



Theoreticians Toolkit, 2009

Some of the topics to be covered will be lectured by Johan Hästad while some other topics will be lectured by students. The choice of lecturer depends on the wishes of the students and the number of students taking the class. We will probably not cover all topics, at least not on all the subtopics listed below.

1 Possible Topics

Probabilistic arguments Basic inequalities Markov, Chebychev, and Chernoff. The probabilistic method for constructing combinatorial objects. Small sample spaces that are (almost) k -wise independent. Lovasz local lemma.

Expander graphs Definition, relation to eigenvalues. $SL=L$.

Randomness Pseudorandom generators, the Nisan-Wigderson generator, Trevisan's extractor. Reducing randomness.

Magic of Polynomials Schwartz-Zippel, $IP=PSPACE$ Reed-Solomon codes, secret sharing and multi-party computations.

Parallel repetition Raz' theorem on parallel repetition of two prover games.

Lattices The LLL lattice reduction algorithm and some application.

Fourier transforms The discrete Fourier transform, Bonami-Beckner operator, influence of variables, Kahn-Kalai-Linial.

Linear Programming Polynomial time algorithms, duality, application (maybe approximate inclusion-exclusion).

Semi-definite programming Max-Cut and coloring of three colorable graphs.

Property testing Basic example of property testing. Graph-regularity theorem.

The PCP theorem At least one proof.

Markov chains The use of Markov chains for approximate counting. Mixing time.