Intensive Computation

Prof. A. Massini

31 May 2022

End-of-term test

- Student's Name -

_____

- *Matricola* number -

_____

Exercise 1 (4 points)	
Exercise 2 (4 points)	
Exercise 3 (4 points)	
Question 1 (5 points)	
Exercise 4 (4 points)	
Exercise 5 (4 points)	
Exercise 6 (6 points)	
Question 2 (4 points)	
Total (35 points)	

Exercise 1 (4 points) – Interconnection Networks

a) Design a Clos network of size 250 x 250, using in the first stage modules having 18 inputs. Consider both cases, **strictly non-blocking** and **rearrangeable** network.

b) Compare the cost of the crossbar 250 x 250 and the Clos network, strictly non-blocking and rearrangeable, designed in the previous point.

Exercise 2 (4 points) – Interconnection Networks

Illustrate the design of an XGFT(3; 4, 2, 2; 1, 4, 1), specifying how many nodes there are on each level, how many parents and children they have, and then showing the drawing of the network.

Exercise 3 (4 points) – Interconnection Networks

The bit-reversal permutation is a permutation of a sequence of $N=2^n$ elements, where each element is mapped to the element whose binary representation has the same bits in the reversed order.

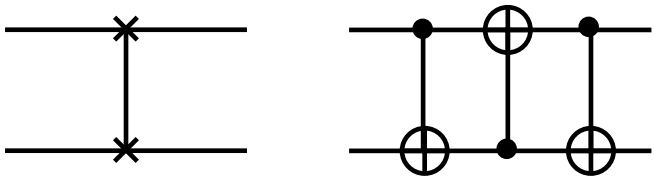
Consider the case of N=8. Can the bit-reversal permutation be routed on a Butterfly? And on a Shuffle-Exchange? Give an explanation of the result.

Question 1 (5 points) – Interconnection networks

Explain the recursive construction of the Benes Network and the Looping algorithm.

Exercise 4 (4 points) – Quantum circuits

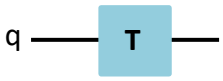
Show that the SWAP gate can be obtained using three CNOT gates arranged as shown below.



SWAP gate and its realization with three CNOT gates

Exercise 5 (4 points) – Quantum circuits

Show how the matrix of a controlled gate T is obtained in both cases when the control bit is the upper and the lower bit, using the method of the projection matrix.



$$T = \begin{bmatrix} 1 & 0 \\ 0 & e^{i\frac{\pi}{4}} \end{bmatrix}$$

Exercise 6 (6 points) – Sparse matrices

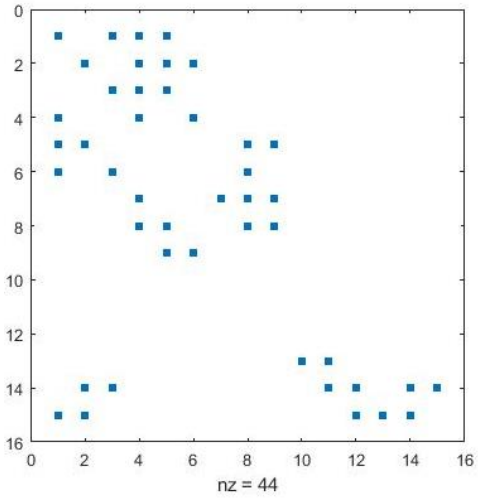
Consider the sparse matrix 15x15 and its pattern shown here below

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**1,571**	0	**-94,252**	**0,785**	**-283**	0	0	0	0	0	0	0	0	0	0
2	0	**256**	0	**-6,28**	**314,17**	**-942,52**	0	0	0	0	0	0	0	0	0
3	0	0	**0,609**	**94,252**	**0,785**	0	0	0	0	0	0	0	0	0	0
4	**-94,252**	0	0	**508,4**	0	**-754,02**	0	0	0	0	0	0	0	0	0
5	**0,785**	**3,142**	0	0	0	0	0	**-42,52**	**0,785**	0	0	0	0	0	0
6	**-83**	0	**256**	0	0	0	0	**-28**	0	0	0	0	0	0	0
7	0	0	0	**-0,304**	0	0	**0,609**	**-0,304**	**94,258**	0	0	0	0	0	0
8	0	0	0	**-754,02**	**-94,25**	0	0	**154,5**	**-75,022**	0	0	0	0	0	0
9	0	0	0	0	**0,609**	**94,252**	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	**-0,304**	**0,609**	0	0	0	0
14	0	**150,45**	**94,252**	0	0	0	0	0	0	0	**942,52**	**0,785**	0	**314,17**	**0,785**
15	**-40,2**	**-94,252**	0	0	0	0	0	0	0	0	0	**942,52**	**0,785**	**157,08**	0

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 $m_{10,6}$=94,3 $m_{11,5}$=0,765, $m_{12,4}$=-0,304 and what is the new memory occupation.

c) Explain how arrays change after the cancellation of elements $m_{4,4}$ and $m_{4,6}$ and what is the new memory occupation.



Ellpack-Itpack

BSR (block size 3x3)

Question 2 (4 points) – Sparse matrices

Explain how to extract a column when the sparse matrix is stored using the following formats:

a) CSR

b) Skyline