Horn, Roger A.; Johnson, Charles R.
Matrix analysis. 2nd ed. (English) Zbl 1267.15001

The first edition (see [(1985; Zbl 0576.15001); reprinted with corrections (1990; Zbl 0704.15002); translated into Russian (1989; Zbl 0734.15002)]) has become a widely used graduate textbook and a standard reference book – it could perhaps even be called the bible of linear algebra.

In the preface of the second edition, the authors start out by describing differences: “The core role of canonical forms has been expanded as a unifying element in understanding similarity (complex, real, and simultaneous), unitary equivalence, unitary similarity, congruence, *congruence, unitary congruence, triangular equivalence, and other equivalence relations. More attention is paid to cases of equality in the many inequalities considered in the book. Block matrices are a ubiquitous feature of the exposition in the new edition.”

They continue: “Learning mathematics has never been a spectator sport, so the new edition continues to emphasize the value of exercises and problems for the active reader.” Throughout the text, there are easy and pedagogically valuable exercises that allow readers to check comprehension, and, at the end of each section, there is a rich and masterfully collected set of problems that includes both very easy and very difficult ones. The first edition had these features as well, but the second features many more. In the first edition, only a few problems had hints, given in the problems themselves; in the second, many problems have hints, and they are listed in an appendix.

Developments in linear algebra since 1985 have motivated the authors to include several new topics in the second edition. One of them is the Weyr canonical form discovered by Eduard Weyr (1852–1903). This form is probably unfamiliar to many linear algebraists but has recently received some attention. The authors introduce the Jordan canonical form via the Weyr characteristic and present many interesting properties of the Weyr canonical form.

The chapters have the same or almost the same titles as in the first edition, but their contents have been thoroughly revised, expanded and updated. Some topics have also been moved to a different chapter. For example, the definition of the singular value decomposition, previously in Chapter 7, is now in Chapter 2, which makes this important tool more widely available than in the first edition.

Nice new details appear throughout. Just to mention one, in a certain semi-inner product space, the Cauchy-Schwarz inequality yields the Schrödinger uncertainty principle concerning a finite-dimensional quantum system.

This book is indeed “a monumental contribution on the theory and applications of matrices”, as a review on the back cover states. Hopefully, the authors will also update its sequel [R. A. Horn and C. R. Johnson, Topics in matrix analysis. Cambridge etc.: Cambridge University Press. (1991; Zbl 0729.15001), (1994; Zbl 0801.15001)].

Reviewer: Jorma K. Merikoski (Tampere)

MSC:
15-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to linear algebra
15A18 Eigenvalues, singular values, and eigenvectors
15A21 Canonical forms, reductions, classification
15A23 Factorization of matrices
15A42 Inequalities involving eigenvalues and eigenvectors
15A45 Miscellaneous inequalities involving matrices
15A60 Norms of matrices, numerical range, applications of functional analysis to matrix theory
15B48 Positive matrices and their generalizations; cones of matrices
15B57 Hermitian, skew-Hermitian, and related matrices
15A63 Quadratic and bilinear forms, inner products

Cited in 6 Reviews
Cited in 744 Documents
Keywords:
matrix analysis; eigenvalues; singular values; unitary similarity; unitary equivalence; canonical forms; matrix factorization; matrix inequalities; norms; nonnegative definite matrices; nonnegative matrices; textbook; congruence; Weyr canonical form; Jordan canonical form; singular value decomposition; semi-inner product space; Cauchy-Schwarz inequality; Schrödinger uncertainty principle