Conditional Lower Bounds

Tsvi Kopelowitz, University of Michgan

June 10, 10:00 – 12:15; 1:00 – 3:15 **Hosted by James Abello**

CoRE Building 431

Abstract

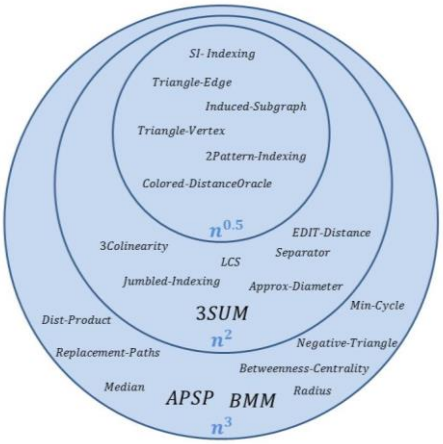
A central theme in Computer Science is classifying computational problems by their inherent difficulties. Perhaps the most striking example is NP-hardness which has allowed computer scientists to classify nearly all problems of practical interest as polynomial-time solvable (in P) or NP -hard. However, only recently has there been a similar development in classifying problems within the class P. It is known that there exist problems requiring quadratic time or cubic time, but exhibiting a natural such problem has remained elusive. All known lower bounds in P are conditional, that is they depend on the conjectured hardness of certain archetypal problems such as 3SUM, CNF Satisfiability, all-pairs shortest paths (APSP), and many more.

This tutorial will cover the recent exciting developments in the realm of **conditional lower bounds**, by exploring reductions which exhibit the intuition behind the inherent hardness of some well-studied problems. Topics will include:

1. 3SUM: While this simple to state problem (given a set of n elements decide of three of them sum up to zero) has an almost naive quadratic time algorithm, obtaining polynomial speed-ups seems to be beyond our reach. We will show how this (in)famous problem serves as a base for many conditional lower bounds, predominantly through a reduction to set-intersection problems.

2. SETH: The Strong Exponential Time Hypothesis states (informally) that for unbounded k, one cannot solve k -CNF much faster than exhaustive search. This conjecture has lead to several important conditional lower bounds for graph string problems.

3. APSP: Solving the all pairs shortest path problem polynomially faster than cubic time (in the number of vertices) is a barrier which seems currently unbreakable. We will show some subcubic reductions from APSP, and discuss their implications.



Speaker

Dr. Tsvi Kopelowitz is a postdoctoral fellow at the University of Michigan, under the supervision of Professor Seth Pettie. Kopelowitz is an expert in the design and analysis of (dynamic) graph algorithms, data structures and pattern matching problems. During his PhD studies in Bar-Ilan University, Kopelowitz developed new techniques for solving algorithmic challenges in the seam of these subfields. Kopelowitz has also introduced several new exciting techniques for proving conditional lower bounds for graph algorithms, data structures, and string problems. In particular, Kopelowitz has recently shown the first tight conditional lower bounds based on the 3SUM conjecture for a variety of problems, and is actively researching new and exciting venues for conditional lower bounds.

For questions or more information, please contact Dr. Eugene Fiorini, Associate Director of DIMACS and Program Coordinator (gfiorini@dimacs.rutgers.edu). The Workshop is organized by the DIMACS REU program (http://dimacs.rutgers.edu/REU/).

DIMACS