Intensive Computation

Prof. A. Massini

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Part B

- **Student's Name** -

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- ***Matricola* number** -

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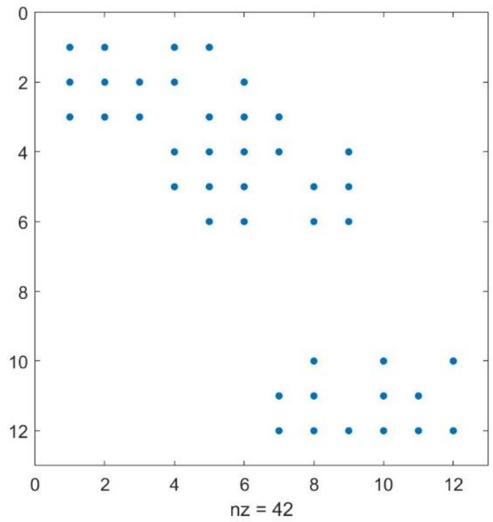
Exercise 1 (7 points)	
Exercise 2 (6 points)	
Exercise 3 (4 points)	
Exercise 4 (6 points)	
Exercise 5 (5 points)	
Exercise 6 (4 points)	
Total (32 points)	

Exercise 1 (7 points)

Consider the sparse matrix here below, whose pattern is shown on the right.

	1	2	3	4	5	6	7	8	9	10	11	12
1	16.9	19.1	0	12.8	1.25	0	0	0	0	0	0	0
2	19.1	25.5	13.2	21.9	0	25.5	0	0	0	0	0	0
3	9.9	13.2	9.56	0	9.5	1.13	13.9	0	0	0	0	0
4	0	0	0	18.4	12.9	8.2	4.5	0	2.7	0	0	0
5	0	0	0	12.9	1.1	6.1	0	1.2	3.9	0	0	0
6	0	0	0	0	6.1	4.6	0	2.7	3.9	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	16.3	0	12.8	0	9.5
11	0	0	0	0	0	0	12.5	24.9	0	16.3	22.9	0
12	0	0	0	0	0	0	18.4	22.5	25.5	17.7	25.5	13.9



a) Explain which arrays you need for the following representations, specifying their role and elements they contain.

b) Specify how many bytes the arrays occupy in memory.

c) Explain how arrays change after the deleting the elements $m_{2,6}$ and $m_{10,8}$ and what the new memory occupation is corresponds to.

d) Explain how arrays change after inserting the elements $m_{9,10}$=9,35 $m2_{8,10}$=27,81 and what the new memory occupation corresponds to.

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Exercise 2 (6 points) – Interconnection Networks

a) Design a Clos network of size 225 x 225, using modules having **20 inputs in the first and middle stages** (the third stage is symmetrical to the first for the number of inputs and outputs). Specify the size and the number of switches for each stage. Consider both cases, **strictly non-blocking** and **rearrangeable** network.

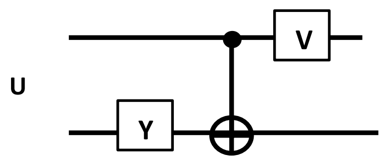
b) Compute the cost of the crossbar 225 x 225, the cost of the Clos networks strictly non-blocking and rearrangeable non-blocking designed in the previous point, and the cost of the Benes with 256 inputs. Which network is more advantageous?

Exercise 3 (4 points) – Interconnection networks

Explain how an Extended Generalized Fat Tree is made and show the representation of the XGFT(3; 2, 4, 2; 2, 4, 1).

Exercise 4 (5 points) – Quantum circuits

Consider the two-qubit transformations U shown below:



where $Y = \begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}$ and $V = \frac{1}{2}\begin{bmatrix} 1+i & 1-i \\ 1-i & 1+i \end{bmatrix}$.

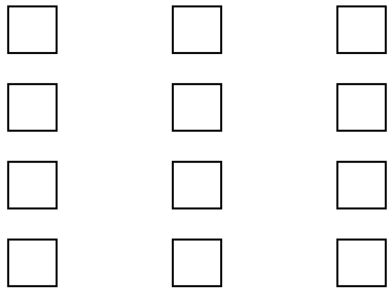
a) Show what transformation U represents writing the associated 4x4 matrix.

b) Show if U is unitary.

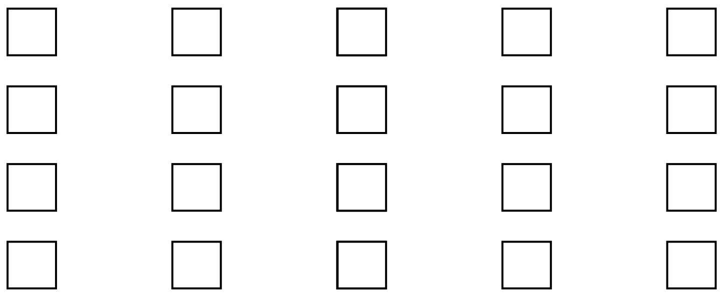
c) Show how U acts on the system state $|\psi_1\psi_2\rangle$, where $|\psi_1\rangle = \frac{\sqrt{2}}{\sqrt{3}}|0\rangle - \frac{\sqrt{3}}{3}i|1\rangle$ and $|\psi_2\rangle = \frac{2}{6}|0\rangle + \frac{1}{\sqrt{3}}i|1\rangle$.

Exercise 5 (5 points) – Interconnection Networks

a) Complete the scheme of the Baseline network of size N=8 and show if it can realize permutation $P = \begin{pmatrix} 01 & 23 & 45 & 67 \\ 54 & 12 & 07 & 36 \end{pmatrix}$, showing the switch setting obtained using the self-routing algorithm.



b) Complete the scheme of the Butterfly-Reverse Butterfly network of size N=8 and show how it can realize the permutation *P* using the Looping algorithm. Show how the algorithm proceeds in the diagram below.



Exercise 6 (4 points) – Quantum computing

Briefly explain what entanglement is and which gates you can use to realize it.