

Insertion Sort

CS32

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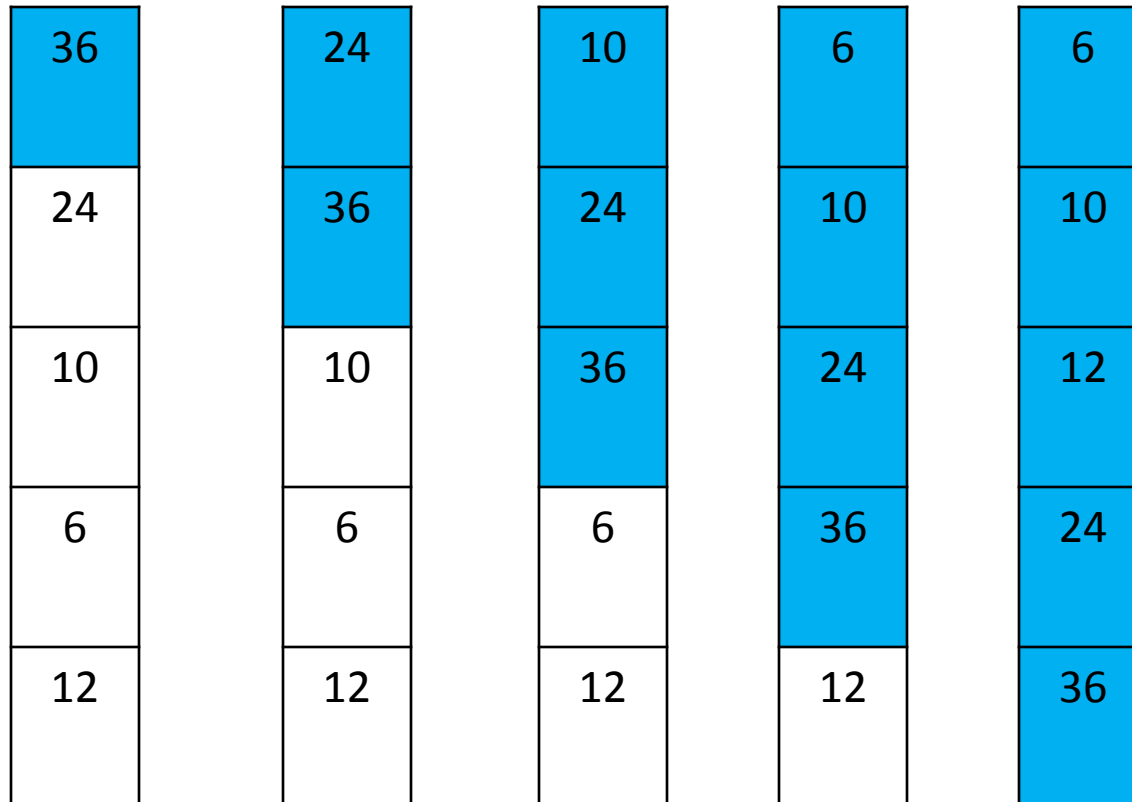
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General Idea

- Each successive element in the array to be sorted is inserted to its proper place with respect to the other, already-sorted elements.
- Initially, the sorted portion contains only one element in the array: the first element in the array
- Take the second element in the array and put it into its correct place in the sorted part.
- This process continues until all the elements have been sorted

Example



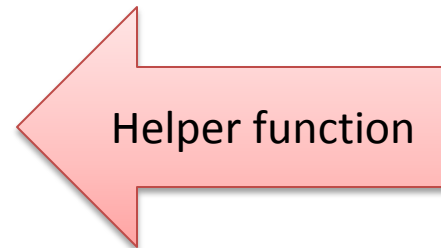
Pseudo Code

InsertSort

```
for count from 0~ arraysize-1
    InsertItem(array,0 count);
```

InsertItem(array,startIndex,endIndex)

```
Finished=false;
Current=endIndex
moreToSearch= current!=startIndex
While(moreToSearch && !finished)
    if(values[current]< values[current-1])
        swap(values[current],values[current-1])
        current=current-1;
        moreToSearch = current!=startIndex;
    else
        finished=true;
```



Example

Pass1	3	7	4	9	5	2
Pass2	3	7	4	9	5	2
Pass3	3	7	4	9	5	2
Pass4	3	4	7	9	5	2
Pass5	3	4	7	9	5	2
Pass6	3	4	5	7	9	2
Pass7	2	3	4	5	7	9

Time Complexity

- Average & worse case: $O(N^2)$
- Best case: $O(N)$ array is already sorted

1	2	3	4	5	6
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- Worse case: $O(N^2)$ array is reversed sorted

6	5	4	3	2	1
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- N is the size of the array
- More efficient than most other quadratic algorithm like selection sort and bubble sort

Worse case $O(N^2)$

- The array is sorted in reverse order.

6	5	4	3	2	1
6	5	4	3	2	1
5	6	4	3	2	1
4	5	6	3	2	1
3	4	5	6	2	1
2	3	4	5	6	1

- Every iteration of the inner loop will scan and shift the entire sorted subsection of the array before inserting the next element

Summary

- Efficient for small array
- Time-consuming for sorting large array
- Same TC as Bubble sort, Selection sort
- Insertion sort is one of the fastest algorithms for sorting very small arrays
- Run In-place: $O(1)$ additional memory space
- Stable: the relative order of elements with equal key won't be changed