Algorithmic & Python Programming

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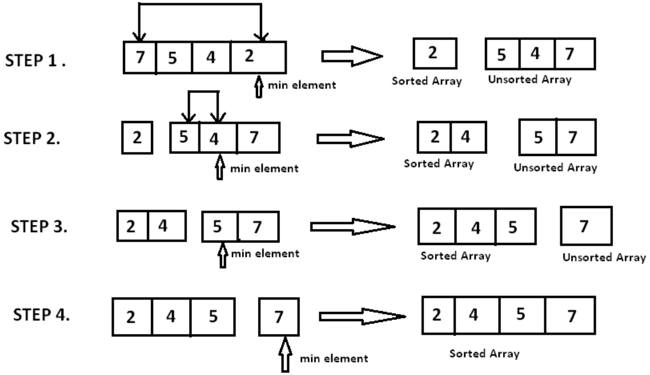
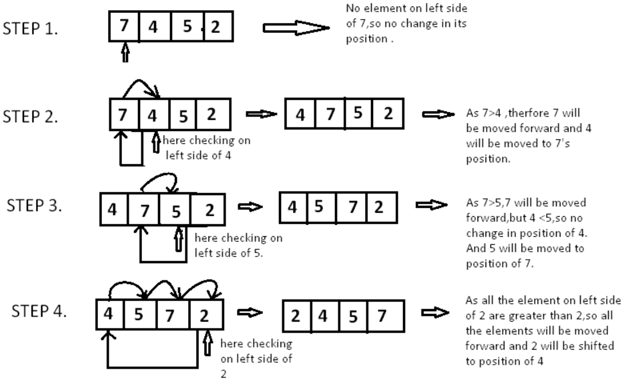
The Selection sort algorithm is based on the idea of finding the minimum or maximum element in an unsorted array and then putting it in its correct position in a sorted array.
Example:



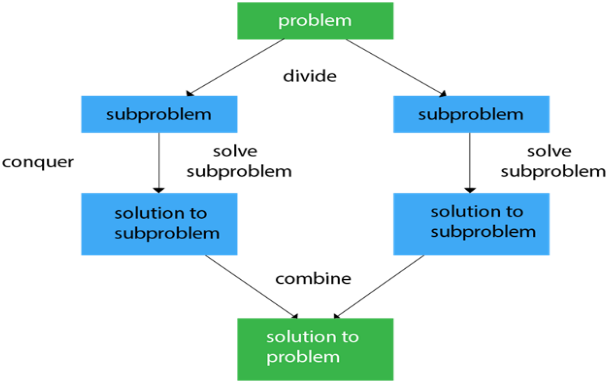
Insertion sort is based on the idea that one element from the input elements is consumed in each iteration to find its correct position i.e, the position to which it belongs in a sorted array.
Example:



Divide and Conquer Introduction

Divide and Conquer algorithm consists of a dispute using the following three steps.

- Divide the original problem into a set of subproblems.
- Conquer: Solve every subproblem individually, recursively.
- Combine: Put together the solutions of the subproblems to get the solution to the whole problem.



Merge sort is a divide-and-conquer algorithm based on the idea of breaking down a list into several sub-lists until each sublist consists of a single element and merging those sublists in a manner that results into a sorted list.

Idea:

- Divide the unsorted list into N sublists, each containing 1 element.
- Take adjacent pairs of two singleton lists and merge them to form a list of 2 elements. N will now convert into $\frac{N}{2}$ lists of size 2.
- Repeat the process till a single sorted list of obtained.

Example:

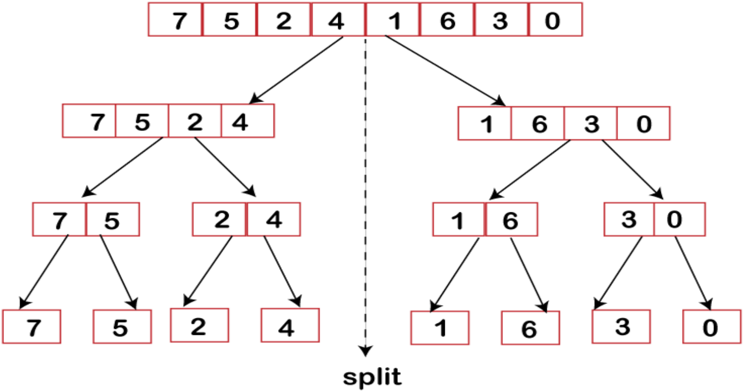


Figure 1: Merge Sort Divide Phase

Example:

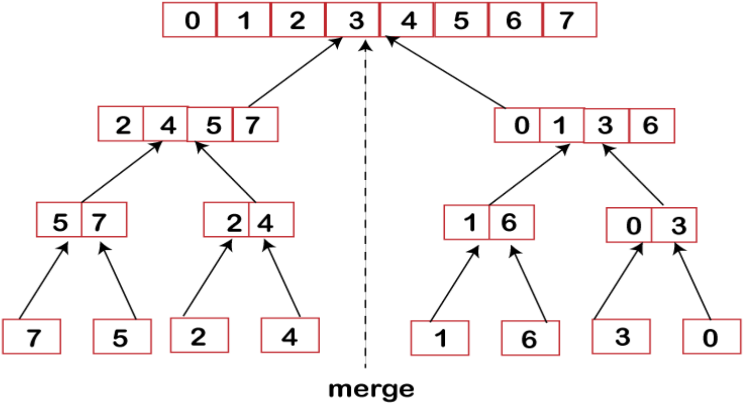


Figure 2: Merge Sort Combine Phase

Quick sort is based on the divide-and-conquer approach based on the idea of choosing one element as a pivot element and partitioning the array around it such that: Left side of pivot contains all the elements that are less than the pivot element Right side contains all elements greater than the pivot

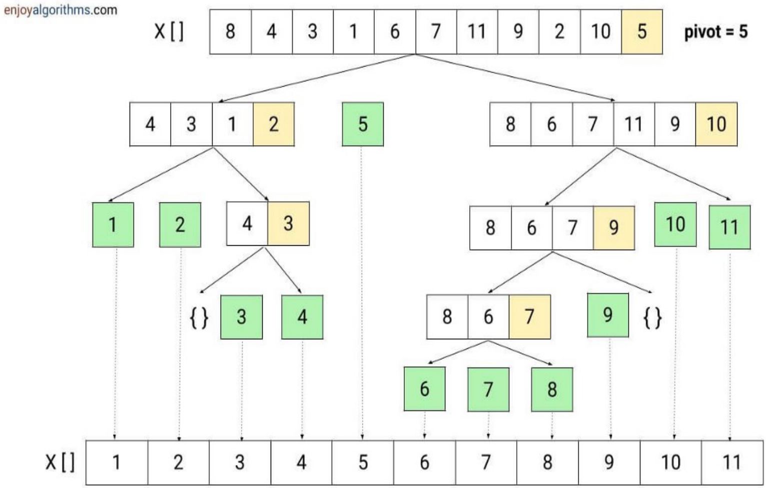
There are many different versions of quickSort that pick pivot in different ways.

- Always pick the first element as a pivot.
- Always pick the last element as a pivot.
- Pick a random element as a pivot.
- Pick median as the pivot.

Sorting Algorithms

Quick sort Algorithm

Example:



Sorting Algorithms

Name	Best	Average	Worst	Memory	Stable	Method	Other notes
Tree sort	$n \log n$	$n \log n$	$n \log n$ (balanced)	n	Yes	Insertion	When using a self-balancing binary search tree.
Tournament sort	$n \log n$	$n \log n$	$n \log n$	n[11]	No	Selection	Variation of Heapsort.
Introsort	$n \log n$	$n \log n$	$n \log n$	$\log n$	No	Partitioning & Selection	Used in several STL implementations.
Bubble sort	n	n^2	n^2	1	Yes	Exchanging	Tiny code size.
Exchange sort	n^2	n^2	n^2	1	No	Exchanging	Tiny code size.
Gnome sort	n	n^2	n^2	1	Yes	Exchanging	Tiny code size.
Selection sort	n^2	n^2	n^2	1	No	Selection	Stable with $O(n)$ extra space, when using linked lists, or when made as a variant of Insertion Sort instead of swapping the two items.[10]
Shellsort	$n \log n$	$n^{4/3}$	$n^{3/2}$	1	No	Insertion	Small code size.
Library sort	$n \log n$	$n \log n$	n^2	n	No	Insertion	Similar to a gapped insertion sort. It requires randomly permuting the input to warrant with-high-probability time bounds, which makes it not stable.
Quicksort	$n \log n$	$n \log n$	n^2	$\log n$	No	Partitioning	Quicksort is usually done in-place with $O(\log n)$ stack space.[5][6]
Insertion sort	n	n^2	n^2	1	Yes	Insertion	$O(n+d)$, in the worst case over sequences that have *d* inversions.
Timsort	n	$n \log n$	$n \log n$	n	Yes	Insertion & Merging	Makes *n-1* comparisons when the data is already sorted or reverse sorted.
Cubesort	n	$n \log n$	$n \log n$	n	Yes	Insertion	Makes *n-1* comparisons when the data is already sorted or reverse sorted.
Cycle sort	n^2	n^2	n^2	1	No	Selection	In-place with theoretically optimal number of writes.
Merge sort	$n \log n$	$n \log n$	$n \log n$	n	Yes	Merging	Highly parallelizable (up to $O(\log n)$ using the Three Hungarians' Algorithm).[7]
Patience sorting	n	$n \log n$	$n \log n$	n	No	Insertion & Selection	Finds all the longest increasing subsequences in $O(n \log n)$.
Comb sort	$n \log n$	n^2	n^2	1	No	Exchanging	Faster than bubble sort on average.
Block sort	n	$n \log n$	$n \log n$	1	Yes	Insertion & Merging	Combine a block-based $O(n)$ in-place merge algorithm[9] with a bottom-up merge sort.
Odd-even sort	n	n^2	n^2	1	Yes	Exchanging	Can be run on parallel processors easily.
In-place merge sort	—	—	$n \log^2 n$	1	Yes	Merging	Can be implemented as a stable sort based on stable in-place merging.[8]
Smoothsort	n	$n \log n$	$n \log n$	1	No	Selection	An adaptive variant of heapsort based upon the Leonardo sequence rather than a traditional binary heap.
Cocktail shaker sort	n	n^2	n^2	1	Yes	Exchanging	A variant of Bubblesort which deals well with small values at end of list
Heapsort	$n \log n$	$n \log n$	$n \log n$	1	No	Selection	
Strand sort	n	n^2	n^2	n	Yes	Selection	