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Krylov subspace methods. Principle and analysis.

Numerical Mathematics and Scientific Computation. Oxford: Oxford University Press (ISBN 978-0-19-965541-0/hbk). xv, 391 p. £ 75.00/hbk (2013).

This book treats the methods for solving large linear systems $Ax = b$ using Krylov subspaces, i.e. subspaces spanned by some r_0 and its first k iterates $r_0, Ar_0, \dots, A^{k-1}r_0$. After an introduction these Krylov subspace methods are described in Chapter 2. They are derived from a general projection framework. In particular the CG method, GMRES method and its variants are described.

In chapter 3 these methods are described from different points of view, among others as methods to matching moments and considering it as model reduction, also orthogonal polynomials, Jacobi matrices and the connections to continued fractions. In chapter 4 the existence or non-existence of short recurrences for generating orthogonal Krylov subspace bases is discussed. Here several new results are given.

Chapter 5 with the title “computational costs” describes the numerical aspects of the Krylov space methods such as number of operations and error considerations. In particular the different types of errors are discussed, rounding errors and convergence aspects. Interesting numerical examples can be found here.

A special aspect of this book are the many historical notes. Most were completely new to the reviewer and helpful to understanding.

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Classification: 65F10 65-02 65F15

Keywords: Krylov subspace; Arnoldi and Lanczos algorithm; orthogonal polynomials; CG-method; GMRES-method; matrix theory