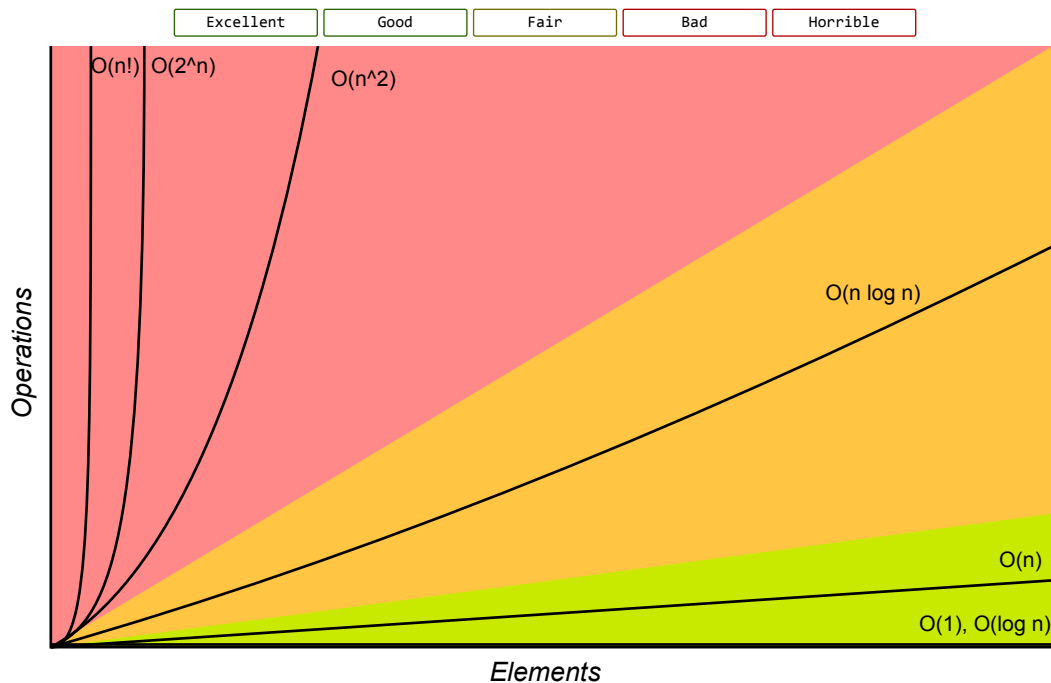


Know Thy Complexities!

Hi there! This webpage covers the space and time Big-O complexities of common algorithms used in Computer Science. When preparing for technical interviews in the past, I found myself spending hours crawling the internet putting together the best, average, and worst case complexities for search and sorting algorithms so that I wouldn't be stumped when asked about them. Over the last few years, I've interviewed at several Silicon Valley startups, and also some bigger companies, like Google, Facebook, Yahoo, LinkedIn, and eBay, and each time that I prepared for an interview, I thought to myself "Why hasn't someone created a nice Big-O cheat sheet?". So, to save all of you fine folks a ton of time, I went ahead and created one. Enjoy! - [Eric](#)

If you're trying to catch them all, you might also check out the [Pokemon Go Evolution Chart](#).

Big-O Complexity Chart



Common Data Structure Operations

Data Structure	Time Complexity								Space Compl
	Average				Worst				Worst
	Access	Search	Insertion	Deletion	Access	Search	Insertion	Deletion	
Array	O(1)	O(n)	O(n)	O(n)	O(1)	O(n)	O(n)	O(n)	0
Stack	O(n)	O(n)	O(1)	O(1)	O(n)	O(n)	O(1)	O(1)	0
Queue	O(n)	O(n)	O(1)	O(1)	O(n)	O(n)	O(1)	O(1)	0
Singly Linked List	O(n)	O(n)	O(n)	O(n)	O(n)	O(n)	O(n)	O(n)	O(n)

<u>Singly-Linked List</u>	$O(n)$	$O(n)$	$O(1)$	$O(1)$	$O(n)$	$O(n)$	$O(1)$	$O(1)$	$O(n)$
<u>Doubly-Linked List</u>	$O(n)$	$O(n)$	$O(1)$	$O(1)$	$O(n)$	$O(n)$	$O(1)$	$O(1)$	$O(n)$
<u>Skip List</u>	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(n)$	$O(n)$	$O(n)$	$O(n)$	$O(n)$
<u>Hash Table</u>	N/A	$O(1)$	$O(1)$	$O(1)$	N/A	$O(n)$	$O(n)$	$O(n)$	$O(n)$
<u>Binary Search Tree</u>	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(n)$	$O(n)$	$O(n)$	$O(n)$	$O(n)$
<u>Cartesian Tree</u>	N/A	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	N/A	$O(n)$	$O(n)$	$O(n)$	$O(n)$
<u>B-Tree</u>	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(n)$
<u>Red-Black Tree</u>	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(n)$
<u>Splay Tree</u>	N/A	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	N/A	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(n)$
<u>AVL Tree</u>	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(n)$
<u>KD Tree</u>	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(n)$	$O(n)$	$O(n)$	$O(n)$	$O(n)$

Array Sorting Algorithms

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

Graph Data Structure Operations

Data Structure	Time Complexity					
	Storage	Add Vertex	Add Edge	Remove Vertex	Remove Edge	Query
<u>Adjacency list</u>	$O(V + E)$	$O(1)$	$O(1)$	$O(V + E)$	$O(E)$	$O(V)$
<u>Incidence list</u>	$O(V + E)$	$O(1)$	$O(1)$	$O(E)$	$O(E)$	$O(E)$
<u>Adjacency matrix</u>	$O(V ^2)$	$O(V ^2)$	$O(1)$	$O(V ^2)$	$O(1)$	$O(1)$
<u>Incidence matrix</u>	$O(V \cdot E)$	$O(V \cdot E)$	$O(V \cdot E)$	$O(V \cdot E)$	$O(V \cdot E)$	$O(E)$

Heap Data Structure Operations

Data Structure	Time Complexity					
	Find Max	Extract Max	Increase Key	Insert	Delete	Merge
<u>Binary Heap</u>	$O(1)$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(\log(n))$	$O(m+n)$
<u>Pairing Heap</u>	$O(1)$	$O(\log(n))$	$O(\log(n))$	$O(1)$	$O(\log(n))$	$O(1)$
<u>Binomial Heap</u>	$O(1)$	$O(\log(n))$	$O(\log(n))$	$O(1)$	$O(\log(n))$	$O(\log(n))$
<u>Fibonacci Heap</u>	$O(1)$	$O(\log(n))$	$O(1)$	$O(1)$	$O(\log(n))$	$O(1)$

Graph Algorithms

Algorithm	Time Complexity		Space Complexity
	Average	Worst	Worst
<u>Dijkstra's algorithm</u>	$O(E \log V)$	$O(V ^2)$	$O(V + E)$
<u>A* search algorithm</u>	$O(E)$	$O(b^d)$	$O(b^d)$
<u>Prim's algorithm</u>	$O(E \log V)$	$O(V ^2)$	$O(V + E)$
<u>Bellman-Ford algorithm</u>	$O(E \cdot V)$	$O(E \cdot V)$	$O(V)$
<u>Floyd-Warshall algorithm</u>	$O(V ^3)$	$O(V ^3)$	$O(V ^2)$