Algorithms and networks

Period 1, 2012/2013

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Today

- Graphs and networks and algorithms: what and why?

- This course: organization

- Case introduction: facility location problems

- Shortest path I

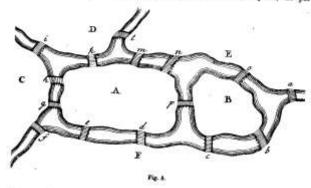Universiteit Utrecht

What and why?

Graphs

- Started in 1736 with paper by Euler: bridges of Königsberg
- Can we make a walk where we cross each bridge once (Euler-tour)?

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Networks

- Graphs are a model for many things in the real world:
  - Road networks, electrical networks, organizational diagrams, social networks, structure of software, data bases, …
- Often with *additional information*: network is graph with some extra info (like *weights, lengths, labels, …*)

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Problems

- Often, we want to compute something on the network, motivated from the application (or theoretical curiosity).

- How good and fast can we let the computer do this computation?

Algorithms and complexity

- Algorithms
  - Exact, heuristic, special case
  - Polynomial time, exponential time, …
  - …
- Complexity
  - NP-completeness, other classes
  - …

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Techniques

- **Combinatorial algorithms**
- Branch and bound
- Local search (iterative improvement, simulated annealing, tabu search, …)
- (Integer) linear programming
- …

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Model and algorithm

1. Real life problem
2. Mathematical model of real life problem
3. Algorithm for mathematical model
4. Solution produced by algorithm
5. Translation of solution to solution for real life problem

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This course (organization)

Teacher

- Hans Bodlaender
- H.L.Bodlaender@uu.nl
- 030-2534409
- Room BBL 503
- Office hours:
  - Wednesday 15-17
  - Or see if I've time
  - Or make appointment with email

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Algorithms and networks

- 2 times per week lectures
- Approximately 8 sets of exercises
  - Two weeks time for handing in
- 2 partial exams

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Final grade

- (Average exercise sets *2 + 1e exam + 2e exam)/4

- Assuming
  - Exercise sets at least 6
  - Average exams at least 5

- Details see webpage

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Exercise sets

- 8 sets (Maybe 7 or 9)
- Grade
- Hand in on paper, before or on deadline
- Dutch or English
- Write clear, legible, etc.
- Unreadable, messy: 0

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On the exercise sets

- Lots of work...

- You learn a lot...

- Working together? Yes, but:
  - Write names of cooperators on handed in work
  - Cooperate only in finding solutions, NOT in writing: write in your own words the solutions down!

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Purpose of course

- Knowing and being able to use and apply
  - Important algorithmic techniques
  - Important algorithms
  - Modelling
- In particular for combinatorial problems involving graphs and networks

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Topics of course (1)

1. Paths, flows, matchings, ...
   - Shortest paths
   - TSP
   - Maximum flow
   - Minimum cost flow
   - Matching (bipartite, general graphs)
   - Stable marriage
   - Certifying algorithms
2. Hard problems

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Topics of course (2)

1. Paths, flows, matchings, ...
2. Hard problems
   - NP-completeness and complexity
   - Exact algorithms for hard problems
   - Parameterized complexity
   - Kernelization
   - Treewidth
   - To be decided

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More on the contents

- Modeling
- Applications
- Analysis of algorithms

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The website of this course

- See www.cs.uu.nl/docs/vakken/an   for
  - Powerpoint files
  - Exercises
  - Schedules
  - Dates, etc

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Studying this course

- Be there!
  - Materials are scattered through literature: often hard to study at home if you were not at the course
  - If you are not at the course: borrow/copy notes of other students!
- Some books are recommended, but not necessary
- Make notes
- Do your exercises
  - Preferably before the corresponding exam, even when the deadline is later!
- Use the powerpoints and pdf's

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Exercises

- Hand-in on paper (mailbox or in classroom)
- Use folder
  - One folder for: new exercise; handing in exercises; getting graded material back
- Once during course you can extend your deadline with three days (joker-rule)
- Real deadline: next day 09.00 hours sharp

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Are there ...

- questions on the organization of the course?

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