Learning goals: Practice exercises for Python programming on numpy, matplotlib and pandas.
EXERCISES

(1) Import numpy and check the version using the command `print(np.__version__)`
(2) Array creation and manipulation exercises. Print all the arrays in each exercise.
   (i) Create a 1D array from 0 to 9.
   (ii) Create a boolean array of size 3x3.
   (iii) Using syntax from list comprehension, create an array that satisfies the condition. For example,
   ```
   arr = np.arange(10)
   arr = arr[ arr%2 == 1 ]
   ```
   Create an array of prime numbers from 1 to 50 using a similar approach.
   (iv) Create a 1D array with 20 random elements, and reshape it as a 4x5 array. Print the two arrays.
   (v) Create two 1D arrays `a` and `b` where `a` has numbers ranging from 0 to 9 and `b` has only 1s. Then stack the two arrays horizontally.
   (vi) Define two 1D arrays, where array `a` has list of first 100 numbers, and `b` has first 100 prime numbers. Obtain a new array that is the intersection of these two arrays (Hint: use `np.intersect1d()`)
   (vii) Use the above two arrays with the aim this time to remove items from `a` that are in `b`. (We are doing `a-b` operation, use `np.setdiff1d()`)
   (viii) Use the above two arrays with the aim of getting the indices of common elements between the two arrays. (Hint: Use `np.where(a==b)`)
   (ix) Extract the elements of the array `a` above that are greater than 5 and less than 20.
(3) We know how to reverse the elements in a 1D array- `a[::-1]`. How would you reverse the rows in a 2D array? How would you reverse the columns in a 2D array?
(4) Thinking along the same lines of the above question, how will you swap two columns in a 2D array? Define a 3x3 matrix with random values, and swap first and second columns in this array.
(5) You are given two 1D arrays. Write a function to create a new array that contains the maximum of the respective elements in the two arrays. For example, if `a=[1,2]` and `b=[0,5]` then the new array will be `c=[1,5]`.
(6) Explore the `set_printoptions()` function to print a 3x3 matrix containing random numbers up to 3 decimal places.
(7) Explore the `set_printoptions()` function to pretty-print a numpy array by suppressing the scientific notation (like 1e10).
(8) Read in the file diabetes.csv, and after obtaining the pandas dataframe, do the following:
   (i) Print all the column names
   (ii) Print the first 10 rows
   (iii) Print the mean of the BloodPressure column values
   (iv) Print the first 4 rows of columns 3,4,5
   (v) Add another column 'NormalizedBP' using (max-min) normalization to the dataframe as: `BP[i] -min(BP) / (max(BP) - min(BP))`.
   (vi) Write a function `categorize_age(age)` that returns "Youth", "Adult" or "Senior" based on the age brackets (1-18, 19-50, ¿50). Create a new column in the dataframe with this function called age_category.

(9) Plot the function

$$f_1(x) = ln(\frac{1}{\cos^2 x}) \text{ and } f_2(x) = ln(\frac{1}{\sin^2 x}) \tag{1}$$

on 1000 points across the range $-20 \leq x \leq 20$. What happens to these functions at $x = n\pi/2(n = 0, \pm 1, \pm 2, \ldots)$? What happens in your plot of them?

(10) The normalized Gaussian function centered at $x = 0$ is

$$g(x) = \frac{1}{\sigma\sqrt{2\pi}} exp(-\frac{x^2}{2\sigma^2}). \tag{2}$$

Plot and compare the shapes of these functions for standard deviations $\sigma = 1, 1.5$ and 2.