香港中文大學
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Institute of Theoretical Computer Science and Communications

*CSE-ITCSC Seminar*

# Promise Constraint Satisfaction

*By*

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***3:30 pm – 4:30 pm***

***Room 121, 1/F, Ho Sin Hang Engineering Building, CUHK***

**Abstract:**

Given a k-SAT instance (k odd) with the promise that there is an assignment satisfying at least (k-1)/2 out of k literals in each clause, can one efficiently find a satisfying assignment that sets at least one literal to true in each clause? Given a k-uniform hypergraph promised to admit a red-blue coloring of its vertices such that exactly t vertices are red in each hyperedge, for some $0 < t < k$, can one efficiently find a red-blue coloring that leaves no hyperedge monochromatic? Given a 3-colorable graph, can one find efficiently find a 5-coloring of the graph? Given a graph admitting a homomorphism to the 7-cycle, can one efficiently 3-color it?

The answers to these questions are: No (assuming P \neq NP), yes, open, and open, respectively. These are examples of ***promise*** constraint satisfaction problems (PCSP), where in the decision version, we need to distinguish instances satisfiable according to one set of predicates, from those that not satisfiable even under relaxed versions of those predicates. PCSPs generalize normal CSPs where the two sets of predicates are identical. The (recently resolved) famous dichotomy conjecture states that every CSP is either polytime decidable or NP-hard. Further, the tractable cases are precisely those with non-trivial "polymorphisms" which are operations preserving the predicates defining the CSP.

The landscape of PCSPs seems much more complicated, and the complexity of many natural problems remains open. This talk will describe some of our forays into better understanding PCSPs. These revolve around the notion of "weak polymorphisms" which generalize the concept of polymorphisms from CSP land. We will sketch our hardness proof (with P. Austrin and J. Håstad) for the above promise k-SAT problem, based on a characterization of the weak polymorphisms as juntas depending on few variables. We will touch upon on a body of work (with J. Brakensiek) that applies the weak polymorphism framework to prove new hardness results for graph coloring and establish a complexity dichotomy for the case of Boolean symmetric PCSP.

## Biography:

Prof. Guruswami received his Bachelor's degree in Computer Science from the Indian Institute of Technology at Madras in 1997 and his Ph.D. in Computer Science from the Massachusetts Institute of Technology in 2001. He is currently a Professor in the Computer Science Department at Carnegie Mellon University. Earlier, during 2002-09, he was a faculty member at the University of Washington. Prof. Guruswami was a Miller Research Fellow at the UC Berkeley during 2001-02, and was a member in the School of Mathematics, Institute for Advanced Study during 2007-08.

Prof. Guruswami's research interests span several topics in theoretical computer science such as the theory of error-correcting codes, approximability of fundamental optimization problems, explicit combinatorial onstructions and pseudorandomness, probabilistically checkable proofs, computational complexity theory, and algebraic algorithms.

Prof. Guruswami currently serves on the editorial boards of the SIAM Journal on Computing and the ACM Transactions on Computation Theory, and as the program committee chair for the 2015 FOCS conference. Previously, he was on editorial board of the IEEE Transactions on Information Theory and was program committee chair for the 2012 Computational Complexity conference. He was an invited speaker at the 2010 International Congress of Mathematicians. Prof. Guruswami is a recipient of the Presburger Award (2012), Packard Fellowship (2005), Sloan Fellowship (2005), NSF CAREER award (2004), the ACM Doctoral Dissertation Award (2002), and the IEEE Information Theory Society Paper Award (2000).

******* ALL ARE WELCOME *******

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