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Fine-Grained Look at Graph and Matrix Problems

Algorithms research is usually concerned with how fast a given computational problem can be solved. However, without matching complexity lower bounds we cannot know if further speedups are possible or if the current algorithms are optimal. The classic conjecture that P is not NP is very successful at explaining why we cannot not find polynomial time algorithms for certain problems. However, it fails to address questions of the form "Given a problem with a cubic time algorithm, shall we expect to speed it up to quadratic or linear time?".

This motivates the area of fine-grained complexity, which studies sharper complexity hypotheses and reductions between problems with precise control over running times. A fine-grained reduction from a problem believed to be hard proves that the problem which we reduce to is also hard, and explains a reason for that hardness. More importantly, by studying reductions, we gain a better understanding of combinatorial structures involved in computational problems.

In this talk I will focus on fine-grained relations between a group of graph and matrix problems, dubbed "intermediate", whose time complexity situates them between "easy" matrix multiplication and "hard" All Pairs Shortest Paths. The technical part of the talk will be based on joint work with Andrea Lincoln and Virginia Vassilevska Williams (ITCS'20).