Intensive Computation

Prof. A. Massini

13 June 2022

Part 2

Exercise 1 (5 points)	
Exercise 2 (5 points)	
Question 1 (5 points)	
Exercise 3 (6 points)	
Question 2 (5 points)	
Exercise 4 (6 points)	
Total (32 points)	

- Student's Name -

_____

- *Matricola* number -

_____

Exercise 1 (5 points) – Interconnection Networks

a) Design a Clos network of size 256 x 256, using in the first stage modules having 20 inputs. Consider both cases, **strictly non-blocking** and **rearrangeable** network.

b) Compare the cost of the two Clos networks designed in the previous point with:

   i. The crossbar 256 x 256

   ii. The butterfly of size N=256 (256 inputs and outputs).

Exercise 2 (5 points) – Interconnection Networks

Briefly explain how the routing algorithm works for a **Butterfly network** and a **Cube network.** Consider both networks of size N=8 and show the path between input 0 and output 4 and between input 2 and output 0.

Question 1 (5 points) – Interconnection networks

Give the definition (and a picture) of the Fat Tree in both versions, the GFT and the XGFT, highlighting the differences.

Exercise 3 (6 points) – Quantum circuits

Consider the two-qubit transformations U1 and U2 shown below

- Show if U1 and U2 represent the same transformation writing the associated 4x4 matrices.
- Show how U1 and U2 act on the states $|00\rangle = |0\rangle \otimes |0\rangle$ and $|10\rangle = |1\rangle \otimes |0\rangle$.

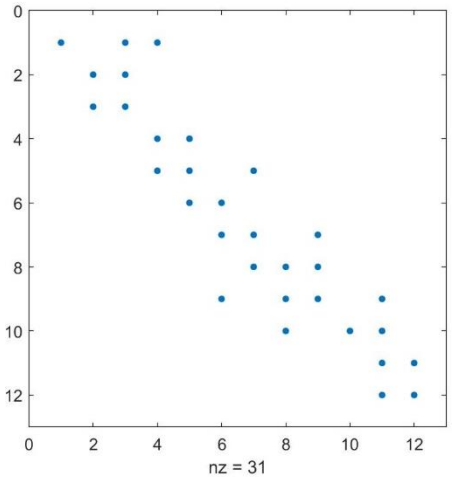
Question 2 (5 points) – Quantum circuits

Explain how to obtain a controlled gate in both cases when the control bit is the upper and the lower bit, using the method of the projection matrix.

Exercise 4 (6 points) – Sparse matrices

Consider the sparse matrix 12x12 and its pattern shown here below

	1	2	3	4	5	6	7	8	9	10	11	12
1	**834 0**	**928**	**234 0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2	**0**	**625**	**234**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3	**0**	**137**	**761**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4	**0**	**0**	**0**	**819**	**765**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5	**0**	**0**	**0**	**345**	**826**	**0**	**321**	**0**	**0**	**0**	**0**	**0**
6	**0**	**0**	**0**	**0**	**275**	**741**	**0**	**0**	**0**	**0**	**0**	**0**
7	**0**	**0**	**0**	**0**	**0**	**234**	**425**	**0**	**876**	**0**	**0**	**0**
8	**0**	**0**	**0**	**0**	**0**	**0**	**273**	**758**	**854**	**0**	**0**	**0**
9	**0**	**0**	**0**	**0**	**0**	**197**	**0**	**234**	**0**	**541**	**0**	**0**
10	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**549**	**0**	**546**	**765**	**0**
11	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**379**	**547**
12	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**674**	**425**



a) Specify which arrays you need for the following compressed representations and how many bytes they occupy in memory.

b) Explain how arrays change after the insertion of the elements $m_{3,5}$=943 $m_{5,2}$=765, $m_{9,12}$= - 304 and what is the new memory occupation.

c) Explain how arrays change after the cancellation of elements $m_{5,7}$ and $m_{10,8}$ and what is the new memory occupation.

MSR

Skyline