Sorting an array

Johan Montelius

KTH

HT23

why, when and how

- Working with sorted data is often more efficent (searching).
- Sort data and keep sorted data sorted.
- ... todays lecture.

why, when and how

- Working with sorted data is often more efficent (searching).
- Sort data and keep sorted data sorted.
- ... todays lecture.

why, when and how

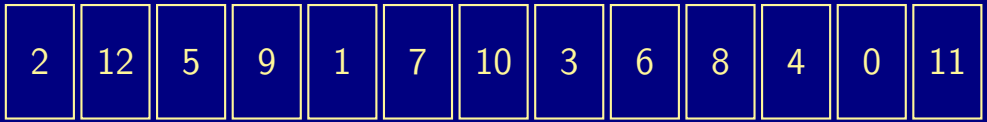
- Working with sorted data is often more efficent (searching).
- Sort data and keep sorted data sorted.
- ... todays lecture.

why, when and how

- Working with sorted data is often more efficent (searching).
- Sort data and keep sorted data sorted.
- ... todays lecture.

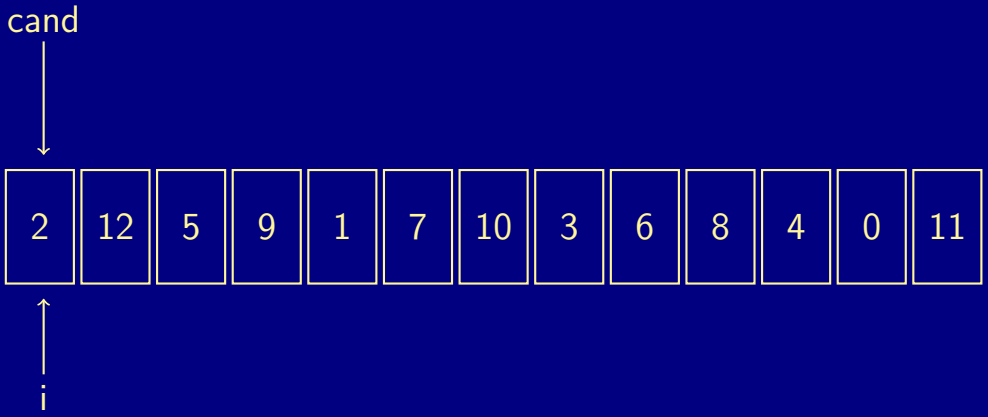
selection sort

selection sort

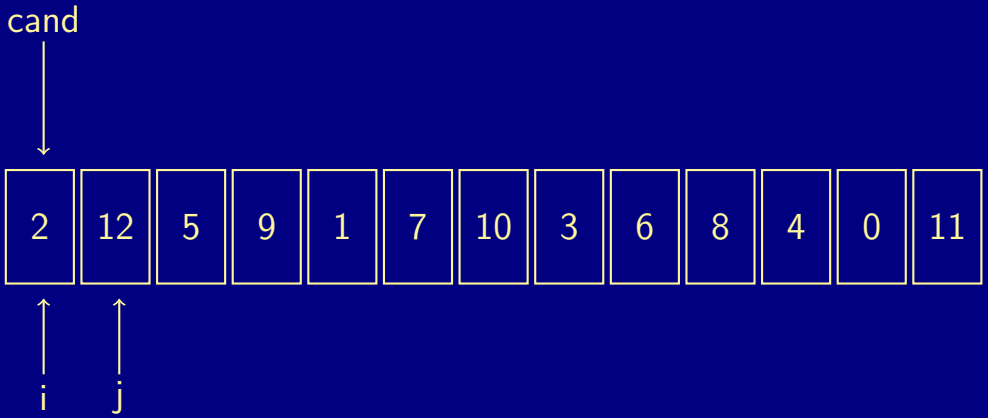


selection sort

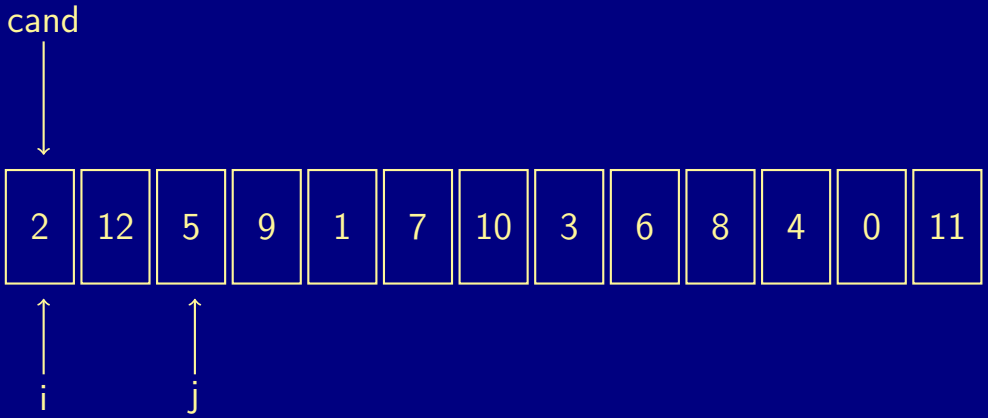
selection sort



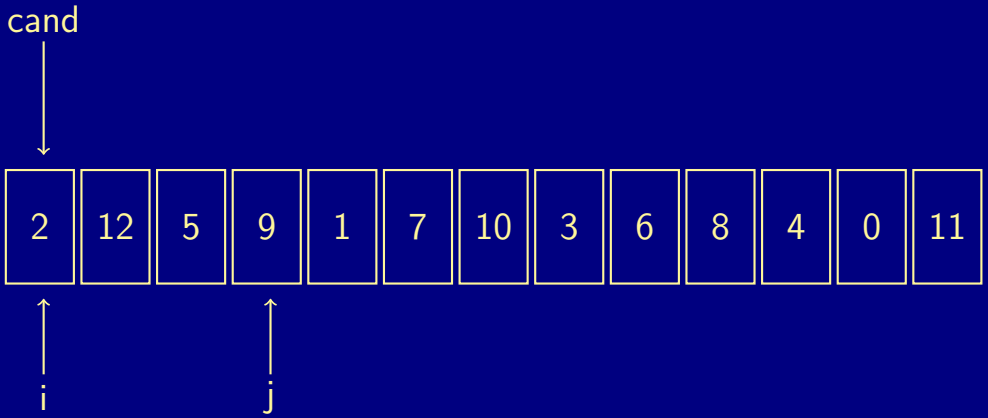
selection sort



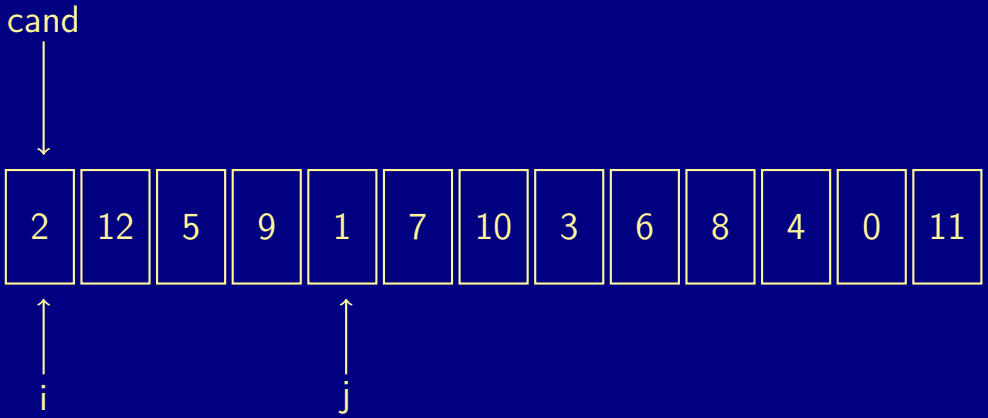
selection sort



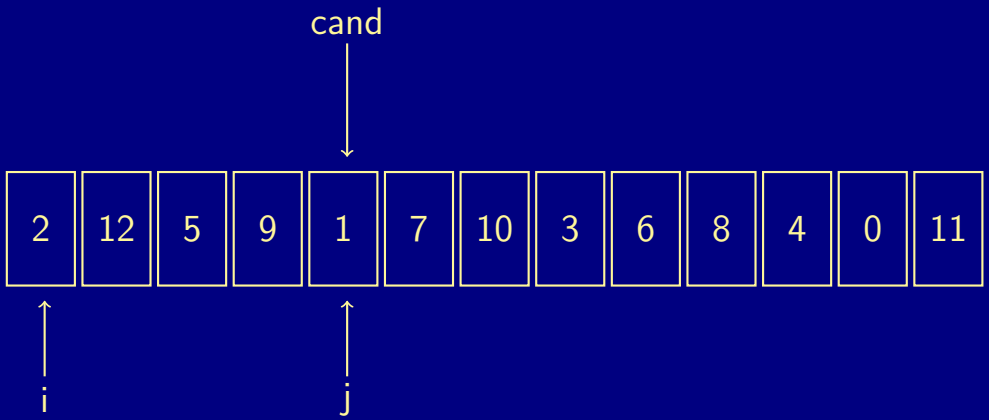
selection sort



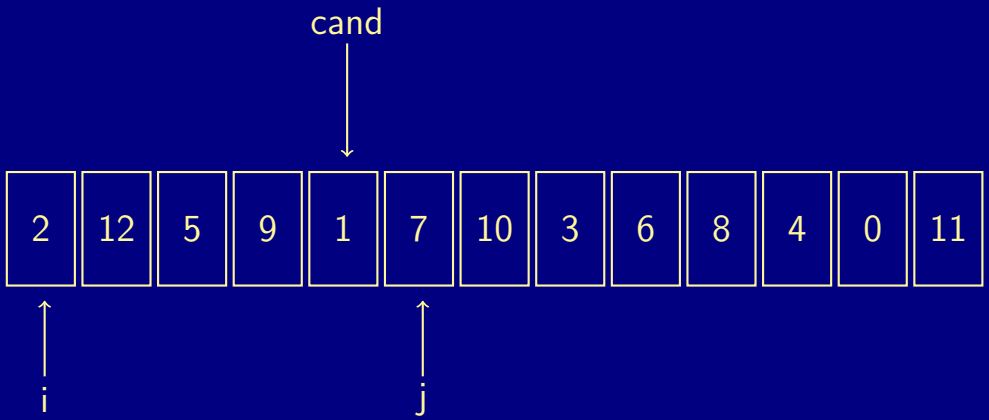
selection sort



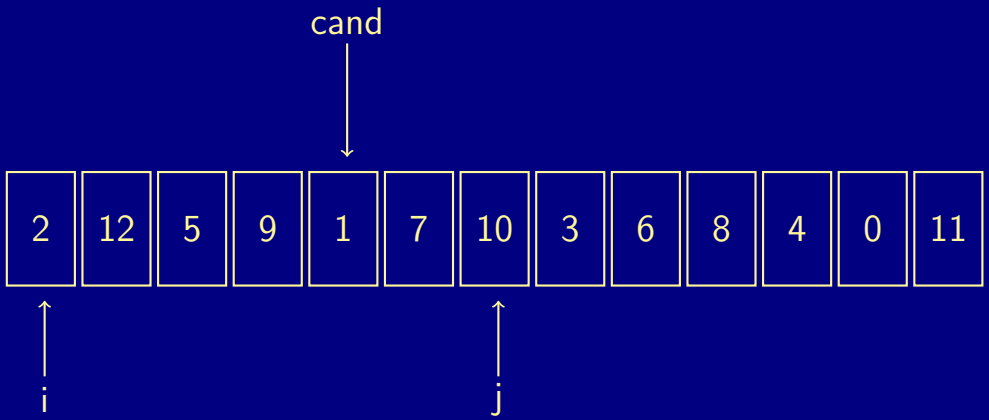
selection sort



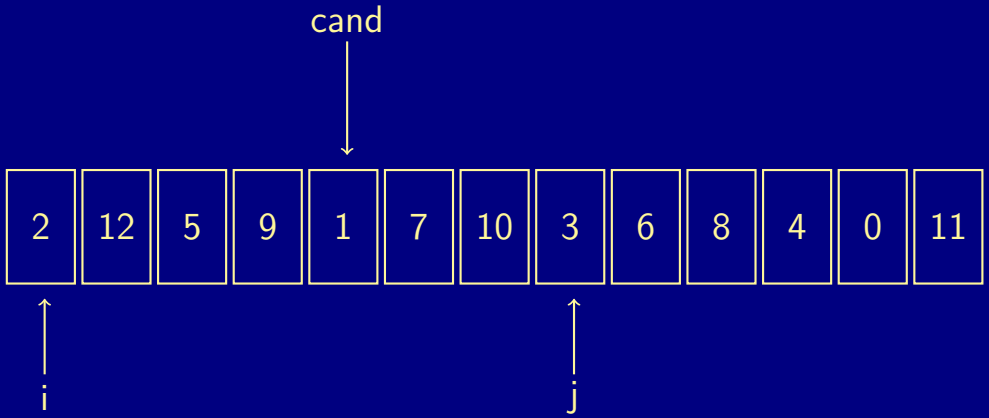
selection sort



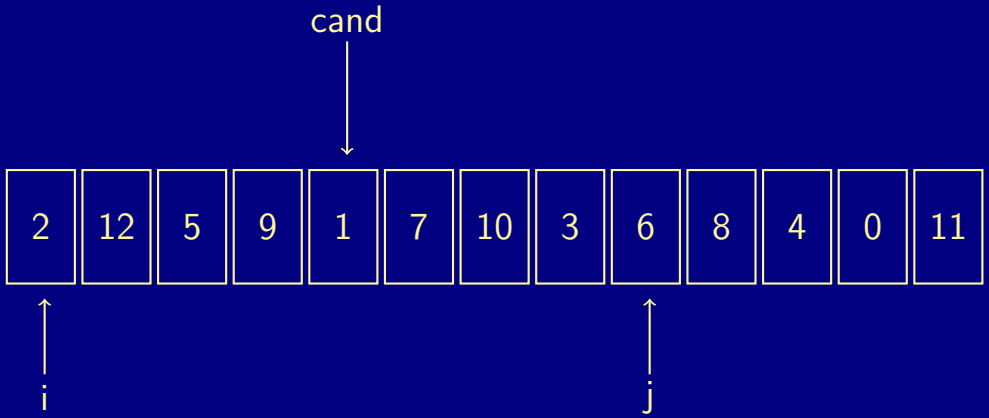
selection sort



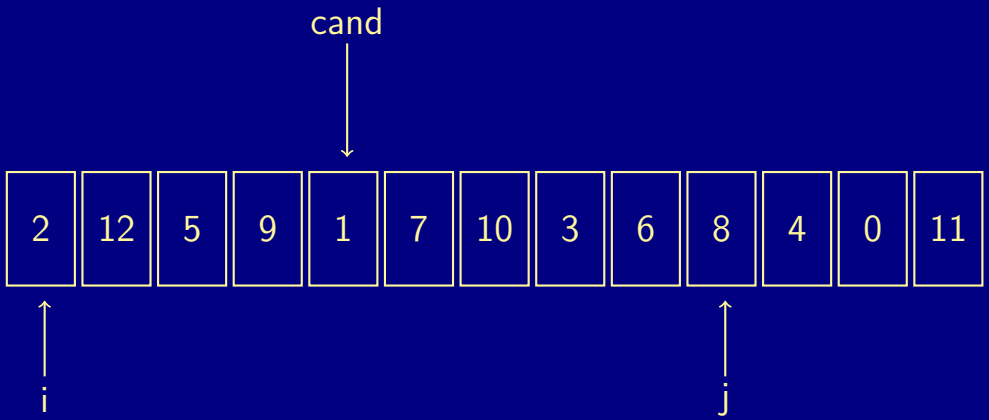
selection sort



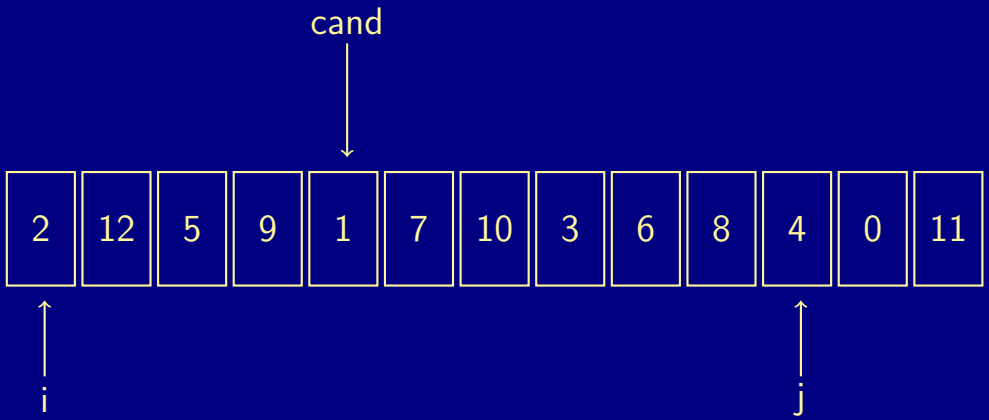
selection sort



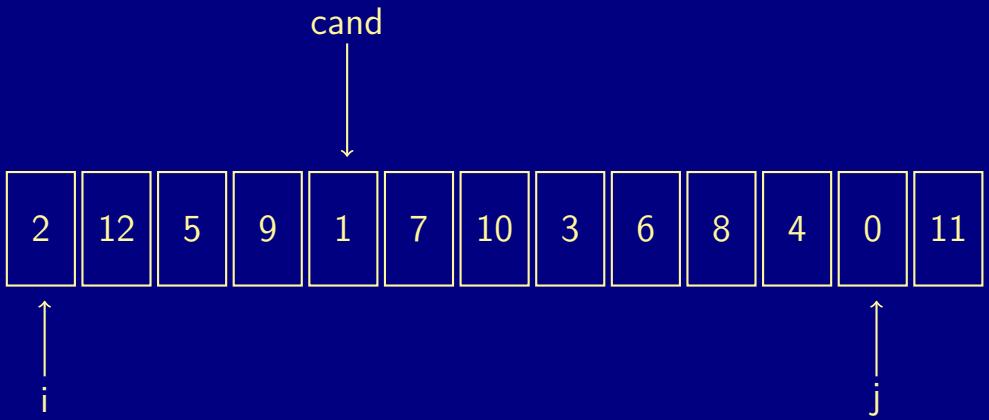
selection sort



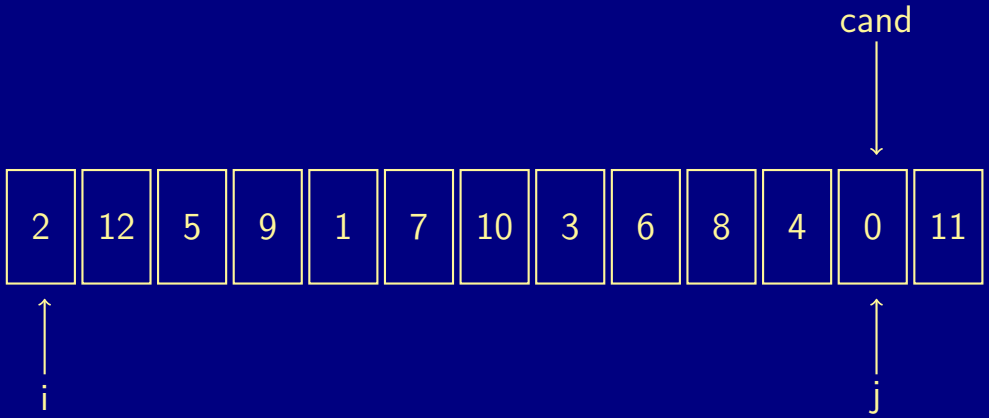
selection sort



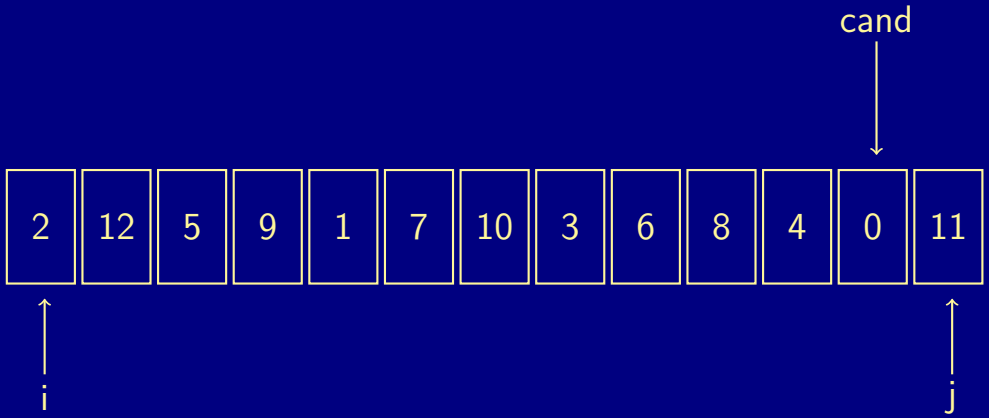
selection sort



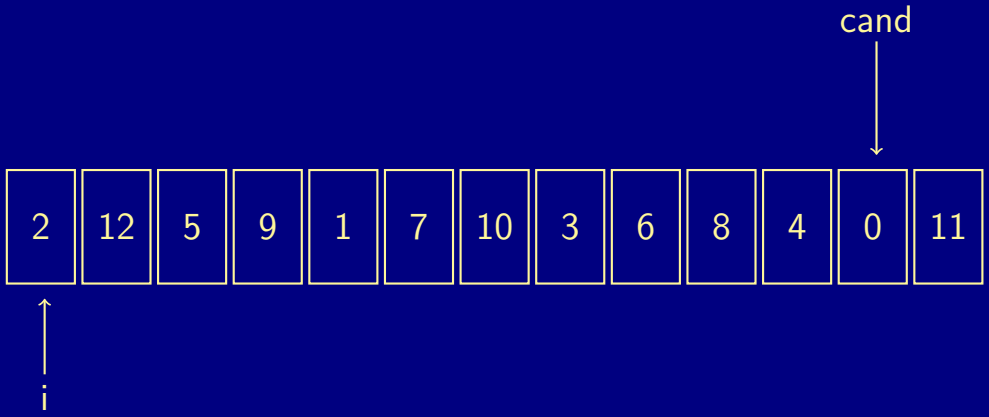
selection sort



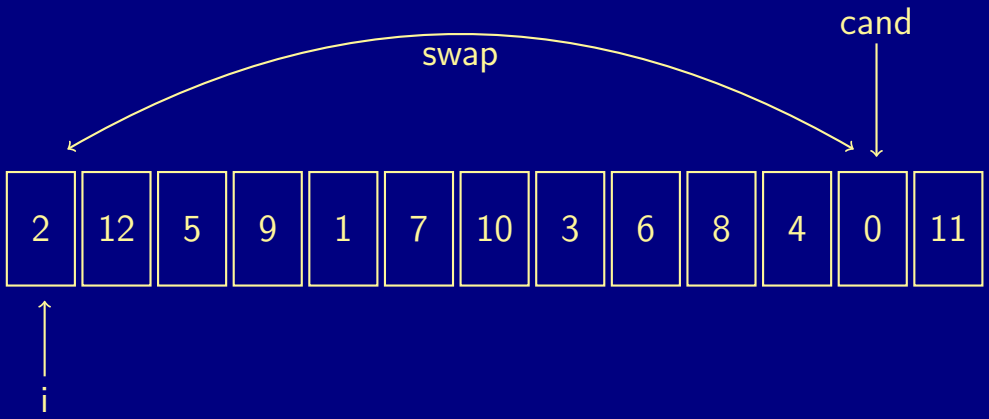
selection sort



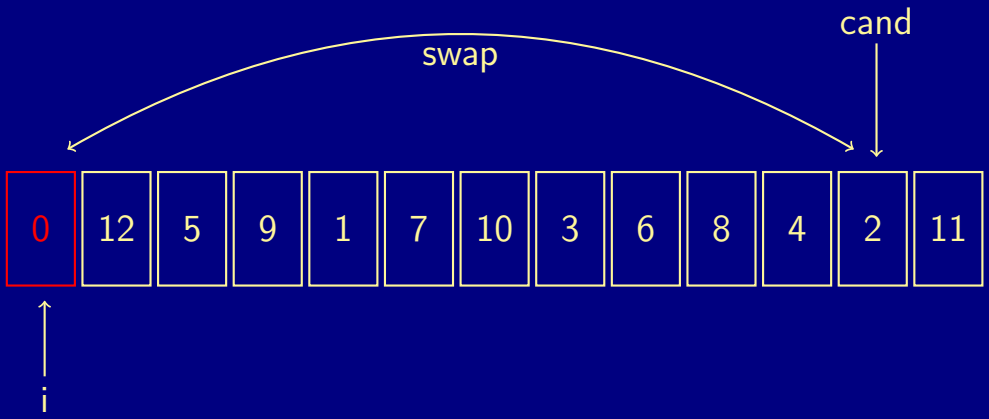
selection sort



selection sort



selection sort



selection sort

selection sort

selection sort

selection sort

selection sort

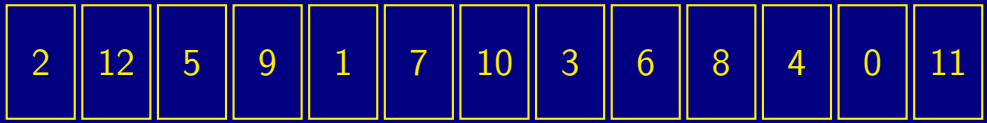
selection sort

selection sort

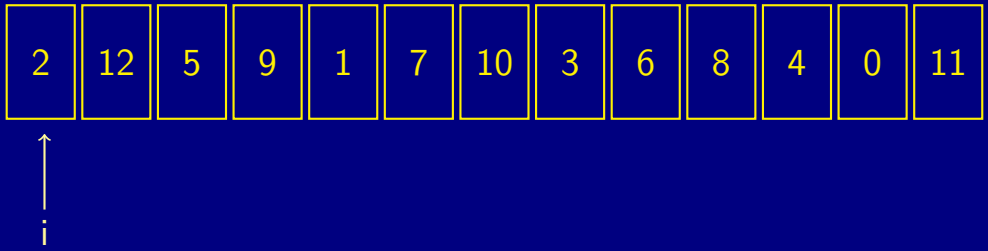
- How many compare operations?
- How many swap operations?
- Any special cases?

insertion sort

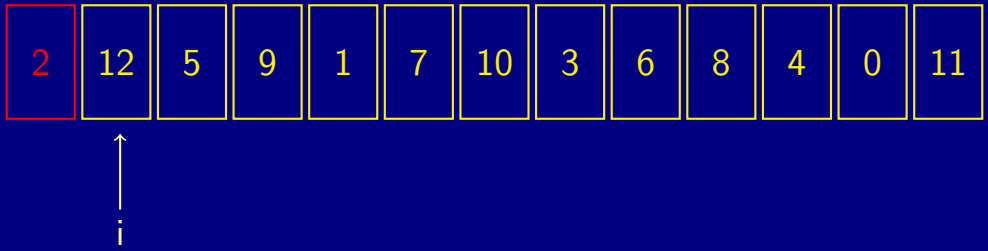
insertion sort



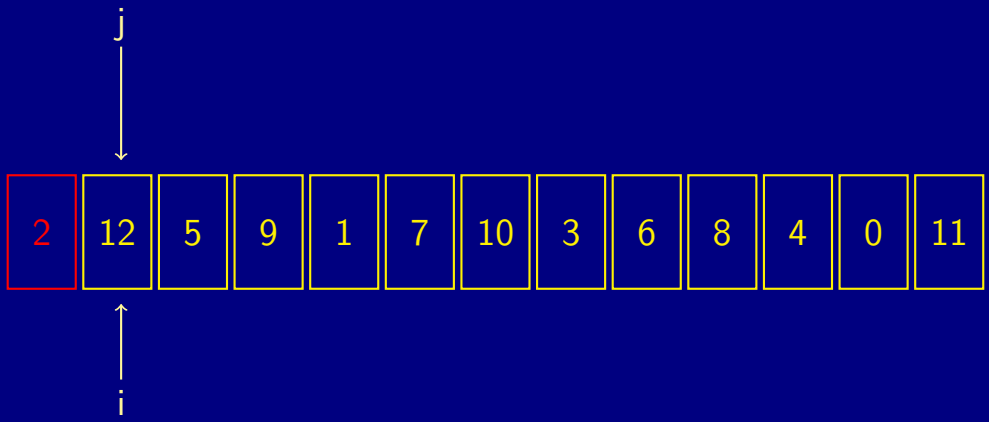
insertion sort



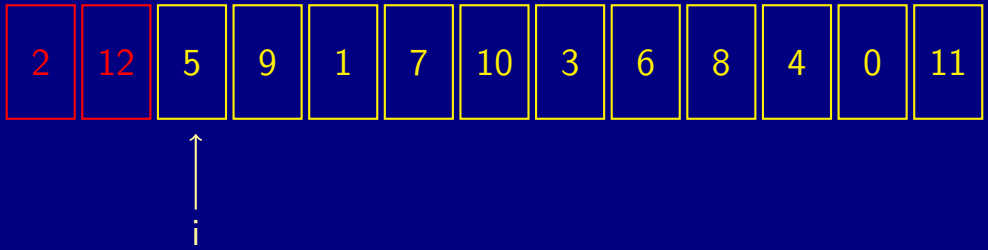
insertion sort



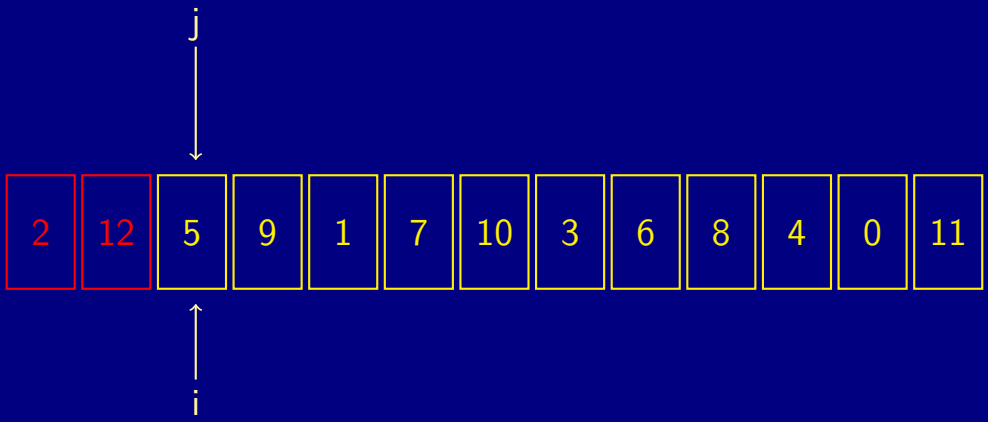
insertion sort



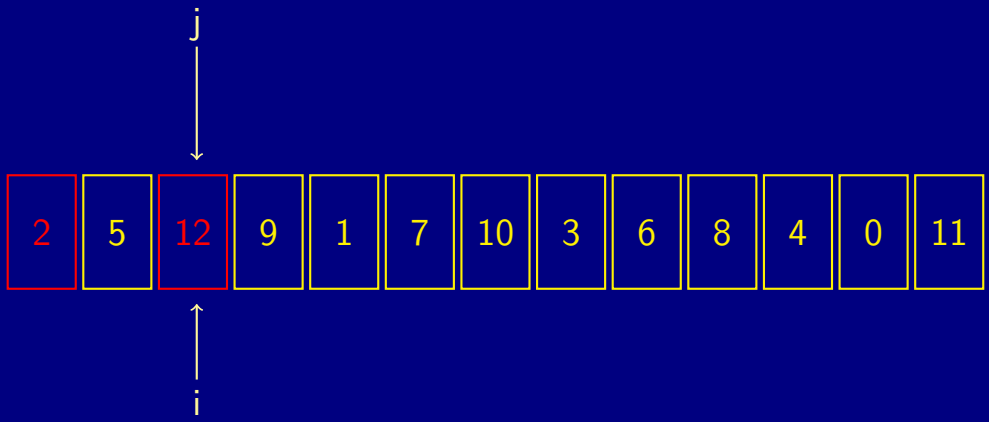
insertion sort



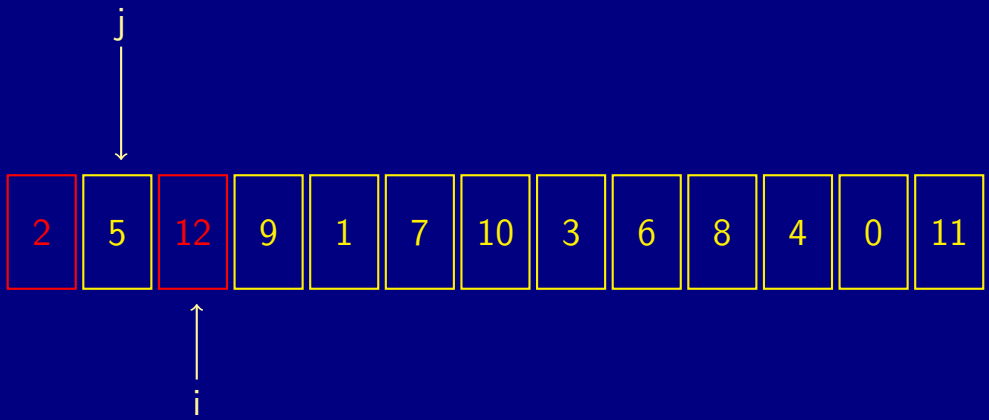
insertion sort



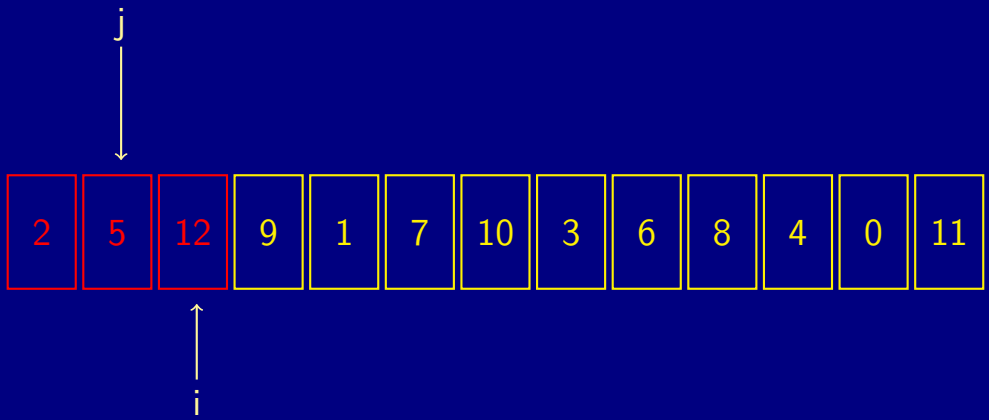
insertion sort



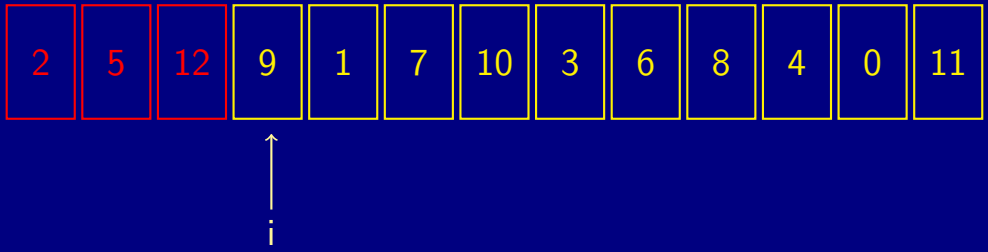
insertion sort



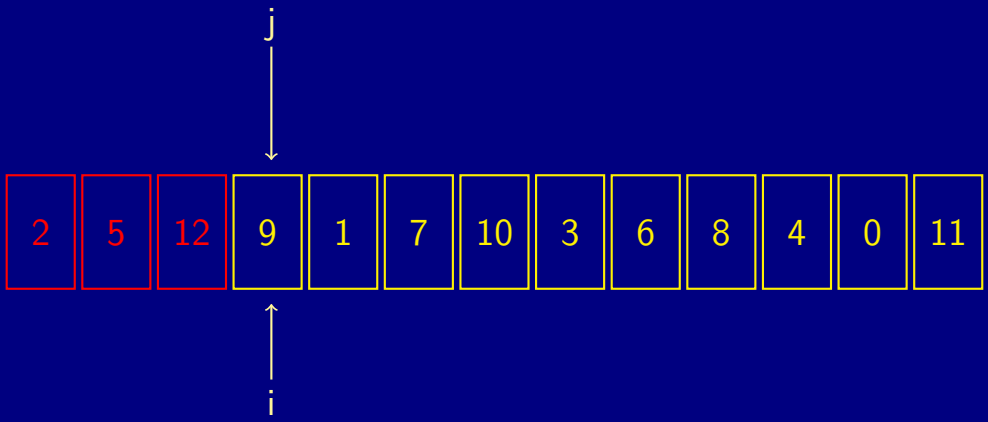
insertion sort



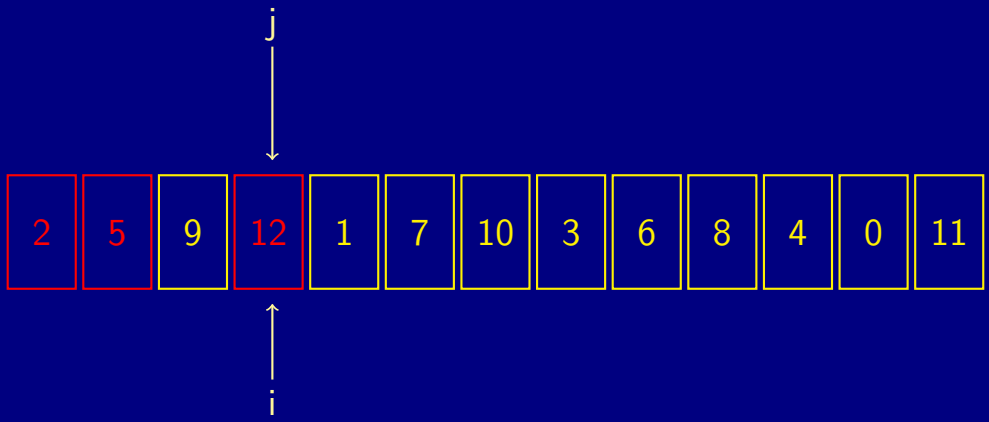
insertion sort



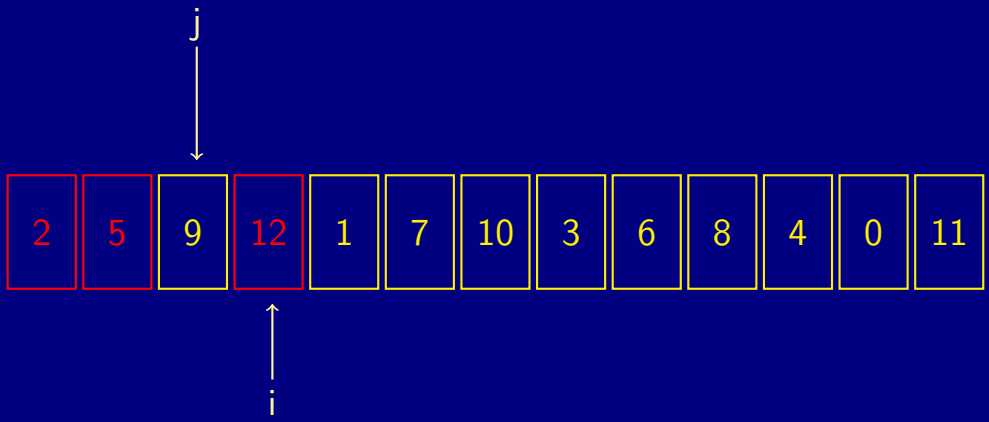
insertion sort



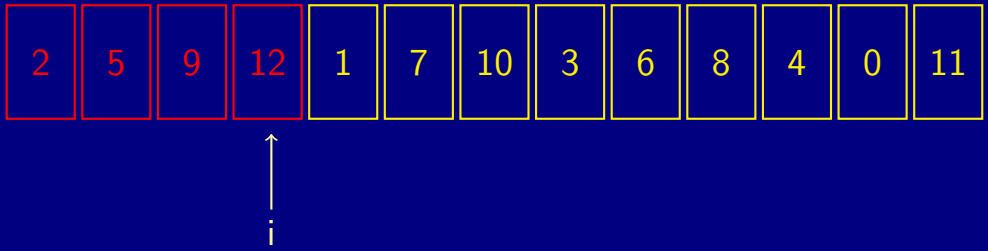
insertion sort



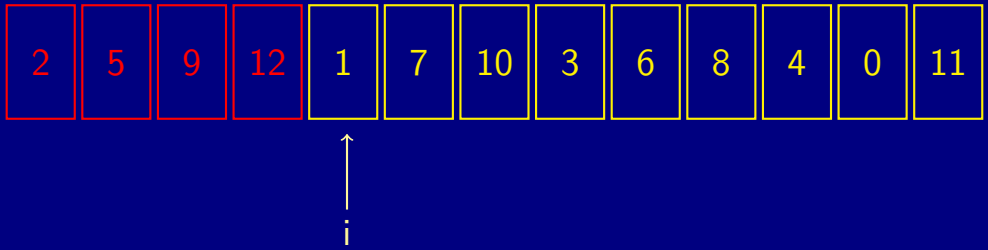
insertion sort



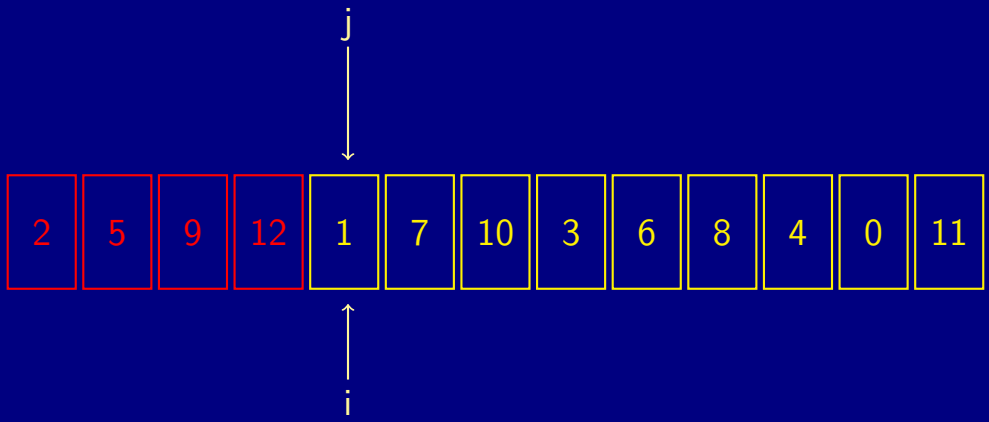
insertion sort



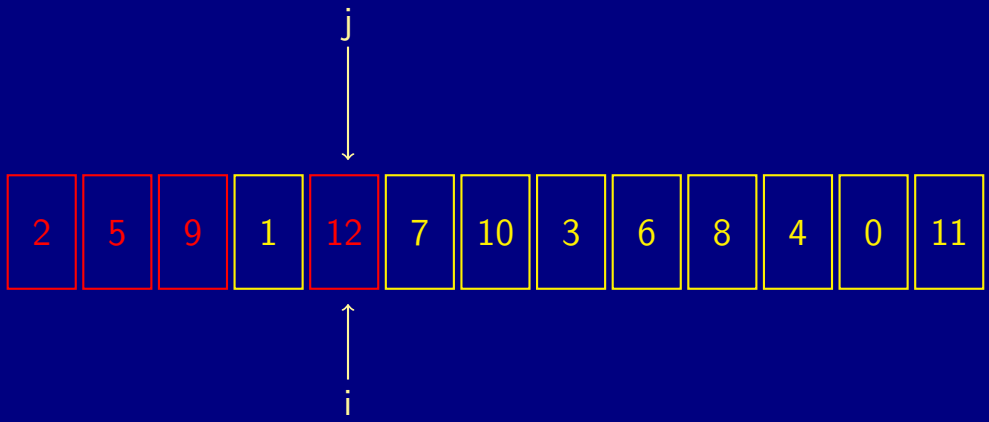
insertion sort



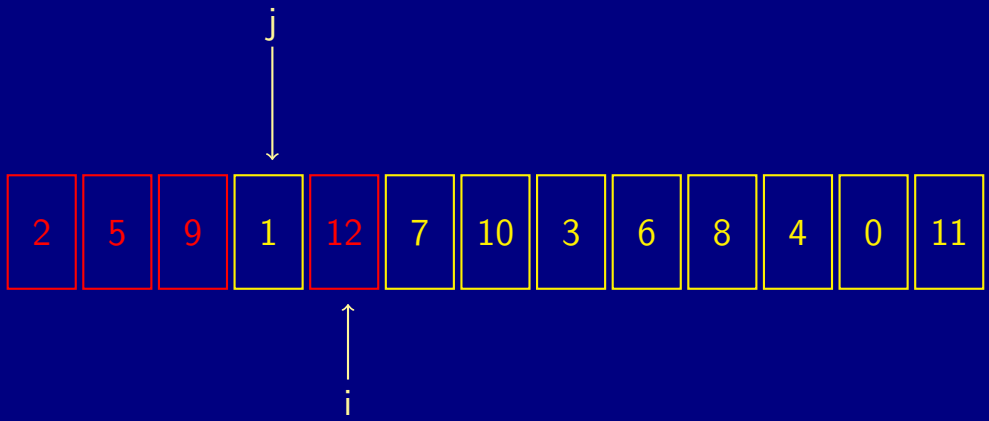
insertion sort



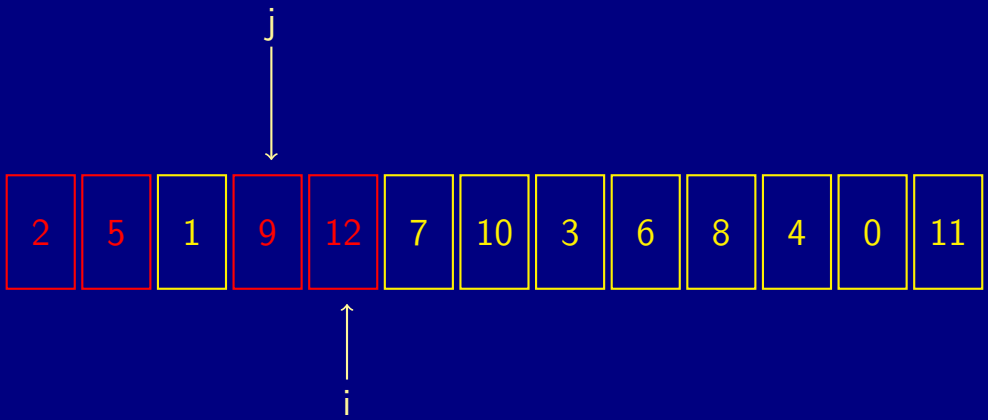
insertion sort



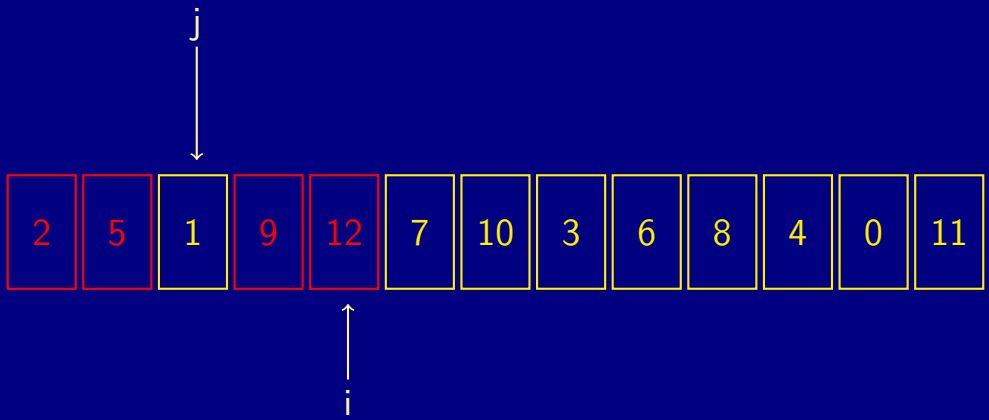
insertion sort



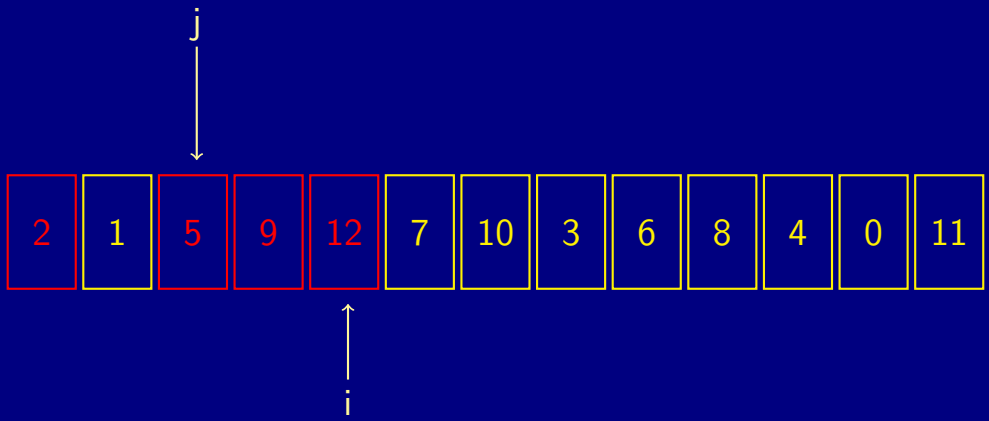
insertion sort



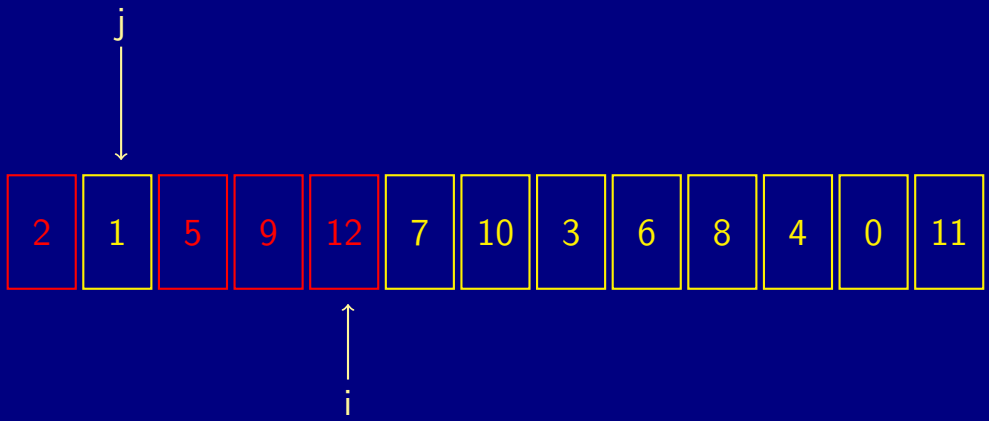
insertion sort



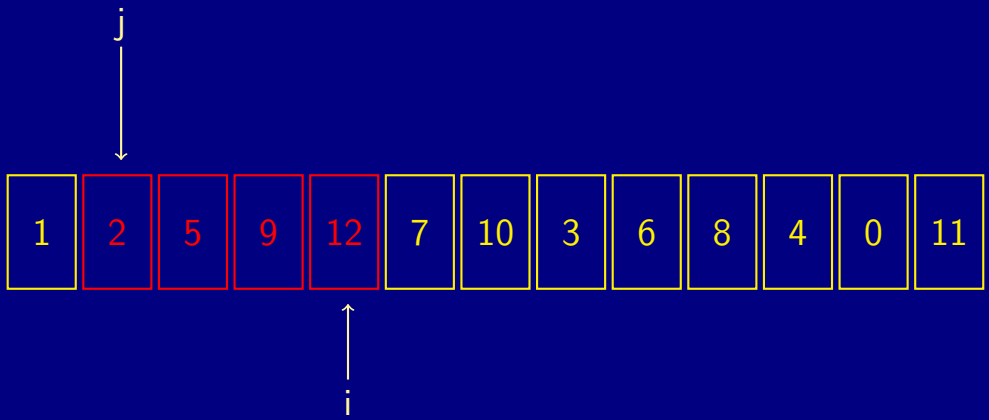
insertion sort



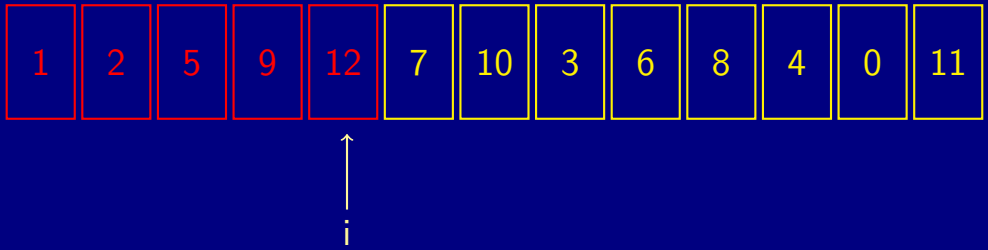
insertion sort



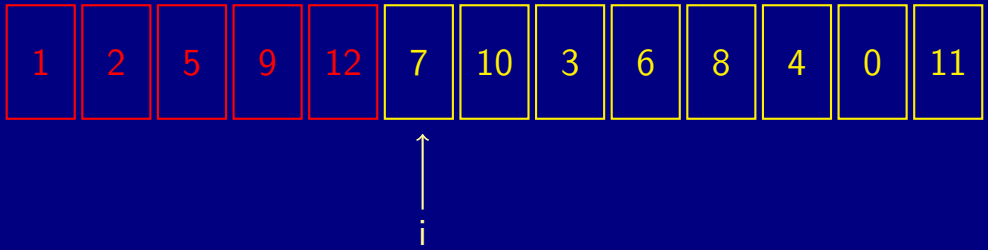
insertion sort



insertion sort



insertion sort



insertion sort

- How many compare operations?
- How many swap operations?
- Any special cases?

Can we do better?

Divide and conquer.

- divide array in two
- sort first part
- sort second part
- merge the two parts

Can we do better?

Divide and conquer.

- divide array in two
- sort first part
- sort second part
- merge the two parts

Can we do better?

Divide and conquer.

- divide array in two
- sort first part
- sort second part
- merge the two parts

Can we do better?

Divide and conquer.

- divide array in two
- sort first part
- sort second part
- merge the two parts

Can we do better?

Divide and conquer.

- divide array in two
- sort first part
- sort second part
- merge the two parts

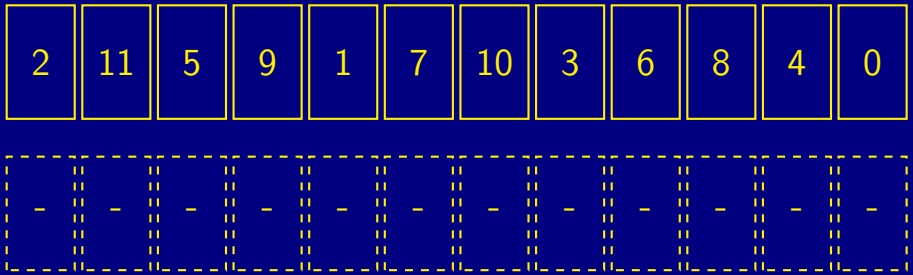
Can we do better?

Divide and conquer.

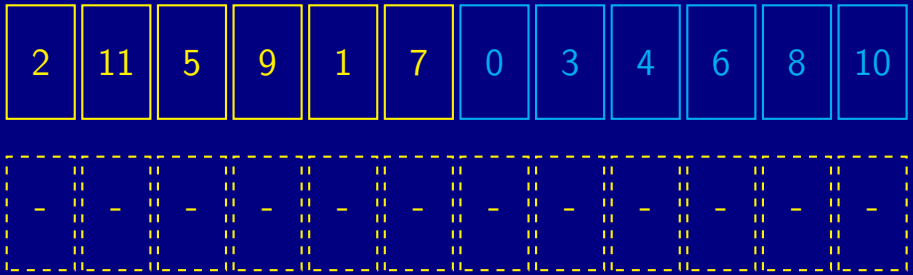
- divide array in two
- sort first part
- sort second part
- merge the two parts

merge-sort

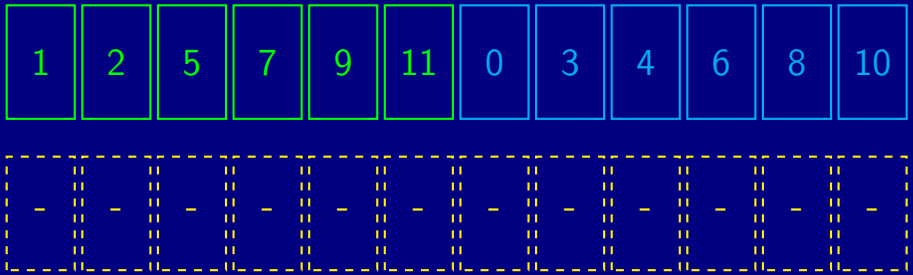
merge-sort



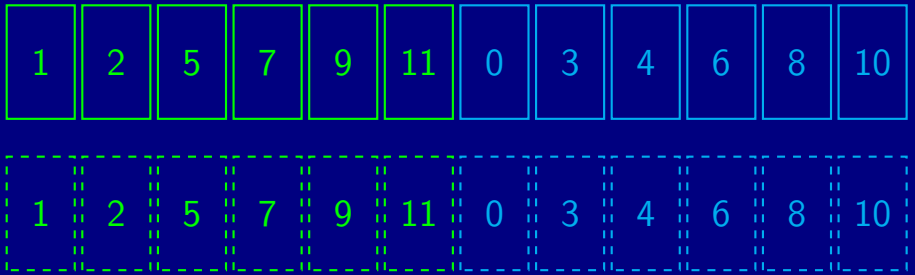
merge-sort



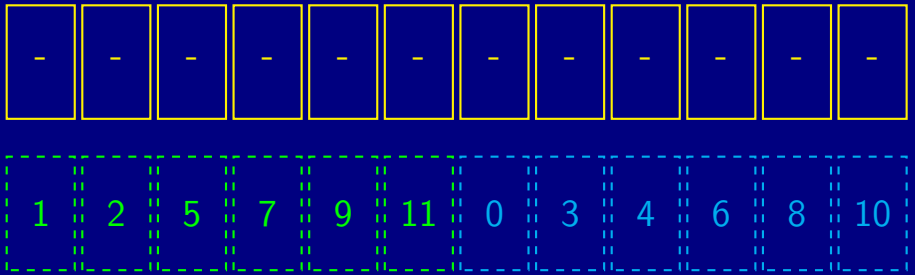
merge-sort



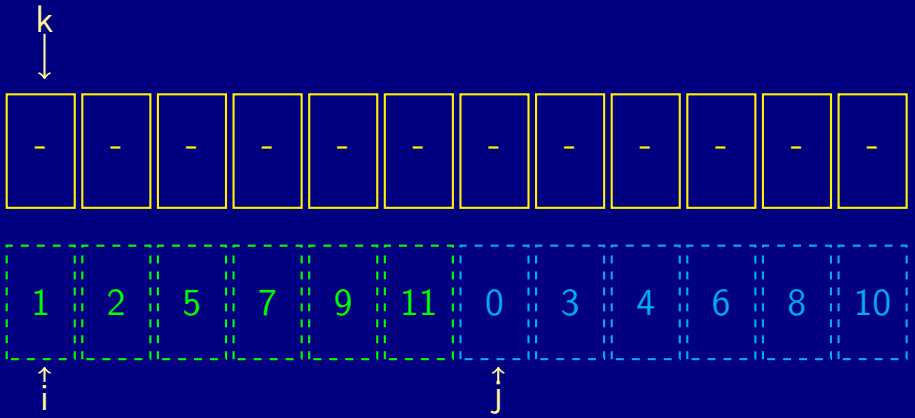
merge-sort



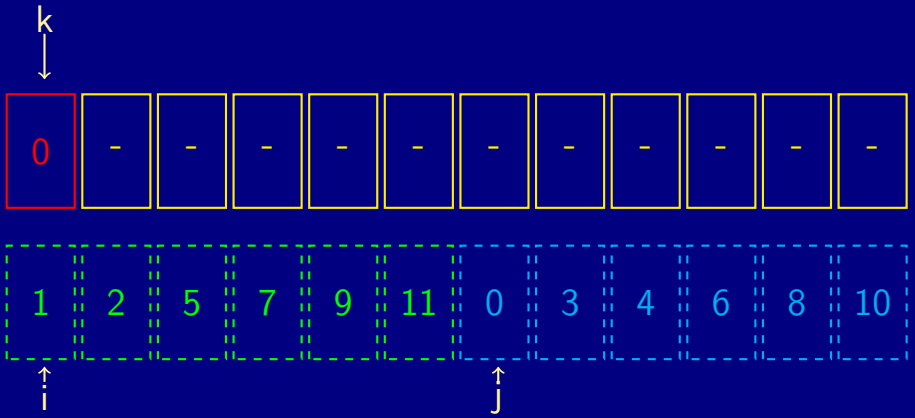
merge-sort



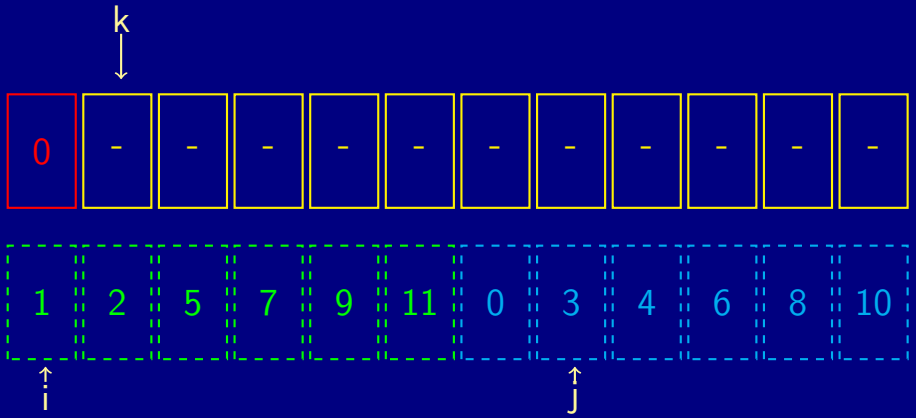
merge-sort



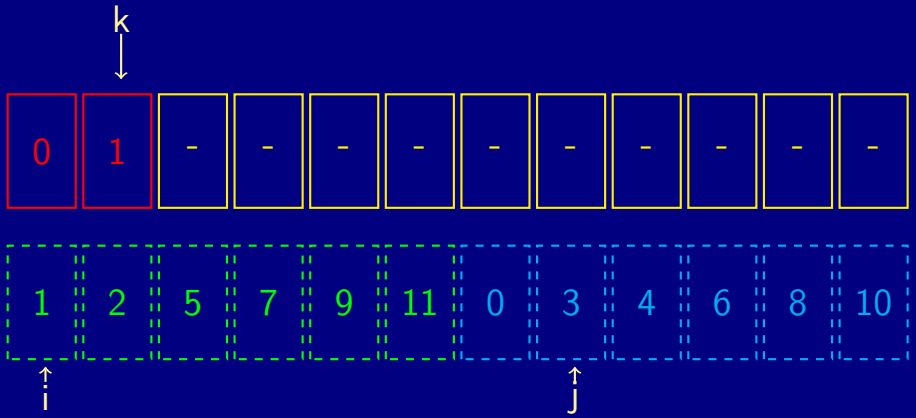
merge-sort



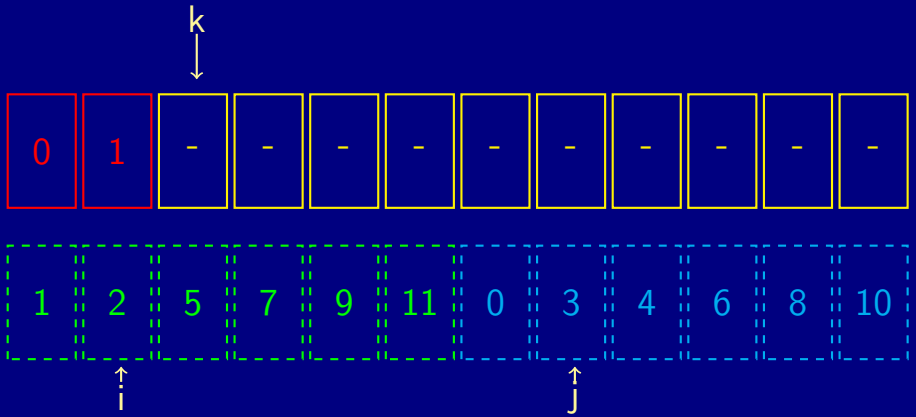
merge-sort



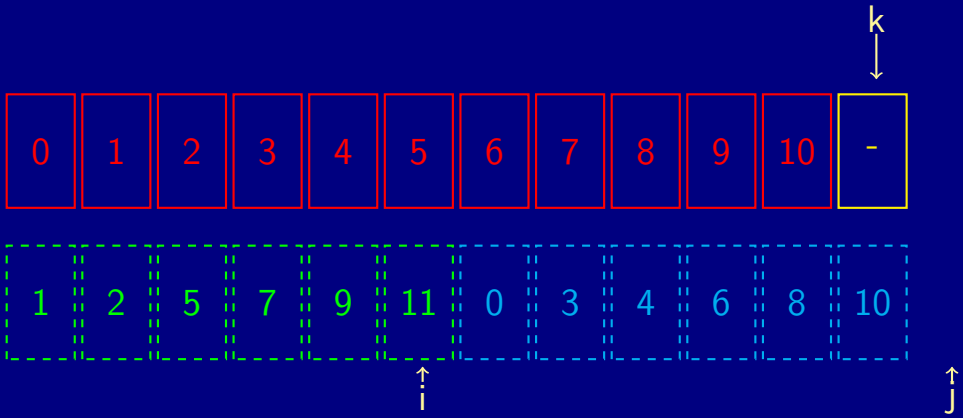
merge-sort



merge-sort

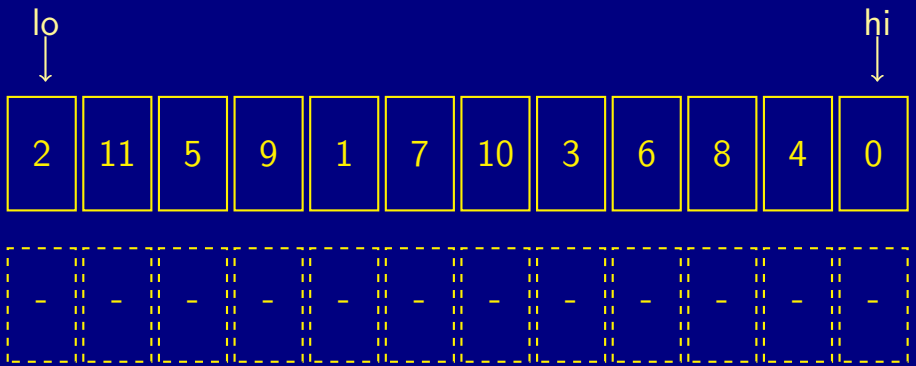


merge-sort

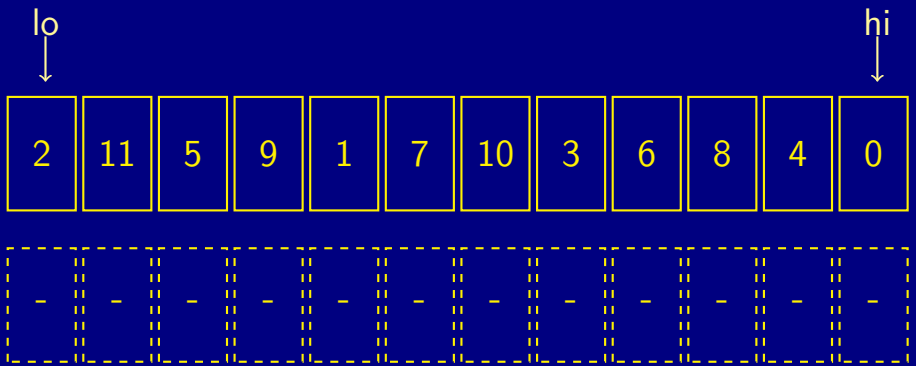


merge-sort

one small problem

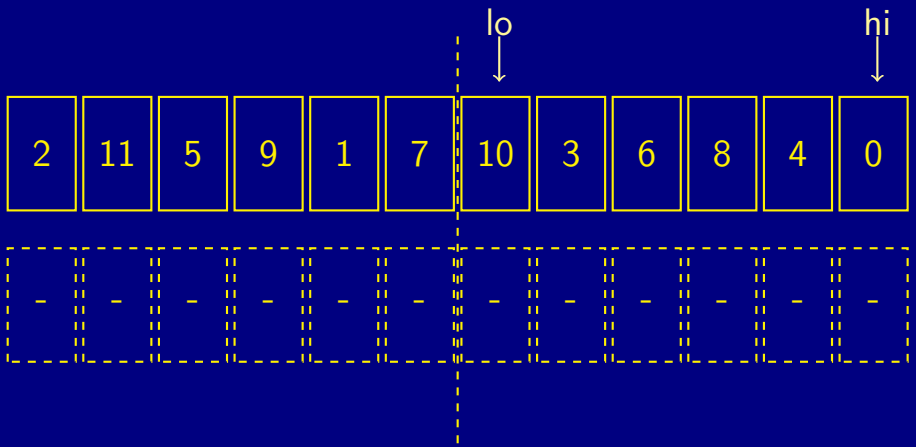


one small problem



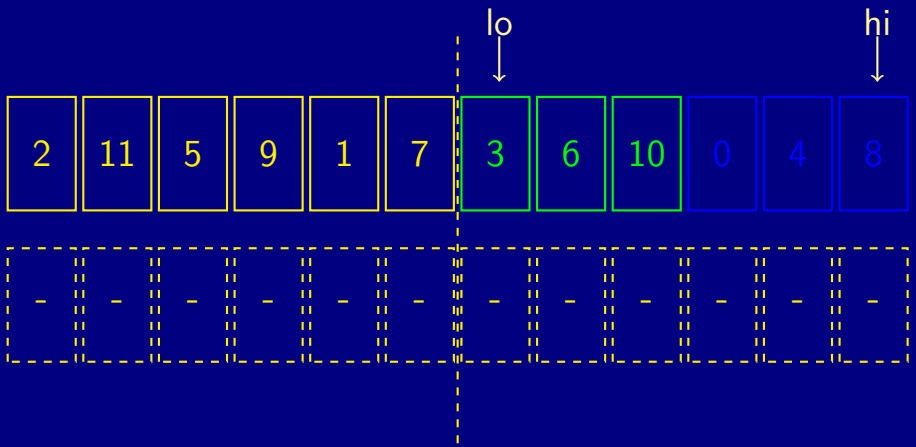
How do we sort the two smaller arrays?

one small problem



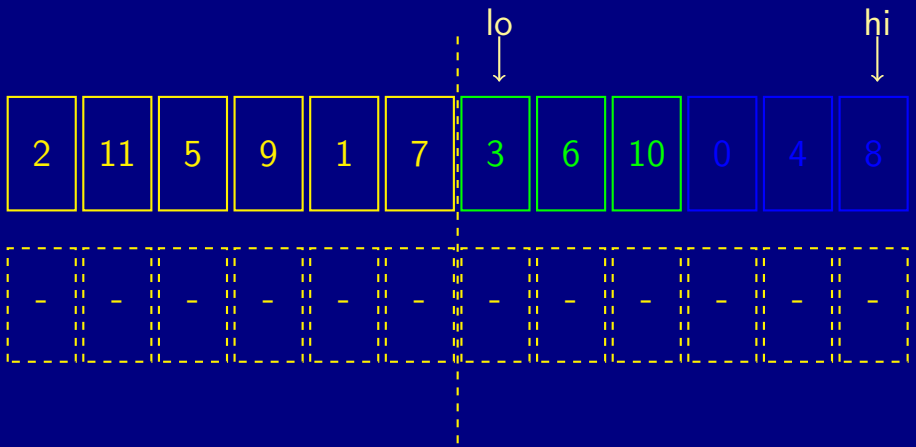
How do we sort the two smaller arrays?

one small problem



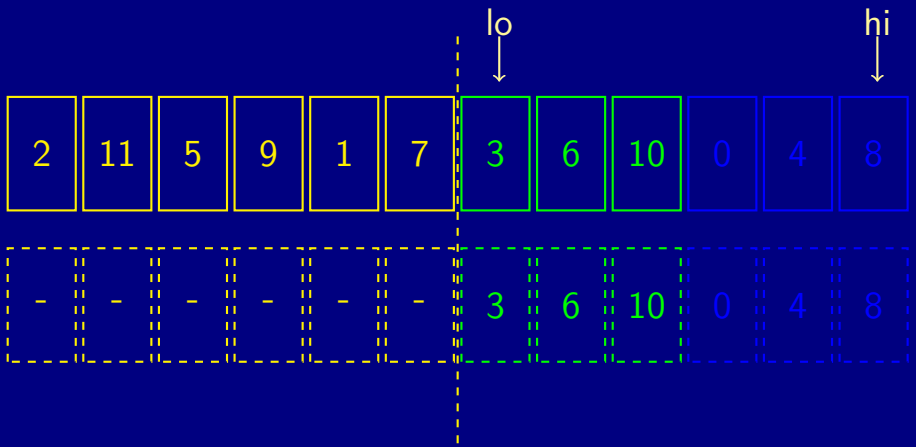
How do we sort the two smaller arrays?

one small problem



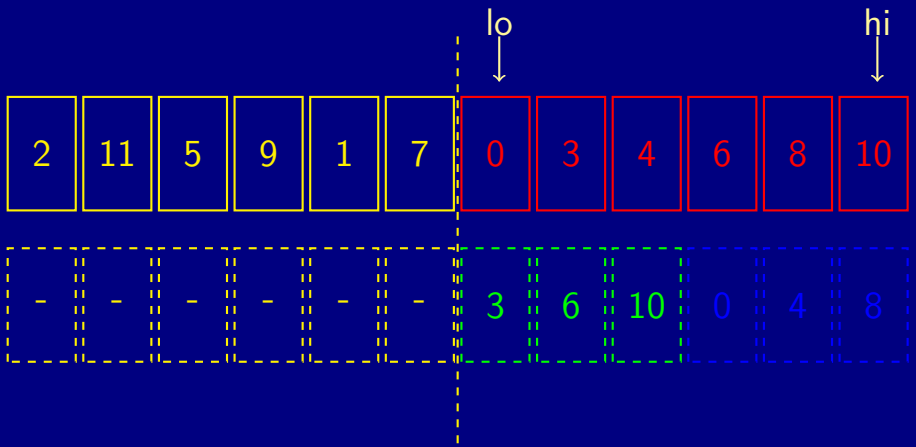
How do we sort the two smaller arrays?

one small problem



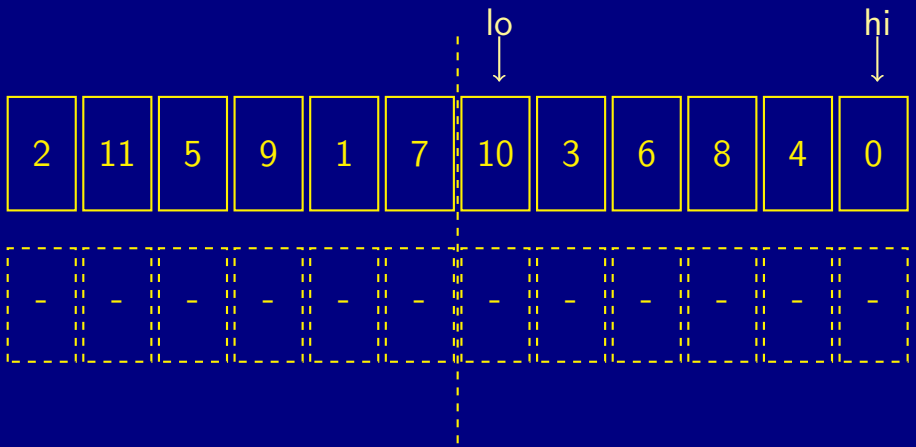
How do we sort the two smaller arrays?

one small problem

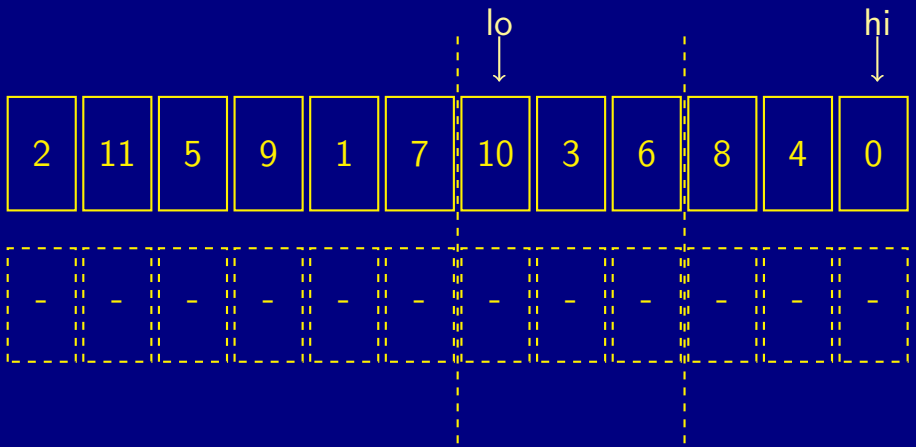


How do we sort the two smaller arrays?

.... one small problem

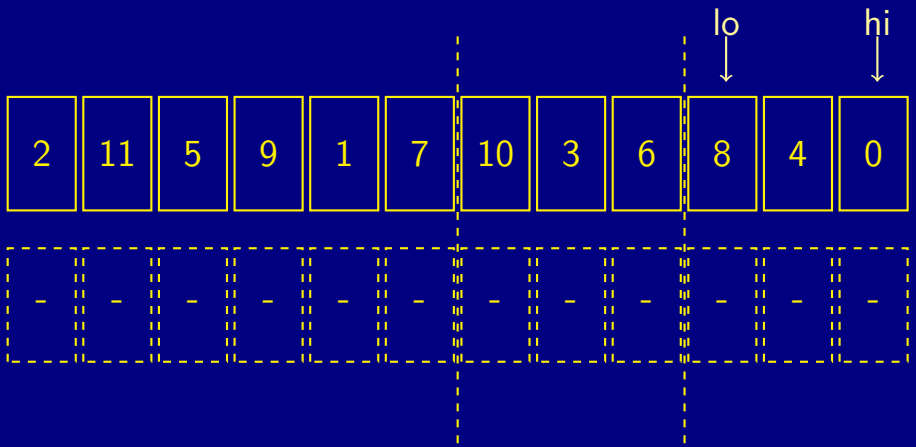


.... one small problem



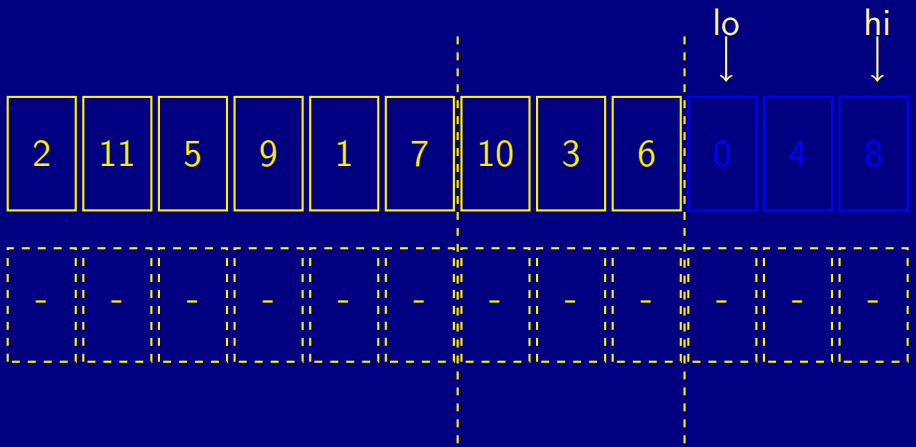
.... how do we sort the two smaller arrays?

.... one small problem



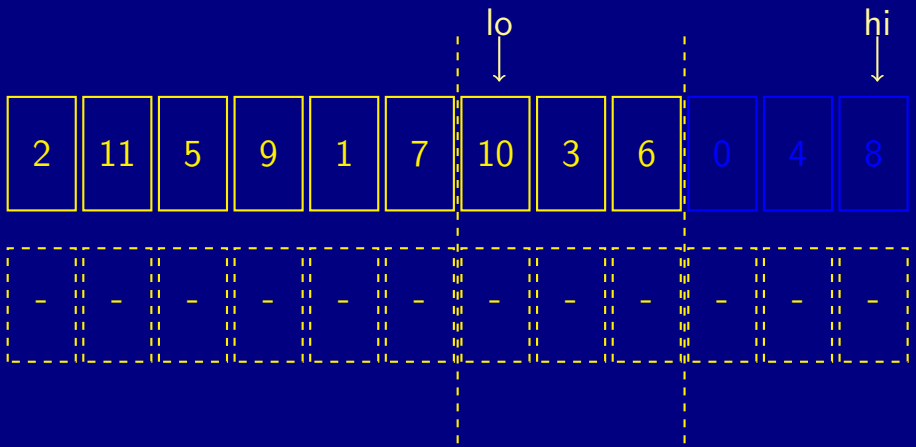
.... how do we sort the two smaller arrays?

.... one small problem



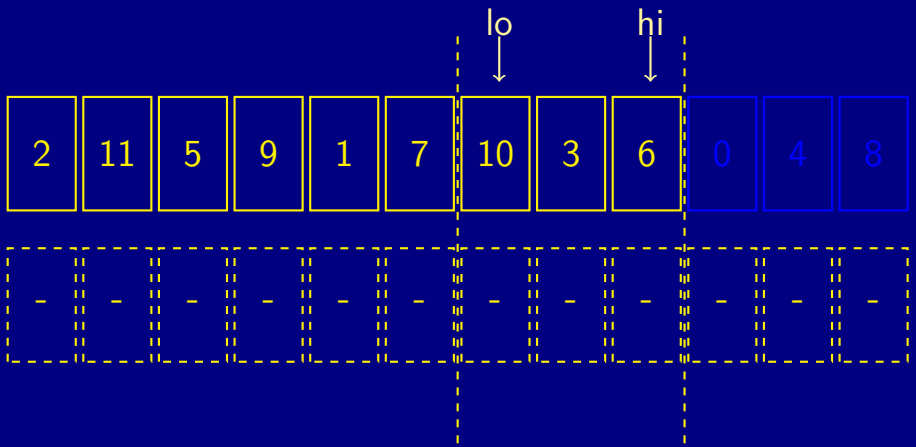
.... how do we sort the two smaller arrays?

.... one small problem



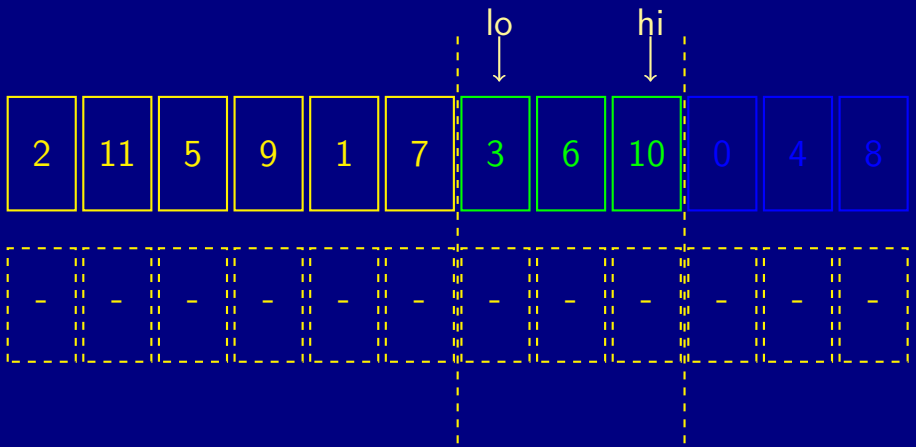
.... how do we sort the two smaller arrays?

.... one small problem



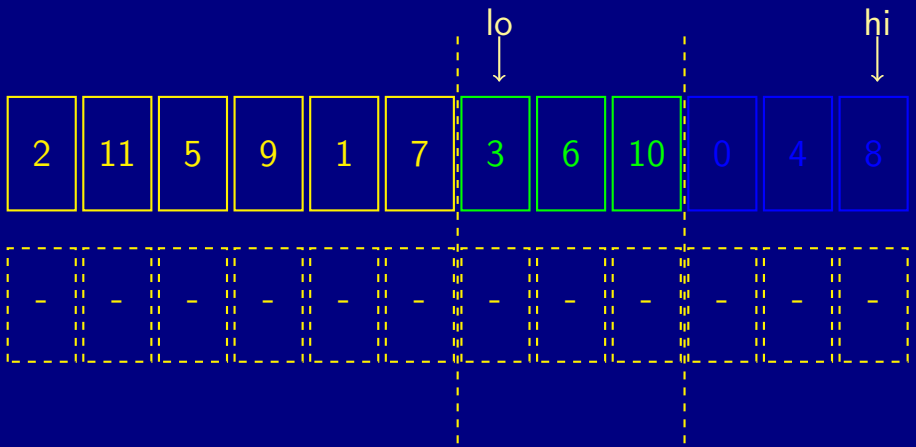
.... how do we sort the two smaller arrays?

.... one small problem



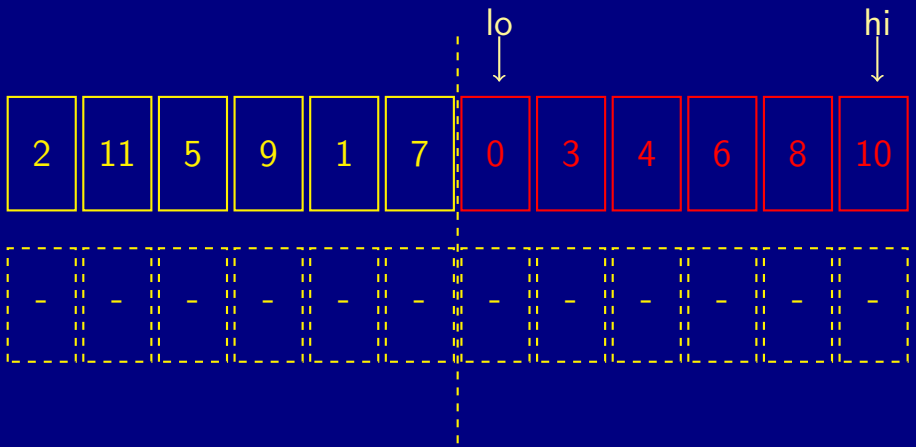
.... how do we sort the two smaller arrays?

.... one small problem



.... how do we sort the two smaller arrays?

.... one small problem



.... how do we sort the two smaller arrays?

Recursion

Recursion

- If you can sort an array with up to n elements

Recursion

- If you can sort an array with up to n elements
- and can merge two sorted arrays

Recursion

- If you can sort an array with up to n elements
- and can merge two sorted arrays
- then you can sort an array of up to $2 \times n$ elements.

Recursion

- If you can sort an array with up to n elements
- and can merge two sorted arrays
- then you can sort an array of up to $2 \times n$ elements.
- Since an array with only one element is sorted

Recursion

- If you can sort an array with up to n elements
- and can merge two sorted arrays
- then you can sort an array of up to $2 \times n$ elements.
- Since an array with only one element is sorted
- then you can sort an array of arbitrary length.

sum of elements

```
public static int sum(int[] arr) {
   int sum = 0;
   for(int i = 0; i < arr.length, i++)
     sum += arr[i];
   return sum;
 }
```

sum of elements

```
public static int sum(int[] arr) {
   return sum(arr, 0, arr.length-1);
}

private static int sum(int[] arr, int from, int to) {

  if (from == to )
    return arr[from];
  else
    return arr[from] + sum(arr, from+1, to);
}
```

sum of elements

```
private static int sum(int[] arr, int from, int to) {

  if (from == to )
    return arr[from];
  else {
    int mid = (from + to)/2;
    return sum(arr, from, mid) + sum(arr, mid+1, to);
  }
}
```

binary search revisited

```
public static boolean search(int[] array, int key) {
  int min = 0;
  int max = array.length -1;
  while (true) {
    int mid = (min + max)/2;
    if (array[mid] == key) return true;
    if ((array[mid] > key) & (mid > min))
      max = mid -1;
    else if (mid < max)
      min = mid +1;
    else
      return false;
  }
}
```

binary search revisited

```
public static boolean search(int[] array, int key) {
  search(array, key, 0, array.length - 1);
}
```

binary search revisited

```
public static boolean search(int[] array, int key, int min
  int mid = (min + max)/2;

  if (array[mid] == key) return true;

  if ((array[mid] > key) & (mid > min))
    search(array, key, min,  mid -1);

  else if (mid < max)
    search(array, key, mid + 1,  max);

  else
     return false;
}
```

recursive procedures

Use with care.

recursive procedures

Use with care.
Every method call will push a frame on the stack.

recursive procedures

Use with care.
Every method call will push a frame on the stack.
The stack is not unlimited.