University of Huddersfield
School of Computing and Engineering

CFM2103 Mathematical Programming

Practical **Week 3**

Work through the questions included below. If you get stuck, please revisit the information on the slides used today before you ask for help.

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1. There are many different ways to generate a random integer in Python. One way is to use the module **random**; the lines of code included below show how you can generate a random integer d such that $1 \leq d \leq 12$:

```
import random
d = random.randint(1,12)
```

   You can get a random integer between two given integers A and $B \in \mathbb{Z}$ $(A < B)$ by changing $1 \to A$ and $12 \to B$.
   You are asked to use loops to generate a list of N random integers whose absolute value is less than or equal to 10; N must be specified by the user (interactively). By using the accumulator pattern find the average of the elements in your list and display the result on the screen. Check your answer manually.

2. Generate 10 random 2D points inside of a square centred at $(a, b) = (1, 1)$ and having its sides parallel to the x- and y-axes; each side is 10 units. The points should be stored in a list, and their coordinates must be integers between (-7) and 7. Determine how many of these points are within the circle of radius $r = 4$ and centred at the origin.
   [Hint: One option would be to use the built-in 'zip' function – see the notes.]

3. Write two *lambda* functions for $g(x) = x^4 - x^2 + 1$ and $h(x, y) = (x + y)^2$, respectively. Test your functions by calculating several values which should be displayed on the screen together with some relevant text.

4. The *Triangle Inequality Theorem* states that the sum of the lengths of any two sides of a triangle must be greater than the length of the third. Write a Python function that determines if three given integers can represent the distances between the vertices of a triangle. Write also a piece of code to test your function: the code must generate a list of 10 random positive integers between 1 and 50, and it should identify how many such triangle triples exist.
   [Hint: You need to loop over a set of 10 integers and identify all triples that satisfy the conditions of the above theorem.]

5. For $0 < h \ll 1$ (fixed), the derivative of a function $f(x)$ can be approximated by the formula

$$f'(x) \simeq \frac{f(x+h) - f(x-h)}{2h} .$$

   Write a Python function to implement this result. The parameters of this function should consist of the *generic* name of a function (whose derivative is to be approximated), the value of x, and h.

Write a short piece of code to test your function, e.g. test your code for $f(x) = \cos x$ (so $f'(x) = -\sin x$) and a set of integers between (-5) and 4. The output of such a test is included below:

```
   x   NumApprox.   Exact
------------------------------
  -5  -0.95892   -0.95892
  -4  -0.75680   -0.75680
  -3   0.14112    0.14112
  -2   0.90930    0.90930
  -1   0.84147    0.84147
   0   0.00000   -0.00000
   1  -0.84147   -0.84147
   2  -0.90930   -0.90930
   3  -0.14112   -0.14112
   4   0.75680    0.75680
```

and corresponds to $h = 10^{-3}$. Experiment with what happens if $h = 10^{-2}$ and $h = 5 \times 10^{-1}$.

Optional question:
If you would like to receive additional feedback on your work, you should attempt the questions included below and submit your computer code in a zipped folder on Brightspace by no later than 5:00 PM next Tuesday.

1. Consider the following list of integers

$$[2, 3, 4, 21, 19, 44, 100, 23, 57] .$$

Use loops to replace every other element by the string 'Apples'. Try to do the same by using a single statement (e.g., by using slicing). At the end of your code you should also include two 'print' statements that display on the screen both the original and the modified lists.

2. Write a Python function that prompts the user to provide an N-digit positive integer (with $3 \leq N \leq 10$) and reverses its digits. The output of this function must be returned in a list. Write a short piece of code to test your function. At the very least, your code needs to check that the user does provide a number that has the correct number of digits, and both the original number and the reversed version must be displayed on the screen:

```
Give an N (between 3 and 10): 7

Give an N-digit number: 123
Try again...

Give an N-digit number: 1234567

Original number:  1234567
Reversed number:  7654321
```