

Numerical Computing

2022

Student: FULL NAME

Discussed with: FULL NAME

Solution for Project 1

Numerical Computing 2022 — Submission Instructions (Please, notice that following instructions are mandatory:

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

- 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:

submissions that don't comply with, won't be considered)

 $Project_number_lastname_firstname$

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 assignment¹ 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?

¹This 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]