University of Huddersfield
School of Computing and Engineering

CFM2103 Mathematical Programming

Practical **Week 4**

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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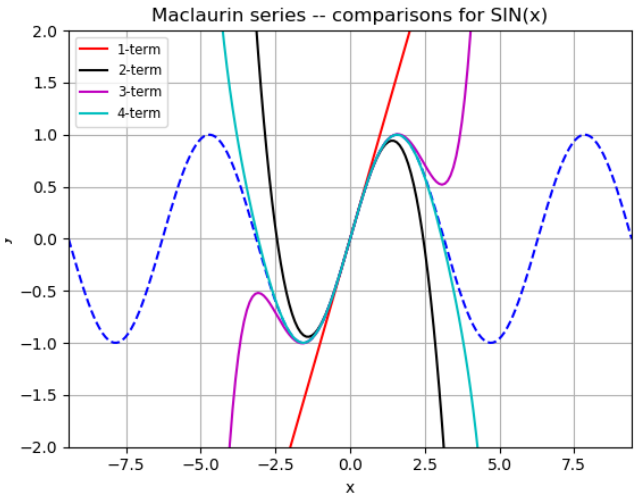
1. According to the Maclaurin series for the `sin(x)` function,

$$\sin(x) \simeq x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!}\,, \qquad \text{for all } x \in \mathbb{R}\,. \tag{1}$$

   (a) Use `matplotlib` to plot the function `sin(x)` for $-3\pi \leq x \leq 3\pi$.

   (b) On the previous plot superimpose the plots of the one-, two-, three- and four-term *approximations* that can be derived from (1). You need to ensure that the curve corresponding to each approximation is easily identified (e.g., by using different colours, markers, etc.). Possible output for this second part:



2. Create a `NumPy` array that has 7 rows and 7 columns. The only non-zero elements of this array are situated along its minor and major diagonals, and they are all equal to 7. Display your array on the screen.

3. Create a `NumPy` array that has 4 rows and 8 columns, and whose elements are random integers from the set $\{-1, 0, 1\}$. Display on the screen every other column (add also some short text messages; e.g., 'col. 1', 'col. 2', etc).

4. (a) Create a `NumPy` array which has 5 rows and 5 columns, and whose entries are random integers between 1 and 20. Your array should also be displayed on the screen.

   (b) Use nested for-loops to find the number of entries in your array that are divisible by 4. The result should be displayed on the screen together with an informative text message.

(c) Use for-loops to find the sum of all the entries in each column of your array, and then display the results on the screen. The sums must be calculated using the *accumulator pattern*.

(d) Write your solutions to the last two sub-questions as **functions** that perform the stated tasks.

5. Write a Python **function** that takes as input two points $P_1(x_1, y_1)$ and $P_2(x_2, y_2)$ and provides the equation for the line that passes through those two points in the form $ax + by = c$, where a, b and c will correspond to the outputs of your code. Also, arrange for your code to display the equation on the screen in the form stated above (with the three numbers a, b and c replaced by their corresponding numerical values). Use `matplotlib` to plot the line. Possible outputs for this question:

```
The equation of the line is:

                (-0.23)*x + (1.00)*y= 4.15
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Another way to display the result:

Line equation is:  a*x + b*y = c

a is:   -0.23
b is:    1.00
c is:    4.15
```

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. Write a Python **function** that takes two square arrays of size N ($2 \leq N \leq 10$) and returns a new array that corresponds to their product. If the two arrays are 'a' and 'b', and their product is the array 'c', then

$$c[i, j] = \sum_{k=1}^{N} a[i, k] * b[k, j] \,, \qquad (1 \leq i, j \leq N) \,.$$

Test your function on a few 2×2 and 3×3 matrices.
[**Note:** the above sums must be calculated by using the *accumulator pattern*.]