

MTH343 Final Project - Lanczos Algorithm

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Overview

In this programming assignment, I will create a library of functions for operating on matrices stored in a Compressed Sparse Row format, as well as a presentation layer (web application), using Angular and TypeScript.

More specifically, this library will be able to:

- Read a matrix A from a CSR-format file
- Produce $B = A^T$, and store B in CSR format.
- Compute $C = AB$, check C for symmetry, and store C in CSR format.

This application will also:

- Implement the Lanczos algorithm, to generate the tridiagonal matrix $T = Q^T A Q$, with the option to stop at any step $m \geq 1$, where $Q = [q_1, q_2, \dots, q_m]$ will consist of only the first m orthonormal vectors computed by the Lanczos algorithm.
- Compute the eigenvalues of the tridiagonal matrix T , for selected values of m .

In the subsequent sections of this report, I will briefly explain the algorithms used, as well as technical implementation details, and an analysis of the behavior of the eigenvalues of T for increasing values of m .

Algorithms

Compressed Sparse Row (CSR)

Compressed Sparse Row

Related:

- Sparse matrix

Lanczos

Lanczos algorithm

Related:

- Generalized minimal residual method
- Matrix-free methods
- Arnoldi iteration
- Householder transformation
- Singular-value decomposition

Technical Implementation

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LAPACK and OpenBLAS

- LAPACK
- OpenBLAS

JavaScript Libraries

- math.js | an extensive math library for JavaScript and Node.js
- scijs/packages

Analysis

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Input Matrices

- The Matrix Market Top Ten
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Eigenvalue Comparison (for selected values of m)

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Conclusion

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