Spring 2020 Course in Data Science / ML

Linear Algebra: A Computational Approach

CS-4342/6342

Whether you've taken a standard course in Linear Algebra or not, you might have questions like …

What is a vector and why is it defined the way it is? What are matrices and what do they have to do with vectors? And what exactly is an eigenvalue?

How does Google's famous page-rank algorithm work?

How do you construct an algorithm to identify the topic of a chunk of text?

How are objects transformed and rendered in computer graphics?

How does the MP3 format compress audio?

Why is Linear Algebra considered a critical tool in Data Science and Machine Learning?

Linear Algebra is one of the most powerful and widely applied tools in mathematics. Unfortunately, even though it's considered relatively "easy" among math courses, intuition in linear algebra is often hard to come by. In this course, we will use a computational approach to both convey intuition and to show how to apply linear algebra algorithmically in a variety of modern applications. At the center of it all is the "superstar" of linear algebra: the Singular Value Decomposition (SVD). We will see what this has to do with the questions above.

SPRING 2020 COURSE INFORMATION:

When: 10.30am – 1pm, Fridays

Instructor: Prof. Rahul Simha

Prerequisites: Sufficient programming skill in Java (at least CS-1112).

Topics: Vectors, matrices, matrix operations. Geometric transformations through matrices. The RREF: how to compute it, and how it answers questions about solving linear equations, matrix inversion. Core linear algebra: linear combinations, linear independence, rank, spaces, the fundamental theorem of linear algebra. Orthogonality, Gram-Schmidt process, and the QR decomposition. Eigenvalues and eigenvectors, the QR algorithm. Singular Value Decomposition, principal component analysis. Pseudo-inverse, least squares and fitting curves to data. Applications to computer graphics, text and image similarity, audio processing, compression, data analysis.

NOTE: the next time (after Spring 2020) this course will be offered is Spring 2022.