DM819 – Computational Geometry

(Geometriske Algoritmer)

"Elective Courses Presentation"

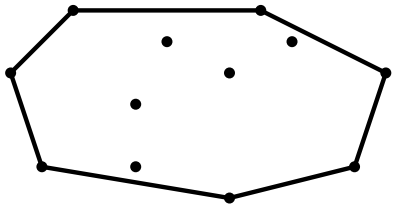
Kim Skak Larsen

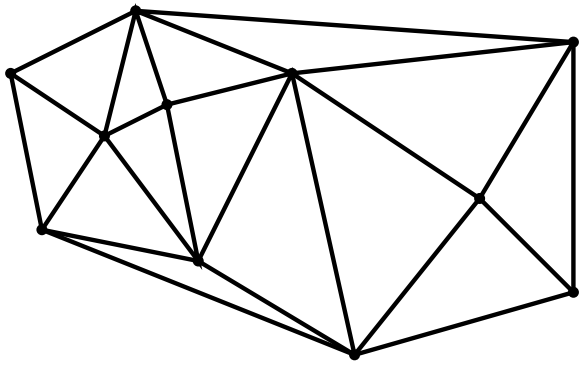
IMADA
University of Southern Denmark

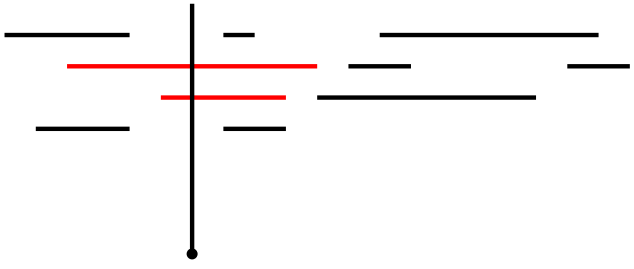
kslarsen@imada.sdu.dk

imada.sdu.dk/u/kslarsen/

Examples







- Given n points, compute the *convex hull*. Be able to maintain it dynamically under insertion of points.
- Given n points, compute their *triangulation*.
- Preprocess n line segments in $O(n \log n)$, building a data structure in preparation for *ray shooting* so that queries such as this can be answered in time $O(\log n + k)$, where k is the number of line segments to report.

Course Content

SDU

Algorithms and **Data Structures** for **Geometric Objects**

- Triangulations and Voronoi Diagrams
- Interval and Point Searches
- Convex Hulls
- Ray Shooting and Range Searching
- Motion Planning and more...

Introduction to (continuation of) important general techniques:

- Plane Sweeping and Fractional Cascading
- Randomization and Amortization

Geometric algorithms have applications (not covered) in

- Computer Graphics, Geographic Information Systems, Design
- Robot Motion Planning, Image Analysis, Computer Games

Prerequisites

SDU

Analysis of Algorithms and Data Structures

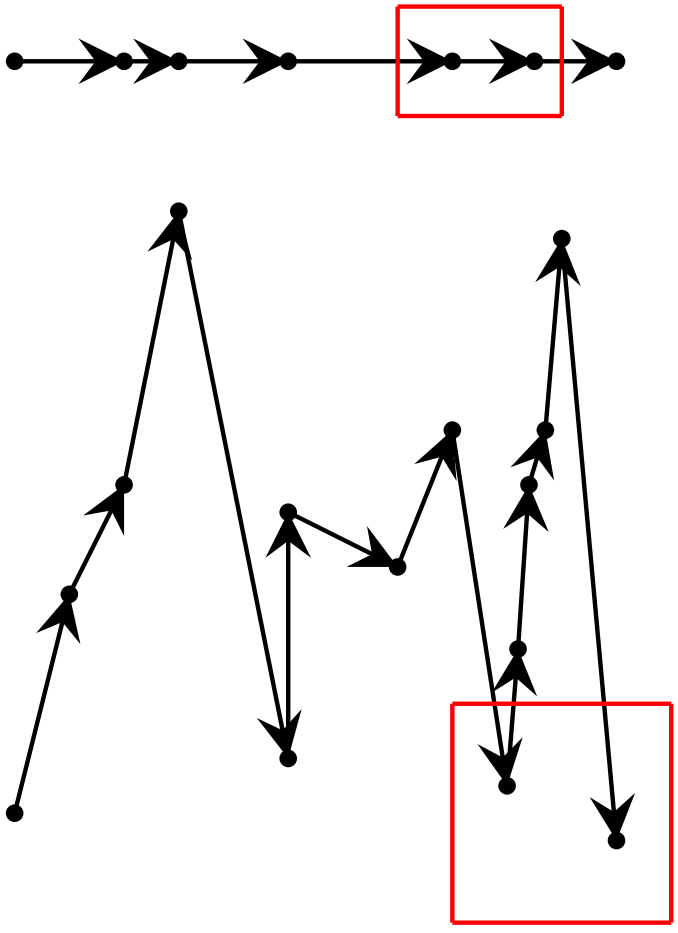
- primarily *algorithms and data structures*
- and a little *discrete math* and *probability theory*
- for maturity, having followed *advanced algorithms* and *computability and complexity* wouldn't hurt

If you want the course, but don't have the prerequisites, then talk to me!

More concretely,

- Search Trees (red-black trees) and Priority Queues
- Divide and Conquer
- Asymptotic Notation
- Correctness Analysis
- Time and Space Analysis,
  including simple probability theory and adversarial arguments

Why Is This a Separate Course?



Q: It appears that it's bacially algorithms! Why is it then a separate course and not just a part of other courses?

A: Beyond one dimension, there's no total ordering that preserves geometric proximity - this leads to all sorts of (fun) challenges that are quite different from the usual set-ups!

Format

SDU

- 10 ECTS over one semester
- Exam: oral (heighest weight) and programming project (in parts)
- 2h lectures, 2h exercises per week
- programming project continuously throughout the semesters
- Good book: Computational Geometry
  Algorithms and Applications, 3. eds.
  de Berg, Cheong, van Kreveld, Overmars
  Springer, 2008.

Disclaimer

SDU

- Chalk & blackboard lectures
- Core algorithmic problems (not graphics and games)
- The focus is on *efficient* algorithms – mostly $O(n \log n)$
- It says "geometry", but this is *not* math! ($\leq$ high school geometry)
- But there will be proofs/arguments in most lectures (of correctness and/or complexity)
- Course language is English, if necessary
- No TA, and the lecturer will not help with debugging

See My Home Page for More Information