geeksforgeeks.org

Counting Sort - GeeksforGeeks

5-6 minutes

Counting sort is a sorting technique based on keys between a specific range. It works by counting the number of objects having distinct key values (kind of hashing). Then doing some arithmetic to calculate the position of each object in the output sequence.

Let us understand it with the help of an example.

```
For simplicity, consider the data in the range 0
to 9.
Input data: 1, 4, 1, 2, 7, 5, 2
  1) Take a count array to store the count of each
unique object.
  Index:     0  1  2  3  4  5  6  7  8  9
  Count:     0  2  2  0   1  1  0  1  0  0

  2) Modify the count array such that each element
at each index
  stores the sum of previous counts.
  Index:     0  1  2  3  4  5  6  7  8  9
  Count:     0  2  4  4  5  6  6  7  7  7

The modified count array indicates the position of
each object in
the output sequence.

  3) Output each object from the input sequence
```

```
followed by
  decreasing its count by 1.
  Process the input data: 1, 4, 1, 2, 7, 5, 2.
Position of 1 is 2.
  Put data 1 at index 2 in output. Decrease count
by 1 to place
  next data 1 at an index 1 smaller than this
index.
```

Following is C implementation of counting sort.

- C/C++
- Java
- Python

C/C++

```
#include <stdio.h>
#include <string.h>
#define RANGE 255
void countSort(char arr[])
{
    char output[strlen(arr)];
    int count[RANGE + 1], i;
    memset(count, 0, sizeof(count));
    for(i = 0; arr[i]; ++i)
        ++count[arr[i]];
    for (i = 1; i <= RANGE; ++i)
        count[i] += count[i-1];
    for (i = 0; arr[i]; ++i)
    {
        output[count[arr[i]]-1] = arr[i];
        --count[arr[i]];
    }
    for (i = 0; arr[i]; ++i)
        arr[i] = output[i];
}
int main()
{
    char arr[] = "geeksforgeeks";
    countSort(arr);
    printf("Sorted character array is %sn", arr);
    return 0;
}
```

Java

```
class CountingSort
{
    void sort(char arr[])
    {
        int n = arr.length;
        char output[] = new char[n];
        int count[] = new int[256];
        for (int i=0; i<256; ++i)
            count[i] = 0;
        for (int i=0; i<n; ++i)
            ++count[arr[i]];
        for (int i=1; i<=255; ++i)
            count[i] += count[i-1];
        for (int i = 0; i<n; ++i)
        {
            output[count[arr[i]]-1] = arr[i];
            --count[arr[i]];
        }
        for (int i = 0; i<n; ++i)
            arr[i] = output[i];
    }
    public static void main(String args[])
    {
        CountingSort ob = new CountingSort();
        char arr[] = {'g', 'e', 'e', 'k', 's',
'f', 'o',
                      'r', 'g', 'e', 'e', 'k',
's'
                     };
        ob.sort(arr);
        System.out.print("Sorted character array
is ");
        for (int i=0; i<arr.length; ++i)
            System.out.print(arr[i]);
    }
}
```

Python

```
def countSort(arr):
    output = [0 for i in range(256)]
    count = [0 for i in range(256)]
    ans = ["" for _ in arr]
    for i in arr:
        count[ord(i)] += 1
    for i in range(256):
        count[i] += count[i-1]
    for i in range(len(arr)):
        output[count[ord(arr[i])]-1] = arr[i]
        count[ord(arr[i])] -= 1
    for i in range(len(arr)):
        ans[i] = output[i]
    return ans
arr = "geeksforgeeks"
ans = countSort(arr)
print "Sorted character array is %s"
```

```
%("".join(ans))
```

Output:

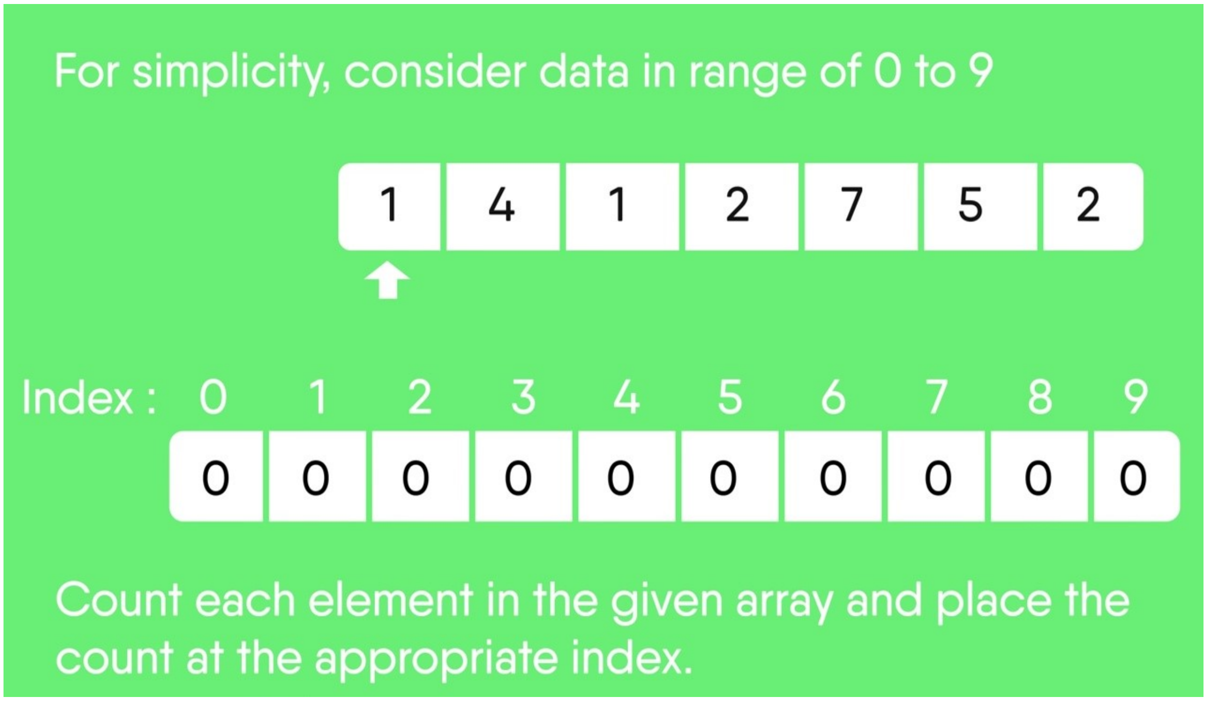
```
Sorted character array is eeeefggkkorss
```

Time Complexity: O(n+k) where n is the number of elements in input array and k is the range of input.
Auxiliary Space: O(n+k)

Points to be noted:
1. Counting sort is efficient if the range of input data is not significantly greater than the number of objects to be sorted. Consider the situation where the input sequence is between range 1 to 10K and the data is 10, 5, 10K, 5K.
2. It is not a comparison based sorting. It running time complexity is O(n) with space proportional to the range of data.
3. It is often used as a sub-routine to another sorting algorithm like radix sort.
4. Counting sort uses a partial hashing to count the occurrence of the data object in O(1).
5. Counting sort can be extended to work for negative inputs also.

Exercise:
1. Modify above code to sort the input data in the range from M to N.
2. Modify above code to sort negative input data.
3. Is counting sort stable and online?
4. Thoughts on parallelizing the counting sort algorithm.

Snapshots:

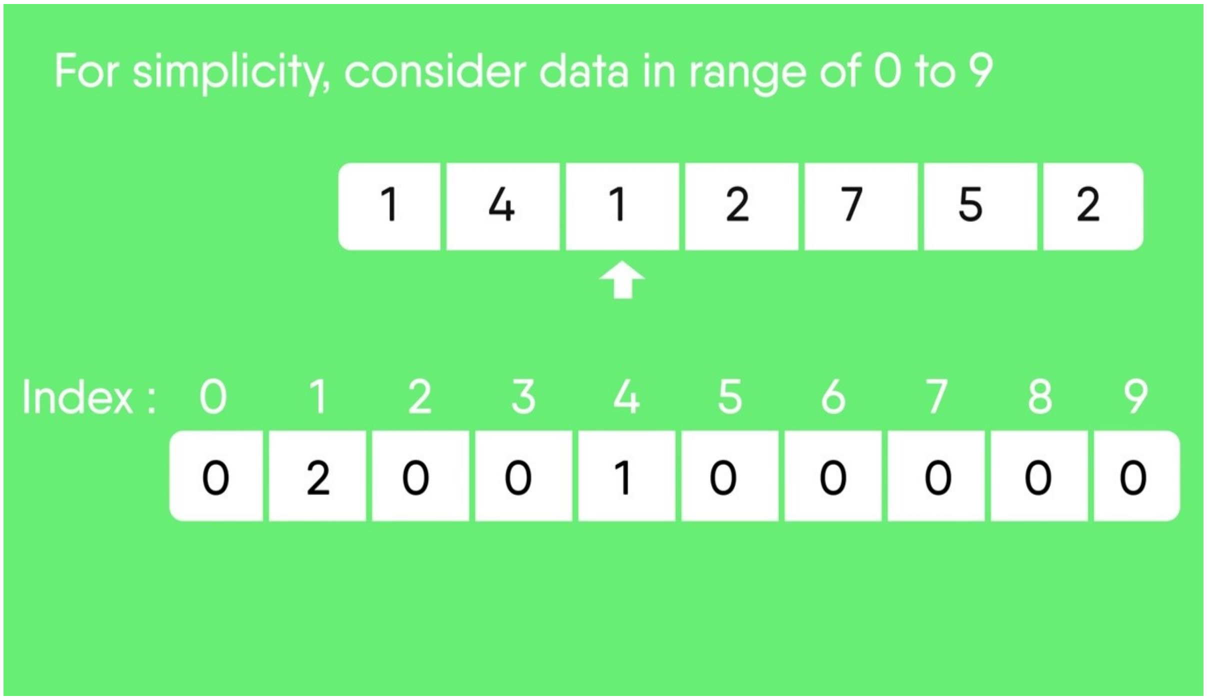


For simplicity, consider data in range of 0 to 9

1	4	1	2	7	5	2

Index :	0	1	2	3	4	5	6	7	8	9
	0	0	0	0	0	0	0	0	0	0

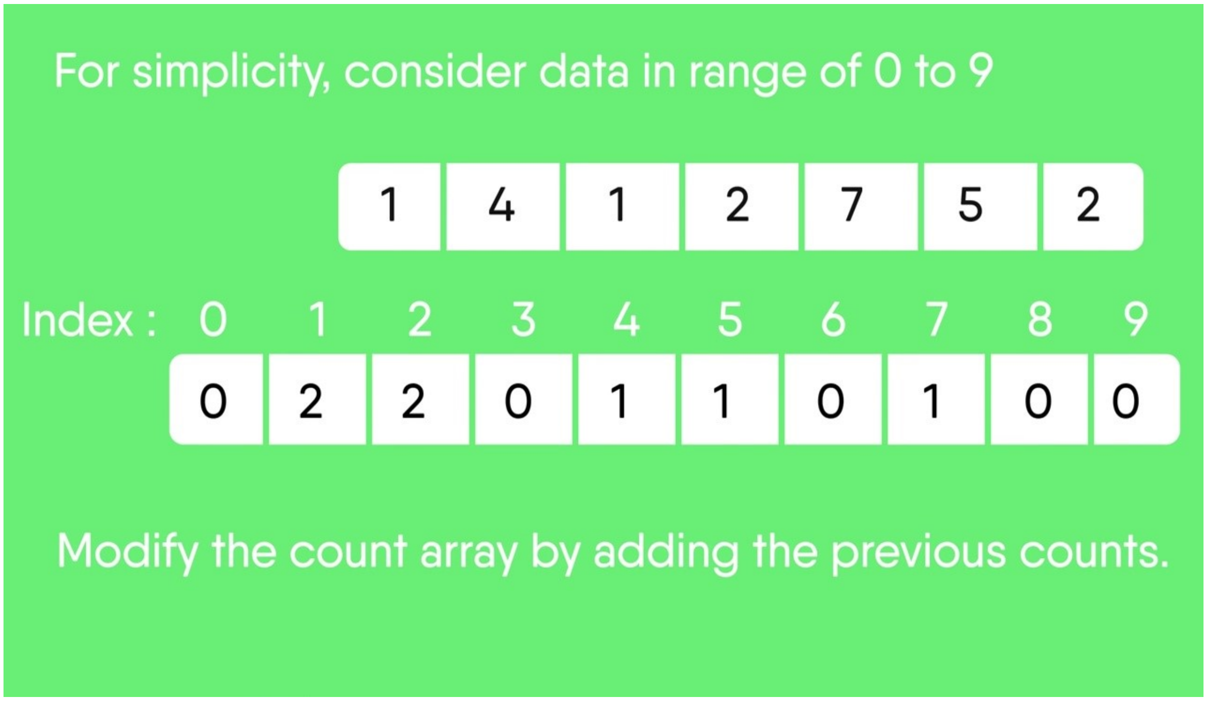
Count each element in the given array and place the count at the appropriate index.



For simplicity, consider data in range of 0 to 9

1	4	1	2	7	5	2

Index :	0	1	2	3	4	5	6	7	8	9
	0	2	0	0	1	0	0	0	0	0

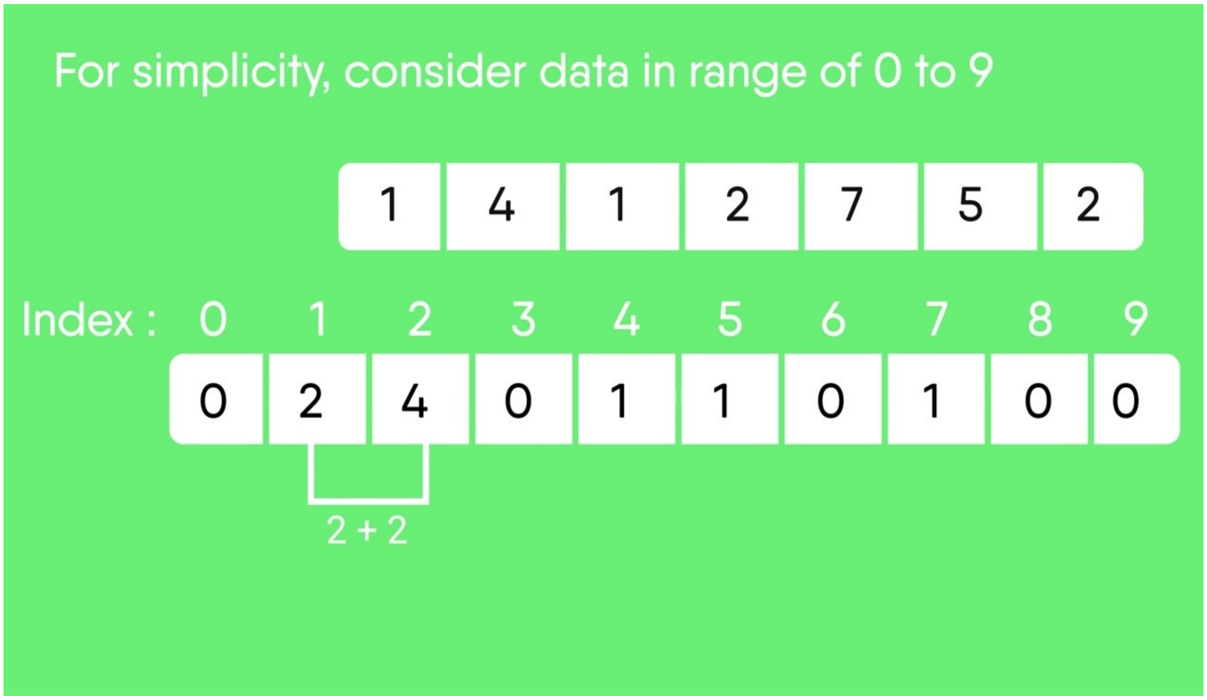


For simplicity, consider data in range of 0 to 9

1	4	1	2	7	5	2

Index :	0	1	2	3	4	5	6	7	8	9
	0	2	2	0	1	1	0	1	0	0

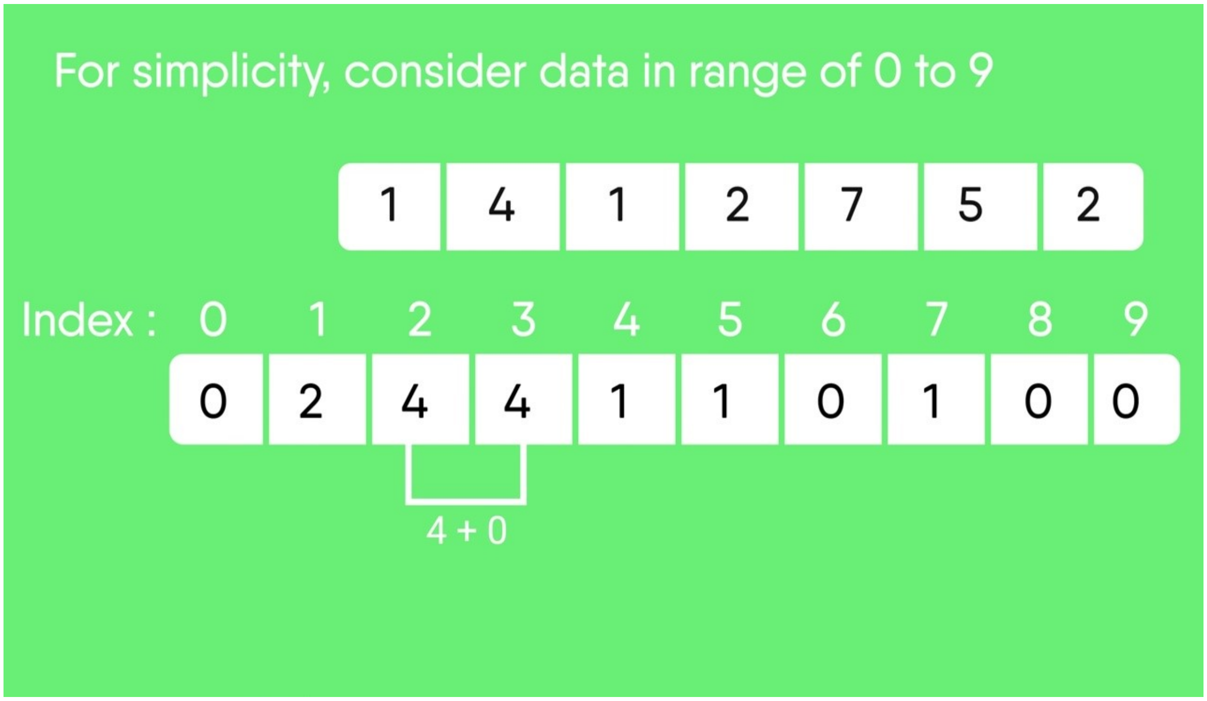
Modify the count array by adding the previous counts.



For simplicity, consider data in range of 0 to 9

1	4	1	2	7	5	2

Index :	0	1	2	3	4	5	6	7	8	9
	0	2	4	0	1	1	0	1	0	0

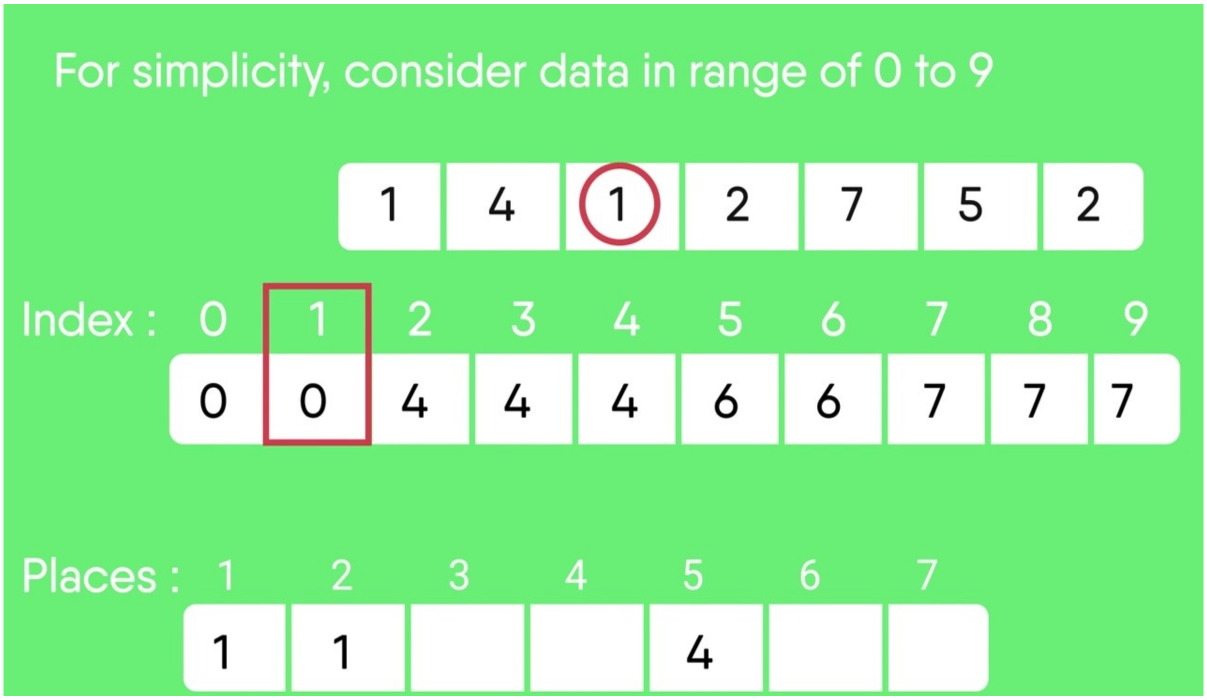


For simplicity, consider data in range of 0 to 9

1	4	1	2	7	5	2

Index :	0	1	2	3	4	5	6	7	8	9
	0	2	4	4	1	1	0	1	0	0

4 + 0

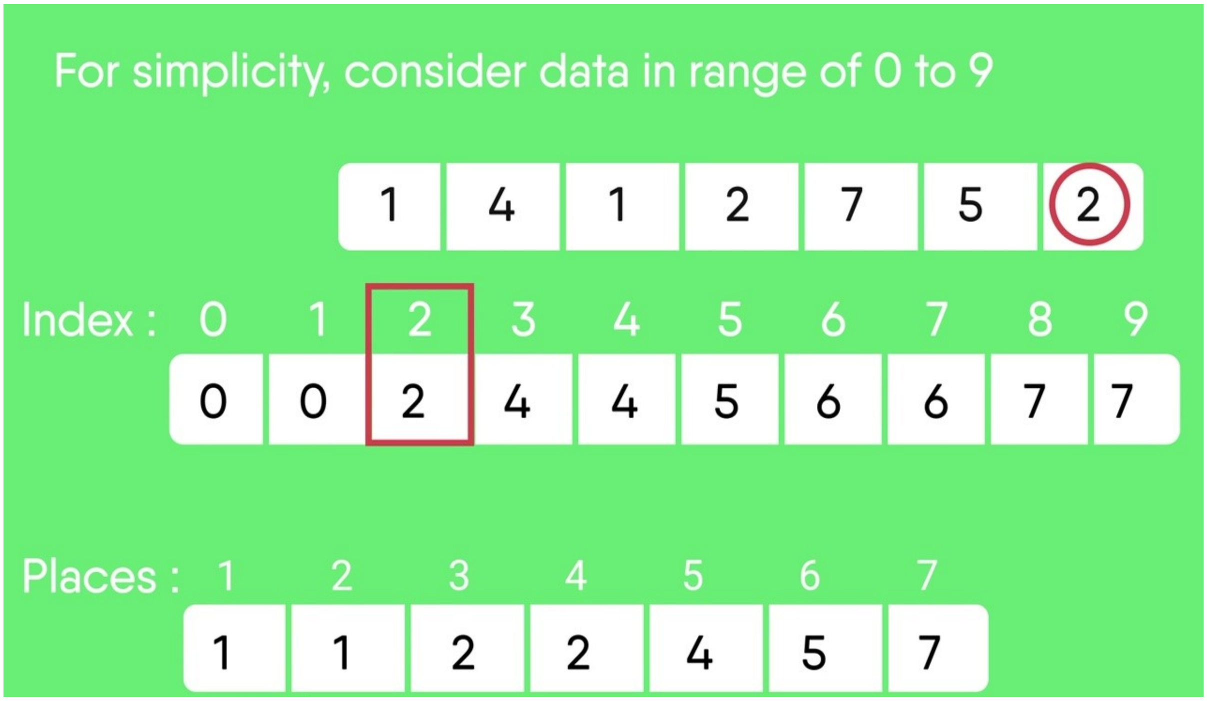


For simplicity, consider data in range of 0 to 9

1	4	1	2	7	5	2

Index :	0	1	2	3	4	5	6	7	8	9
	0	0	4	4	4	6	6	7	7	7

Places :	1	2	3	4	5	6	7
	1	1			4		



For simplicity, consider data in range of 0 to 9

1	4	1	2	7	5	2

Index :	0	1	2	3	4	5	6	7	8	9
	0	0	2	4	4	5	6	6	7	7

Places :	1	2	3	4	5	6	7
	1	1	2	2	4	5	7

Quiz on Counting Sort

Coding Practice for Sorting

Other Sorting Algorithms on GeeksforGeeks/GeeksQuiz
Selection Sort, Bubble Sort, Insertion Sort, Merge Sort, Heap Sort, QuickSort, Radix Sort, Counting Sort, Bucket Sort, ShellSort, Comb Sort, PegionHole Sorting

This article is compiled by Aashish Barnwal. Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above.