

## Sorting restricted ranges of numbers

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- Array  $A[1 \dots n]$  – holds input
- Array  $C[1 \dots k]$  –  $C[j]$  holds number of elements of A less than or equal to  $j$

**Example:**

<b>index</b>	1	2	3	4	5	6	7	8	9
<hr/>									
A :	2	9	1	8	6	5			

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$A$ :	2	9	1	8	6	5			
$C$ :	1	2	2	2	3	4	4	5	6

**Questions**

- How do we compute C
- We need to be careful dealing with duplicates (stability)

# Counting Sort

*Counting – Sort*( $A, B, k$ )

```
1  for  $i \leftarrow 0$  to  $k$ 
2      do  $C[i] \leftarrow 0$ 
3  for  $j \leftarrow 1$  to  $\text{length}[A]$ 
4      do  $C[A[j]] \leftarrow C[A[j]] + 1$ 
5  ▷  $C[i]$  now contains the number of elements equal to  $i$ .
6  for  $i \leftarrow 1$  to  $k$ 
7      do  $C[i] \leftarrow C[i] + C[i - 1]$ 
8  ▷  $C[i]$  now contains the number of elements less than or equal to  $i$ .
9  for  $j \leftarrow \text{length}[A]$  downto 1
10     do  $B[C[A[j]]] \leftarrow A[j]$ 
11     do  $C[A[j]] \leftarrow C[A[j]] - 1$ 
```

# Analysis

- Running Time  $O(n + k)$
- No Comparisons
- Doesn't work on all data
- Good when  $k$  is small
- Examples?

**Question:** Is Counting Sort appropriate for alphabetizing the Columbia directory?

# Radix Sort

*Radix - Sort*( $A, d$ )

- 1 for  $i \leftarrow 1$  to  $d$
- 2     do use a stable sort to sort array  $A$  on digit  $i$

## Example

379	<b>STABLE SORT</b>	912	<b>STABLE SORT</b>	802	<b>STABLE SORT</b>	258
912	$\Rightarrow$	802	$\Rightarrow$	803	$\Rightarrow$	259
258		823		804		269
269		803		912		279
823		804		823		379
259		258		258		802
803		269		259		803
279		259		269		804
804		379		379		823
802		279		279		912