

# Computation of matrix functions with fully automatic Schur-Parlett and Rational Krylov methods

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We present MatFun, a Julia package for computing dense and sparse matrix functions fully automatically (no user input required, other than the code to compute the function  $f$  and the matrix  $A$  themselves). This is achieved by combining specifically chosen algorithms and some peculiar feature of Julia. For dense matrices, the Schur-Parlett algorithm [1] has been implemented, leveraging Julia's automatic differentiation capabilities. The algorithm has also been improved from a performance standpoint, making the Parlett recurrence cache-oblivious and enabling the whole procedure to work mostly in real arithmetic, for real inputs. For sparse matrices, we implemented a Rational Krylov method [2], alongside the AAA Rational Approximation [3]. Given a function's samples, AAA is often able to accurately identify its poles, which can then be used by the Rational Krylov method itself for the approximation of  $f(A)b$ . The accuracy and performance of the algorithms are evaluated, in comparison with already existing specialized methods.

## References

- [1] Philip I. Davies and Nicholas J. Higham, *A Schur-Parlett Algorithm for Computing Matrix Functions*, SIAM Journal on Matrix Analysis and Applications, 25 (2003) 464-485.
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- [3] Nakatsukasa Yuji, Sète Olivier and Trefethen Lloyd N., *The AAA algorithm for rational approximation*, ArXiv e-prints, print 1612.00337 (2016).