

# PS Algorithms and Data Structures 2026

## Task sheet 3

### Task 7

Let  $A[1, \dots, n]$  be an array with  $n$  numbers. Formulate a recursive divide and conquer algorithm in pseudocode to calculate the maximum of the values in the array  $A$ .

### Task 8

Formulate an algorithm in pseudocode that determines which number  $s$  in the array  $A[1, \dots, n]$  appears consecutively the most. The algorithm should output both the number  $s$  and its count.

- The algorithm should have a runtime of  $O(n)$ .
- Specify a suitable loop invariant to show that the algorithm is correct.

The following examples illustrate how the algorithm works:

<i>Input</i>	<i>Output</i>
$A = [3, 7, 2, 2, 2, 6, 1, 2]$	$s = 2$ with count 3
$A = [3, 7, 3, 3, 7, 3, 7, 3]$	$s = 3$ with count 2
$A = [1, 2, 2, 3, 3, 3, 4, 4, 4, 4]$	$s = 4$ with count 4

### Task 9

Consider the following pseudocode, which describes a so-called randomized search for the element  $s$  in the array  $A$ .

```
1: RANDOM-SEARCH( $A, s$ )
2:   while True
3:      $i =$  uniformly selected random index in  $A$ 
4:     if  $A[i] = s$ 
5:       return true
```

What is the expected number of elements of  $A$  that are examined during the search for  $s$ , assuming that the element  $s$  occurs exactly once in  $A$ ? First, determine which probability distribution the random variable  $X$  follows, where  $X$  denotes the number of search steps (i.e., the number of accesses to the array). Investigate which known probability distribution can be used to model  $X$ , and determine the expected value of the random variable  $X$ . Derive this expected value.

Now consider the following pseudocode, which searches for the element  $s$  in the array  $A$  after applying a single random permutation.

```
1: PERMUTATION-SEARCH( $A, s$ )
2:    $A =$  random permutation of  $A$ 
3:    $i = 1$ 
4:   while True
5:     if  $A[i] = s$ 
6:       return true
7:      $i = i + 1$ 
```

What is the expected number of elements of  $A$  that are examined during the search for  $s$ , assuming that the element  $s$  occurs exactly once in  $A$ ? Which probability distribution arises in this case?