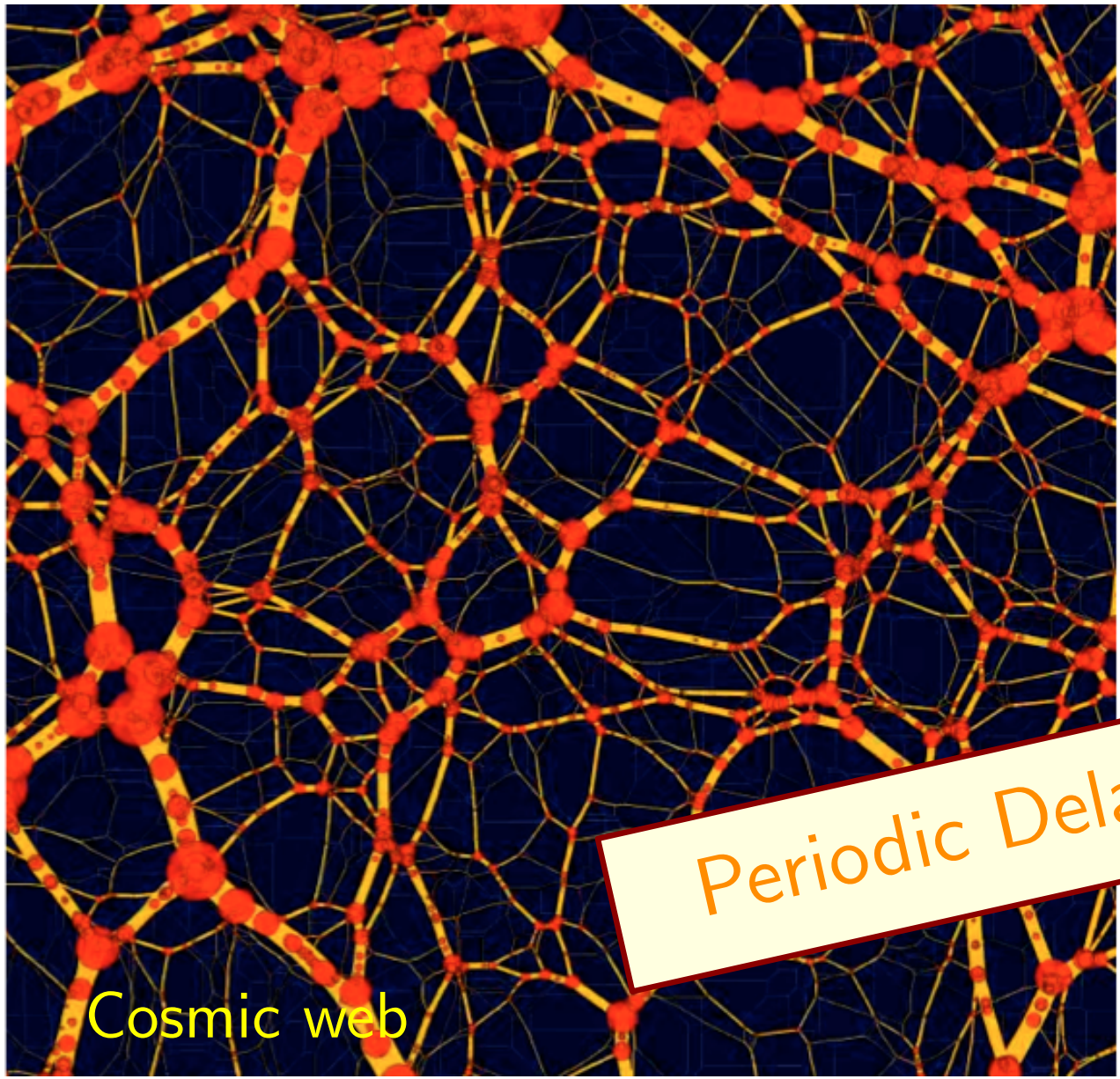
Computational geometry, 2000-



Periodic Delaunay lecture

Bone scaffolding

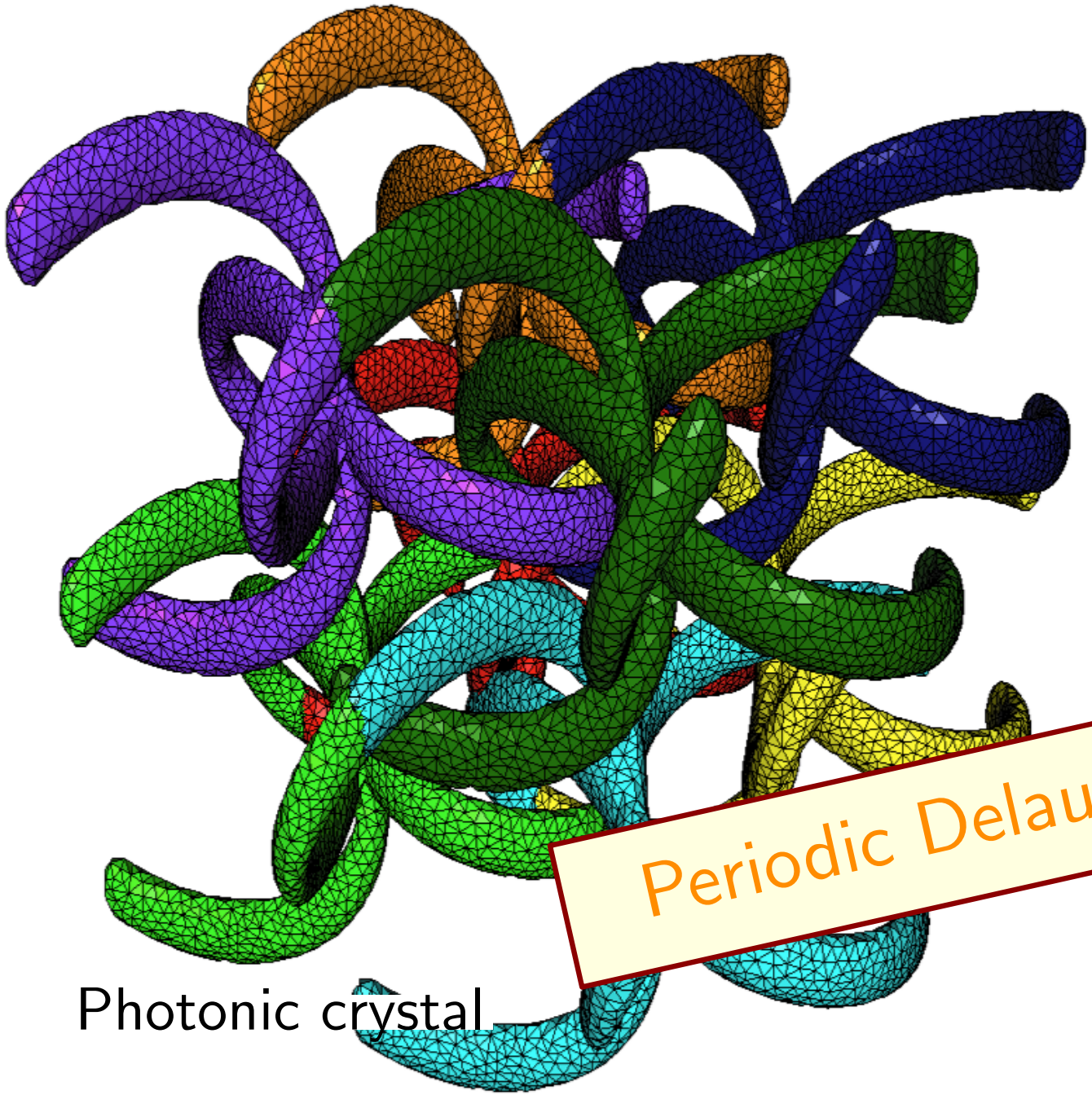
Computational geometry, 2000-



Cosmic web

Periodic Delaunay lecture

Computational geometry, 2000-



Photonic crystal

Periodic Delaunay lecture

Computational geometry, 2000-

Complicated algorithms

Worst case complexities

Asymptotic complexities

Real RAM model

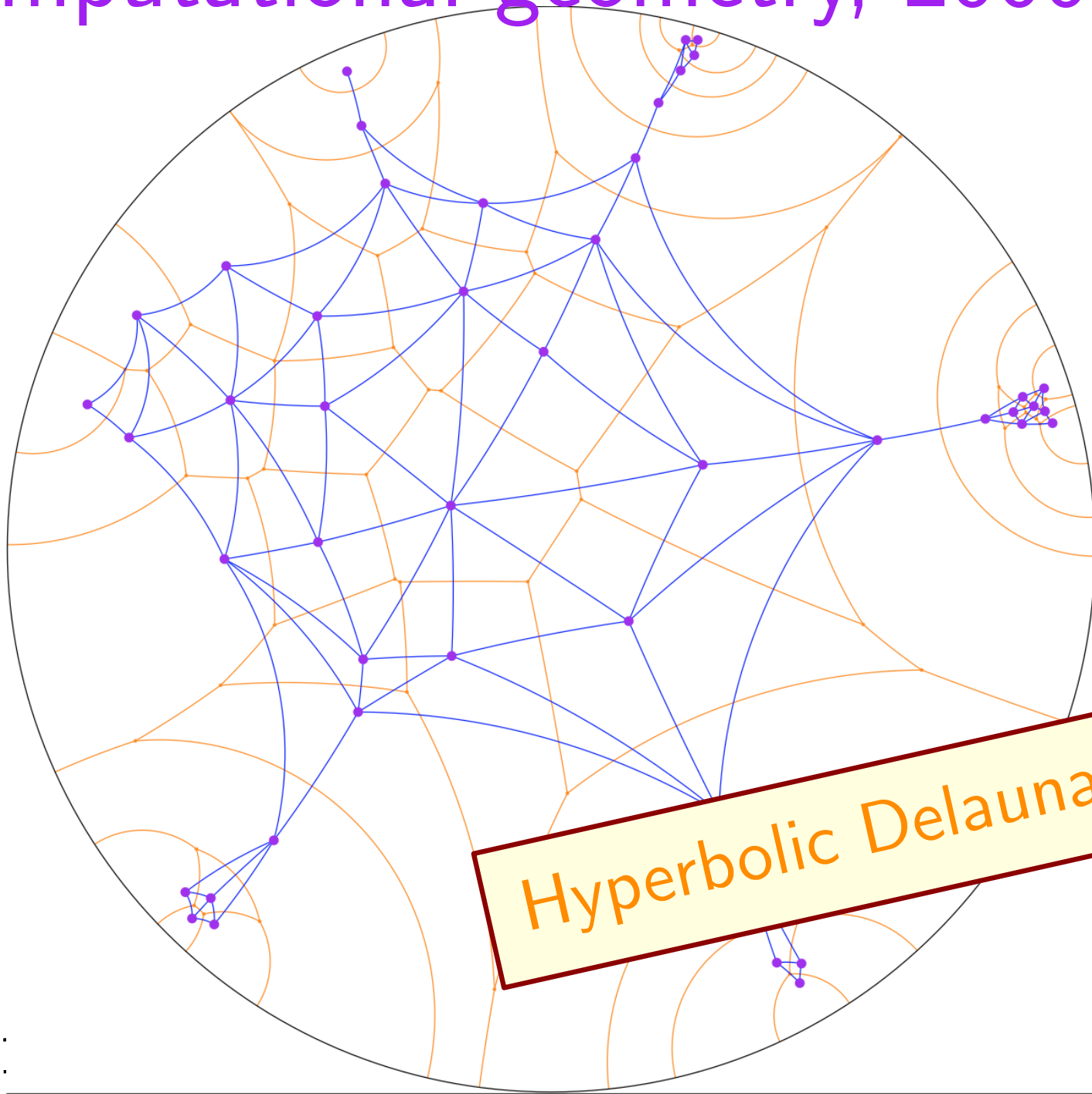
Lower bounds

General position

Beyond the Euclidean realm

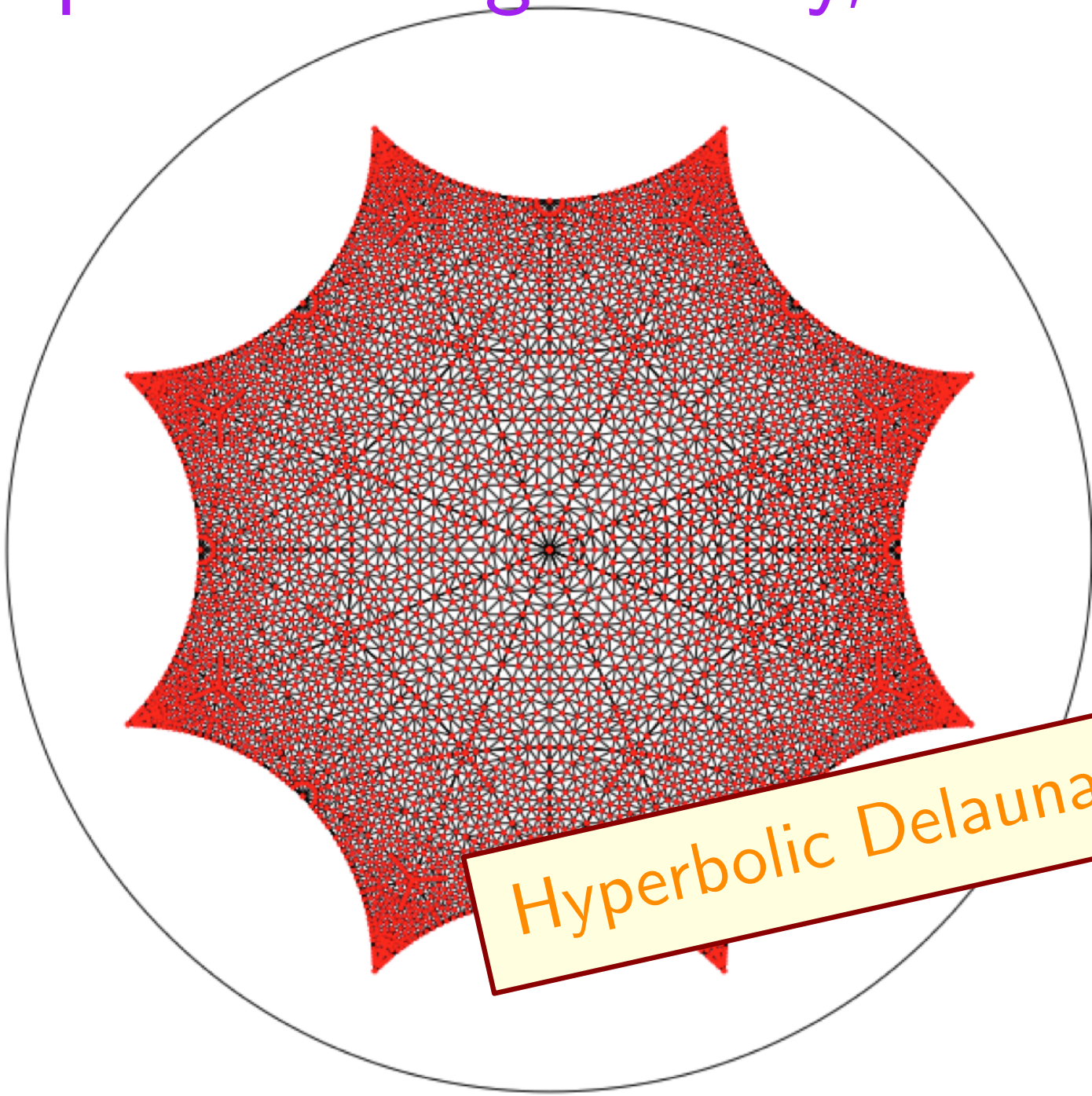
Hyperbolic Delaunay lecture

Computational geometry, 2000-



Hyperbolic Delaunay lecture

Computational geometry, 2000-



Hyperbolic Delaunay lecture