CDS-230-001 - FALL 2023

PROBLEM SET 5

9/28/23

Instructions: Use the PS template provided in class to enter your name and your answers. When you are done run your script and make sure it executes without syntax errors. Note: You will need the the following at the top of your script.

```
import numpy as np
np.set_printoptions(precision=3)
# This guarantees the code will generate the same set of
# random numbers whenever executed:
np.random.seed(123)
```

Finally, note that in all the exercises below **you are to use Numpy functions only**, unless specified otherwise.

Exercise 5.1: (1 point) Create and print a null vector (i.e. all zeros) of size 11.

Exercise 5.2: (1 point) Create and print a 3x5 matrix of ones.

Exercise 5.3: (1 point) Create and print a vector with 10 linearly spaced elements having values ranging from 0.0 to 10.0

Exercise 5.4: (1 point) Create and print a 4x3 matrix with values from 1 to 12. Hint: use reshape()

Exercise 5.5: (1 point) Create a vector with values from 20 to 30, and print it with its values in reverse order.

Exercise 5.6: (3 points)
Use **linspace()** to create a linearly spaced 1D array that contains all the **integers** (and zero) between -5 and 15. Print the array.

Exercise 5.7: (3 points)
Use **arange()** to create a linearly spaced 1D array that contains **real numbers** between -10.0 and 10.0 in intervals of 0.1. Print the *size* of the resulting array.

Exercise 5.8: (3 points)

Create a 1D array of size 100 whose elements are all ones. Then, set the values with odd indices to -1. Print the *first 10* elements of the array.

Exercise 5.9: (5 points)

Create and print numpy arrays representing each of the following (note that z is a column vector)

$$B = \begin{bmatrix} 1 & 2 & -3 \\ 3 & 4 & -1 \end{bmatrix}; \quad A = \begin{bmatrix} 2 & 5 & -1 \\ 1 & 4 & 5 \\ 2 & 1 & -6 \end{bmatrix}; \quad y = \begin{bmatrix} -1, 3, 7 \end{bmatrix}; \quad z = \begin{bmatrix} 13 \\ 0 \\ 2 \end{bmatrix}$$

Exercise 5.10: (6 points)

Your task is to convert temperatures in degrees Celsius to Fahrenheit using the formula

$$F = \frac{9}{5}C + 32$$

Suppose you have an array of Celsius temperatures ranging from -40^oC to 100^oC in steps of 1^oC, i.e.,

```
-40, -39., -38, ..., 98, 99, 100
```

Convert the temperatures from C to F and print the first and last values of the converted temperatures.

Note: There is no need to write a function or to use loops.

Exercise 5.11: (5 points)

The numpy random.randint() function works exactly like Python's random.randint() - except that now you call it using np.random.randint().

Use *np.random.randint()* to create a 4 × 6 matrix of integers on the interval [-10, 10].
Use array slicing to retrieve and print the values from the following locations in the matrix : $(1,1)$, $(2,3)$, $(3,0)$, $(0,5)$.

Exercise 5.12: Averages (7 points)

a) Create a 1D array, call it **my_vec**, containing 10^6 normally distributed random numbers . To generate those numbers use the numpy random.normal() function with loc (i.e. mean) = 0 and scale (i.e. standard deviation) = 1

b) Compute the *average* of **my_vec** using the old-fashioned, slow, for loop method. Show the code and the result.

c) Compute the average using the numpy mean() function. Show the code and the result.

d) Does the average value of the random numbers make sense to you?

Exercise 5.13: (4 points)

Create three vectors, each of length 10, that contain random **integers** defined on the interval [1,10]. Name the vectors a,b,and c. Then, compute $d = ab + c$ and print the result d. Use np.random.randint() to generate the random integers.

Exercise 5.14: (9 points)

Create a **function** called *position* that takes in an array argument t containing *time* measurements and *returns* a distance *array* computed as follows:

$$d = 0.5gt^2$$

where d is in meters and g is a constant with value $-9.81\ m/s^2$. Add a short docstring.

Write the function and test it with an array t containing values on the interval $[0, 10]$ defined in steps of 0.1 s, i.e, $t[0] = 0.0$, $t[1] = 0.1$, etc...

Print the value of d when time equals 1 second and state whether it is the expected result (or not).