Exact exponential and parameterized algorithms
Summer Semester 2021

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Brief description:
The goal of algorithm design is to come up with efficient algorithms for problems that arise in applications. By efficient, we usually mean "polynomial running time for every instance". Unfortunately several (or even most) of the natural problems that we want to solve are NP-hard, and thus finding polynomial-time algorithms for them is hopeless.

Two broad approaches for dealing with this situation, when approximations are not acceptable, are exact exponential algorithms, and parameterized algorithms. In the first case, we look for algorithms that solve the problem in exponential time, but faster, and possibly using less space, than a trivial brute force approach. In the second case, we try to identify meaningful parameters, so that the exponential growth in running time is limited to these parameters, thus yielding efficient algorithms in important special cases.

Bibliography:

Topics Covered:


**WEEK 6.** Dynamic programming. Graph coloring. Counting perfect matchings in bipartite and general graphs. Ryser formula, inclusion-exclusion.

**WEEK 7.** Pathwidth. Treewidth. Algorithmic applications. (Guest lectures by Benjamin Berendsohn.)


**WEEK 9.** Color coding vs. divide and conquer. Local search for satisfiability.

**WEEK 10.** Derandomizing the local search algorithm. Time-space tradeoff.

**WEEK 11.** Time-space tradeoff: TSP, graph coloring.


**WEEK 13.** Two case studies: 1. graph bandwidth, 2. permutation pattern matching.

**WEEK 14.** Lower bounds. ETH, SETH, FPT-reductions and W-hierarchy.