# SHELL SORT

Shell sort is a highly efficient sorting algorithm and is based on insertion sort algorithms. This algorithm avoids large shifts as in case of insertion sort, if the smaller value is to the far right and has to be moved to the far left.

- The **shell sort**, sometimes called the "diminishing increment sort.

- The idea of shell Sort is to allow exchange of far items

## *SHELL SORT*

- In shellSort, we make the array h-sorted for a large value of h.
- We keep reducing the value of h until it becomes 1.
- An array is said to be h-sorted if all sublists of every h’th element is sorted.

## *SHELL SORT* ALGORITHM

- **Step 1 –** Initialize the value of *h.*
- **Step 2 –** Divide the list into smaller sub-list of equal interval *h.*
- **Step 3 –** Sort these sub-lists using **insertion sort.**
- **Step 3 –** Repeat until complete list is sorted.

- ***Time complexity of above implementation of shellsort is O($n^2$)***

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## SHELL SORT EXAMPLE

*Unsorted List*

| | | | | | |
|---|---|---|---|---|---|
| 60 | 40 | 10 | 30 | 50 | 20 |

*No.of elements = 6.*

*Distance (or) Gap = floor(No.of Elements/2).*

*i.e. Distance (or) Gap = floor(6/2) = 3*

# SHELL SORT EXAMPLE

***Unsorted List***

| 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 60 | 40 | 10 | 30 | 50 | 20 |

***<u>Pass – 1 :-</u>***

**(0,3)**

| 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 60 | 40 | 10 | 30 | 50 | 20 |
| 30 | 40 | 10 | 60 | 50 | 20 |

**(1,4)**

| | | | | | |
|---|---|---|---|---|---|
| 30 | 40 | 10 | 60 | 50 | 20 |
| 30 | 40 | 10 | 60 | 50 | 20 |

**(2,5)**

| | | | | | |
|---|---|---|---|---|---|
| 30 | 40 | 10 | 60 | 50 | 20 |
| 30 | 40 | 10 | 60 | 50 | 20 |

(3,6) – Out of List

# SHELL SORT EXAMPLE

*Gap = floor(Gap/2)* *i.e. Gap = floor(3/2) = 1*

*If Gap (or) Distance reaches to 1 apply Insertions Sort*

***Pass – 2 :-***

*Apply Insertions Sort*

| 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 30 | 40 | 10 | 60 | 50 | 20 |
| 30 | 40 | 10 | 60 | 50 | 20 |
| 30 | 40 | 10 | 60 | 50 | 20 |
| 30 | 10 | 40 | 60 | 50 | 20 |
| 10 | 30 | 40 | 60 | 50 | 20 |
| 10 | 30 | 40 | 60 | 50 | 20 |
| 10 | 30 | 40 | 50 | 60 | 20 |
| 10 | 30 | 40 | 50 | 60 | 20 |

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| | | | | | |
|---|---|---|---|---|---|
| 10 | 20 | 30 | 40 | 50 | 60 |

# *SHELL SORT ALGORITHM*

```
shellSort(array, size)
  for interval i <- size/2n down to 1
      for each interval "i" in array
            sort all the elements at interval "i"
end shellSort
```

# SHELL SORT IMPLEMENTATION

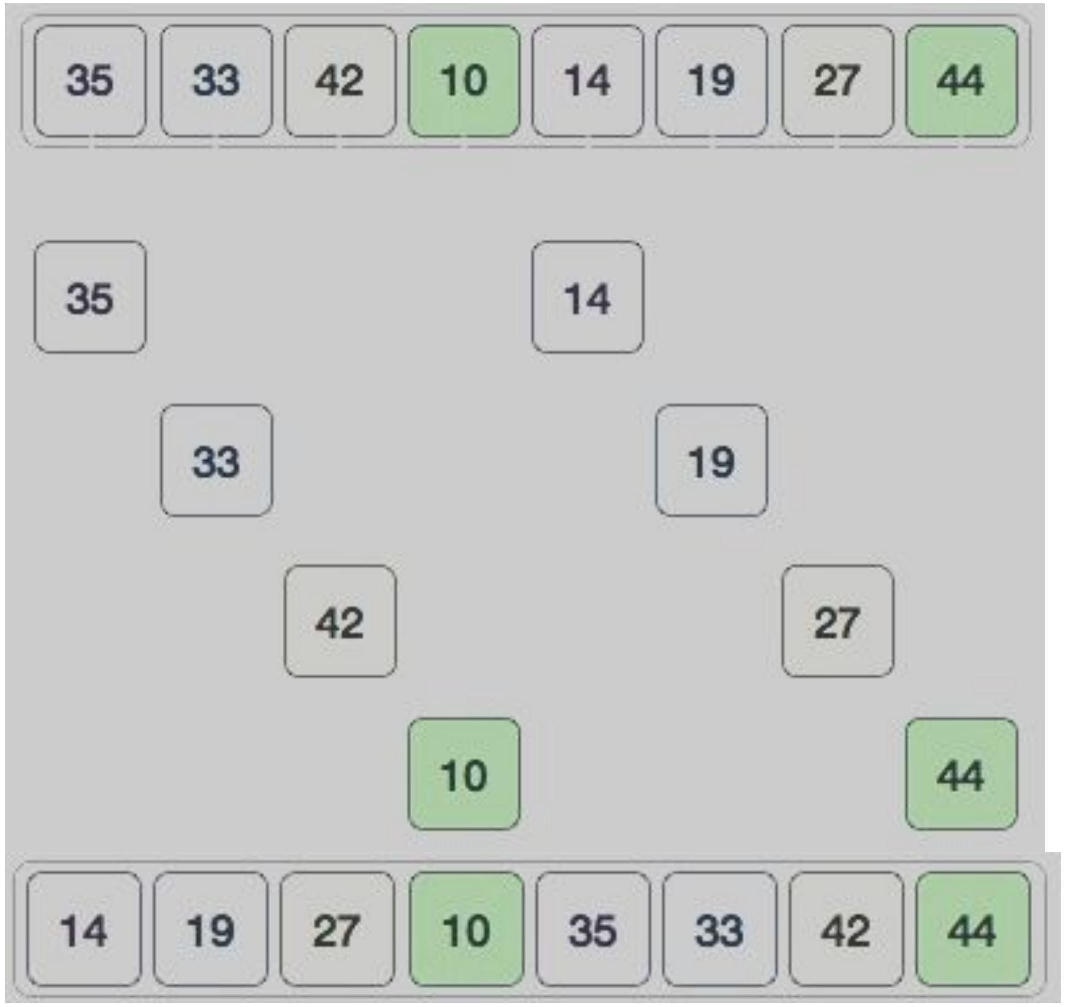
```
#include <stdio.h>
void shellSort(int array[], int n)
{ // Rearrange elements at each n/2, n/4, n/8, ... intervals
  for (int interval = n / 2; interval > 0; interval /= 2)
  {
    for (int i = interval; i < n; i += 1)
    {
       int temp = array[i];
       int j;
       for (j = i; j >= interval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

## SHELL SORT IMPLEMENTATION

```
// Print an array
void printArray(int array[], int size)
{
   for (int i = 0; i < size; ++i)
   {
      printf("%d ", array[i]);
   }
   printf("\n");
}
// Driver code
int main()
{
    int data[] = {9, 8, 3, 7, 5, 6, 4, 1};
    int size = sizeof(data) / sizeof(data[0]);
    shellSort(data, size);
    printf("Sorted array: \n");
    printArray(data, size);
}
```

# SHELL SORT EXAMPLE

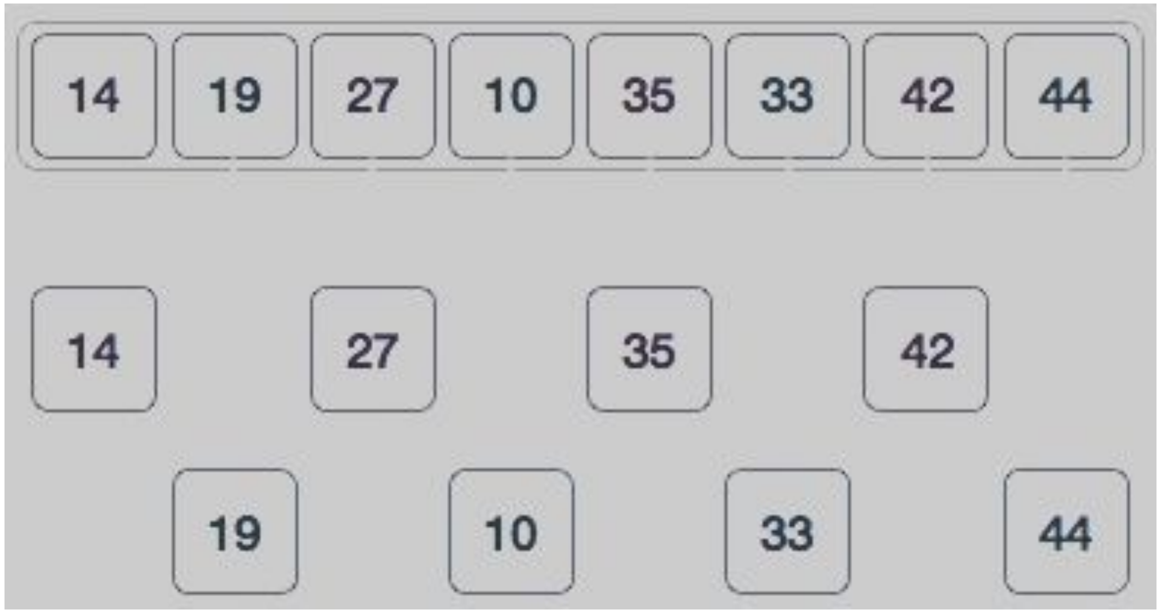
**The interval of 4. Make a virtual sub-list of all values located at the interval of 4 positions. Here these values are {35, 14}, {33, 19}, {42, 27} and {10, 44}**

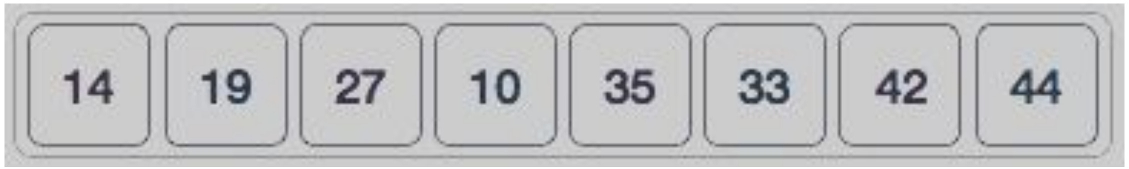


# SHELL SORT EXAMPLE

**Then, we take interval of 1 and this gap generates two sub-lists**

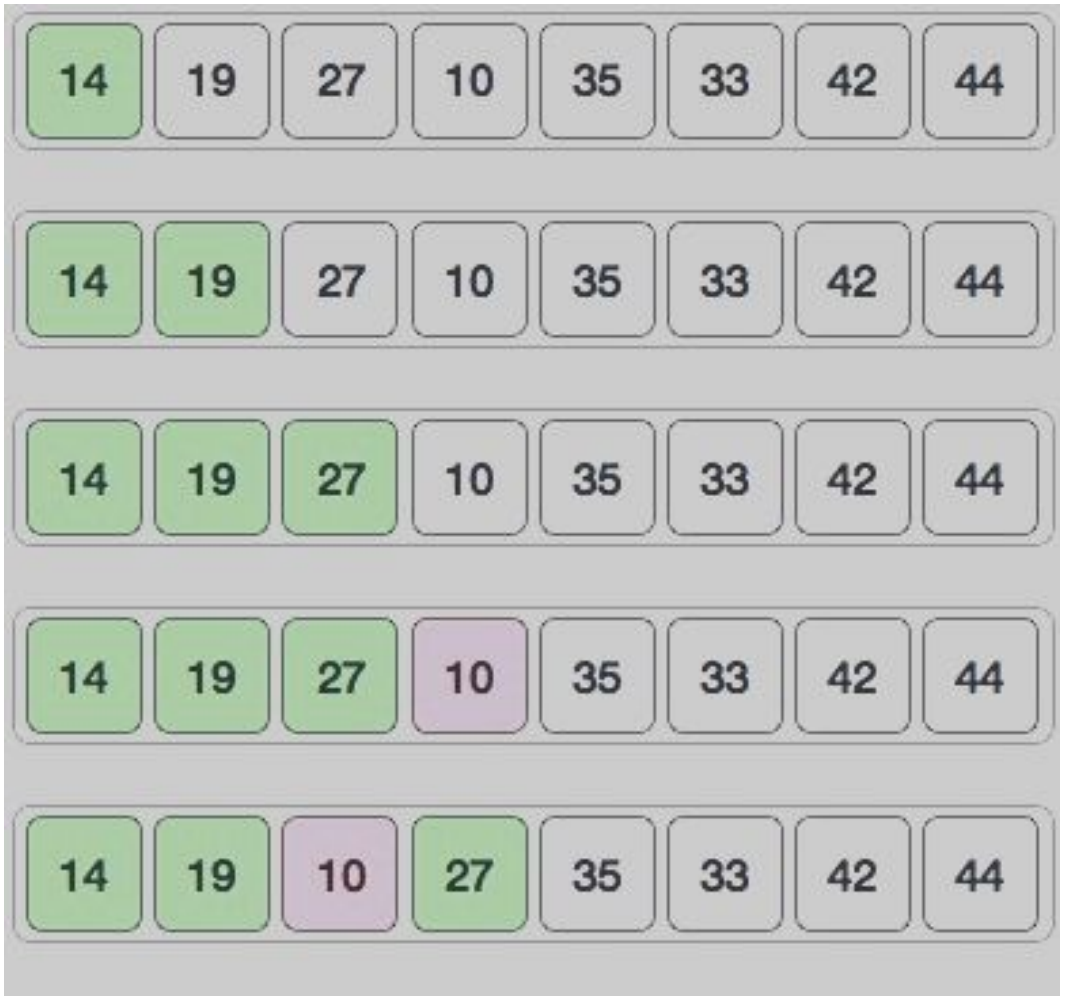
**- {14, 27, 35, 42}, {19, 10, 33, 44}**



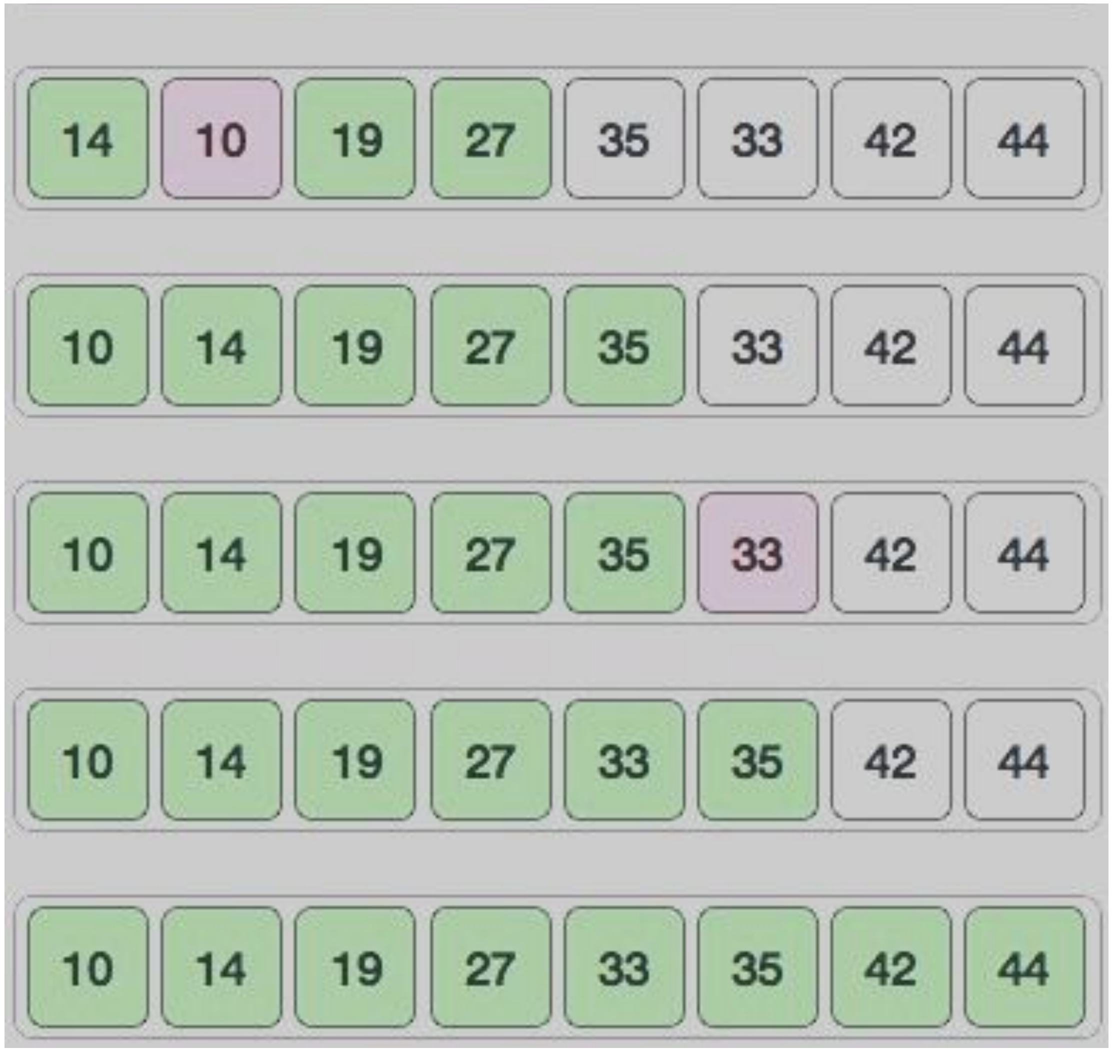


# SHELL SORT EXAMPLE

**Finally, we sort the rest of the array using interval of value 1. Shell sort uses insertion sort to sort the array.**



# SHELL SORT EXAMPLE



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## *Shell Sort*

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**Thank You.**