CSC 226

Algorithms and Data Structures: II

Final Review

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ECS 466

Final Review

- Friday, August 9 in ECS 123
- 2 p.m. to 5 p.m. (3 Hours)
- 10 Questions – 10 marks each
- Question 1 – Miscellaneous (5 parts)
- Question 2 – Miscellaneous (5 parts)
- Question 3 – Search Trees (2 parts)
- Question 4 – MSTs (2 parts)
- Question 5 – MSTs and Shortest Paths (2 parts)

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- Question 6 – Shortest Paths (3 parts)
- Question 7 – Network Flow (4 parts)
- Question 8 – Longest Common Subsequence (2 parts)
- Question 9 – Substring Search (2 parts)
- Question 10 – Planar Graphs (2 parts)

Topics

- Lecture 1 – Intro
  - Big-Oh, Big-Omega, Big-Theta, Little-oh, Little-omega definitions
  - Properties of Big-Oh and proofs
- Lecture 2 – Sorting Review
  - Selection, Insertion, Bubble, Shell, Merge, Heap, Quick, Bucket, Radix
  - Best-, Expected-, Worst-cases

Topics

- Lecture 3 – Counting
  - ➢Rule of Sum
  - ➢Rule of Product
  - ➢Permutations
  - ➢Combinations, with and without repetition
  - ➢The Binomial Theorem
- Lecture 4 – More Discrete Math
  - ➢The pigeonhole principle
  - ➢Posets
    - Relations, Partial order, Hasse diagrams

Topics

- Lecture 5 – Lower-bound on Comparison-based sorting
  - $\Omega(n \log n)$ proof, decision trees
- Lecture 6 – 2-3 Trees
  - 2-nodes, 3-nodes, 4-nodes
  - Height property
  - Search and insertion algorithms
  - Splitting 4-nodes
  - Proof height is $O(\log n)$

Topics

- Lecture 7 – Red-black Trees
  - ➢ Left-leaning red-black tree properties
    - Left red nodes, black height
  - ➢ flipColors(h), rotateLeft(h), rotateRight(h), put(k,v) methods

- Lecture 8 – More Red-black Trees
  - ➢ Red-black tree = 2-3 tree proof
  - ➢ Proof height is $O(\log n)$
  - ➢ deleteMin() from 2-3 tree

Topics

- Lecture 9 – Graph Theory
  - Graph, digraph, vertex, edge, degree, etc.
  - Walk, trail, circuit, path, cycle
  - Connected, simple, complete
  - Reachable, strongly connected
  - Dags
  - Subgraph, spanning subgraph
  - Euler circuits, Euler trails
  - Free trees, spanning trees

Topics

- Lecture 10 – Minimum Spanning Trees
  - MST definition and applications
  - Brute-force vs. greedy approach
  - Prims, Kruskals, Barouvkas examples
- Lecture 11 – Prim’s Implementation
  - Cycle property, Cut property
  - Correctness Prim’s
  - Pseudocode vs. Java implementation

Topics

- Lecture 12 – Kruskal's Implementation
  - ➢ Bottom-up heap construction
    - Recursive vs. in-place
  - ➢ Edge-painting proof $O(m)$

- Lecture 13 – Union-find
  - ➢ find(), union(), makeSet()
  - ➢ Quick-find, quick-union, weighted quick-union
  - ➢ Union-by-size (or rank or height)
  - ➢ Path compression
  - ➢ $\log^* n$ vs. $\alpha(n)$ (pseudo-linear)

Topics

- Lecture 14 –Barouvka's implementation
  - ➢Implementation and runtimes
- Lecture 15 – More about MSTs
  - ➢Proofs with Cycle Property
  - ➢Proofs with Cut Property
- Lecture 16 – Midterm Review

Topics

- Lecture 17 – Shortest Paths Dijkstra
  - ➢Single-source shortest paths
  - ➢Runtime and correctness
  - ➢Implementation details
    - Indexed min-PQ

- Lecture 18 – Shortest Paths Bellman-Ford
  - ➢Algorithm implementation and runtime
  - ➢Correctness
  - ➢Simple dynamic program

Topics

- Lecture 19 – All-Pairs Shortest Paths
  - Floyd-Warshall dynamic approach
  - Run through of algorithm

- Lecture 20 – Network Flow
  - s,t-flow, source, sink, flow value
  - Maxlow, mincut problems
  - Augmenting paths, residual graph
  - Ford-Fulkerson, Edmonds-Karp
  - Baseball elimination

Topics

- Lecture 21 – Longest Common Subsequence
  - Dynamic program example
  - Determining length and sequence

- Lecture 22 – Pattern Matching
  - Brute-force, backing up in text string
  - Knuth-Morris-Pratt
    - DFA simulation
  - Boyer-Moore
  - Rabin-Karp

Topics

- Lecture 23 – Planar Graphs
  - Complete, bipartite and complete bipartite graphs
  - Planar graphs, Kuratowski's theorem
  - Euler's theorem and corollaries
- Lecture 24 – Final Review
  - Office hours next week
  - Course evaluation: ces.uvic.ca
  - Thanks for the term!