

Assignment 2: CS60023: Approximation and online algorithms

Spring 2024

You must answer all questions totalling 100 marks.

All proofs and arguments must be complete and clear.

Follow lucid writing style, using suitable notation and maintaining rigour.

January 14, 2024

1. Show that 2SAT is the class P. Show that 3SAT is NP-hard by a reduction from the general satisfiability problem where clauses can have more than three literals. [15 marks]
2. Why is the general TSP problem NP-hard? Why is it also strongly NP-hard? Why is approximating too NP-hard and in what quantitative way? Do matters improve if we introduce the triangle inequality conditions? How? [15 marks]
3. Why is approximating bin packing (even with two bins) NP-hard for smaller than 1.5 approximation ratio? How is approximation ratio 2 achieved? [10 marks]
4. Define the k -centre problem and derive the approximation ratio of 2. [15 marks]
5. Show that the feedback vertex set and the feedback edge set problems are NP-hard. [20 marks]
6. Briefly state the NP-hardness reductions for the vertex cover, stable set, clique and Hamiltonian circuit problems on undirected graphs. [15 marks]
7. Show that MAX3SAT has a 2-factor approximation algorithm. If we use randomized polynomial time then can this factor be improved? Why? [10 marks]

References

- [1] T. H. Cormen, C. E. Leiserson, R. L. Rivest, Introduction to algorithms, Second Edition, Prentice-Hall India, 2003.
- [2] J. Hopcroft and J. D. Ullman, Introduction to Automata, Languages and Computation, Addison-Wesley, 1979.
- [3] David P. Williamson and David B. Shmoys, The design of approximation algorithms, Cambridge University Press, 2010.
- [4] V. Vazirani, Approximation algorithms, Springer, 2003.