Data Structure and Algorithms

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Agenda

- Searching and sorting
- Concept of internal and external sorting
- Sort stability
- Sorting methods: Bubble, insertion, Quick, Merge, shell and comparison of all sorting methods.
- Case Studies Set Operation, String Operation
- Fibonacci Series.

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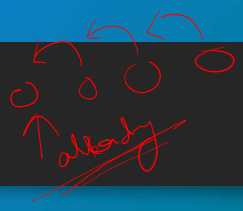
Shell Sort



- Shell sort is an algorithm that first sorts the elements far apart from each other and successively reduces the interval between the elements to be sorted. It is a generalized version of insertion sort.
- In shell sort, elements at a specific interval are sorted. The interval between the elements is gradually decreased based on the sequence used.
- The performance of the shell sort depends on the type of sequence used for a given input array.

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Shell Sort

- Shellsort is an optimization of insertion sort that allows the exchange of items that are far apart.
- The idea is to arrange the list of elements so that, starting anywhere, taking every *h*th element produces a sorted list.
- Such a list is said to be *h*-sorted.
- It can also be thought of as *h* interleaved lists, each individually sorted.
- Beginning with large values of *h* allows elements to move long distances in the original list, reducing large amounts of disorder quickly, and leaving less work for smaller *h*-sort steps to do.
- If the list is then *k-sorted* for some smaller integer *k*, then the list remains *h*-sorted. Following this idea for a decreasing sequence of *h* values ending in 1 is guaranteed to leave a sorted list in the end.

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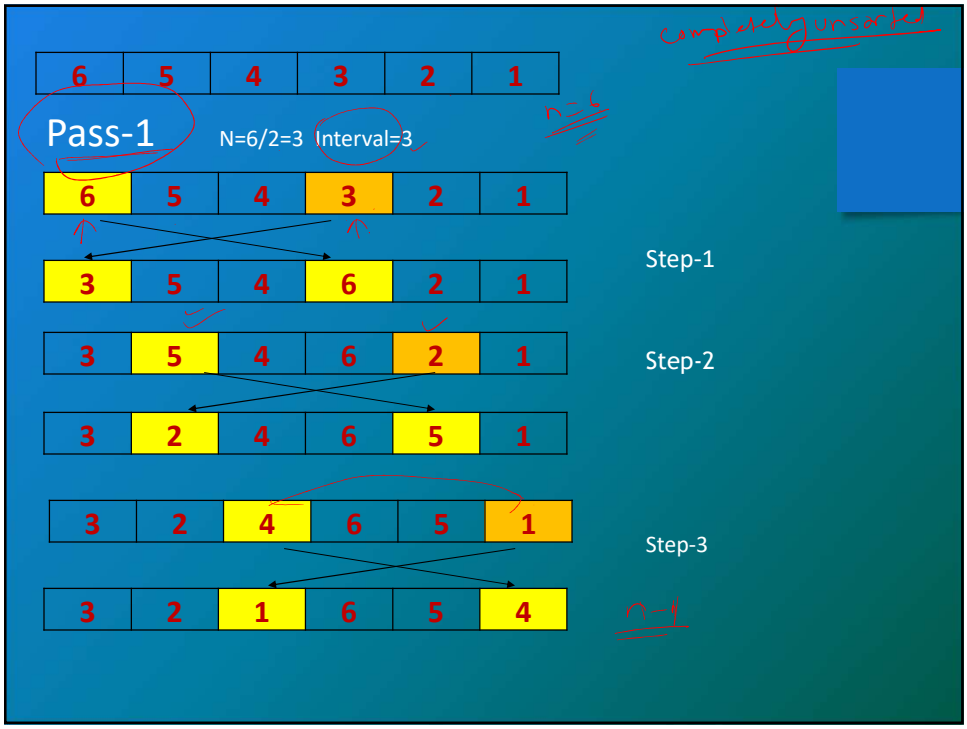
6 5 4 3 2 1
Pass-1
N=6/2=3 Interval=3
6 5 4 3 2 1
Step-1
3 5 4 6 2 1
Step-2
3 5 4 6 2 1
3 2 4 6 5 1
3 2 4 6 5 1
Step-3
3 2 1 6 5 4

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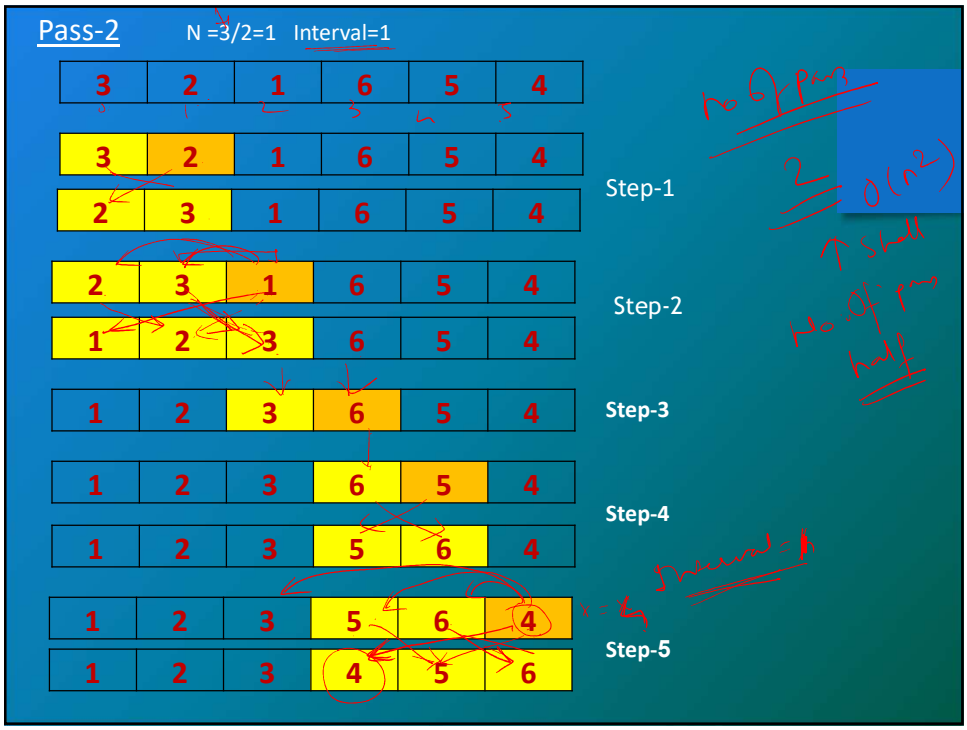
Pass-2
N =3/2=1 Interval=1
3 2 1 6 5 4
3 2 1 6 5 4
Step-1
2 3 1 6 5 4
2 3 1 6 5 4
Step-2
1 2 3 6 5 4
Step-3
1 2 3 6 5 4
1 2 3 6 5 4
Step-4
1 2 3 5 6 4
1 2 3 5 6 4
Step-5
1 2 3 4 5 6

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Shell Sort Algorithm

```
void shellSort(int array[], int n) {
  // Rearrange elements at each n/2, n/4, n/8, ... intervals
  for (int interval = n / 2; interval > 0; interval /= 2) {
       for (int i = interval; i < n; i += 1) {
            int temp = array[i];
            for (int j = i; j >= interval && array[j - interval] > temp; j -= interval)
            {       array[j] = array[j - interval];      }
            array[j] = temp;
        }
   }
}
```

https://www.youtube.com/watch?v=CmPA7zE8mx0

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Shell Sort Summary

- Worst Case Complexity
  - Comparisons - $O(n^2)$
- Best Case Complexity
  - Comparisons $O(n \log n)$
- Average Case Complexity Depend on Gap Sequence
- Is it Stable? No
- **Shellsort** is **not stable**: it may change the relative order of elements with equal values. It is an adaptive **sorting** algorithm in that it executes faster when the input is partially **sorted**.

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Summary

- Bubble sort, selection sort, and insertion sort are all $O(n^2)$
- As we will see later, we can do much better than this with somewhat more complicated sorting algorithms
- Within $O(n^2)$,
  - Bubble sort is very slow, and should probably never be used for anything
  - Selection sort is intermediate in speed
  - Insertion sort is usually the fastest of the three--in fact, for small arrays (say, 10 or 15 elements), insertion sort is faster than more complicated sorting algorithms
- Selection sort and insertion sort are "good enough" for small arrays

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References

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Thank You !!!

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