Electrical and Electronics Engineering Institute
University of the Philippines, Diliman, Quezon City

CoE 163 Computing Architecture and Algorithms

Study Guide: Week 4
(March 14-18, 2022)

Introduction

After reviewing some fundamentals about algorithms in the first part of this course, we will now begin to look at how algorithms interact with their underlying platform. Our exploration of this interaction will begin with linear algebra algorithms, since these have many practical applications--many phenomena in the real world are linear and can be modeled and manipulated using linear algebra. This week we will first review some linear algebra operations and how they can be used to solve problems. Then we will discuss what things we need to consider when we translate these operations into computer algorithms, especially if we want the algorithms to be efficient and accurate.

The detailed schedule for the week is as follows:

Time (min)	Activity	Topic	Assessment	Score
10	📦	Study guide		
30	📦 🖥	Review of Linear Algebra Operations		
20	📦 🖥	Solving problems using linear algebra		
30	📦 🖥	Considerations in running linear algebra algorithms on a computer		

Objectives

The objectives for this week's activities are for you to be able to:
- recall fundamentals of linear algebra
- Identify and describe problems that can be solved using linear algebra
- enumerate and explain what we need to consider if we want to have efficient and accurate linear algebra computer algorithms

Activity 1: Review of Linear Algebra Operations

Go through the materials (which are mostly in manga format!) and try to practice solving some linear algebra problems again by hand. Some supplementary videos/links are uploaded on UVLe, but feel free to review linear algebra in the way that you think is most effective for you. The following are the operations that you will need to be familiar with again:

- Matrix-matrix multiplication
- Gaussian elimination
- Matrix inversion
- Matrix decomposition

Activity 2: Solving Problems Using Linear Algebra

In this section, we will establish the relevance of creating computer algorithms for linear algebra operations. Several examples of interesting applications of linear algebra are described in this section.

One notable application is PageRank the original search engine algorithm used by Google (the one today is probably more even more complex). If you are interested to really understand how PageRank works and why matrices are used, you can go through the blog entry[1] linked on UVLe.

Some additional supplementary links are posted on UVLe if you have time and would like to know more details about some of the examples mentioned in the slides.

Activity 3: Considerations in running linear algebra algorithms on a computer

The last part of week 4 begins the discussion on what we need to consider if we want our algorithms to be more efficient and accurate. We review briefly some concepts about computer memory and discuss how computer memory and

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[1] https://jeremykun.com/2011/06/18/googles-pagerank-a-first-attempt/

the limitations of a computer in general can impact the performance of our algorithm.

There is a 25-minute video, Halide Talk[2], that demonstrates with good visuals the impact of locality on the speed of an algorithm. You only need to watch until around the 12-minute mark, because after that the talk focuses on a specific programming language. Watch

End of Week 4
Next Week's Topic: Matrix-Matrix Multiplication and ATLAS

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[2] https://youtu.be/3uiEyEKji0M