PHOT 110: Introduction to programming

Midterm exam questions (version C)

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Before you start

The midterm exam counts for 10% of your total grade of the course. The exam is performed on the computer, and you do not need to provide any answers on paper. There is one question (the third question) which asks to correct a script which contains various errors, other questions require you to write Python scripts.

Take the following points into account before you start the exam.

- Your exam is located in a folder on the computer:

    - The questions: `midterm_questions_x.pdf`
    - The script with errors for question 3: `script_with_errors.py`
    - Three cheat-sheets: for Python, Numpy, and Matplotlib.

- Please make sure that you save all the scripts and output files of the exam, so you can upload them at the end of the exam.
- Let us know if during the exam there is any issue with the computer, PyCharm, or libraries. We will try to verify this up front, but please inform us in case of any issues.

You will be asked to save plots to your folder, this can be done using the `savefig` method, see the following example (the output of this example is a simple line plot):

```python
import matplotlib.pyplot as plt

fig, ax = plt.subplots()
x = [1, 2, 3, 5]
y = [2, 5, 1, 3]
ax.plot(x, y)
fig.savefig("output_plot_example.png")
```

Questions

Question 1: Print numbers series

Write a script that prints the series $\sqrt{n(n+3)}$ for numbers $n = 1, \ldots, N$, that is, for a given N (you can take N as a parameter of your script) prints the numbers:

$$1, \sqrt{4}, \sqrt{10}, \sqrt{18}, \ldots, \sqrt{N(N+3)}$$

where each number is printed on a separate line. If you set `N = 5`, then the output should look similar to:

```
2.0
3.1622776601683795
4.242640687119285
5.291502622129181
6.324555320336759
```

Save your solution as a script with file name: `solution_1.py`.

Question 2:

Create a script that prompts the user to input a sentence with a minimum of 5 words. If the sentence contains less than 5 words, allow the user to try again until he/she provides a long enough sentence. You can check the number of words e.g. by counting spaces.

Save your solution as a script with file name: `solution_2.py`. This is the output of a correct working script:

```
Please provide a sentence (min. 5 words): It is sunny weather.
This sentence has not enough words, please try again.
Please provide a sentence (min. 5 words): The apples.
This sentence has not enough words, please try again.
Please provide a sentence (min. 5 words): This book is very nice.
Thank you for your input.
```

Question 3: Correct a Python script

Open the script with name: `script_with_errors_c.py` and correct the errors.

The correct script plots a series of circles at random positions and with random radii. It then saves the plot as a PNG-file under the name: `output_script_with_errors_c.png`.
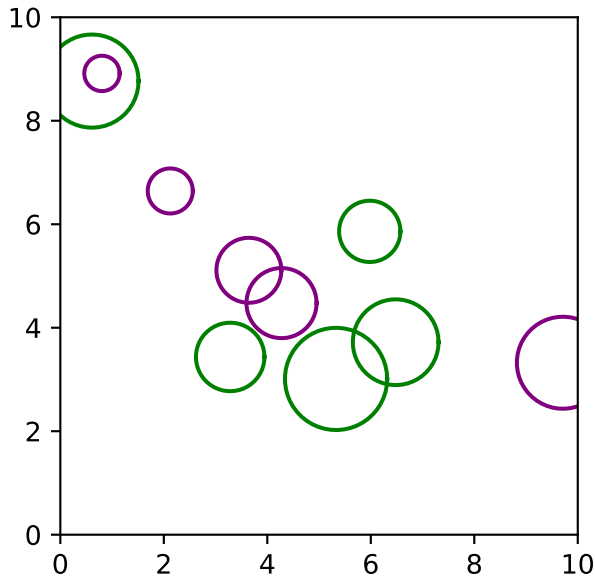
Question 4: Repeated input

Prompt the user to input an integer number N between 100 and 200. Repeatedly divide the number by 2 or if not possible by 3 and print the result. If it cannot divided by 2 and cannot divided by 3 stop the program and print the resulting number.

Example:

```
Give an integer in interval [100, 200]: 120
120 / 2 = 60
60 / 2 = 30
30 / 2 = 15
15 / 3 = 5
The result is: 5
```

Save your solution as a script with file name: `solution_4.py`.

Question 5: Plot functions

Plot a graph with the following sigmoid functions (in interval $[-3, 3]$):

$$f_1(x) = \frac{x}{\sqrt{1 + x^2}}$$

$$f_2(x) = \frac{x}{1 + |x|}$$

$$f_3(x) = \tanh(x)$$

You can make use of the functions in the `numpy` library: `sqrt()`, `tanh()`, `abs()`. Take a sufficiently high number of x values so the curve looks smooth, you can use the `numpy` function `linspace()`. **Save the plot** under the file name: `output_plot_math.png`. **Save your solution** as a script with file name: `solution_5.py`.