

COMP36111: Advanced Algorithms I

Lecture 11: How to Pass the Examination

Ian Pratt-Hartmann

Room KB2.38: email: ipratt@cs.man.ac.uk

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- Basic graph algorithms
 - directed and undirected graphs
 - DFS (depth-first search)
 - reachability
 - connectedness
- Strongly connected components of directed graphs
 - finding a topological sort of a dag
 - Tarjan's algorithm
- Connected components of undirected graphs
 - union-find
 - optimizations
 - running time
- Matching and flow optimization
 - Flow networks
 - The Min-cut-max-flow theorem
 - How to compute optimal flows
 - Application to the marriage problem

- Stable marriage problem
 - Gale-Shapley algorithm
 - running-time
 - correctness
 - optimality (for boys!)
- String matching
 - Rabin-Karp
 - Knuth-Morris-Pratt
- Linear programming
 - Problem definition
 - Geometrical analysis
 - The simplex method (bounded cases, feasible)
 - The integer-case (ILP)

- Turing machines and complexity
 - Definition of Turing machines
 - Definitions of recursive, recursively enumerable (r.e.)
 - The existence of a universal TM and simulations
 - Undecidability of the halting problem
 - Time and space complexity (deterministic, non-deterministic)
 - Complement classes
 - The time-bounded halting problem and $P_{TIME} \neq EXP_{TIME}$
- Propositional satisfiability
 - Basic propositional logic
 - The problem SAT
 - The Davis-Putnam algorithm
 - The problem k -SAT
 - The problem Horn-SAT
 - Phase-transition phenomena (high-level description only)

- Reductions, completeness and hardness
 - Many-one polynomial-time/log-space reductions
 - Transitivity of many-one log-space reductions
 - Cook's Theorem (Cook-Levin Theorem)
 - 3-SAT is NP-hard
 - 2-SAT (KROM-SAT) is (co-) NLogSpace-hard.
- Hard graph-theoretic problems
 - 3-colourability is NP_{TIME}-hard
 - Hamiltonian and Eulerian circuits
 - The travelling salesman problem

- Two important theorems
 - Savitch's Theorem (both forms)
 - The Immerman-Szelepcsényi Theorem (both forms)
 - Configuration graphs for Turing machines
- The standard complexity hierarchy

- Reading:

<http://studentnet.cs.manchester.ac.uk/ugt/2017/COMP36111/syllabus/>

- Past exam papers:

http://studentnet.cs.manchester.ac.uk/assessment/exam_papers/index.php?view=ug

Note that the syllabus may vary slightly from year to year.