Intensive computation

Prof. A. Massini

Mid Term Exam – April 12, 2016

- **Student's Name** -

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- *Matricola* number -

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

Question 1 (4 points)

Describe the following compressed schemes for the representation of sparse matrices: Coordinate, CSR, Skyline, Diagonal, Ellpack-Itpack.

Exercise 1 (4 points)

a) Consider the sparse matrix here below

1,57088	0	0	-94,2528	0,78544	0	0	0	0	0	0	0	0	0
0	12566400	0	0	0	-6283200	0	0	0	0	0	0	0	0
0	0	0,608806	0	0	0	-0,3044	0	0	0	0	0	0	0
-94,2528	0	0	15080,45	0	0	0	-7540,22	94,2528	0	0	0	0	0
0,78544	0	0	0	3,14176	0	0	-94,2528	0,78544	0	0	0	0	0
0	-6283200	0	0	0	12566400	0	0	0	-6283200	0	0	0	0
0	0	-0,3044	0	0	0	0,608806	0	0	0	-0,3044	0	0	0
0	0	0	-7540,22	-94,2528	0	0	15080,45	0	0	0	-7540,22	94,2528	0
0	0	0	94,2528	0,78544	0	0	0	3,14176	0	0	-94,2528	0,78544	0
0	0	0	0	0	-6283200	0	0	0	12566400	0	0	0	0
0	0	0	0	0	0	-0,3044	0	0	0	0,608806	0	0	0
0	0	0	0	0	0	0	-7540,22	-94,2528	0	0	15080,45	0	94,2528
0	0	0	0	0	0	0	94,2528	0,78544	0	0	0	3,14176	0,78544
0	0	0	0	0	0	0	0	0	0	0	94,2528	0,78544	1,57088

nz = 46

whose pattern is shown on the right.

Specify which arrays you need for the following compressed representations (you need to specify also their size assuming each element is represented by 8 bytes).

Coordinate

_____

_____

_____

_____

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_____

CSR

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Skyline

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Diagonal

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_____
_____
_____
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_____

Ellpack-Itpack

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_____

b) We can permute the original matrix whose pattern is shown in the figure on the left, so that we obtain a permuted matrix whose pattern is shown in the figure on the left.

Which format takes advantage of the permutation in terms of memory storage?

Quantify the save in terms of number of bytes.

_____
_____
_____
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Question 2 (4 points) Describe the Gaussian Elimination method.
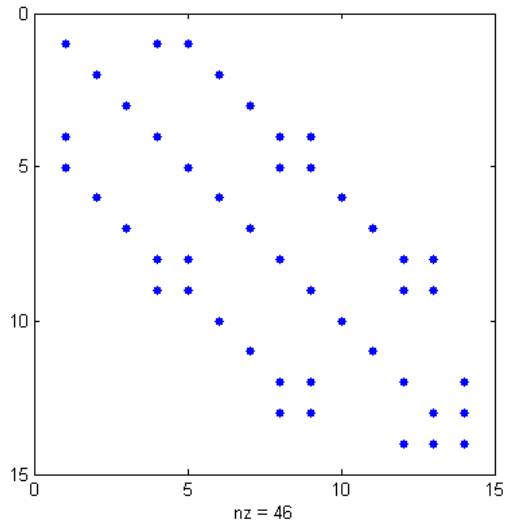
Exercise 2 (4 points)

Solve the following system using Gaussian elimination:

$$\begin{cases} x_1 - x_2 + x_3 = 1 \\ -x_1 \qquad + x_3 = 1 \\ x_1 + x_2 + x_3 = 0 \end{cases}$$

Question 3 (4 points) Describe the iterative Jacobi's method.

Exercise 3 (4 points)

Solve the system

$$\begin{cases} 4x_1 + x_2 - x_3 = 3 \\ 2x_1 + 7x_2 + x_3 = 19 \\ x_1 - 3x_2 + 12x_3 = 31 \end{cases}$$

with Jacobi's Method using $x^{(0)} = (0, 0, 0)$ as starting solution.

Complete the table below, doing five iterations.

k	$x_1^{(k)}$	$x_2^{(k)}$	$x_3^{(k)}$
0	0	0	0
1			
2			
3			
4			
5			

.

Question 4 (4 points) Matlab

Describe the techniques for improving performance in Matlab.

Question 5 (4 points) GPU

Explain what CUDA threads are and how they are organized in terms of blocks and grids.

Describe how we can make an unique ID for each thread per kernel by using block ID and thread ID.