Algorithmics and Programming II: Introduction

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Algorithmics and Programming II

- Lecturers:
  - Jordi Cortadella (jordi.cortadella@upc.edu)
  - Jordi Petit (jordi.petit-silvestre@cs.upc.edu)

- Sessions:
  - Theory & Problems (Jordi C.)
  - Lab (Jordi P. & Jordi C.)

Material

- Slides, exercises:

  https://www.cs.upc.edu/~jordicf/Teaching/AP2

- Jutge (for lab sessions):

  https://jutge.org

- Lliçons (by J. Petit and S. Roura):

  https://lliçons.jutge.org

Algorithmics and Programming II

This material is used for the course Algorithmics and Programming II of the Degree Data Science and Engineering.

The lectures of the course are combined with practical programming sessions using a virtual learning environment for computer programming (Jutge.org).

Lectures

1. Introduction	
2. Abstract Data Types	
3. Algorithm Analysis	
4. Divide and Conquer	
5. Memory Management	
6. Containers: Stack	
7. Containers: Queue and List	
8. Containers: Priority Queue	
9. Graphs: Connectivity	
10. Graphs: Paths, Trees and Flows	
11. Trees	
12. Containers: Set and Dictionary	
13. Hashing	
14. Fast Fourier Transform	
15. Cryptography	

Evaluation

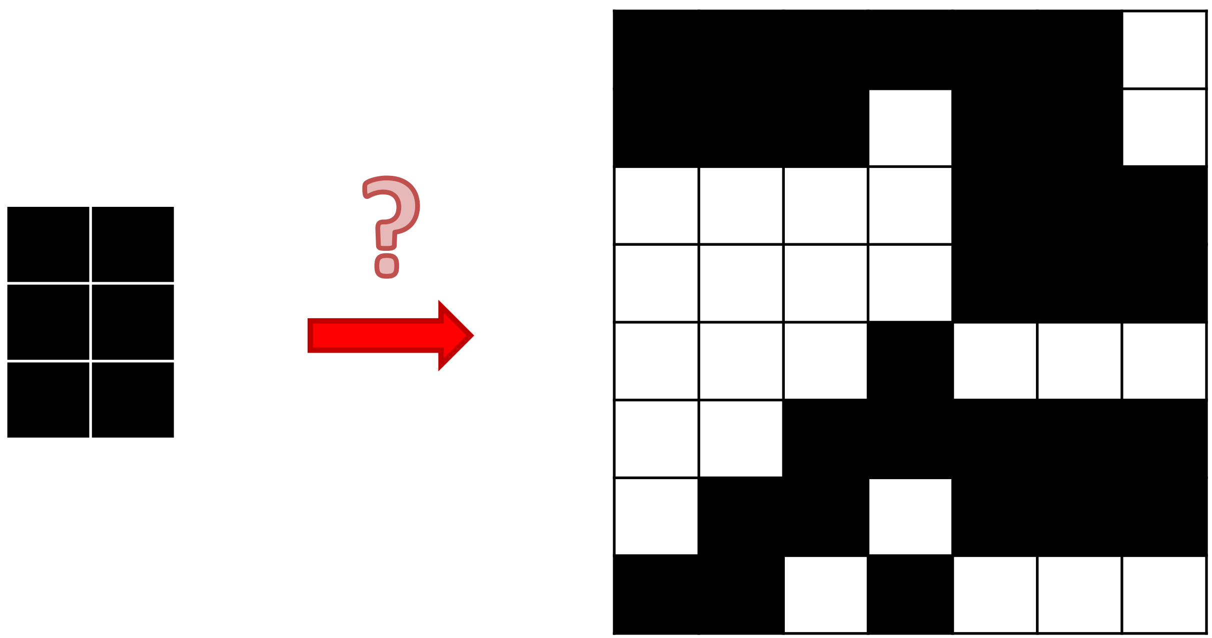
- Evaluation items:
  - Projects (Proj), Parcial Lab (PLab), Final Theory (FTh), Final (FLab).

- Grading:
  - $N_1 = \mathbf{0.2\ Proj} + \mathbf{0.25\ PLab + 0.25\ FLab} + \mathbf{0.3\ FTh}$
  - $N_2 = \mathbf{0.2\ Proj} + \mathbf{0.4\ FLab} + \mathbf{0.4\ FTh}$
  - $N = \max(N_1, N_2)$

First project: Blocks puzzle

- Design a class to play with blocks (a simplified version of Tetris).

- Language: Python.



Peer and self assessment

- The project will be evaluated by the students themselves.

- Each project will be evaluated by three students. The grade will be calculated as the average grade given by the students.

- The evaluation will be completely blind.

- Biased evaluations will be detected and penalized.

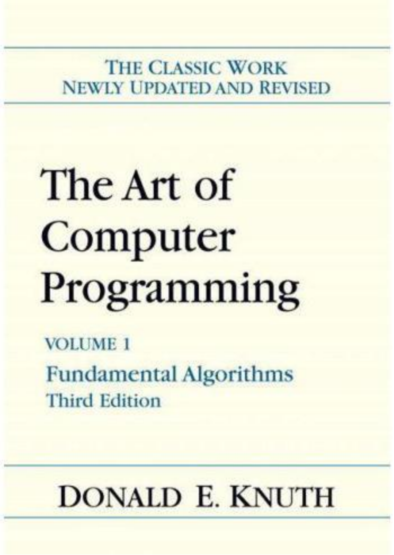
- Each student will have the right to request the evaluation by the professor (who can upgrade or downgrade the evaluation given by the students).

Donald Knuth (Turing award, 1974)

- "Programming is an art of telling another human what one wants the computer to do."

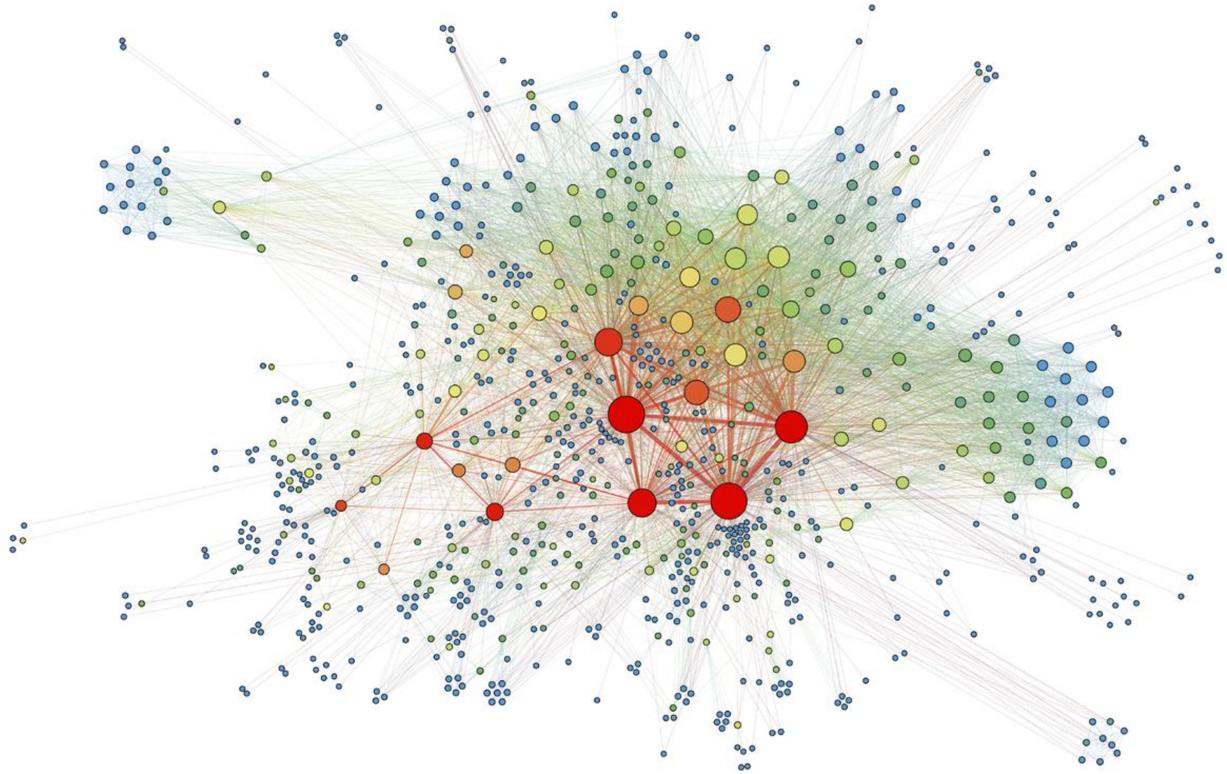
- "An algorithm must be seen to be believed."

- "The real problem is that programmers have spent far too much time worrying about efficiency in the wrong places and at the wrong times; premature optimization is the root of all evil (or at least most of it) in programming."



Second Project: crawling the web

Telegram



Language: python

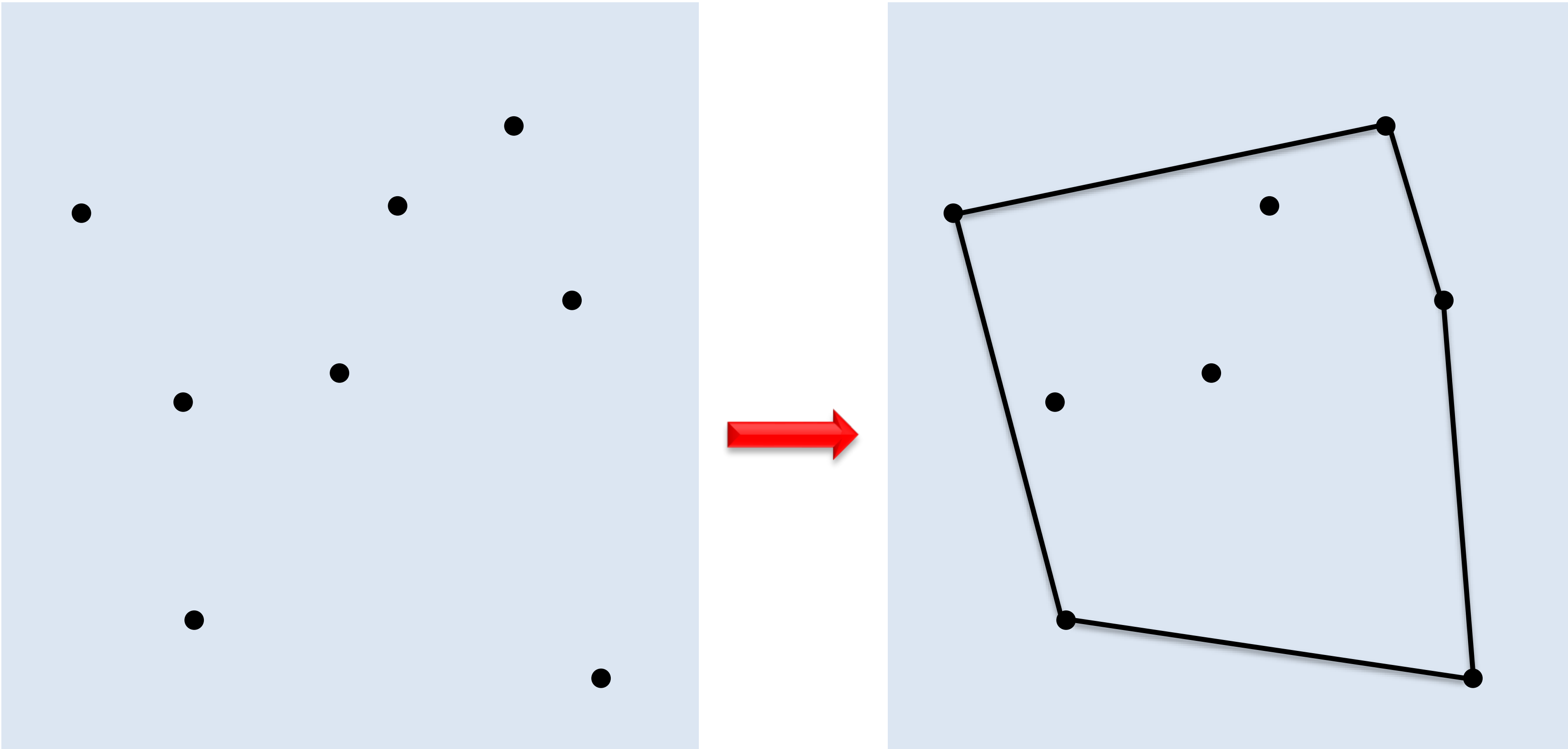
Analyzing the web as a graph: connectivity, pagerank, distances, …

Objective of the course

Confronting large and difficult problems. How?

- Skills for abstraction and algorithmic reasoning.
- Design and use of complex data structures.
- Techniques for complexity analysis.
- Methodologies for modular programming.
- High-quality code.

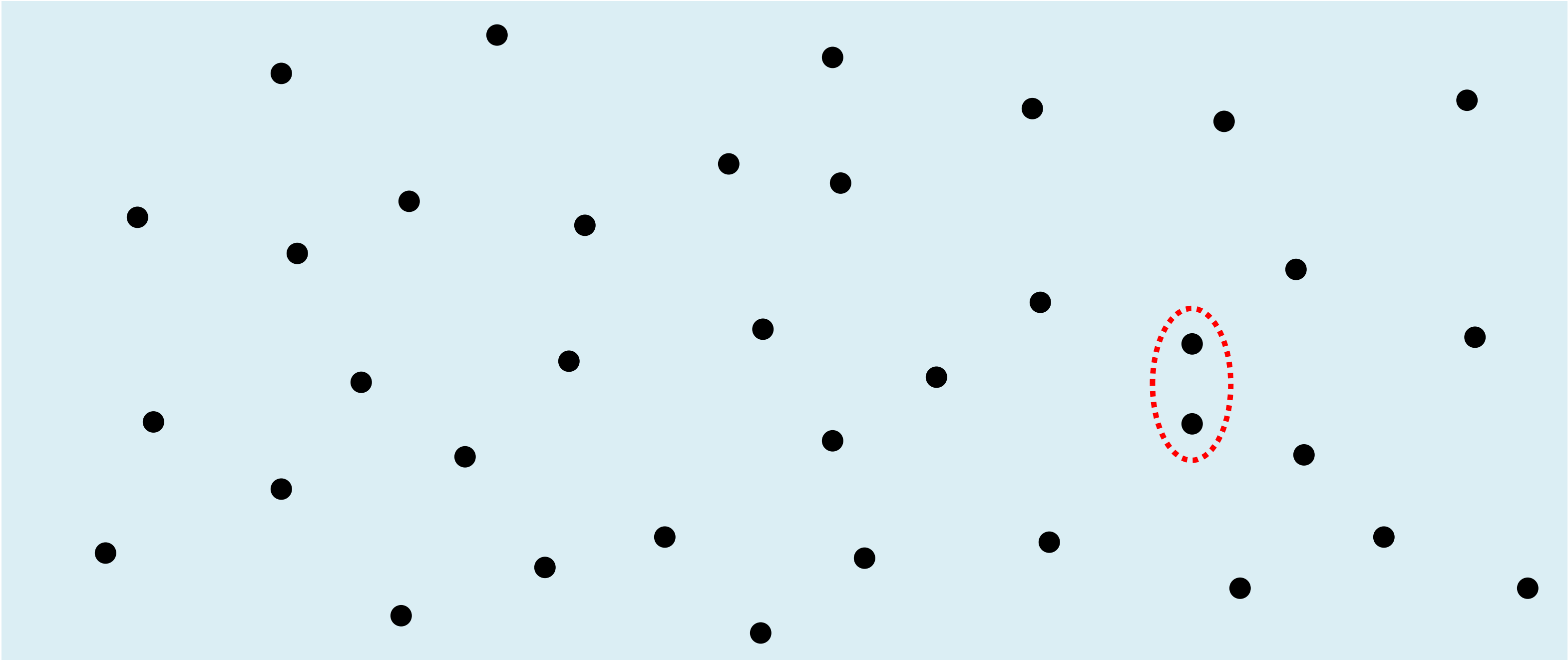
Problems on polygons



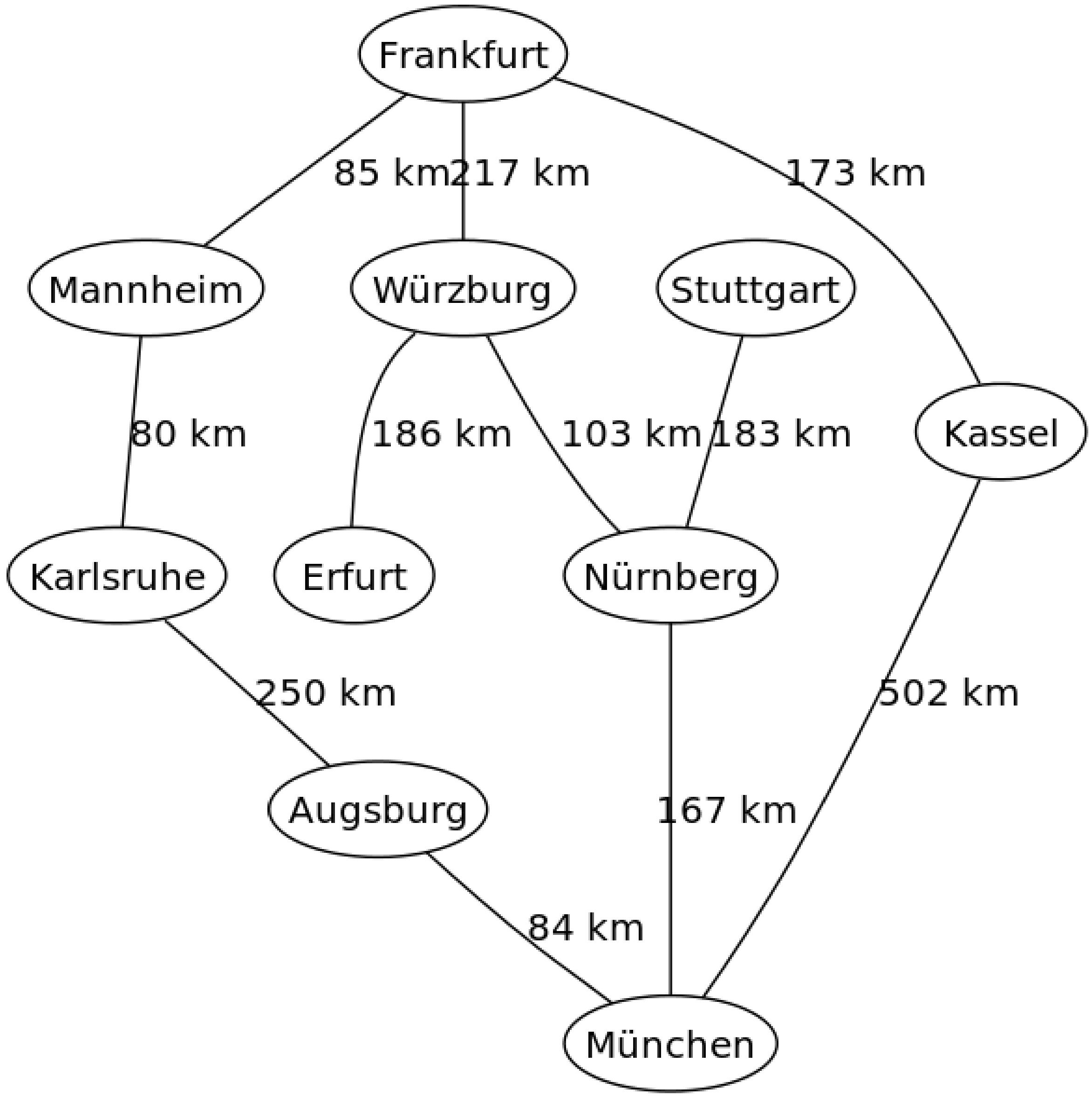
Compute the convex hull of n given points in the plane.

The Closest-Points problem

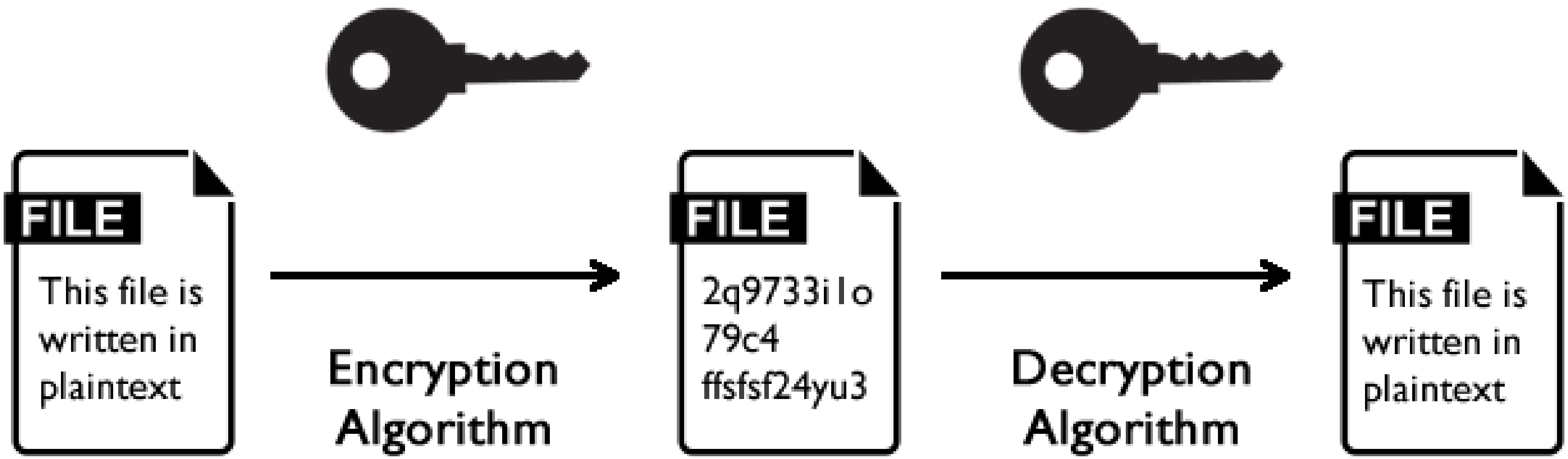
- **Input:** A list of n points in the plane
  $$\{(x_1, y_1), (x_2, y_2), \dots, (x_n, y_n)\}$$
- **Output:** The pair of closest points
- **Simple approach:** check all pairs → $O(n^2)$
- We want an $O(n \log n)$ solution !



Navigation: find the shortest path



How to encrypt messages?




The secret: training, training, training ...


Red
1
… up to the finish line