Fast SVD of Hankel/Toeplitz and Takagi Factorization Package (Matlab)

1 Introduction

For any symmetric matrix A, there exists a special form of SVD, called Takagi factorization:

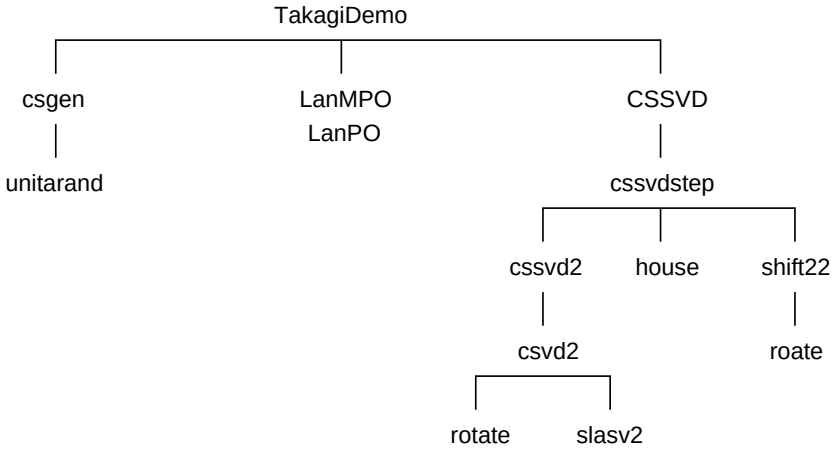
$$A = Q\Sigma Q^{\mathrm{T}},$$

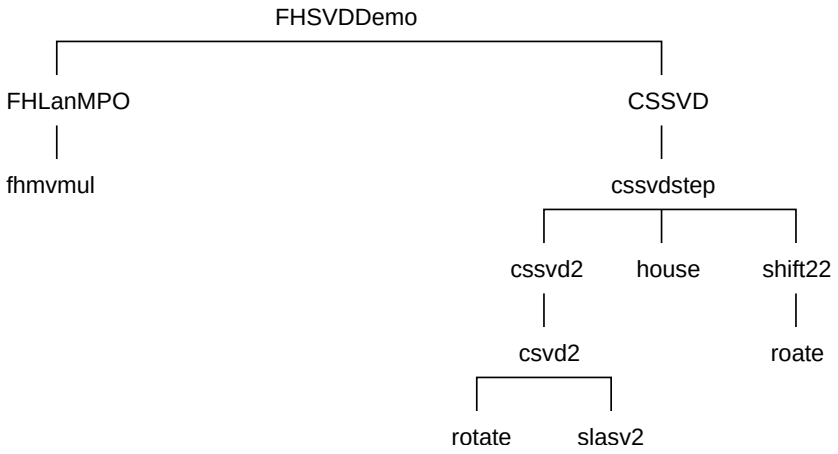
where Q is unitary and Σ is the diagonal singular value matrix.

This package of Matlab functions computes the Takagi factorization of a complex-symmetric matrix. The computation consists of two stages: Lanczos tridiagonalization and implicit QR method. Two Lanczos tridiagonalization functions are provided. One uses partial orthogonalization, another uses modified partial orthogonalization. In general, the modified partial orthogonalization version is more efficient than the partial orthogonalization version. The implicit QR method uses order two class two shift.

The matrix-vector multiplication in the Lanczos functions can be replaced by a matrix-vector multiplication function. For example, if it is replaced by a fast Hankel matrix-vector multiplication, this package can be used for fast Hankel SVD. If it is replaced by a sparse symmetric matrix-vector multiplication, this package can be used for sparse symmetric SVD. Since a Toeplitz matrix can be transformed into a Hankel by reversing its columns or rows, this package can also be used for fast Toeplitz SVD.

2 Dependency





3 Functions

csgen.m Generate a random complex-symmetric matrix, given its singular values.

CSSVD.m The SVD of a tridiagonal complex-symmetric matrix using implicit QR method with order two class two shifts.

cssvd2.m Compute the SVD of a 2-by-2 complex-symmetric matrix.

cssvdstep.m One step of the implicit QR method for tridiagonal complex-symmetric matrices using order two class two shift.

csvd2.m The SVD of a 2-by-2 complex matrix.

FHLanMPO.m Fast Lanczos tridiagonalization of Hankel matrices using the modified partial orthogonalization.

fhmvmul.m Fast Hankel matrix-vector multiplication.

FHSVDDemo.m Demonstrate the fast Hankel SVD.

house.m Householder transformation given a vector.

LanMPO.m Lanczos tridiagonalization of a complex-symmetric matrix using the modified partial orthogonalization.

LanPO.m Lanczos tridiagonalization of a complex-symmetric matrix using the partial orthogonalization.

rotate.m Rotation transformation given a 2-D vector.

shift22.m Find the order two class two shift.

slasv2.m Compute the SVD of a 2-by-2 real and upper triangular matrix.

TakagiDemo.m Demonstrate the Takagi factorization, or symmetric SVD, of a complex-symmetric matrix.

unitarand.m Generate a random unitary matrix.