Counting Sort

```
CountingSort(A, B, k)
1. For i ← 0 to k
2.     do C[i] ← 0
3. For j ← 1 to length[A]
4.     do C[A[j]] ← C[A[j]] + 1
5. For i ← 1 to k
6.     do C[i] ← C[i] + C[i-1]
7. For j ← length[A] down to 1
8.     do B[C[A[j]]] ← A[j]
9.        C[A[j]] ← C[A[j]] - 1
```

Counting Sort Assume that each of n input element is an integer in range 0 to k for some k.

It is a stable sort

↓ stability

numbers with the same value appear in the output array in the same order as they do in the input array.

Question-1

Illustrate the operation of COUNTING SORT on the array

	1	2	3	4	5	6	7	8
A =	2	5	3	0	2	3	0	3
		↑ Max					↑ min	

Range : 0-5

Here $k = 5$

```
For i ← 0 to k
    do C[i] ← 0
```

	0	1	2	3	4	5
C =	0	0	0	0	0	0

```
For J ← 1 to length[A]
    do C[A[J]] ← C[A[J]] + 1
```

	0	1	2	3	4	5
C =	2	0	2	3	0	1

$J = 1$

$C[A[1]] = C[A[1]] + 1$

$C[2] = C[2] + 1$

$= 0 + 1$

$C[2] = 1$

J = 2

C[A[2]] = C[A[2]] + 1

C[5] = C[5] + 1

C[5] = 0 + 1

C[5] = 1

J = 3

C[A[3]] = C[A[3]] + 1

C[3] = C[3] + 1

= 0 + 1

C[3] = 1

J = 4

C[A[4]] = C[A[4]] + 1

= C[0] + 1

= 0 + 1

C[0] = 1

J = 5

C[A[5]] = C[A[5]] + 1

= C[2] + 1

= 1 + 1

C[2] = 2

J = 6

C[A[6]] = C[A[6]] + 1

= C[3] + 1

= 1 + 1

C[3] = 2

J = 7

C[A[7]] = C[A[7]] + 1

= C[0] + 1

= 1 + 1

C[0] = 2

J = 8

C[A[8]] = C[A[8]] + 1

= C[3] + 1

= 2 + 1

C[3] = 3

```
For i ← 1 to k
    do C[i] ← C[i] + C[i-1]
```

	0	1	2	3	4	5
C =	2	2	4	7	7	8

$i = 1$

$C[1] = C[1] + C[0]$

$C[1] = 0 + 2$

$C[1] = 2$

$i = 2$

$C[2] = C[2] + C[1]$

$= 2 + 2$

$C[2] = 4$

$i = 3$

$C[3] = C[3] + C[2]$

$= 4 + 3$

$i = 4$

$C[4] = C[4] + C[3]$

$= 0 + 7$

$C[4] = 7$

$i = 5$

$C[5] = C[5] + C[4]$

$= 1 + 7$

$C[5] = 8$

```
For J ← length(A) down to 1
    do  B[C[A[J]]] ← A[J]
        C[A[J]] ← C[A[J]] - 1
```

B =

1	2	3	4	5	6	7	8
0	0	2	2	3	3	3	5

C =

0	1	2	3	4	5
~~1~~ 0	2	~~3~~ 2	~~6~~ 5	7	~~8~~ 7

J = 8

$B[C[A[8]]] = A[8]$

$B[C[3]] = 3$

$B[7] = 3$

$C[A[8]] = C[A[8]] - 1$

$C[3] = C[3] - 1$

$C[3] = 7 - 1$

$C[3] = 6$

J = 7

$B[C[A[7]]] = A[7]$

$B[C[D]] = 0$

$B[2] = 0$

$C[A[7]] = C[A[7]] - 1$

$= C[0] - 1$

$C[0] = 2 - 1$

$C[0] = 1$

J = 6

$B[C[A[6]]] = A[6]$

$B[C[3]] = 3$

$B[6] = 3$

$C[A[6]] = C[A[6]] - 1$

$= C[3] - 1$

$= 6 - 1$

$C[3] = 5$

$J = 5$

$B[C(A[5])] = A[5]$

$B[C[2]] = 2$

$B[4] = 2$

$C[A[5]] = C[A[5]] - 1$

$C[2] = C[2] - 1$

$= 4 - 1$

$C[2] = 3$

.....

$C =$

0	1	2	3	4	5
0	2	2	5	7	7

1	2	3	4	5	6	7	8
0	0	2	2	3	3	3	5

Sorted Array

Question-2

Illustrate the operation of Counting-Sort on the Array:

	1	2	3	4	5	6	7	8	9	10	11
A =	6	0	2	0	1	3	4	6	1	3	2

Solution: Here, $k=6$ [Highest number in A]

Range is 0–6

for $i=0$ to 6

$C[i]=0$

i.e.

	0	1	2	3	4	5
C =	0	0	0	0	0	0

for $j \leftarrow 1$ to 11

	0	1	2	3	4	5	6
C =	2	2	2	2	1	0	2

for $i=1$ to 6

	0	1	2	3	4	5	6
C =	2	4	6	8	9	9	11

i	A[j]	C[A[j]]	B[C[A[j]]] ← A[j]	C[A[j]] ← C[A[j]]-1
11	2	6	B[6] ← 2	C[2] ← 5
10	3	8	B[8] ← 3	C[3] ← 7
9	1	4	B[4] ← 1	C[1] ← 3
8	6	11	B[11] ← 6	C[6] ← 10
7	4	9	B[9] ← 4	C[4] ← 8
6	3	7	B[7] ← 3	C[3] ← 6
5	1	3	B[3] ← 1	C[1] ← 2
4	0	2	B[2] ← 0	C[0] ← 1
3	2	5	B[5] ← 2	C[2] ← 4
2	0	1	B[1] ← 0	C[0] ← 0
1	6	10	B[10] ← 6	C[6] ← 9

Sorted Array

1	2	3	4	5	6	7	8	9	10	11
0	0	1	1	2	2	3	3	4	6	6