

LU or Gaussian elim. with outer products (1)

Algorithm 2.4, see also CE 26.

First step: $A^{(2)} = A^{(1)} - m_1 \cdot [a_{11}^{(1)} \cdots a_{1n}^{(1)}], m_1 = \begin{pmatrix} 0 \\ m_{21} \\ \vdots \\ m_{n1} \end{pmatrix}$
 $m_{i1} = \frac{a_{i1}^{(1)}}{a_{11}^{(1)}}, i \geq 2$ outer products

Second step: $A^{(3)} = A^{(2)} - m_2 \cdot [a_{21}^{(2)} \cdots a_{2n}^{(2)}], m_2 = \begin{pmatrix} 0 \\ m_{32} \\ \vdots \\ m_{n2} \end{pmatrix}$
 $m_{i2} = \frac{a_{i2}^{(2)}}{a_{22}^{(2)}}, i \geq 3$

\vdots
 $A^{(n)} = A^{(n-1)} - m_{n-1} \cdot [a_{n-1,1}^{(n-1)} \cdots a_{n-1,n}^{(n-1)}], m_{n-1} = \begin{pmatrix} 0 \\ \vdots \\ 0 \\ m_{n,n-1} \end{pmatrix}$
 $m_{n,n-1} = \frac{a_{n,n-1}^{(n-1)}}{a_{n-1,n-1}^{(n-1)}}$

$A^{(n)} = \square$.

If we want L: $A^{(2)} = M_1 A^{(1)}$, $M_1 = I - w_1 e_1^T = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ -w_{21} & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & 0 \\ -w_{n1} & 0 & \cdots & 1 \end{bmatrix}$
 $A^{(3)} = M_2 A^{(2)}$, $M_2 = I - w_2 e_2^T = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & 1 \\ 0 & -w_{32} & \cdots & 0 \\ \vdots & \vdots & \ddots & 0 \\ 0 & -w_{n2} & \cdots & 1 \end{bmatrix}$

\vdots
 $A^{(n)} = M_{n-1} A^{(n-1)} = \cdots = M_{n-1} M_{n-2} \cdots M_2 M_1 A^{(1)}$
 $L^{-1} A \iff A = LU$
 $\square =$

so $L = M_1^{-1} M_2^{-1} \cdots M_{n-1}^{-1}$.

L is triangular: (i) $M_1^{-1} = I + w_1 e_1 e_1^T$ since $(I + w_1 e_1 e_1^T)(I + w_1 e_1 e_1^T) = I + w_1 e_1 e_1^T + w_1 e_1 e_1^T + \underbrace{w_1 e_1 e_1^T w_1 e_1 e_1^T}_{=0} = I$

(ii) $M_1^{-1} M_2^{-1} = (I + w_1 e_1 e_1^T)(I + w_2 e_2 e_2^T) = I + w_1 e_1 e_1^T + w_2 e_2 e_2^T + \underbrace{w_1 e_1 e_1^T w_2 e_2 e_2^T}_{=0} = I + w_1 e_1 e_1^T + w_2 e_2 e_2^T =$

Numerical Linear Algebra

Holger Wendland

Numerical Linear Algebra:

Numerical Linear Algebra Lloyd N. Trefethen, David Bau, III, 1997-06-01 Numerical Linear Algebra is a concise insightful and elegant introduction to the field of numerical linear algebra [Numerical Linear Algebra with Applications](#) William Ford, 2014-09-14 Numerical Linear Algebra with Applications is designed for those who want to gain a practical knowledge of modern computational techniques for the numerical solution of linear algebra problems using MATLAB as the vehicle for computation. The book contains all the material necessary for a first year graduate or advanced undergraduate course on numerical linear algebra with numerous applications to engineering and science. With a unified presentation of computation basic algorithm analysis and numerical methods to compute solutions this book is ideal for solving real world problems. The text consists of six introductory chapters that thoroughly provide the required background for those who have not taken a course in applied or theoretical linear algebra. It explains in great detail the algorithms necessary for the accurate computation of the solution to the most frequently occurring problems in numerical linear algebra. In addition to examples from engineering and science applications proofs of required results are provided without leaving out critical details. The Preface suggests ways in which the book can be used with or without an intensive study of proofs. This book will be a useful reference for graduate or advanced undergraduate students in engineering science and mathematics. It will also appeal to professionals in engineering and science such as practicing engineers who want to see how numerical linear algebra problems can be solved using a programming language such as MATLAB, MAPLE or Mathematica. Six introductory chapters that thoroughly provide the required background for those who have not taken a course in applied or theoretical linear algebra. Detailed explanations and examples. A thorough discussion of the algorithms necessary for the accurate computation of the solution to the most frequently occurring problems in numerical linear algebra. Examples from engineering and science applications **Numerical Linear Algebra** SUNDARAPANDIAN, V., 2008-04-23 This well organized text provides a clear analysis of the fundamental concepts of numerical linear algebra. It presents various numerical methods for the basic topics of linear algebra with a detailed discussion on theory, algorithms and MATLAB implementation. The book provides a review of matrix algebra and its important results in the opening chapter and examines these results in the subsequent chapters. With clear explanations the book analyzes different kinds of numerical algorithms for solving linear algebra such as the elimination and iterative methods for linear systems, the condition number of a matrix, singular value decomposition (SVD) of a matrix and linear least squares problem. In addition it describes the Householder and Givens matrices and their applications and the basic numerical methods for solving the matrix eigenvalue problem. Finally the text reviews the numerical methods for systems and control. Key Features: Includes numerous worked out examples to help students grasp the concepts easily. Provides chapter end exercises to enable students to check their comprehension of the topics discussed. Gives answers to exercises with hints at the end of the book. Uses MATLAB software for problem solving. Primarily designed as a textbook for

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Numerical Linear Algebra Holger Wendland, 2017-11-16 This self contained introduction to numerical linear algebra provides a comprehensive yet concise overview of the subject. It includes standard material such as direct methods for solving linear systems and least squares problems error stability and conditioning basic iterative methods and the calculation of eigenvalues. Later chapters cover more advanced material such as Krylov subspace methods multigrid methods domain decomposition methods multipole expansions hierarchical matrices and compressed sensing. The book provides rigorous mathematical proofs throughout and gives algorithms in general purpose language independent form. Requiring only a solid knowledge in linear algebra and basic analysis this book will be useful for applied mathematicians engineers computer scientists and all those interested in efficiently solving linear problems *Numerical Linear Algebra* Folkmar Bornemann, 2018-01-29 This book offers an introduction to the algorithmic numerical thinking using basic problems of linear algebra. By focusing on linear algebra it

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Guaranteed Accuracy in Numerical Linear Algebra S.K.

Godunov,A.G. Antonov,O.P. Kiriljuk,V.I. Kostin,2013-03-14 There exists a vast literature on numerical methods of linear algebra In our bibliography list which is by far not complete we included some monographs on the subject 46 15 32 39 11 21 The present book is devoted to the theory of algorithms for a single problem of linear algebra namely for the problem of solving systems of linear equations with non full rank matrix of coefficients The solution of this problem splits into many steps the detailed discussion of which are interesting problems on their own bidiagonalization of matrices computation of singular values and eigenvalues procedures of deflation of singular values etc Moreover the theory of algorithms for solutions of the symmetric eigenvalues problem is closely related to the theory of solving linear systems Householder s algorithms of bidiagonalization and tridiagonalization eigenvalues and singular values etc It should be stressed that in this book we discuss algorithms which to computer programs having the virtue that the accuracy of computations is guaranteed As far as the final program product is concerned this means that the user always finds an unambiguous solution of his problem This solution might be of two kinds 1 Solution of the problem with an estimate of errors where absolutely all errors of input data and machine round offs are taken into account 2

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