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A Julia package for practical iterative SVDs

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We present an implementation of iterative Golub-Kahan-Lanczos (GKL) bidiagonalization in the Julia package `IterativeSolvers.jl`, allowing for the iterative computation of the singular value decomposition. The implementation combines the best features of available implementations, featuring a standardized palette of techniques aiding practical computation such as restarting and reorthogonalization. Our implementation offers multiple restarting strategies, such as explicit restarts, implicit restarts as in ARPACK, thick restarts as in SLEPc, and harmonic restarts. We also offer multiple reorthogonalization strategies, such as partial orthogonalization as in PROPACK, and full reorthogonalization using QR and various Gram-Schmidt methods.

We show how the multimethods (multiple dispatch) system of Julia allows for modular composition of these various components, allowing for very fine grained control over roundoff error. The Julia type system also allows for bidiagonalizations to be computed over a wide variety of matrix data types, ranging from ordinary dense matrices to sparse matrices with multiprecision floating point numbers. Overloading elementary operators such as multiplication (*) and subtraction (-) allow the same code to run on new data structures, such as out of core arrays in a database, or custom matrix representations. The same technique allows us to provide run time control over the underlying linear algebra library, allowing users to change between OpenBLAS, MKL, Eigen, and others. The result is a flexible yet performant library of components which can be used for high performance computation that at the same time facilitates further experimentation and prototyping of new algorithms.