Training Assignment 03

NUMA01: Computational Programming with Python
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The purpose of this training assignment is to repeat list comprehensions, to give some examples for slicing, work more with functions and investigate sets in Python.
This assignment has 8 tasks.

Warming-up Exercises

You should *not* run the code before you have written down what it will do when executed.

Task 1

Assume we have stored the following values in a list:

```
L = [0,1,2,1,0,-1,-2,-1,0]
```

What is the outcome of the following commands?

```
L[0]
L[-1]
L[:-1]
L + L[1:-1] + L
L[2:2]=[-3]
L[3:4]=[]
L[2:5]=[-5]
```

Task 2

What parts of the code below generate an error, and why?

```
d = dict()

print(d['nokey'])
d['key'] = 3
print(d['key'])

del d['key']
print(d['key'])

d[ (1,2) ] = 'tuple'
d[ [1,2] ] = 'list
```

Task 3

Programming Exercises

Task 4

Let a distance table between some villages be given by the following data

$$\begin{bmatrix} 0 & 20 & 30 & 40 \\ 20 & 0 & 50 & 60 \\ 30 & 50 & 0 & 70 \\ 40 & 60 & 70 & 0 \end{bmatrix}$$

Construct a list (of lists) which contains this data. Call this list `distance`. Construct from this list a list `reddistance` which contains only the relevant data in the following form

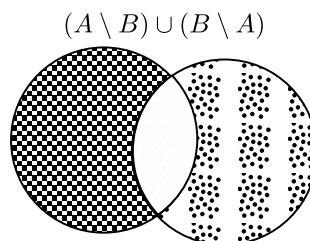$$\begin{bmatrix} 20 & & \\ 30 & 50 & \\ 40 & 60 & 70 \end{bmatrix}$$

Use slicing for this task. Solve this task in two ways:

1. by using for-loops

2. by using *only* list comprehension and slicing (no for loops at all)

Task 5

Let A and B be sets. The set $(A \setminus B) \cup (B \setminus A)$ is called the *symmetric difference* of the two sets.

$(A \setminus B) \cup (B \setminus A)$

Write a function, which performs this operation. Compare your results to the result of the command `A.symmetric_difference(B)`.

Task 6

Study also other operations on sets. You find a complete list of those by using the "tab"-key in Spyder / IPython after `A.`, where A is a previously defined set in Python. In particular study the method `update` and `intersection_update`. Explain what the difference between the two commands `intersection` and `intersection_update` is.

Task 7

Test in Python by considering a couple of examples the statement that the empty set is a subset of any set.

If you have no time left to make the following exercise during the training exercise session, you should do it at home, so that you are able to pose questions during the next lecture.

Bisection Method

A continuous function which changes its sign in an interval $[a, b]$ has at least one root in this interval. Such a root can be found by the *bisection method*.

This method starts from the given interval. Then it investigates the sign changes in the subintervals $[a, \frac{a+b}{2}]$ and $[\frac{a+b}{2}, b]$. If the sign changes in the first subinterval, b is redefined to be

$$b := \frac{a + b}{2}$$

otherwise a is redefined in the same manner to be

$$a := \frac{a + b}{2}$$

and the process is repeated until $b - a$ is less than a given tolerance.
Note, a sign change is characterized by the condition

$$f(a)f(b) < 0.$$

Task 8

Implement this algorithm. It needs the initial interval $[a, b]$ and the tolerance. Test the method with the function `arctan` and also with the polynomial

$$f(x) = 3x^2 - 5$$

in the interval $[-0.5, 0.6]$ and alternatively in $[-1.5, -0.4]$.

If you are uncertain of your results it might be helpful to plot the functions in the given intervals.