Programming for Data Science (20/6/2023)

0% of the points are assigned to quality of documentation and/or comments to solutions. Solutions must include tests of executions of the developed functions.

Name files as "<your matricola>_<firstname>_<lastname>_ex2.py" for Exercise 2, and "<your matricola>_<firstname>_<lastname>_ex3.c" for the third exercise.

Upload the TWO files in a folder
(named with your student number and your last name) at the following URL: *Upload here*
(access GDrive using your university credentials)

Exercise 1. (Math, on paper)

a. Write a 3x3 matrix of rank 1
b. Write its transpose
c. Write a 3x3 matrix of rank 2
d. Find its null space
e. Write a 3x3 matrix of rank 3
f. Write its characteristic equation (without solving it)
g. Consider a set of square matrices of dimension n x n, denoted by M, and a relation, denoted by ≤, defined on this set as follows: for any two matrices A and B in M, A is less than or equal to B if and only if the rank of the matrix A is less than or equal to the rank of the matrix B. What are the properties of this relation?

Exercise 2. (Python) Write a Python program implementing a set data structure using only lists. You need to implement the following functions providing methods for set operations:

- **add(set_data, elem)** method that takes an element as input and adds it to the set represented by the list set_data. The method should not add the element if it already exists in the set.
- **remove(set_data, elem)** method that takes an element as input and removes it from the set represented by the list set_data. The method should not raise an error if the element does not exist in the set.
- **contains(set_data, elem)** method that takes an element as input and returns True if the element exists in the set, and False otherwise.
- **size(set_data)** method that returns the number of elements in the set.
- **union(set_data1, set_data2)** method that takes two sets as input and returns a new set that contains all the elements from both sets, without any duplicates.
- **intersection(set_data1, set_data2)** method that takes two sets as input and returns a new set that contains only the common elements between the two sets.

Test your set implementation, starting from an empty set (list) and then invoking several time the set methods above defined.

Exercise 3. (C) Write a C program that:

1. Asks the user to input a number n in between 3 and 5;
2. Build two square matrices a and b of size nxn each, with randomly generated integer values between -10 and 20;

3. Prints the content of the two matrices
4. Compute the matrix multiplication of a and b
5. Prints the content of the resulting matrix

Bonus points:

1. Define a function for pretty printing a generic square matrix, with columns and rows easily distinguishable and supporting a square matrix of any dimension
2. Dinamically allocate the matrices, and free the space before the end