On Rational Krylov sequences

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The notion of Rational Krylov sequence has been introduced by Axel Ruhe in the linear algebra community in the early eighties [5] [8] [6] [7] [9]. Gorik De Samblanx and Karl Deckers (Adhemar Bultheel PhD students) and myself studied the method by applying new ideas that were developed that time: [2] [1] [4] and more recently [3]. Although aimed at computing eigenvalues of large sparse matrices, the method has mainly been used by the model reduction community. In this talk, we discuss the connection with traditional Krylov spaces and the Padé-via-Lanczos method. We explain why the method has never become popular in the solution of eigenvalue problems.

References

[1] G. De Samblanx and A. Bultheel. Restrictions on implicit filtering techniques for orthogonal projection. *Linear Alg. Appl.*, 286:45–68, 1998.

[2] G. De Samblanx, K. Meerbergen, and A. Bultheel. The implicit application of a rational filter in the RKS method. *BIT*, 37:925–947, 1997.

[3] K. Deckers and A. Bultheel. Rational krylov sequences and orthogonal rational functions. Technical Report TW499, K.U.Leuven, Department of Computer Science, Heverlee, Belgium, 2007.

[4] R.B. Lehoucq and K. Meerbergen. Using generalized Cayley transformations within an inexact rational Krylov sequence method. *SIAM Journal on Matrix Analysis and Applications*, 20(1):131–148, 1998.

[5] A. Ruhe. Rational Krylov sequence methods for eigenvalue computation. *Linear Alg. Appl.*, 58:391–405, 1984.

[6] A. Ruhe. Rational Krylov algorithms for nonsymmetric eigenvalue problems. In G. Golub, A. Greenbaum, and M. Luskin, editors, *Recent advances in iterative methods*, volume 60 of *IMA volumes in mathematics and its applications*, pages 149–164. Springer, 1993.

[7] A. Ruhe. The Rational Krylov algorithm for nonsymmetric eigenvalue problems, III: Complex shifts for real matrices. *BIT*, 34:165–176, 1994.

[8] A. Ruhe. Rational Krylov algorithms for nonsymmetric eigenvalue problems, II: Matrix pairs. *Linear Alg. Appl.*, 197/198:283–296, 1994.

[9] A. Ruhe. Rational Krylov: a practical algorithm for large sparse nonsymmetric matrix pencils. *SIAM Journal on Scientific Computing*, 19(5):1535–1551, 1998.