Intensive Computation

Prof. A. Massini

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PART A

Student's Name

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***Matricola* number**

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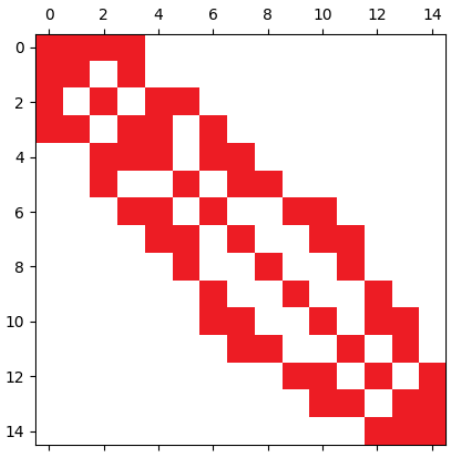
Exercise 1 (6 points)	
Exercise 2 (6 points)	
Exercise 3 (6 points)	
Exercise 4 (6 points)	
Question 1 (4 points)	
Question 2 (4 points)	
Total (32 points)	

Exercise 1 (6 points) - Number representation

- Represent the natural number range [0; 8999] using the residue number system, considering:
  - the moduli set S1 consisting of the three power-of-2 based moduli S1={2^n ; 2^n +1; 2^{n+1}+1 }
  - a moduli set S2 consisting of 3 moduli at your choice.
- Give an estimation of the representational efficiency in both cases.
- Represent A= 39 in **both residue systems** S1 and S2 defined above and in the **mixed radix representation** associated.

Exercise 2 (7 points)



Consider the real elements sparse matrix whose pattern is shown in the figure on the right.

- Explain which arrays you need for the following representations, specifying their role and elements they contain.
- Specify how many bytes the arrays occupy in memory.

DIAG

Skyline

- Explain how arrays change after deleting the elements $m_{8,5}$ and $m_{10,12}$ and what the new memory occupation is.
- Explain how arrays change after inserting real elements in position $m_{1,7}$ and $m_{4,5}$ and what the new memory occupation is.

DIAG

Skyline

Exercise 3 (6 points) Gustafson-Barsis' law and Amdahl's law

a) The analysis of a program has shown a speedup of 5.85 when running on 8 cores. What is the serial fraction according to Gustafson-Barsis's law? And according to Amdahl's law?

b) Considering the serial fraction obtained in point a), compute the speedup when using 18 cores according to Gustafson's law and to Amdahl's law.

Exercises 4 (6 points) Performance equation

Assume that you have the following information on CPI and frequency:

CPI of Arithmetic and logic instructions = 5.9
CPI of Branch instructions = 4.5
Average CPI of other instructions = 5.3
Frequency of Arithmetic and logic instructions = 45%
Frequency of Branch instructions = 32%

Assume that the design alternatives are to decrease the average CPI of Arithmetic and logic instructions to 5.2 or to decrease the average CPI of Branch operations to 3.3. Compare the design alternatives using the **processor performance equation** and show which alternative is more cost-effective computing the respective speedup.

Question 1 (4 points)

Briefly describe the Flynn taxonomy specifying the main characteristics of the machines in each class.

Question 2 (4 points)

Explain how the pipelined multiplier for signed numbers works and show a representation of its scheme.