CS 450 Project Proposal: Computing Singular Value Decomposition (SVD) Through Power Iterations

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1 Introduction

SVD, as introduced in class, is a matrix factorization method that generalizes the eigen-decomposition of a square matrix (n x n) to any matrix (n x m). Following shows the general formula of SVD (Figure 1),

$$A = U\Sigma V^T$$

where U is an m x m orthogonal matrix; Σ is an m x n diagonal matrix with $\sigma_i > 0$ on the diagonal; V is an n x n orthogonal matrix. In the class, we learned how to use SVD method to solve the Linear Least Squares Problem. However, for my final project, I would like to combine the ideas from chapter 5 of power iteration methods to find the singular values of matrix A, U, and V iteratively.

2 Method

1. Power iteration for one pair of ¡eigenvalue, eigenvector¿. Use power iteration to find the biggest eigenvalue pair of Σ.
2. SVD for n singular values. Run power iteration several times and find one pair of ¡eigenvalue, eigenvector¿ each time iteratively.
In the end, we will get U, V, and Σ.
3. Apply Simultaneous Power Iteration / Orthogonal Iteration / Block version of the Power Method to compute U, V, and Σ.

3 Plan

1. Implement the methods and compare the results with API call return values. Make sure my code work and do data analysis. 2. Write the final report.

4 References

1. Lecture slides.
2. https://towardsdatascience.com/simple-svd-algorithms-13291ad2eef2
3. https://en.wikipedia.org/wiki/Singular_value_decomposition
4. https://github.com/RRisto/learning/blob/master/linear_algebra_learn/PCA_SVD/power_method.ipynb

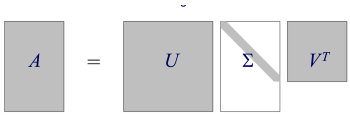

Figure 1: Visualization of SVD method.