

# NETWORK ALGORITHMS WELCOME!!

A.A. 2016/17

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# INTRODUCTION

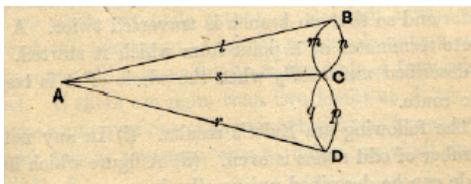
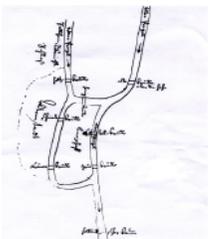
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Network Algorithms

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## THE STARTING POINT(1)

- It is usual to position the birthdate of the modern *graph theory* in 1736, when Euler formulated his Königsberg bridge problem.
- Euler solved this problem proving, in a constructive fashion, a characterization of Eulerian graphs. This is considered the first graph algorithm solving a “real life” problem.

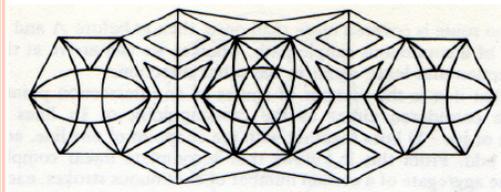
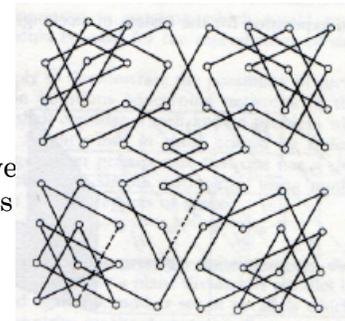


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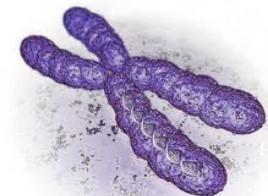
## THE STARTING POINT (2)

Since then, graph algorithms have been used to solve many problems in several applicative fields:

- games and puzzles:
- topology



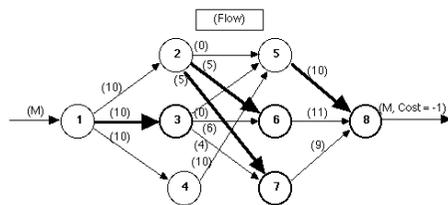
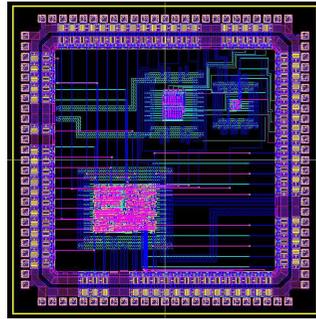
- biology



### THE STARTING POINT (3)

Specifically, in computer science:

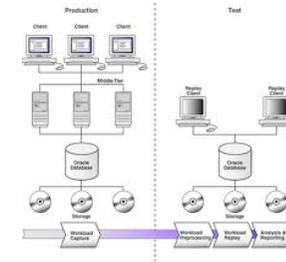
- Electronic engineering:
- Operative research:



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### THE STARTING POINT (4)

- Artificial intelligence:
- Data bases:
- communication:



### THE STARTING POINT (5)

- networks:

This course will be focused on:

- Cable networks
- Wireless networks
  - Fixed
  - Mobile



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### THE STARTING POINT (6)

- All over the world, courses of Network Algorithms are thought.
- Almost all of them have a theoretical approach:

(in the last years)

- Princeton Univ. (Robert Tarjan)  
<http://www.cs.princeton.edu/courses/archive/spr11/cos423/>
- Stanford Univ. (Balaji Prabhakar)  
<http://web.stanford.edu/class/ee384m/>
- Cornell Univ. (David Easley & Eva Tardos)  
[https://courses.cit.cornell.edu/cs2850\\_2016fa/](https://courses.cit.cornell.edu/cs2850_2016fa/)
- Universiteit Utrecht (Hans Bodlaender)  
<http://www.cs.uu.nl/docs/vakken/na/>
- Tel Aviv Univ. (Noga Alon & Amos Fiat) <http://tau-algorithms.wikidot.com/course-schedule>
- Uni Freiburg (Fabian Kuhn)  
[http://ac.informatik.uni-freiburg.de/teaching/ss\\_16/network-algorithms.php](http://ac.informatik.uni-freiburg.de/teaching/ss_16/network-algorithms.php)
- ...

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## THE ARRIVAL POINT

- **Aim:**  
to convince you that **graph algorithms** are not old-fashioned, though dated; instead, they are **useful instruments to solve important and living problems**.
- A number of **advanced techniques** for efficient algorithm design are studied, often at the hand of problems from networks and graphs. In many **network applications**, **graphs** are used **as a model**. In other applications, the graph model may be less obvious, but appears to be very useful.
- The translation of network problem to graph model is treated, and algorithmic problems and their solutions on networks and graphs are looked into.

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ARRIVAL POINT



STARTING POINT

## WHICH ROUTE? (1)

Several topics will be dealt with, all in the same way:

- Definition of the network problem
- Model as (classical) graph problem
- Known solutions for the graph problem
- Other possible approaches based on the properties of the considered networks

Some classical topics

Some research topics  
(suitable for theses and new results)

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## WHICH ROUTE? (2)

- The first topics will be more classical, and they will exploit some things you studied in the past, in order to start in an “easy” way; then the topics will become less and less standard...
- **Why (my) research topics?** three reasons:
  - Passion for these topics
  - International context
  - Chance to approach research topics in the algorithm field and produce new and interesting results (e.g. during your master thesis period...)

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## WHICH ROUTE? (3)

Topics surely dealt with in this course:

- Cable networks:
  - The routing problem  
i.e.  
The minimum cost path problem
  - The interconnection topology layout problem  
i.e.  
The orthogonal grid drawing
  - The problem of minimizing boolean circuits  
i.e.  
The minimum set cover problem
  - The problem of infecting a network with a worm  
i.e.  
The minimum vertex cover problem

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## WHICH ROUTE? (4)

Topics surely dealt with in this course (2):

- Wireless ad hoc networks:
  - The frequency assignment problem  
i.e.  
A vertex coloring problem
  - The minimum energy broadcast problem  
i.e.  
The minimum spanning tree problem

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## WHICH ROUTE? (5)

Topics surely dealt with in this course (3):

- Sensor networks:
  - The centralized deployment problem  
i.e.  
The minimum cost perfect matching problem on bipartite graphs
  - The self-deployment problem  
i.e.  
The Voronoi diagram construction problem

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## WHICH ROUTE? (6)

Books:

- Many topics deal with recent research, so:  
few books and many papers
- In the web page of the course:  
list of papers I have used.
- Attending lessons is particularly important!  
Even because...

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## EXAM PROCEDURE

- Only oral exam
- A (small!) number of **lessons** will be held **by students**.
- These have a twofold aim: from the one hand they get close students to research; from the other hand they are a good exercise to learn to extract the main ideas from a paper.
- These lessons will exonerate students by a part of the oral exam and are **compulsory**.

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## RELATION WITH OTHER COURSES

- No previous exams are required to attend this course, nevertheless **A DEEP FAMILIARITY WITH ALGORITHMS AND DATA STRUCTURES IS NECESSARY.**

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## AT THE END OF THIS COURSE...

I would be happy to have your comments, especially about possible improvements.

Namely:

- What to deep in,
- What to skip,
- What to add,
- Any other suggestion...

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