

MAT167: Applied Linear Algebra Final Project

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Due 6/8/23 at 11:59 pm on Gradescope

1 Introduction

Your final project will be a report on an exploration of a particular application of the matrix methods we studied in class. The last decomposition we will study is singular value decomposition. Afterwards, we'll move on to the applications in the textbook.

Your final project will be related to a topic in a different textbook, by Moler: [Numerical Computing with MATLAB](#). You will study a particular application of the matrix methods we learned in class by answering a series of problems similar to some homework problems.

More information about the final exam:

- All materials for the final project for this course will be due at **11:59 pm on the last day of classes, June 8, 2023, on Gradescope**. You cannot use your late tokens on the final project. However, as this assignment is very important, I will still accept final project submissions up until *11:59 pm on June 9, 2023*; this is a *hard deadline*.
- Your finished product must be **typeset**, using whatever typesetting software you like (e.g. LaTeX, MS Word, Google Docs). Your final product must be **submitted as a PDF to Gradescope**.
- You will be graded on mathematical accuracy, content, clarity, presentation, among other aspects.

2 Project submission and grading

2.1 How to submit your project

On Gradescope, you will see different versions of the final project assignment corresponding to the different project. **Submit your final project to the assignment corresponding to your choice of project**. This is necessary because the rubric for the different projects will be allocated differently.

2.2 How your project will be graded

You will be able to see the rubric on Gradescope for the final project that you choose. The rubric for every project will have the following major components:

Points	Criterion	Explanation
20	Quality of report	Quality of your final product, including spelling/grammar, proper formatting of math symbols and equations, accuracy, clarity of writing, etc.
20	Introductory paragraph	Introduction describing the application of matrix methods, summarizing the problem(s) you solve, the methods you employ, and the results you obtained
20	Background section	Background section explaining, in your own words, the definitions, concepts, or models specific to your project that we did not discuss in class, or that we only touched upon in class
140	Solutions	Mathematical accuracy of your answers to the questions posed in the project. You will be graded on the justification of your answers, as on homework; some problems may ask you to provide your code as well.
200	Total	Total number of points for the entire final project

Make sure you clearly mark where the solutions to each subproblem is in your report. If we can't find your solution, we can't grade it.

3 Project Options

Choose **ONE** of the final projects below to complete. All three are based on exercises from Moler's book:

<https://www.mathworks.com/moler/chapters.html>

Any supporting MATLAB files alluded to in the text are available in a downloadable package at the bottom of the webpage.

3.1 Option 1: Google's Pagerank Algorithm

This project is based on Ex. 2.25 and 2.26 in Moler.

1. Complete Ex. 2.25(a,b,c).
2. Complete Ex. 2.26(a,b,c,d).
3. Pick a dataset from

<http://snap.stanford.edu/data/#web>

and run any of your versions of `pagerank` on the data. Then, discuss your results and any interesting phenomena you discover. Attach (digital) printouts of any code you write and run to do these computations (e.g. parsing the data files). You may use any programming language to parse the data, but you should use MATLAB to do the computations.

3.2 Option 2: Fast Finite Fourier Transform

This project is based on Chapter 8 in Moler.

1. Complete Ex. 8.8(a,b,c) in Moler.
2. Complete Ex. 8.9 in Moler.
3. Investigate the use of the MATLAB functions `audiorecorder` and `audioplayer`, or some other system for making digital recordings. Then, record 4 different, related sounds (e.g. voices of four people, four different bells, etc.), each roughly 3-5 seconds long. Analyze your sound samples to identify the frequency plots for your sounds. Compare and contrast these plots and discuss your findings.

3.3 Option 3: Various applications of PCA

This project is based on Ex. 10.12 and 10.14 in Moler.

1. Complete Ex. 10.12(a,b) in Moler, using one photograph of your choice. Use a program like “screen capture” or “snipping tool” to get a photo that is reasonably sized, e.g. a couple hundred pixels in each dimension.
2. Use the same methods as in Ex. 10.12 to analyze 3 more photos of your choice; for each of them, choose 3 different ranks to approximate the photo, based on the singular values you compute. Discuss your findings and any differences in the lower-rank approximations of your photos.
3. Complete Ex. 10.14(a,b,c,d,e) in Moler.

3.4 Option 4: Independent Study

If for some reason you are highly motivated to investigate a particular topic on your own, you are welcome to do so. However, in order to grade your final project fairly, you should first take a look at the other project topics to get a sense of what your final report should cover. In particular, you must still include

- the introduction
- the background
- actual data
- a computational component where you use MATLAB to perform matrix computations to analyze your data
- analysis of your findings

You must also clearly label where you are using concepts from this course in your analysis.

Should you choose this option, you will be graded on the accuracy and depth of your analysis, in analogy with the suggested project options. Note that this will involve some subjective judgement on the graders’ part; by choosing this option, you indicate that you understand this.

Your topic can be from another part of Moler’s book, or from some other source. This hopefully doesn’t need to be said, but you obviously can’t submit the same project as an assignment to two different classes; this would be *self-plagiarism*, and would be dealt with very seriously.