Università della Svizzera italiana | Faculty of Informatics | Institute of Computing CI

Numerical Computing **2022**

Student: FULL NAME Discussed with: FULL NAME

Solution for Project 1

Due date: Wednesday, 12 October 2022, 23:59 AM

Numerical Computing 2022 — Submission Instructions
(Please, notice that following instructions are mandatory: submissions that don't comply with, won't be considered)

- Assignments must be submitted to iCorsi (i.e. in electronic format).
- Provide both executable package and sources (e.g. C/C++ files, Julia). If you are using libraries, please add them in the file. Sources must be organized in directories called:
  Project_number_lastname_firstname
  and the file must be called:
  project_number_lastname_firstname.zip
  project_number_lastname_firstname.pdf
- The TAs will grade your project by reviewing your project write-up, and looking at the implementation you attempted, and benchmarking your code's performance.
- You are allowed to discuss all questions with anyone you like; however: (i) your submission must list anyone you discussed problems with and (ii) you must write up your submission independently.

The purpose of this assignment[1] is to learn the importance of numerical linear algebra algorithms to solve fundamental linear algebra problems that occur in search engines.

PageRank Algorithm

1. Theory [20 points]

(a) **What are an eigenvector, an eigenvalue and an eigenbasis?**

(b) **What assumptions should be made to guarantee convergence of the power method?**

(c) **What is the shift and invert approach?**

(d) **What is the difference in cost of a single iteration of the power method, compared to the inverse iteration?**

(e) **What is a Rayleigh quotient and how can it be used for eigenvalue computations?**

[1] This document is originally based on a SIAM book chapter from *Numerical Computing with Matlab* from Clever B. Moler.

2. **Other webgraphs [10 points]**
3. **Connectivity matrix and subcliques [5 points]**
4. **Connectivity matrix and disjoint subgraphs [10 points]**
5. **PageRanks by solving a sparse linear system [40 points]**
6. **Quality of the Report [15 points]**