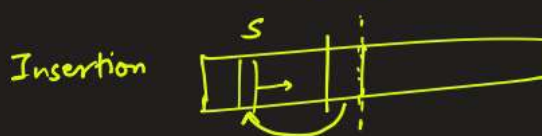
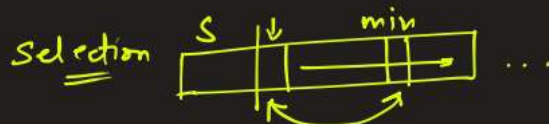


Arrays Lecture 5

Thursday, 18 July 2024 6:06 AM

Insertion Sort

works iteratively inserting each element of an unsorted list into its correct position in a sorted portion of the list.



Insertion-Sort (A, n) {

```
for (j: 2 → n) {
```

key $\leftarrow A[j]$

for (i: j-1 → 1 && A[i] > key) {

$$A[i+1] \leftarrow A[i]$$
$$i^0 = i^{-1}$$

3

$$A[i+1] \leftarrow \text{key}$$

3

3

Time :-

Worst:- $O(n^2)$

Best:- $O(n)$

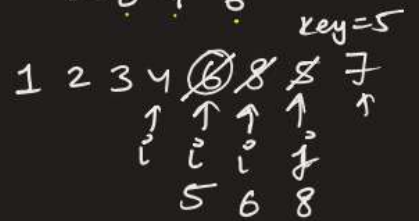
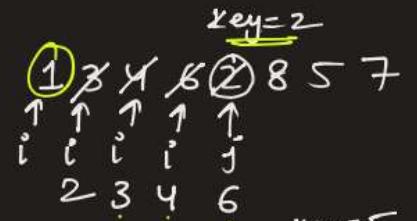
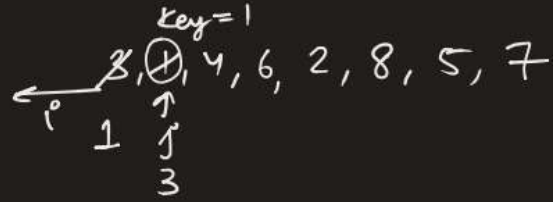
Average:- $O(n^2)$

In-place / out-of-place :-

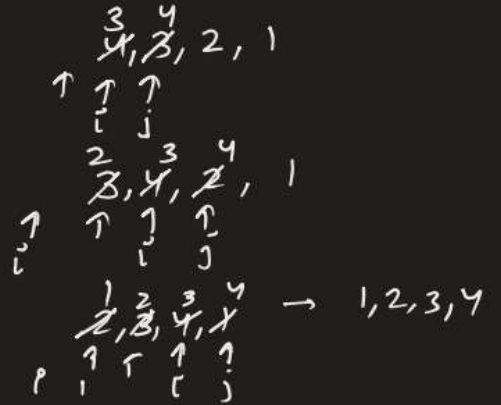
In place

Extra
 $S = O(1)$

Stable/ Unstable:- Stable



↳ 1, 2, 3, 4, 5, 6, 7, 8



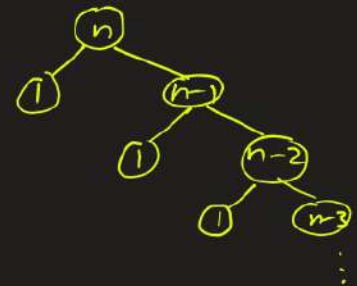
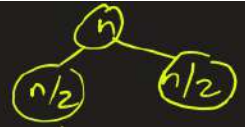
Bubble, Selection, Insertion

↓
one part of the array sorted

$$T(n) = T(n-1) + O(n)$$

[Subtract & Conquer] ↗

{ merge,
quick



Merge Sort

Worst :- $O(n \log n)$
Best :- $O(n \log n)$
Avg :- $O(n \log n)$



$O(n)$ -

$$T(n) = 2T(n/2) + O(n) \rightarrow O(n \log n)$$



Inplace / out-of-place :-

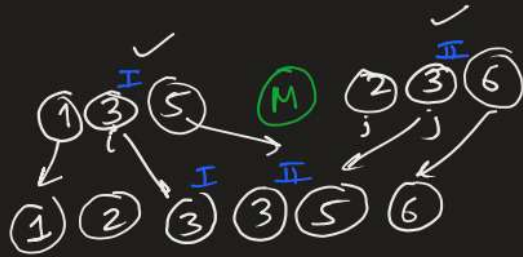
Out-of-place

Extra
space :-

$O(n)$

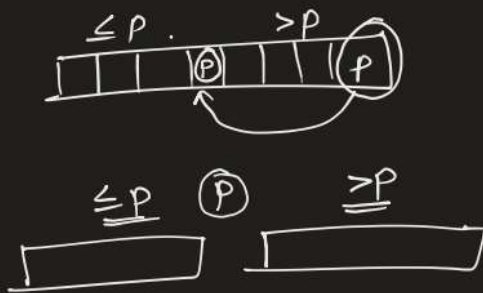
Stable / Unstable :-

Stable



we can guarantee stability while merging

Quick sort



Time:-

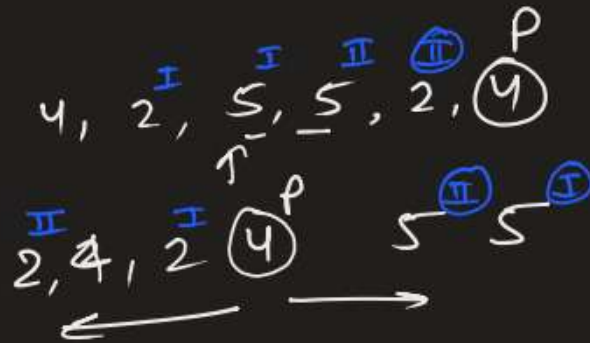
Best :- $O(n \log n)$
Average
Worst :- $O(n^2)$

Inplace/ outplace:- Inplace

Extra Space :- $O(1)$

stable/ unstable :- Unstable

Stack



Heap Sort

Best, Worst, Average $\rightarrow O(n \log n)$

Inplace Algorithm Unstable

=x=

The worst-case running times of Insertion sort, Merge sort, and Quicksort, respectively, are:
[GATE CSE 2016 Set 1]

1. $\Theta(n \log n)$, $\Theta(n \log n)$, and $\Theta(n^2)$.
2. $\Theta(n^2)$, $\Theta(n^2)$, and $\Theta(n \log n)$.
3. $\Theta(n^2)$, $\Theta(n \log n)$, and $\Theta(n \log n)$.
- ✓ 4. $\Theta(n^2)$, $\Theta(n \log n)$, and $\Theta(n^2)$.



Q

An unordered list contains n distinct elements. The number of comparisons to find an element in this list that is neither maximum nor minimum is
[GATE CSE 2015 Set 2]

1. $\Theta(n \log n)$
2. $\Theta(n)$
3. $\Theta(\log n)$
- ✓ 4. $\Theta(1)$

② → max & min $O(n)$

any 3 elements



3, 2, 1



cannot be max/min

What is the number of swaps required to sort n elements using selection sort in the worst case?
[GATE CSE 2009]

- ✓ 1. $\Theta(n)$
2. $\Theta(n \log n)$
3. $\Theta(n^2)$
4. $\Theta(n^2 \log n)$

Complexity:- $O(n^2)$

Comparisons:- $O(n^2)$

Swaps:- $O(n)$

Which of the following sorting algorithms has the lowest worst-case complexity?

[GATE CSE 2007]

- ✓ 1. Merge sort $\rightarrow \underline{n \log n}$
- 2. Bubble Sort $\rightarrow n^2$
- 3. Quick Sort $\rightarrow n^2$
- 4. Selection Sort $\rightarrow n^2$

Which one of the following in place sorting algorithms needs the minimum number of swaps?

[GATE CSE 2006]

- 1. Insertion Sort $\rightarrow n^2$ swaps
- 2. Quick Sort $\rightarrow n \log n$ swaps
- 3. Heap Sort $\rightarrow n \log n$ swaps
- ✓ 4. Selection Sort $\rightarrow \underline{n}$ swaps



Bubble Sort $\rightarrow n^2$ swaps

Merge Sort $\rightarrow \underline{\underline{\text{No swapping}}}$ (Extra space)