Topics in (and out) the theory of computing

http://www.cse.cuhk.edu.hk/~andrejb/csc5060/

Department of Computer Science and Engineering
The Chinese University of Hong Kong, Spring 2012

Lectures Wednesdays 11:30–2:30 in ERB 804

Instructor Andrej Bogdanov, andrejb@cse.cuhk.edu.hk, SHB 926

Description

This course will cover tools and techniques that have proven useful in the theory of computing over the years. They have contributed to advances in many areas inside and outside theory, like learning, cryptography, and optimization. These techniques often originate from distant fields like algebra, signals, and information theory. They found their way into computer science through the effort of passionate graduate students like you, who dazzled the world by mastering them applying them towards solving hitherto intractable problems. It is time for you to continue this tradition!

Regardless of your area of expertise (it doesn't have to be theory), try this course, become more confident in your technical skills, go forth, and make a splash.

Topics

Here are some sample topics. Changes are possible depending on interest.

Coding theory Rate and minimum distance, concatenation, constructions. Efficient decoding and list-decoding algorithms. Relations between the worst case and typical hardness of computational problems. Locally decodable codes and private information retrieval.

Analysis of boolean functions Fourier decomposition, the Kushilevitz-Mansour algorithm. Applications to learning theory and cryptography. The Fourier spectrum of shallow circuits. Small-bias sets and applications to pseudorandomness. Invariance principles and hardness of approximation. Testing properties of boolean functions.

Expander graphs Definitions, properties, connections to coding and Foruier analysis. Combinatorial constructions via zig-zag graph products and/or algebraic constructions via group representations.

Information

Prerequisites There are no formal prerequisites for this class, but it helps to be comfortable with discrete mathematics and probability.

Grading and homeworks Your grade will be determined from homeworks (30%), a take-home midterm exam (30%), and a final project (40%). Three homeworks will be issued throughout the semester. You are encouraged to collaborate on the homeworks as long as you write up your own solutions.

Final project For your final project you will be expected to do some independent reading, a presentation in class, and a short report. A list of suggested projects and more details will be provided around the middle of the semester.