Graph Theory 41000

Outline of the course

1 Description

In this course, we will study fundamental *graph optimization problems*, and *algorithms* to solve them. In a typical setting, we are given a graph and a cost function that assigns a cost to its edges/vertices, and we are interested in finding a subgraph with certain properties, of minimum cost. Since listing all possible solutions is computationally prohibitive, we will learn how the structure of our optimization problems can be exploited to solve/approximate them in an efficient manner.

List of *topics* planned to be covered during this course:

- Trees and arborescences, Non-bipartite weighted matchings and T-joins, Multi-flows and multi-cuts, Metric graphs and tree metrics, Steiner Trees and Steiner Networks.

List of *techniques* that we will explore during this course:

- Combinatorial approaches, Primal-Dual methods, Metric embedding, Iterative rounding, Randomized rounding.

2 Prerequisites

Basic knowledge of graph theory, basic knowledge of algorithms, basic knowledge of linear programming and duality.

3 Grading

To pass the course, each student will have to prepare the following:

1. An oral presentation (length: 25 minutes) on a topic somehow related to the material seen in class (agreed with the instructor before)
2. A report (pdf max 4 pages long). This report should be intended as follows:
   Suppose that you have to give a 1.5 hour blackboard lecture about the topic in (a) (rather than a presentation). What would you write on the blackboard?

4 References

The following book can be used as main references.

(1) W. Cook, W. Cunningham, W. Pulleyblank and A. Schrijver. *Combinatorial Optimization.* Wiley-Interscience (https://onlinelibrary.wiley.com/doi/book/10.1002/9781118033142)

(2) R. Diestel, *Graph Theory.* Springer. (https://www.google.it/books/edition/Graph_Theory/zIxRDwAAQBAJ?hl=en&gbpv=0)

(3) David Williamson and David Shmoys, *The Design of Approximation Algorithms.* (http://www.designofapproxalgs.com/).