METADATA

Title: Numerical Analysis

Other Titles: -

Language: Greek

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ISBN: 978-618-228-157-4

Subject: MATHEMATICS AND COMPUTER SCIENCE

Keywords: Direct methods / Iterative methods / SVD factorization / QR decomposition / Least squares

Bibliographic Reference: Plexousakis, M., & Chatzipantelidis, P. (2023). Numerical Analysis [Postgraduate textbook]. Kallipos, Open Academic Editions. http://dx.doi.org/10.57713/kallipos-395

Abstract

The book consists of two parts. In Part A we review some basic concepts from linear algebra, as these form the basis of what we will be looking at. We study the numerical solution of a linear system with a square matrix using direct methods, which compute the exact solution in a predetermined number of steps, known in advance. We also study iterative methods, where we construct a sequence of vectors that converge to the solution of the linear system. In addition, we consider linear systems with a non-square matrix, where we search for vectors that minimise an appropriate function, like e.g., a residual. We then address the problem of locating the eigenvalues of a matrix and consider methods for solving nonlinear equations and systems. Part B deals with the numerical solution of initial value problems (I.V.P.) for first-order systems of ordinary differential equations. The simplest numerical method for solving the initial value problem (I.V.P.) is Euler's method. We also consider other single-step methods, and more generally the Runge-Kutta family of methods. We also study the linear multistep methods. Their implementation is economical, and this is why they appeared and were applied before the advent of computers. We study these methods' stability, consistency, accuracy, and order of convergence. The implicit Runge-Kutta methods are more demanding to implement than both explicit Runge-Kutta methods and multistep methods. However, they have higher accuracy and excellent stability properties. We also consider stiff linear differential equations. Some numerical methods are unstable and require a small step size to approximate well the exact solution of these problems. This stability property associated with the approximate solution of a method for a stiff differential equation problem is called absolute stability.

The Project is funded by the National Development Programme 2021-2025 of the Ministry of Education and Religious Affairs and implemented by the Special Account for Research Funds of the National Technical University of Athens and the Hellenic Academic Libraries Link.