Wednesday 11th November, 2020
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Exercise Sheet 1

Homework submission deadline: Tuesday 17th November, 2020, 14:00.

Introduction

- Groupwork exercises: Wednesday, 12:15 - 13:45, via Zoom [1]
- Homework exercises: Can be delivered until the following Tuesday, 14:00. Please submit your solutions via StudOn, we will correct and return them afterwards. This is an opportunity to check your learning progress, it is voluntary and there is no bonus for the exam.
- Solutions for all exercises (Groupwork and Homework) will be provided.
- Prerequisite for the exercises: lecture material. No programming background is required.
- You have to register via StudOn, in order to receive lecture material and submit your homework. [2]
- For questions regarding exercises or organization, you can use the forum in our StudOn group. [3]

Groupwork

Exercise 1.
Sort the following sequences using Insertion Sort. Specify all iterations!

a) `FEDCBA`

b) `ABCDEF`

c) `ERLANGEN`

[1] https://fau.zoom.us/j/92452642845?pwd=UW11L0UySmpmdUx3ZDBCTXIrcjhTdz09
[2] https://www.studon.fau.de/crs3304827.html
[3] https://www.studon.fau.de/frm3319720.html

Exercise 2.
Given is the following algorithm:

```
def magic_function(n):
    result = 0
    for i in range(0, n):
        result = result + (2*i + 1)
    return result
```

a) Evaluate `magic_function(n)` for different values of `n`.

b) Can you figure out the functionality of `magic_function(n)`?

Exercise 3.
Probably in primary school, you have heard of multiplication tables. Your task is now to write a function that creates such a table for varying sizes `n`. The following code snippet creates a two-dimensional array `A` of appropriate size using the Python library NumPy.

```
import numpy

def mult_table(n):
    A = numpy.zeros((n, n)) #array of size nxn, filled with zeros
    # TODO: fill the array with the correct values
    return A
```

Complete this code (on paper), such that it returns a multiplication table. If you, for example, want to assign the value `10` at position `[2,5]`, you can do this by writing `A[2,5] = 10`. Here you can see the multiplication table for `n = 5`:

·	0	1	2	3	4
0	0	0	0	0	0
1	0	1	2	3	4
2	0	2	4	6	8
3	0	3	6	9	12
4	0	4	8	12	16

Homework

Exercise 4. 5 P.
Sort your first name in alphabetical order using Insertion Sort.

Exercise 5. 10 P.

Consider the following two functions. Input values are each an array `A` of length `n`, which contains numbers sorted by size, and a number `value`.

```
import numpy as np

def function_1(A, value):
    n = A.shape[0]
    for i in range(0, n):
        if A[i] == value:
            return i
    return -1

def function_2(A, value):
    n = A.shape[0]
    low = 0
    high = n - 1
    while low <= high:
        mid = (low + high)//2
        if A[mid] > value:
            high = mid - 1
        elif A[mid] < value:
            low = mid + 1
        else:
            return mid
    return -1
```

a) Understand what the algorithms do and describe this in words.

b) Do they still work if the entries of A are not sorted?

c) What is the runtime of the algorithms? (Bonus exercise as it has not been covered in the first lecture)

Homework - Programming

From time to time, we will have some implementation exercises in the homework. Therefore, as we can not use the CIP-Pools, you need to install Python on your computer. I recommend to use Anaconda [4], especially if you are working with Windows, and the IDE PyCharm. [5] But, as far as it works for you, feel free to use any installation

[4] https://conda.io/projects/conda/en/latest/user-guide/getting-started.html
[5] https://www.jetbrains.com/help/pycharm/installing-and-launching.html

or editor that you like. You can submit your `.py`-files directly in StudOn.

Exercise 6. 5 P.

Similar to 2, you should now create a three-dimensional multiplication table. For this, complete the following Python code.

```
1 import numpy as np
2
3 def cubic_table(n):
4     #TODO: create a three-dimensional multiplication table
```