CO 450/650, Fall 2020
Combinatorial Optimization

Class time and location: TBA

Instructor: Jochen Koenemann

Teaching Assistants: TBA

Overview:

Combinatorial Optimization is a field that combines techniques from combinatorics, linear programming, and the theory of algorithms to solve discrete optimization problems. In a typical instance of such a problem, we are given a finite discrete space of solutions, and a rational cost function that assigns a cost to each one of them. The question that interests us is: can we find a minimum-cost solution efficiently (i.e., in time polynomial in the size of the input)?

In order to design an efficient algorithm, we need to understand the structure of the given solution set. For example, consider the problem of finding a shortest path between two nodes u and v in a given weighted graph. The number of such paths may well be exponential in the size of the input, yet efficient algorithms to find a shortest one among them exist; these methods crucially exploit the well-behaved structure of the solution set. Slight variants of the above problem are less well-behaved: the problem of finding a shortest u,v-path via a third node z in some input graph is provably hard to solve!

In this class, we primarily study discrete optimization problems that are well-behaved, i.e., for which efficient exact algorithms exist. Topics covered in this class include:

- Flows & flows over time
- Spanning trees & algorithms
- Maximum flows & minimum cuts
- Matchings
- Matroids & Greedy algorithms

Expectations:

Apart from general mathematical maturity, students are expected to be familiar with the fundamentals of linear optimization and graph theory. Chapter 1-3 (pages 1-70) of [*Combinatorial Optimimization*, Korte & Vygen] (see https://link.springer.com/content/pdf/10.1007/978-3-540-71844-4.pdf) serves as an adequate refresher.

Marking:

There will be **4 assignments** that students are expected to complete and hand in. Each of these will typically have to be completed within a two-week period, and a specific hand-in day and time will be provided. Late assignments will not be graded and a mark of zero will be assigned. Some of the questions on the assignments are meant for graduate students, and will be marked with a [G]. Undergraduate students may attempt to solve these questions, and will receive bonus marks for correct solutions.

Assignments are an integral part of this course, and contribute in a substantial way to the final mark (see below for a detailed marking scheme). Therefore, collaboration is not allowed unless otherwise noted. Similarly, the only allowed sources to be used when preparing your assignment solutions are the textbook and your class notes. Copying from old assignment solutions, or using other sources is considered cheating, and if detected, will yield a mark of 0 on the respective assignment. In case you have any question about the way your assignment was graded, please contact the instructor.

There will be a **take home final exam** to be scheduled during the exam period in December (details tba).

All assignments and the final exam will be circulated and solutions will be collected using the Crowdmark platform.