CheatSheet INF102

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Contents

1 Sorting Algorithms

1.1 Selection sort

Time Complexity = $O(n^2)$
Sorts an array by repeatedly selecting the smallest or largest element from the unsorted portion and swapping it with the first unsorted element. Continues until list is sorted. Two pointers one at the first in the unsorted protion and one iterating through list to find the next smallest or largets element.

1.2 Insertion sort

Time Complexity = $O(n^2)$
Simple sorting algorithm that works by iteratively inserting each element of an unsorted list into its correct position in a sorted portion of the list. The same algorithm you use when sorting playing cards. You pick a card and insert it into the correct relative position. When you find a pair that is unorder, swap them and continue swapping the unsorted elements through the sorted part of the array until it is in the right space.

1.3 Bubble sort

Time Complexity = $O(n^2)$
Works by repeatedly swapping the adjacent elements if they are in the wrong order. Each pass lokking ofr two elements that are in the wrong order. Continues this process until it has a pass with know swaps.

1.4 Quick sort

Worst Case = $O(n^2)$ Occures with poor pivot.
Average Case = $\theta(nlog(n))$
Based on divide and conquer. Quick sort chooses a random pivot P, and swaps P with the last element. Two pointer, left bound and right bound points to index 0 and n - 1. Left bound moves to the right until it hits an element $\geq P$ or crosses the right bound. Right bound does the samle until i finds an element $\leq P$. Swap elements that right and left bound points to. Continue this process until either they crosses, this indicates that all elements smaler than P is on the left and larger are one the right. The last element right or left bound points to swap places with pivot. Since pivot was left at the end in first step. Repeat this with left and right sub-list.

1.5 Merge sort

Average Case = $(nlog(n))$
Divide the list into two smaller sublists, continues on dividing until list has size 1. Merges each of the smaller lists in correct order until everything is sorted.

1.6 Bucket sort

Average Case = $(nlog(n))$
Works if you have repeated elements in a list. Adds elements into different groups based on size. Sort each bucket on it own afterwards.

1.7 Radix sort

Rather than comparing elements directly, Radix Sort distributes the elements into buckets based on each digit's value. By repeatedly sorting the elements by their significant digits, from the least significant to the most significant.

2 ArrayList vs. LinkedList

Operation	**ArrayList**	**LinkedList**
size()	O(1)	O(1)
add()	O(n)*	O(1)
contains(obj)	O(n)	O(n)
remove(obj)	O(n)	O(n)
toArray()	O(n)	O(n)
indexOf(obj)	O(n)	O(n)
get(int i)	O(1)	O(n)
set(int i, E e)	O(1)	O(n)
addFirst()	O(n)	O(1)

- *O(1) in amortized time (when resizing is not needed)

3 ArrayList vs. LinkedList (Queue/Stack)

	ArrayList		**LinkedList**	
	Queue	**Stack**	**Queue**	**Stack**
offer / push	O(n)	O(n)*	O(1)	O(1)
poll / pop	O(1)	O(1)	O(1)	O(1)
peek	O(1)	O(1)	O(1)	O(1)

- *O(1) in amortized time (when resizing is not needed)

4 PriorityQueue

4.1 PriorityQueue

Operation	**Time Complexity**
add()	O(log(n))
remove(Head)	O(log(n))
remove(Specific object)	O(n)
poll()	O(log(n))
peek()	O(1)
size()	O(1)

4.2 PriorityQueue - SortedList

Operation	**Time Complexity**
add(T element)	O(n)
T findMin()	O(1)
T removeMin()	O(1)

4.3 PriorityQueue - LinkedList

Operation	**Time Complexity**
add(T element)	O(1)
T findMin()	O(n)
T removeMin()	O(n)

5 HashSet vs. TreeSet

Operation	**HashSet**	**TreeSet**
add()	O(1)*	O(log(n))
remove()	O(1)*	O(log(n))
contains(obj)	O(1)*	O(log(n))
findMin	O(n)	O(log(n))
findMax	O(n)	O(log(n))

- *HashSet har O(1) i snitt, men O(n) i worst case

6 Heap

In a heap, the parent of a node k has the position $k/2$, and the two children in position $2k$ and $2k+1$. A binary heap is a set of nodes with keys arranged in a complete heap-ordered binary tree, represented in level order in an array (not using the first entry). We can travers the heap with simple arithmerics, to move up set k in the $array[k]$, to $k/2$. Or $2k+1$ and $2k$ to move down the binary tree.

Operation	**Time Complexity**
add(T element)	O(log(n))
T peekMin()	O(1)
T removeMin()	O(log(n))
Construct heap	O(n)
delete()	O(log(n))

7 Graph Datastructures

7.1 EdgeList

Metode	**Kjøretid**
Adjacent	O(M)*
Vertices	O(M)
Edges	O(N)
Neighbours	O(M)*
AddVertex	O(1)*
AddEdge	O(1)*

7.2 Adjacency Set

Metode	**Kjøretid**
Adjacent	O(1)*
Vertices	O(1)
Edges	O(M)
Neighbours	O(1)*
AddVertex	O(1)*
AddEdge	O(1)*

7.3 Adjacency List

Method	**Runtime**
Adjacent	O(degree)
Vertices	O(1)
Edges	O(M)
Neighbours	O(1)*
addVertex	O(N)
addEdge	O(degree)

7.4 Adjacency Matrix

Method	**Runtime**
Adjacent	$O(1)$
Vertices	$O(1)$
Edges	$O(N^2)$
Neighbours	$O(N)$
addVertex	$O(N^2)$ or $O(N)$
addEdge	$O(1)$

8 Summary of Graph Algorithms

Algorithm	**Graph Type**	**Time Complexity**
BFS	Unweighted	$O(m+n)$
DFS	Unweighted	$O(m+n)$
Dijkstra	Positive weights	$O(m \log m)$
Bellman-Ford	Negative weights, no negative cycle	$O(n \cdot m)$
Brute-Force	Negative weights	$2^{O(n)}$
A^*	Weighted	$mlog(n)$
Kruskal's	Weighted	$O(m \log n)$
Prim's	Weighted	$O(m \log n)$
Union-Find		$O(m \log n)^*$

Table 1: Summary of Graph Algorithms

9 Comparable and Comparator

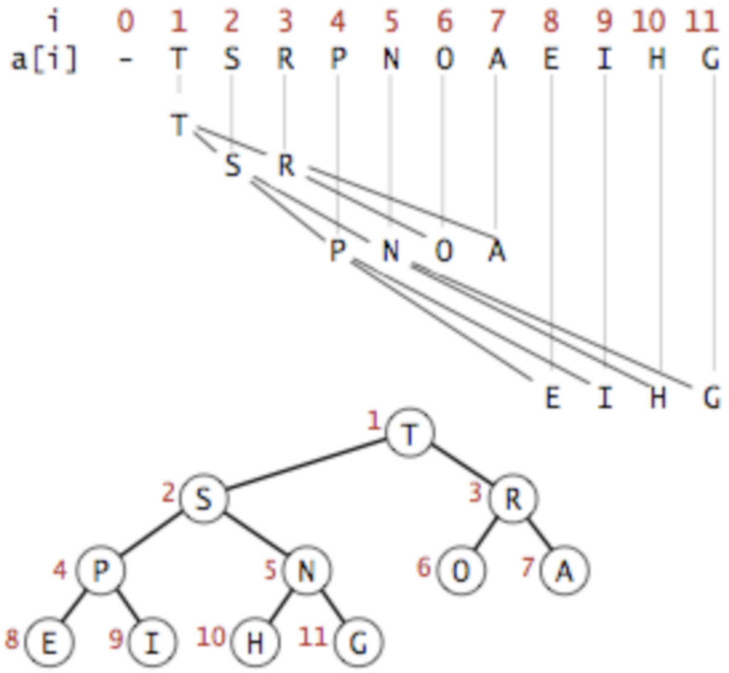
Comparable: A comparable object is capable of comparing itself with another object.
Comparator: A comparator object is capable of comparing two different objects. The class is not comparing its instances, but some other class's instances.

```
  class Pair implements Comparable<Pair> {
    String x;
    int y;
    public Pair(String x, int y)
    {
        this.x = x;
        this.y = y;
    }
    public String toString()
    {
        return "(" + x + "," + y + ")";
    }
    @Override public int compareTo(Pair a)
    {
        // if the string are not equal
        if (this.x.compareTo(a.x) != 0) {
            return this.x.compareTo(a.x);
        }
        else {
            // we compare int values
            // if the strings are equal
            return this.y - a.y;
        }
    }

  class Student {
    // Attributes of a student
    int rollno;
    String name, address;
    // Constructor
    public Student(int rollno, String name, String address)
    {
        // This keyword refers to current instance itself
        this.rollno = rollno;
        this.name = name;
        this.address = address;
    }
    // Method of Student class
    // To print student details in main()
    public String toString()
    {
        // Returning attributes of Student
        return this.rollno + "-" + this.name + "-"
            + this.address;
    }
}
```

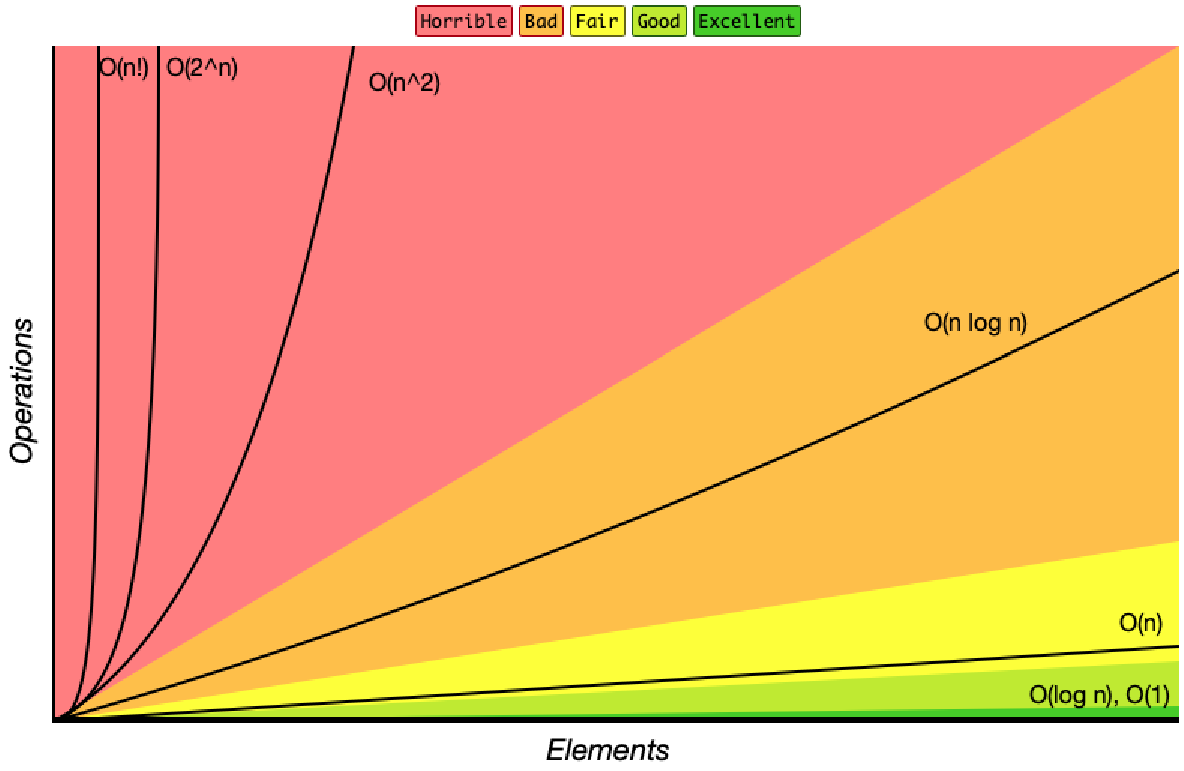
```
// Class 2
// Helper class implementing Comparator interface
class Sortbyroll implements Comparator<Student> {
    // Method
    // Sorting in ascending order of roll number
    public int compare(Student a, Student b)
    {
        return a.rollno - b.rollno;
    }
}
```

10 Images

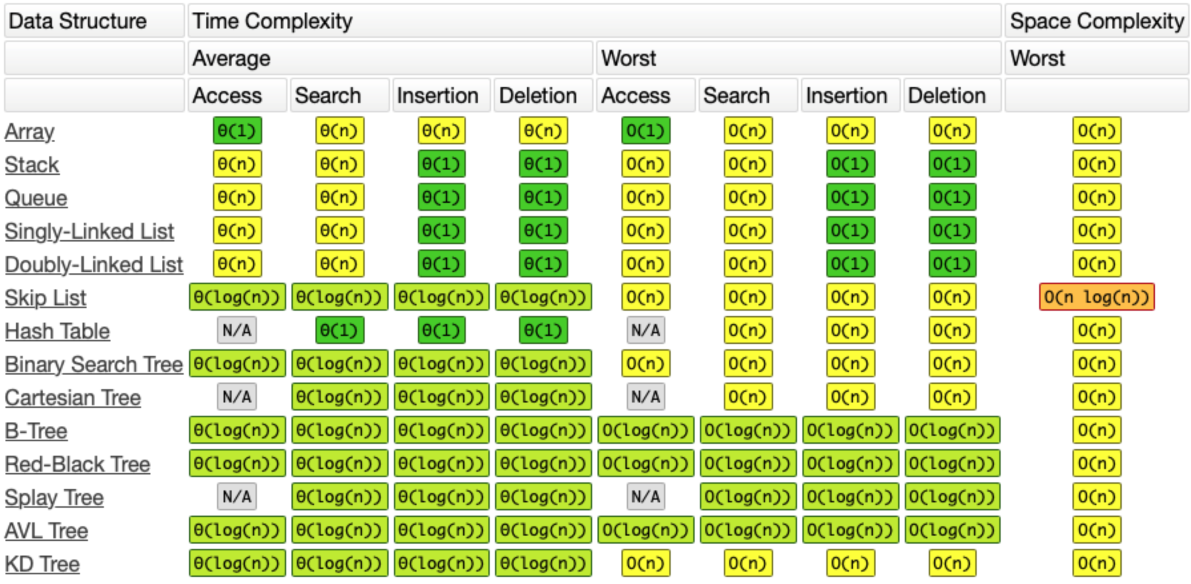


Heap representations

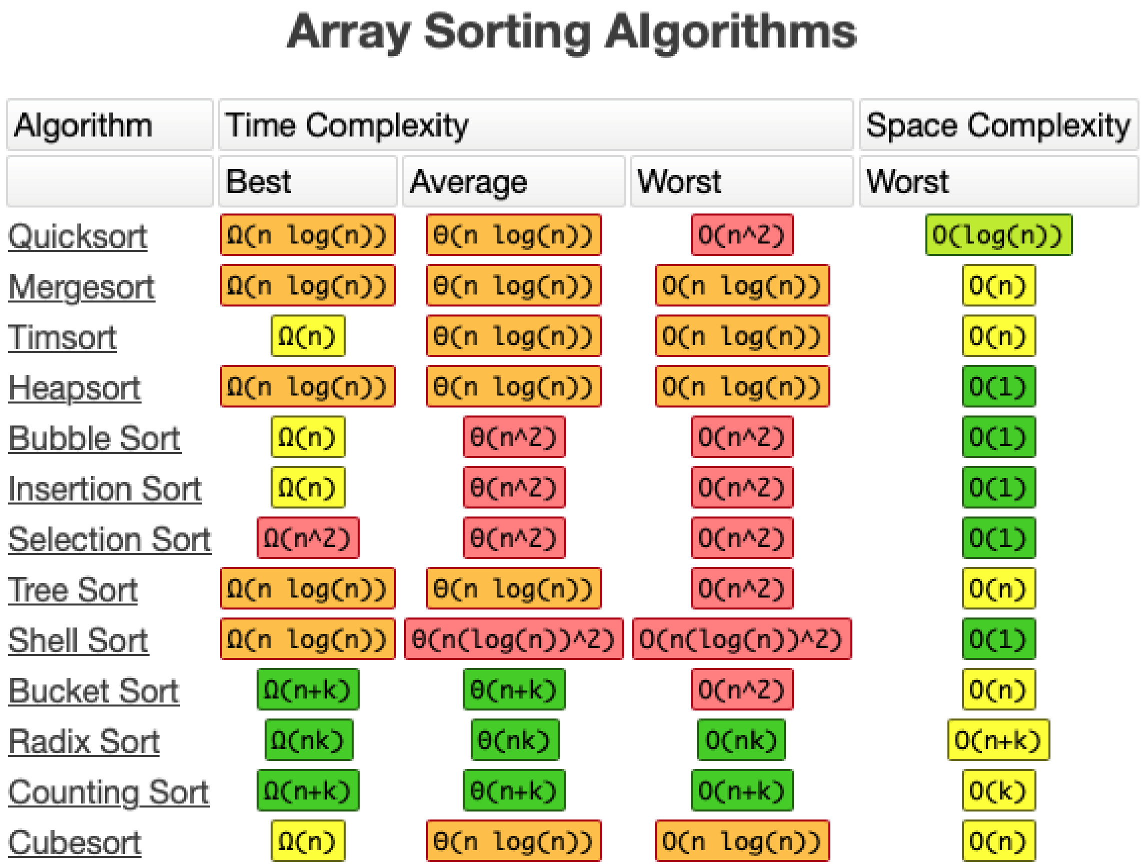
Big-O Complexity Chart



Common Data Structure Operations



Data Structure	Time Complexity								Space Complexity
	Average				Worst				Worst
	Access	Search	Insertion	Deletion	Access	Search	Insertion	Deletion	
Array	Θ(1)	Θ(n)	Θ(n)	Θ(n)	O(1)	O(n)	O(n)	O(n)	O(n)
Stack	Θ(n)	Θ(n)	Θ(1)	Θ(1)	O(n)	O(n)	O(1)	O(1)	O(n)
Queue	Θ(n)	Θ(n)	Θ(1)	Θ(1)	O(n)	O(n)	O(1)	O(1)	O(n)
Singly-Linked List	Θ(n)	Θ(n)	Θ(1)	Θ(1)	O(n)	O(n)	O(1)	O(1)	O(n)
Doubly-Linked List	Θ(n)	Θ(n)	Θ(1)	Θ(1)	O(n)	O(n)	O(1)	O(1)	O(n)
Skip List	Θ(log(n))	Θ(log(n))	Θ(log(n))	Θ(log(n))	O(n)	O(n)	O(n)	O(n)	O(n log(n))
Hash Table	N/A	Θ(1)	Θ(1)	Θ(1)	N/A	O(n)	O(n)	O(n)	O(n)
Binary Search Tree	Θ(log(n))	Θ(log(n))	Θ(log(n))	Θ(log(n))	O(n)	O(n)	O(n)	O(n)	O(n)
Cartesian Tree	N/A	Θ(log(n))	Θ(log(n))	Θ(log(n))	N/A	O(n)	O(n)	O(n)	O(n)
B-Tree	Θ(log(n))	Θ(log(n))	Θ(log(n))	Θ(log(n))	O(log(n))	O(log(n))	O(log(n))	O(log(n))	O(n)
Red-Black Tree	Θ(log(n))	Θ(log(n))	Θ(log(n))	Θ(log(n))	O(log(n))	O(log(n))	O(log(n))	O(log(n))	O(n)
Splay Tree	N/A	Θ(log(n))	Θ(log(n))	Θ(log(n))	N/A	O(log(n))	O(log(n))	O(log(n))	O(n)
AVL Tree	Θ(log(n))	Θ(log(n))	Θ(log(n))	Θ(log(n))	O(log(n))	O(log(n))	O(log(n))	O(log(n))	O(n)
KD Tree	Θ(log(n))	Θ(log(n))	Θ(log(n))	Θ(log(n))	O(n)	O(n)	O(n)	O(n)	O(n)



Array Sorting Algorithms

Algorithm	Time Complexity			Space Complexity
	Best	Average	Worst	Worst
Quicksort	Ω(n log(n))	Θ(n log(n))	O(n^2)	O(log(n))
Mergesort	Ω(n log(n))	Θ(n log(n))	O(n log(n))	O(n)
Timsort	Ω(n)	Θ(n log(n))	O(n log(n))	O(n)
Heapsort	Ω(n log(n))	Θ(n log(n))	O(n log(n))	O(1)
Bubble Sort	Ω(n)	Θ(n^2)	O(n^2)	O(1)
Insertion Sort	Ω(n)	Θ(n^2)	O(n^2)	O(1)
Selection Sort	Ω(n^2)	Θ(n^2)	O(n^2)	O(1)
Tree Sort	Ω(n log(n))	Θ(n log(n))	O(n^2)	O(n)
Shell Sort	Ω(n log(n))	Θ(n(log(n))^2)	O(n(log(n))^2)	O(1)
Bucket Sort	Ω(n+k)	Θ(n+k)	O(n^2)	O(n)
Radix Sort	Ω(nk)	Θ(nk)	O(nk)	O(n+k)
Counting Sort	Ω(n+k)	Θ(n+k)	O(n+k)	O(k)
Cubesort	Ω(n)	Θ(n log(n))	O(n log(n))	O(n)