Lecture topics in DD2442
Seminar course in Theoretical Computer Science
Approximation Algorithms
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Johan Håstad

Abstract

As we are almost done this is the final plan of lectures in the course.

1 Initial words

Even though skipping many of the details of the proof of the PCP-theorem it took longer time than expected. Some topics have hence been dropped.

As a final change, the proof that the unique games hardness implies $2-\epsilon$ hardness for Vertex Cover was, at closer inspection, deemed to difficult and skipped.

At some point the hope was to include a result on how to construct optimal gadgets to get inapproximability for new constraint satisfaction problems. Giving all details of the result for Max-3Lin was given priority, however, and it is unlikely that we will have time for the gadget result.

1. (Aug 24) Overview of the algorithmic part of the course.
2. (Aug 27) Overview of the hardness part of the course. 2-approximation of Vertex Cover and $\ln n$ approximation of set cover.
3. (Aug 31) Approximation of symmetric TSP. Algorithm by Christofides giving 3/2 approximation when triangle inequality is present. Some initial discussions of linear programming.
4. (Sep 3) Algorithmic approaches to LPs, simplex, ellipsoid and interior point. The dual LP.
5. (Sep 7) Semidefinite programs. An approximation algorithm for Max Cut. How to get a better ratio for Max-2Sat (brief sketch).

6. (Sep 14) Coloring a 3-colorable graph. Simple combinatorial algorithm with $O(\sqrt{n})$ colors and a more sophisticated algorithm based on semi-definite programming.

7. (Sep 17) Lattices, motivation and basic definitions.

8. (Sep 21) The L^3-algorithm for finding a $2^{n/2}$ approximation of the shortest vector in a lattice in polynomial time. Approximating independent set (or equivalently clique) within a factor $O(n/(\log n)^2)$.

9. (Sep 24) Efficient proofs and the PCP theorem. A proof that co-NP allows an efficient interactive proof.

10. (Sep 28) The PCP theorem continued. A sketch of all components of the proof.

11. (Oct 1) Proving that label cover is hard to approximate. Done through 2-prover interactive proofs and parallel repetition. Define the long code and the discrete Fourier transform.

12. (Oct 5) More details of the Fourier transform. Linearity testing. The result that Max-3Lin (linear equations modulo 2 with three variables in each equation) is hard to approximate with $\frac{1}{2} + \epsilon$.

13. (Oct 8) Completing the proof of hardness for Max-3Lin. In-approximability of max-clique (independent set) within a polynomial factor. A scetch how to get factor $n^{1-\epsilon}$ inapproximability.

14. (Oct 12) The unique games conjecture (UGC). The implication for inapproximability for Max-Cut. Possibly a sketch of some algorithm for special cases of unique games.