Sort an array of n integers, where each integer is in the range [0...k]

 $n = 8 \quad k = 5$

0 1 2 3 4 5 6 7

a: 2 5 3 0 2 3 0 3

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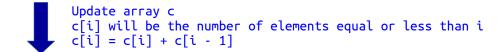
 $n = 8 \quad k = 5$

0 1 2 3 4 5 6 7

a: 2 5 3 0 2 3 0 3

0 1 2 3 4 5

c: 2 0 2 3 0 1



0 1 2 3 4 5

c: 2 ? ? ? ? ?

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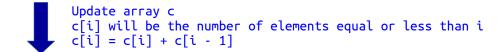
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0 1 2 3 4 5

c: 2 2 4 7 7 8

```
n = 8  k = 5

0 1 2 3 4 5 6 7

a: 2 5 3 0 2 3 0 3

c: 2 4 6 7 8

c[i] : number of elements equal or less than i

0 1 2 3 4 5 6 7

b: 0 0 0 0 0 0 3 0

sorted array

for(j = n - 1; j >= 0; j--)
   insert a[j] in position c[a[j]] - 1 of array b;
   c[a[j]] ← c[a[j]] - 1;
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```
0 1 2 3 4 5 6 7
                           void countingSort(int a[], int b[], int n, int k)
                        2
a: 2 5 3 0 2 3 0 3
                                int c[k + 1];
                        3
                        4
   0 1 2 3 4 5
                        5
                                for(int i = 0; i \le k; i++)
                                    c[i] = 0;
                        6
c: 2 0 2 3 0 1
                        7
                                for(int j = 0; j < n; j++)
                        8
                                    c[a[j]]++;
                        9
                       10
                                // c[i]: number of elements equal to i
                       11
   0 1 2 3 4 5
                       12
  2 2 4 7 7 8
                       13
                                for(int i = 1; i \le k; i++)
                                    c[i] = c[i] + c[i-1];
                       14
                       15
                                // c[i]: number of elements less or equal to i
                       16
                       17
                       18
                                for(int j = n - 1; j >= 0; j--)
                       19
                       20
                                    b[c[a[j]] - 1] = a[j];
                       21
                                    c[a[j]]--;
   0 1 2 3 4 5 6 7
                       22
                       23
b: 0 0 2 2 3 3 3 5
```

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O(n) provided that k is less or equal than n

```
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                           void countingSort(int a[], int b[], int n, int k)
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                                int c[k + 1];
                        3
   0 1 2 3 4 5
                                for(int i = 0; i \le k; i++)
                                    c[i] = 0;
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c: 2 0 2 3 0 1
                        7
                                for(int j = 0; j < n; j++)
                        8
                                    c[a[j]]++;
                        9
                       10
                                // c[i]: number of elements equal to i
                       11
   0 1 2 3 4 5
                       12
  2 2 4 7 7 8
C:
                       13
                                for(int i = 1; i \le k; i++)
                                    c[i] = c[i] + c[i-1];
                       14
                       15
                       16
                                // c[i]: number of elements less or equal to i
                       17
                       18
                                for(int j = n - 1; j >= 0; j--)
                       19
                       20
                                    b[c[a[j]] - 1] = a[j];
                                    c[a[j]]--;
                       21
   0 1 2 3 4 5 6 7
                       22
                       23
  0 0 2 2 3 3 3 5
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