Session 32: Sorting Algorithms

- Bubble Sort
- Insertion Sort

Sorting Problems

Task: Given a list S = a_1, a_2, a_3, …, 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.

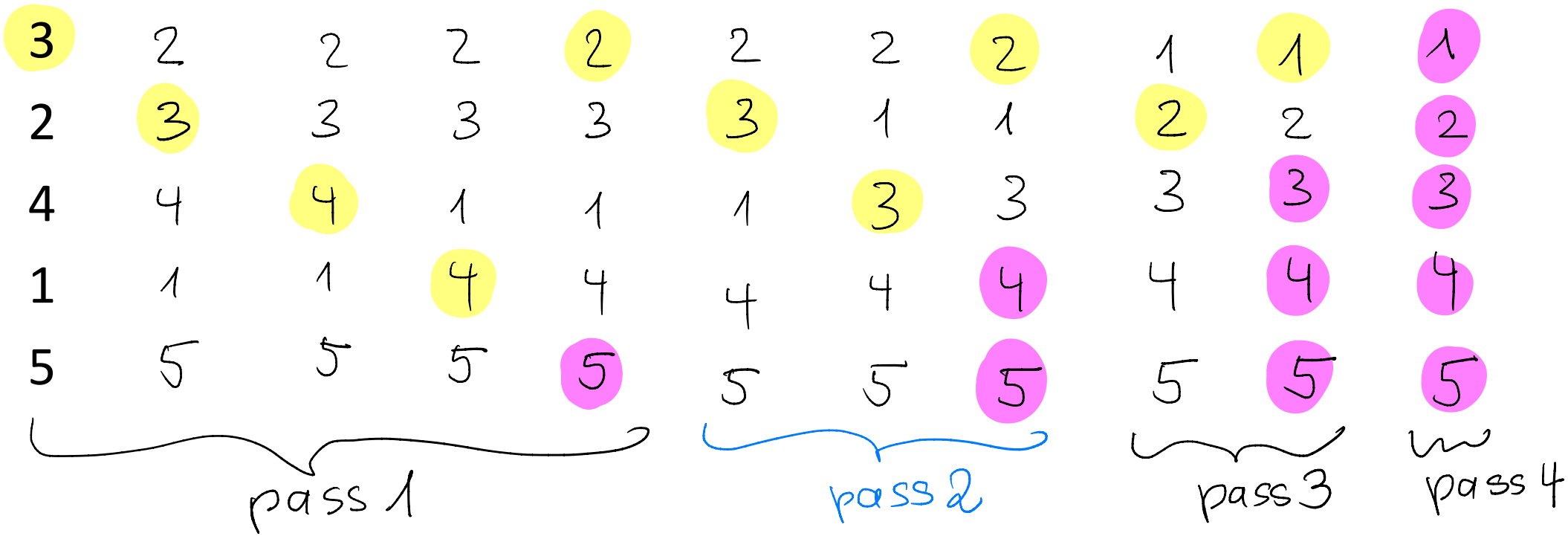
Bubble Sort

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.

Why?

Example


3 2 2 2 2
2 3 3 3 3
4 4 4 1 1
1 1 1 4 4
5 5 5 5 5
pass 1
2 2 2
3 1 1
1 3 3
4 4 4
5 5 5
pass 2
1 1 1
2 2 2
3 3 3
4 4 4
5 5 5
pass 3
pass 4

Bubblesort Pseudocode

procedure *bubblesort*(a_1,…,a_n: real numbers with $n \geq 2$)

  for i := 1 to $n - 1$

    for j := 1 to $n - i$

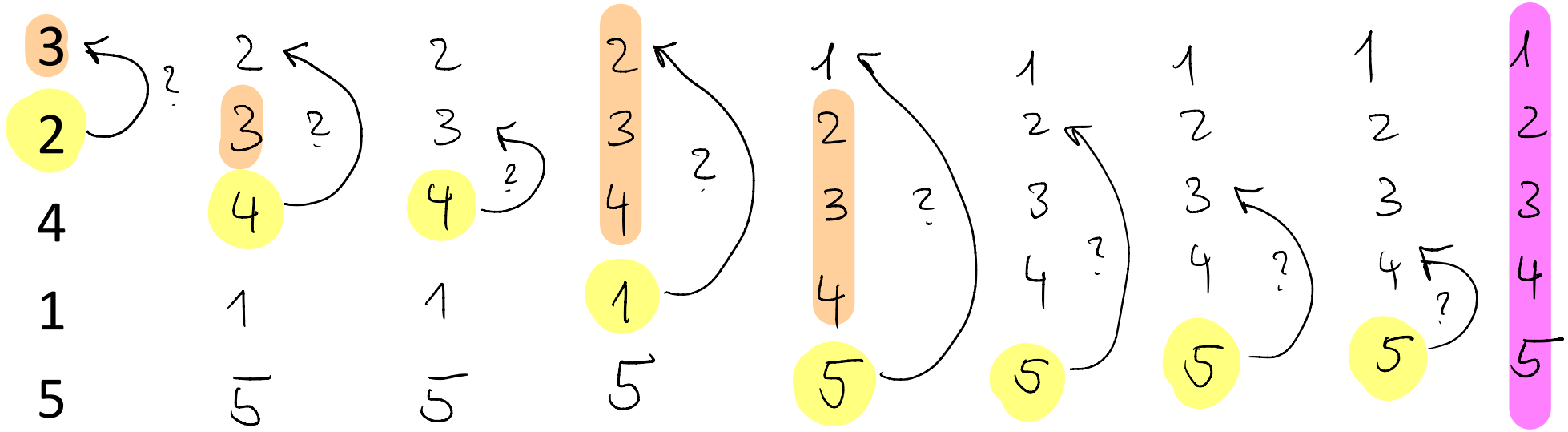
      if $a_j > a_{j+1}$ **then** interchange a_j and a_{j+1}

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+1st element is put into its correct position among the first j+1 elements.
- Linear search is used to find the correct position.

Example



Insertion Sort Pseudocode

```
procedure insertion sort(a_1,...,a_n: real numbers with n ≥ 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_i}
            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