

CS1101: Foundations of Programming

Sorting



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Sorting problem

- Given an array: $a[0]$, $a[1]$, ... , $a[\text{size}-1]$ reorder the element such that $a[0] \leq a[1] \leq \dots \leq a[\text{size}-1]$
- The list becomes in increasing (non-decreasing or ascending) order
- We can also sort the element in decreasing order
- We prefer not to use additional arrays for the element rearrangement
- Example:
 - Original array: 43 24 59 57 98 34 12 61
 - Increasing order: 12 24 34 43 57 59 61 98
 - Decreasing order: 98 61 59 57 43 34 24 12

Selection sort

- Steps:

- Initialize $k=0$
- Find the smallest element $\min$ in the array $x[k, \dots, \text{size}-1]$
- Swap the smallest element with $x[k]$, then increase k

Selection sort

```
int minloc(int x[], int k, int size){  
    int j, pos;  
    pos = k;  
    for(j=k+1; j<size; j++)  
        if(x[j] < x[pos])  
            pos = j;  
    return pos;  
}
```

```
int selsort(int x[], int size){  
    int k, tmp, m;  
    for(k=0; k<size-1; k++){  
        m = minloc(x, k, size);  
        tmp = x[k];  
        x[k] = x[m];  
        x[m] = tmp;  
    }  
}
```

Selection sort

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

Selection sort

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

Selection sort

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

1	9	6	5	8	2	3	7
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Selection sort

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

1	9	6	5	8	2	3	7
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Selection sort

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

1	9	6	5	8	2	3	7
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1	2	6	5	8	9	3	7
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Selection sort

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

1	9	6	5	8	2	3	7
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1	2	6	5	8	9	3	7
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1	2	3	5	8	9	6	7
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Selection sort

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

1	9	6	5	8	2	3	7
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1	2	6	5	8	9	3	7
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1	2	3	5	8	9	6	7
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Selection sort

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

1	9	6	5	8	2	3	7
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1	2	6	5	8	9	3	7
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1	2	3	5	8	9	6	7
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1	2	3	5	8	9	6	7
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Selection sort

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

1	9	6	5	8	2	3	7
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1	2	6	5	8	9	3	7
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1	2	3	5	8	9	6	7
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1	2	3	5	8	9	6	7
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Selection sort

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

1	9	6	5	8	2	3	7
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1	2	6	5	8	9	3	7
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1	2	3	5	8	9	6	7
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1	2	3	5	8	9	6	7
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1	2	3	5	6	9	8	7
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Selection sort

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

1	9	6	5	8	2	3	7
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1	2	6	5	8	9	3	7
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1	2	3	5	8	9	6	7
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1	2	3	5	8	9	6	7
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1	2	3	5	6	9	8	7
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Selection sort

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

1	2	3	5	6	7	8	9
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1	9	6	5	8	2	3	7
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1	2	6	5	8	9	3	7
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1	2	3	5	8	9	6	7
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1	2	3	5	8	9	6	7
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1	2	3	5	6	9	8	7
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Selection sort

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

1	2	3	5	6	7	8	9
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1	9	6	5	8	2	3	7
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1	2	6	5	8	9	3	7
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1	2	3	5	8	9	6	7
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1	2	3	5	8	9	6	7
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1	2	3	5	6	9	8	7
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Selection sort

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

1	9	6	5	8	2	3	7
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1	2	6	5	8	9	3	7
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1	2	3	5	8	9	6	7
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1	2	3	5	8	9	6	7
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1	2	3	5	6	9	8	7
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1	2	3	5	6	7	8	9
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1	2	3	5	6	7	8	9
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Selection sort

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

1	9	6	5	8	2	3	7
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1	2	6	5	8	9	3	7
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1	2	3	5	8	9	6	7
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1	2	3	5	8	9	6	7
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1	2	3	5	6	9	8	7
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1	2	3	5	6	7	8	9
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1	2	3	5	6	7	8	9
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Bubble sort

- Basic idea
 - In every pass, we go on comparing the neighboring pairs and swap them if out of order
 - At the end of each iteration the largest element will settle at the last position
 - Repeat above steps excluding the last element

Bubble sort

```
void bsort (int x[], int size){  
    int t;  
    for (i = 0; i < size; i++)  
        for (j = 0; j < size-i-1; j++)  
            if (x[j] > x[j+1]) {  
                // swap a[j] and a[j+1]  
                t = a[j];  
                a[j] = a[j+1];  
                a[j+1] = t;  
            }  
}
```

Bubble sort

71	44	34	56	87	93	23	12
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Bubble sort

71	44	34	56	87	93	23	12
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Bubble sort

44	71	34	56	87	93	23	12
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Bubble sort

44	71	34	56	87	93	23	12
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Bubble sort

44	34	71	56	87	93	23	12
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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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44	34	56	71	87	23	12	93

Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

44	34	56	71	87	23	12	93
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34	44	56	71	23	12	87	93
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34	44	56	71	23	12	87	93
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Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
34	44	56	71	23	12	87	93

Bubble sort

44	34	56	71	87	23	12	93
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34	44	56	71	23	12	87	93
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34	44	56	23	71	12	87	93
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Bubble sort

44	34	56	71	87	23	12	93
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34	44	56	71	23	12	87	93
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34	44	56	23	71	12	87	93
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Bubble sort

44	34	56	71	87	23	12	93
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34	44	56	71	23	12	87	93
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34	44	56	23	12	71	87	93
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Bubble sort

44	34	56	71	87	23	12	93
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34	44	56	71	23	12	87	93
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34	44	56	23	12	71	87	93
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34	44	56	23	12	71	87	93
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Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
34	44	56	23	12	71	87	93
34	44	56	23	12	71	87	93

Bubble sort

44	34	56	71	87	23	12	93
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34	44	56	23	12	71	87	93
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34	44	56	23	12	71	87	93
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Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
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34	44	56	23	12	71	87	93

Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
34	44	56	23	12	71	87	93
34	44	56	23	12	71	87	93

Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
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34	44	56	23	12	71	87	93

Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
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34	44	23	56	12	71	87	93

Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
34	44	56	23	12	71	87	93
34	44	23	56	12	71	87	93

Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
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34	44	23	12	56	71	87	93

Bubble sort

44	34	56	71	87	23	12	93
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Bubble sort

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Bubble sort

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Bubble sort

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Bubble sort

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34	44	56	23	12	71	87	93
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34	44	23	12	56	71	87	93
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34	23	44	12	56	71	87	93
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Bubble sort

44	34	56	71	87	23	12	93
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34	44	56	71	23	12	87	93
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34	44	56	23	12	71	87	93
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34	44	23	12	56	71	87	93
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34	23	44	12	56	71	87	93
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Bubble sort

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34	44	56	23	12	71	87	93
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34	44	23	12	56	71	87	93
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34	23	12	44	56	71	87	93
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Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
34	44	56	23	12	71	87	93
34	44	23	12	56	71	87	93
34	23	12	44	56	71	87	93
34	23	12	44	56	71	87	93

Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
34	44	56	23	12	71	87	93
34	44	23	12	56	71	87	93
34	23	12	44	56	71	87	93
34	23	12	44	56	71	87	93

Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
34	44	56	23	12	71	87	93
34	44	23	12	56	71	87	93
34	23	12	44	56	71	87	93
23	34	12	44	56	71	87	93

Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
34	44	56	23	12	71	87	93
34	44	23	12	56	71	87	93
34	23	12	44	56	71	87	93
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Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
34	44	56	23	12	71	87	93
34	44	23	12	56	71	87	93
34	23	12	44	56	71	87	93
23	12	34	44	56	71	87	93

Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
34	44	56	23	12	71	87	93
34	44	23	12	56	71	87	93
34	23	12	44	56	71	87	93
23	12	34	44	56	71	87	93
23	12	34	44	56	71	87	93

Bubble sort

44	34	56	71	87	23	12	93
34	44	56	71	23	12	87	93
34	44	56	23	12	71	87	93
34	44	23	12	56	71	87	93
34	23	12	44	56	71	87	93
23	12	34	44	56	71	87	93
23	12	34	44	56	71	87	93

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34	44	23	12	56	71	87	93
34	23	12	44	56	71	87	93
23	12	34	44	56	71	87	93
12	23	34	44	56	71	87	93

Other sorting techniques

- Two other popular techniques are
 - Merge-sort
 - Quick-sort
- Explore yourself!!