Division of Computing Science
Department of Information Technology
Uppsala University

Exam in Programming in Python (1TD327), 5 ECTS

- **Note:** Answers should be written in English. All problems must be solved using Python code. Use short, appropriate and descriptive names for all your variables and functions. Note that your grade will be affected negatively if:
  - your code is unclear and/or hard to read
  - identical snippets of code are repeated several times (copy/paste)
  - common data structures (lists, dictionaries, strings) are not used correctly
- **Tools:** Any electronic devices or any other formula books **are not allowed!**
- **Date:** January 14, 2020, 8:00 – 13:00.
- **Place:** Polackbackens skrivsal.
- **The grading system:**
  - The exam has two parts: (A1.-A7.) Basic and (B8.-B11.) Advanced.
  - If you solve B11., add one row of 'No. 11' in the cover sheet.
  - In order to **Pass**, you need to get at least **75%** of the points from Part (A).
  - If Part (A) is failed, part (B) will not be graded.
  - To get **Grade 4**, you need to pass part (A) and get at least **50%** of the points from part (B).
  - To get **Grade 5**, you need to get at least **85%** of the points **both** from part (A) and (B).

Part A

A 1.

Each of the following question is worth [1p] . Select **ALL** the correct answer(s) to get the full point. A question with 'None of these' as the correct answer has a bonus [1p] if you are able to write down the solution correctly. There might be more than one correct answers for a question.

Note: Use only one paper for all the multiple choice questions.

(a) Define a function

```
def func(y):
    if y == 2:
        print(y)
    elif y > 2:
        print(y)
    else:
        print(y)
```

What is the output of `func(2.0)`?
A. 2 **B**. 2.0 **C**. 3 **D**. 3.0 **E**. None of these.

(b) Consider the same function defined in (a), what is the output of `func(3)`?
A. 2 **B**. 2.0 **C**. 3 **D**. 3.0 **E**. None of these.

(c) What is the output of the following Python code?

```
L1 = [1, 2]
L2 = [3, 4, 5]
print(L1*3+L2*2)
```

A. [3, 6, 6, 8, 10] **B**. [9, 14, 13, 12, 11, 16] **C**. [1, 2, 3, 4, 5] **D**. [4, 6, 6, 5, 5, 7] **E**. None of these.

(d) A file `exam.py` has more than 100 lines. What is the output of the following code?

```
with open('exam.py', 'r') as file:
    read_data = file.read()
    print(read_data)
    read_data = file.read()
    print(read_data)
```

A. Print the whole file once. **B**. Print the whole file twice. **C**. Print the first line. **D**. Print the first two lines **E**. None of these.

(e) What is the output of the following code?

```
x = [3, 7, 8]
y = x
y.append(10)
print(x)
```

A. [3, 7, 8] **B**. [3, 7, 8, 10] **C**. [10, 3, 7, 8] **D**. 'None' **E**. None of these.

(f) What is the output of the following code?

```
a = list(range(10))
print(a[1::3])
```

A. [1, 4, 7] **B**. [1, 4, 7, 10] **C**. [0, 3, 6, 9] **D**. [0, 1, 2, 3] **E**. None of these.

(g) A class `Point` is defined as follows. What is the variable `self.x`?

```
class Point:
    def __init__(self, x = 0, y = 0):
        self.x = x
        self.y = y
    def __add__(self, other):
        x = self.x + other.x
        y = self.y + other.y
        return Point(x, y)
```

A. Argument **B**. Attribute **C**. Constructor **D**. Item of class **E**. None of these.

(h) What is the output of the following code?

```
print('i' in 'This is a string', 'i' in ['This', 'is', 'a', 'string'])
```

A. False False **B**. False True **C**. True False **D**. True True **E**. None of these.

A 2.

The teacher wrote a short program to print all the positive odd numbers less than 30 in one line, separated with ‘,’:

```
y = 0
while y < 30:
    y = 1
    print(f'{y}', end=',')
    y = y + 2
```

When the code is executed, there is no error message, but the output never stops.

(a) Find the bug and fix it. [2p]

(b) Use a `for` loop to rewrite this program. [2p]

A 3.

What is the output of the following program? [1p]

```
print('First row')

def printRows(text):
    print('Second row')
    print(text)

print('Third row')
printRows('Last row')
```

A 4.

After executing the following script,

```
a = list(range(10))
print(f'The first element in the list is {a[0]}')
print(f'The sum of the list is {sum(a)}')
print(f'The mean of the list is {sum(a)/10}')
print(f'The last element in the list is {a[10]}')
```

an error message pops out as:

```
---------------------------------------------------------------------------
IndexError                                Traceback (most recent call last)
<ipython-input-31-dcc09e0d9a5a> in <module>
      3 print(f'The sum of the list is {sum(a)}')
      4 print(f'The mean of the list is {sum(a)/10}')
----> 5 print(f'The last element in the list is {a[10]}')

IndexError: list index out of range
```

Explain the reason of the error message and fix the bug. [2p]

A 5.

Write a function `rep(lst, x)` that replaces all the elements in a given list `lst` by a given number `x`. For instance, the following script

```
a = [1, 3, 7]
rep(a, 3)
print(a)
```

generates the output:

```
>>> [3, 3, 3]
```

The first line of the function is given below. Your task is to fill-in the body of the function. [2p]

```
def res(lst, x):
    ......
    ......
    ......
```

A 6.

Programming tasks (only write the code, comments are not needed).

Note: The three tasks are actually independent to each other, you can solve any of them without having the others.

(a) Given a text file '`exam.txt`', write a script that reads the file, split the text by spaces, put the results in a list named `wordList` and count the number of words. [2p]

(b) Take `wordList` from task (a), for each of the words, count how many time it appears in the list, and save the word and its frequency in a dictionary called `wordDict`. [2p]

(c) Use the `wordDict` from task (b), write a function `filterWords(wordDict, n)` that returns a new dictionary containing only the words that appear less than `n` times [3p]

A 7.

(a) Write a class to describe a city. Your class `City` should contain the name of the city, population, first two digits of the zip code, and GPS coordinates. [2p]

(b) In order to present the city, you can define the '`__str__`' method in your class `City` and return the information in string. Write this method, you need to include **ALL** the information you have defined in task (a). [2p]

Part B

B 8.

Write a function `Bsort(lst)` to sort an array by repeatedly finding the minimum element (considering ascending order) from unsorted part and putting it at the beginning of the unsorted part. The algorithm maintains two sub-arrays in a given array: 1) The sub-array which is already sorted. 2) Remaining sub-array which is unsorted. [4p]

The following example shows the sorting process in every iteration, where the minimum element from the unsorted sub-array is picked and moved to the beginning of the unsorted sub-array.

```
lst = [64, 25, 12, 22, 11]

// Find the minimum element in lst[0 to 4] and place it at beginning
11 25 12 22 64

// Find the minimum element in lst[1 to 4] and place it at beginning of lst[1 to 4]
11 12 25 22 64

// Find the minimum element in lst[2 to 4] and place it at beginning of lst[2 to 4]
11 12 22 25 64

// Find the minimum element in lst[3 to 4] and place it at beginning of lst[3 to 4]
11 12 22 25 64
```

B 9.

We have used `numpy.ndarray` to handle two dimensional array in the MINI projects. However, in some situations, you may not have access to the `numpy` library. Then, you have to use `list` to store the two dimensional(2D) array. A common idea is to use a list of lists. For instance, a matrix

$$A = \begin{bmatrix} 1 & 3 & 5 \\ 2 & 7 & 8 \end{bmatrix}$$

can be represented in row-wise as `matA=[[1, 3, 5], [2, 7, 8]]`. You can access the element A_{ij} by `matA[i][j]`. However, this approach may not be optimal for the memory and computation. An easy fix is to convert the 2D row-wise representation to a one dimensional(1D) array as `matA_1D=[[1, 3, 5, 2, 7, 8]]` and access A_{ij} by `matA_1D[i*N+j]`, where `N` is the number of columns of matrix A.

(a) Write a function `convertTo1D(matA)` to convert a given row-wise matrix `matA` to a new 1D array and return the list. You may need to compute the number of rows and columns of the given matrix `matA` in your function. [2p]

(b) Another way to represent a 2D matrix is to save the element in column-wise such as `matA_CW=[[1, 2], [3, 7], [5, 8]]`. Write a function `convertToCol(matA)` to convert a given row-wise matrix `matA` to a column-wise representation and return the new list. You can first convert `matA` to 1D array using your function `convertTo1D` in (a) and then continue. [2p]

B 10.

The railway company is going to redesign their scheduling system, one part of the job is to change how the network is stored. In the old system, a list of tuples is used to represent the connections between cities. For example, `[('Stockholm', 'Uppsala'), ('Uppsala', 'Gävle'), ('Stockholm', 'Västerås')]` means there are railways between these three pairs of cities.

For the new system, the company would like to know the connectivity of each city, which is a dictionary with each city name as a key and a list of the cities which are connected to the key city as the value.

Your task is to write a function `convert(oldList)` which takes the list of the network from the old system and return a dictionary with all the cities and their connections for the new system.

[4p]

B 11.

In this task, you are going to write a function `convolve(f, g)` to compute the discrete convolution of two given arrays `f` and `g`. The convolution is defined as

$$(f * g)[n] = \sum_{m=1}^{M} f[n-m]g[m], \tag{1}$$

where M is the length of `g`. In general, the convolution can be used as a filter `f` over the data `g`, since for each value of the convolution, the choice of `g` is fixed but `f` moves accordingly.

Recall the smooth functions we wrote in lesson 6, which is very similar to the convolution. Additionally, special treatments close to the two boundaries are needed for the convolution function. In this task, we pad `f` with 0 when $n - m$ is out of range of `f`.

Note: `f` and `g` do not necessarily have the same length!

(a) Write a function `convole(f, g)`, return the result in a list with the same length of `g`. [2p]

(b) Only use list comprehension to write the function `convole(f, g)` as in task (a). If you have done this in task (a), you can get the points automatically. [3p]

Good luck!
Adrien and Cheng Gong

Reference

Lists

- `lst = []` - Create an empty list
- `len(lst)` - Return the list's length.
- `sorted_list = sorted(lst)` - Return a sorted version of `lst` and save it in `sorted_list`. `lst` is not modified.
- `lst.pop(2)` - Delete and return the third element in `lst`.
- `lst.append(value)` - Add a new value at the end of the list.

Strings

- `len(s)` - Return the string's length.
- `s.split()` - Return a list of the words in the string (separated by whitespace)
  Example: `'This is a string'.split()` becomes `['This', 'is', 'a', 'string']`.

Dictionaries

- `d = {}` - Create an empty dictionary
- `d['a'] = 8` - Set the value of key `'a'` to `8`
- ```
  for key, value in d.items():
      print(key, value)
      ...
  ```

  Go over all key/value pairs in the dictionary and print them.
  ```