Intensive computation

Prof. A. Massini

Exam – June 10, 2016

Part A

- Student's Name -

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- ***Matricola*** **number -**

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Question 1 (8 points)	
Question 2 (6 points)	
Question 3 (6 points)	
Question 4 (4 points)	
Exercise 1 (8 points)	
Total (32 points)	

Question 1 (8 points) Sparse matrices

a) Briefly describe the Coordinate, Skyline and Ellpack-Itpack compressed schemes for the representation of sparse matrices.

b) Explain how to realize the insertion of a new element for each of the previous schemes.

Question (6 points) GPU

Describe the different levels of memory on the GPU device.

Question 3 (6 points)

Describe the Cholesky factorization method.

Question 4 (4 points)

Briefly describe the matrix form of the iterative Jacobi's method.

Exercise 1 (8 points)

Solve the system

$$\begin{cases} 4x_1 - x_2 - x_3 = 3 \\ -2x_1 + 6\,x_2 + x_3 = 9 \\ -x_1 + x_2 + 7x_3 = -6 \end{cases}$$

with Jacobi's Method in the **matrix form** using $\boldsymbol{x}^{(0)} = (0, 0, 0)$ as starting solution.

Complete the table below, doing three iterations.

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

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Part B

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Question 1 (3 points)	
Exercise 1 (3 points)	
Question 2 (6 points)	
Exercise 2 (6 points)	
Question 3 (6 points)	
Exercise 3 (8 points)	
Total (32 points)	

Question 1 (3 points) Errors

Briefly explain the meaning of ***computational error*** and ***propagated data error***.

Exercise 1 (3 points) Errors

Show the contribution of ***computational error*** and ***propagated data error*** when computing cos(5π/8).

Question 2 (6 points) Eigenvalues and eigenvectors

a) Explain what the Deflation method is.
b) Discuss what problems you can encounter when applying the Deflation method.
c) Provide an example of when the Deflation method can be utilized.

Exercise 2 (6 points) Methods for Differential equations

Consider the initial value problem $y' = x + 2y \qquad y(0) = 0$

Use Euler's Method for four iterations (e.g compute the approximation y_4) with a step size of h = 0.25 to find approximate values of the solution at x = 1. The exact solution is: $y = \frac{1}{4}e^{2x} - \frac{1}{2}x - \frac{1}{4}$

Repeat with a step size of h = 0.1

Compare approximate solutions obtained for h = 0.25 and h = 0.1 with the exact value of the solution, giving the percentage error in both cases.

Question 3 **(6 points) Methods for Differential equations**

Explain the Verlet method and the Velocity Verlet method for solving second order differential equations.

Exercise 3 (8 points) Simulated Annealing

Consider the Knapsack problem (0-1 version):

> *Given a set of objects, each with a weight and a value, determine which object to put in a bag so that the total weight is less than or equal to a given limit and the total value is as large as possible.*

More formally:

Let there be *n* objects, x_1 to x_n where each x_i has a value v_i and weight w_i (all values and weights are greater than zero). The maximum weight that we can carry in the bag is *W*.
Maximize:

$$\sum_{i=1}^{n} v_i x_i \qquad x_i = \begin{cases} 1 & \text{if the item is in the bag} \\ 0 & \text{otherwise} \end{cases}$$

subject to the constraint

$$\sum_{i=1}^{n} w_i x_i \leq W \qquad x_i \in 0,1$$

Model the Knapsack problem according to the **simulated annealing** approach.