Sumary of COSC229 - Algorithms

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The topics covered are given in the following with time complexities.

1. Data structures
1.1 Binary search trees --- O(n log n) average for n insertions
1.2 AVL trees --- O(n log n) worst case for n insertions
1.3 Splay trees --- O(n log n) worst case for n insertions
1.4 2-3 trees --- O(n log n) worst case for n insertions
1.5 Heaps --- O(n) for n insertions and O(log n) for delete-min
1.6 Binomial queues --- O(log n) for delete-min and O(log n) for meld

2. Sorting
2.1 Bubble sort --- $O(n^2)$
2.2 Minimum selection sort --- $O(n^2)$
2.3 Insertion sort --- $O(n^2)$
2.3 Heap sort --- O(n log n) worst case
2.4 Quick sort --- O(n log n) average
2.5 Merge sort --- O(n log n) worst case
2.6 Radix sort --- O(dn) where d is number of digits

3. Graph algorithms
3.1 Basic definitions
3.2 Depth-first search --- O(m + n)
3.2 Breadth-first search --- O(m + n)
3.3 Tarjan's algorithm for strongly connected components -- O(m+n)
3.4 Dijkstra's algorithm for the single source shortest path problem -- $O(n^2)$
with heap -- O(m log n)
3.5 Warshall's algorithm for reflexive-transitive closure --- $O(n^3)$
3.6 Floyd's algorithm for the all pairs shortest path problem --- $O(n^3)$
3.7 Kruskal's algorithm for the minimum cost spanning tree --- O(m log n)
3.8 Prim's algorithm for the same problem --- O(m log n)

4. Pattern matching
4.1 Naive algorithm --- O(m n)
4.2 KMP algorithm --- O(m + n)
4.3 Boyer-Moore algorithm --- O(n/m) average
4.4 Bird's algorithm for two-dimensional pattern matching --- $O(m^2+ n^2)$

5. Computational geometry
5.1 Intersection of line segments --- O(1)
5.2 Interior point in a polygon --- O(n)
5.3 Naive algorithm for convex hull --- $O(n^2)$
5.4 Graham's algorithm for convex hull --- O(n log n)
4.5 Lee's algorithm for Voronoi diagram --- O(n log n)

6. Semi-numerical algorithms

6.1 Basics form number theory

6.2 Horner's algorithm for polynomial evaluation --- O(n)

6.3 Repeated squaring for exponentiation --- O(m) where exponent is m bit number

6.4 Theory of Fibonacci numbers --- O(log n) for the n-th Fibonacci number

6.5 Euclidean algorithm for greatest common divisors --- O(kD(k)) where a and b are k bit numbers and D(k) is the time for division

6.6 Euclidean algorithm for multiplicative inverses

6.7 Analysis of Euclidean algorithm

6.8 Discrete Fourier transform --- $O(n^2)$ by naive method and O(n log n) by FFT

6.9 Convolution --- $O(n^2)$ by naive method and O(n log n) by FFT

6.10 Haw to multiply polynomials fast --- (n^2) by naive method and O(n log n) by FFT

6.11 How to multiply multiple precision numbers fast --- $O(n^2)$ by naive method and O(n log n) by FFT