

Session 32: Sorting Algorithms

- Bubble Sort
- Insertion Sort

Sorting Problems

Task: Given a list $S = a_1, a_2, a_3, \dots, a_n$, return a list where the elements are put in increasing order.

Sorting is an important problem because:

- A nontrivial percentage of all computing resources are devoted to sorting (e.g. in large databases)
- An amazing number of fundamentally different algorithms have been invented for sorting
- Sorting algorithms are useful to illustrate the basic notions of computer science.

Bubble Sort

Bubble sort makes multiple passes through a list.

- In one pass, every pair of elements that are found to be out of order are interchanged.
- Since the last element is guaranteed to be the largest after the first pass, in the second pass it needs no more to be inspected.
- In every pass one more element at the end needs to be no more inspected.

Example

3

2

4

1

5

Bubblesort Pseudocode

```
procedure bubblesort( $a_1, \dots, a_n$ : real numbers with  $n \geq 2$ )  
  for  $i := 1$  to  $n - 1$   
    for  $j := 1$  to  $n - i$   
      if  $a_j > a_{j+1}$  then interchange  $a_j$  and  $a_{j+1}$ 
```

Insertion Sort

Insertion sort begins with the 2nd element.

- It compares the 2nd element with the 1st and puts it before the first if it is not larger.
- Next the 3rd element is put into the correct position among the first 3 elements.
- In each subsequent pass, the $j+1^{\text{st}}$ element is put into its correct position among the first $j+1$ elements.
- Linear search is used to find the correct position.

Example

3

2

4

1

5

Insertion Sort Pseudocode

```
procedure insertion sort( $a_1, \dots, a_n$ : real numbers with  $n \geq 2$ )  
  for  $j := 2$  to  $n$   
     $i := 1$   
    while  $a_j > a_i$  and  $i < j$            {move element  $a_j$  to right position}  
       $i := i + 1$   
     $m := a_j$   
    for  $k := 0$  to  $j - i - 1$            {shift elements to make place for  $a_j$ }  
       $a_{j-k} := a_{j-k-1}$   
     $a_i := m$ 
```


Summary

- Sorting is a fundamental operation for data
- Bubble and Insertion Sort are basic algorithms