Introduction to Numerical Computing

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Abstract

The main aim of this paper is to understand the information to numerical computing. In this paper we solve some examples of numerical computing. The numerical computational techniques are the technique by which mathematical problems are formulated and they can be solved with arithmetic operations. Those techniques are basically numerical methods. Numerical method supports the solution of almost every type of problem. The numerical methods are classified depending upon the type of the problem.

Keywords: Numerical computing; Roots of equation

Introduction to Numerical Computing

Numerical computing is an approach for solving complex mathematical problems using only simple arithmetic operations [1]. The approach involves formulation of mathematical models physical situations that can be solved with arithmetic operations [2]. It requires development, analysis and use of algorithms. Numerical computations invariably involve a large number of arithmetic calculations and, therefore, require fast and efficient computing devices [3]. The microelectronic revolution and the subsequent development of high, low cost personal computers have had a profound impact on the application of numerical computing methods to solve scientific problems [4].

Numerical Methods are Classified Basically Depending upon the Type of Problem

Numerical methods to find roots of equations

In many Engineering and Science application we come across some algebraic and transcendental equation [5].

Ex. Consider the equation:

$$F(x)=x^2-3x+2$$

Such equation is satisfied at some specific value of x. These values are called roots of the equation. The solution of this equation can be obtained with the help of numerical methods [6].

System of Linear Algebric Equation

Consider,

$$2x+3y=7$$

$$5x+8y=18.$$

The values of x and y in these equation can be obtained with help of numerical method [7].

Direct method become complex for no. of variables.

Numerical method are the best solution for large system. Such equation are generated in analysis of electronic ckts. Large structures etc. [8].

Floating Point Numbers

The term floating point is derived from fact that there is fixed no of digit before and after the decimal point i.e., the decimal point can float [9].

There are also representation in which number of digit before and after the decimal no is set called as fixed point representation [10].

In general, floating point representations are slower and less accurate. Than fixed point representation, but they can handled a large range of numbers [11].

Distinguish Between Analog Computing and Digital Computing

Analog computing

Analog refers to the principle of solving a problem by using a tool which operates in way analogues to the problem [12,13]. Many real life measurable quantities are analog in nature: time, temperature, pressure, and speed, for instance. The basic requirement in the application of analog computers is the writing down of differential equations describing the physical system of interest [14,15].

Digital Computing

A digital computer is a computing device that operates on inputs which are discrete in nature [16,17]. The input data are numbers that may represents numeral, letters, or other special symbols. Digital computers are more accurate than analog computers. Digital computers are widely used for many different applications and are often called general purpose computer [18-20].

Characteristics of Numerical Computing

1. **Accuracy:** Every method of numerical computing introduces errors. They may be either due to using an appropriate in pace of an exact mathematical procedure or due to inexact representation and manipulation of numbers in the computer. These errors affect the accuracy of the results.

2. **Efficiency:** One more consideration in choosing a numerical method for solution of a mathematical model is efficiency.

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Numerical Computing An Introduction

Einar Smith

Numerical Computing An Introduction:

Numerical Computing Lawrence F. Shampine,Richard C. Allen,1973 *Introduction to Scientific Computing and Data Analysis* Mark H. Holmes,2023-07-11 This textbook provides an introduction to numerical computing and its applications in science and engineering The topics covered include those usually found in an introductory course as well as those that arise in data analysis This includes optimization and regression based methods using a singular value decomposition The emphasis is on problem solving and there are numerous exercises throughout the text concerning applications in engineering and science The essential role of the mathematical theory underlying the methods is also considered both for understanding how the method works as well as how the error in the computation depends on the method being used The codes used for most of the computational examples in the text are available on GitHub This new edition includes material necessary for an upper division course in computational linear algebra **Numerical Computing** L. F. Shampine,R. C. Allen,1963 An Introduction to Numerical Methods in C++ Brian Hilton Flowers,2000 Designed for the many applied mathematicians and engineers who wish to explore computerized numerical methods this text communicates an enthusiasm for the power of C an object oriented language as a tool for this kind of work This revision of the successful first edition includes for the first time information on programming in Windows based environments In addition this revision includes new topics and methods throughout the text that clarify and enhance the treatment of the subject From reviews of the first edition If you are interested in numerical methods or are looking for a course text this book is worth your attention Journal of the Association of C and C Users A Graduate Introduction to Numerical Methods Robert M. Corless,Nicolas Fillion,2013-12-12 This book provides an extensive introduction to numerical computing from the viewpoint of backward error analysis The intended audience includes students and researchers in science engineering and mathematics The approach taken is somewhat informal owing to the wide variety of backgrounds of the readers but the central ideas of backward error and sensitivity conditioning are systematically emphasized The book is divided into four parts Part I provides the background preliminaries including floating point arithmetic polynomials and computer evaluation of functions Part II covers numerical linear algebra Part III covers interpolation the FFT and quadrature and Part IV covers numerical solutions of differential equations including initial value problems boundary value problems delay differential equations and a brief chapter on partial differential equations The book contains detailed illustrations chapter summaries and a variety of exercises as well some Matlab codes provided online as supplementary material I really like the focus on backward error analysis and condition This is novel in a textbook and a practical approach that will bring welcome attention Lawrence F Shampine A Graduate Introduction to Numerical Methods and Backward Error Analysis has been selected by Computing Reviews as a notable book in computing in 2013 Computing Reviews Best of 2013 list consists of book and article nominations from reviewers CR category editors the editors in chief of journals and others in the computing community *Theoretical Numerical Analysis*

Peter Linz,2019-06-12 This concise text introduces numerical analysis as a practical problem solving discipline The three part presentation begins with the fundamentals of functional analysis and approximation theory Part II outlines the major results of theoretical numerical analysis reviewing product integration approximate expansion methods the minimization of functions and related topics Part III considers specific subjects that illustrate the power and usefulness of theoretical analysis Ideal as a text for a one year graduate course the book also offers engineers and scientists experienced in numerical computing a simple introduction to the major ideas of modern numerical analysis Some practical experience with computational mathematics and the ability to relate this experience to new concepts is assumed Otherwise no background beyond advanced calculus is presupposed Moreover the ideas of functional analysis used throughout the text are introduced and developed only to the extent they are needed *Introduction to Numerical Computations* James S. Vandergraft,2014-05-10 Computer Science and Applied Mathematics Introduction to Numerical Computations Second Edition introduces numerical algorithms as they are used in practice This edition covers the usual topics contained in introductory numerical analysis textbooks that include all of the well known and most frequently used algorithms for interpolation and approximation numerical differentiation and integration solution of linear systems and nonlinear equations and solving ordinary differential equations A complete discussion of computer arithmetic problems that arise in the computer evaluation of functions and cubic spline interpolation are also provided This text likewise discusses the Newton formulas for interpolation and adaptive methods for integration The level of this book is suitable for advanced undergraduate students and readers with elementary mathematical background *Introduction to Numerical Analysis and Scientific Computing* Nabil Nassif,Dolly Khuwayri Fayyad,2013-08-05 Designed for a one semester course Introduction to Numerical Analysis and Scientific Computing presents fundamental concepts of numerical mathematics and explains how to implement and program numerical methods The classroom tested text helps students understand floating point number representations particularly those pertaining to IEEE simple and double precision standards as used in scientific computer environments such as MATLAB version 7 Drawing on their years of teaching students in mathematics engineering and the sciences the authors discuss computer arithmetic as a source for generating round off errors and how to avoid the use of algebraic expression that may lead to loss of significant figures They cover nonlinear equations linear algebra concepts the Lagrange interpolation theorem numerical differentiation and integration and ODEs They also focus on the implementation of the algorithms using MATLAB Each chapter ends with a large number of exercises with answers to odd numbered exercises provided at the end of the book Throughout the seven chapters several computer projects are proposed These test the students understanding of both the mathematics of numerical methods and the art of computer programming Introduction to the Tools of Scientific Computing Einar Smith,2022-10-27 The book provides an introduction to common programming tools and methods in numerical mathematics and scientific computing Unlike standard approaches it does not focus on any specific language but aims to explain the underlying ideas

Typically new concepts are first introduced in the particularly user friendly Python language and then transferred and extended in various programming environments from C C Julia and MATLAB to Maple and Mathematica This includes various approaches to distributed computing By examining and comparing different languages the book is also helpful for mathematicians and practitioners in deciding which programming language to use for which purposes At a more advanced level special tools for the automated solution of partial differential equations using the finite element method are discussed On a more experimental level the basic methods of scientific machine learning in artificial neural networks are explained and illustrated *Introduction to Numerical Analysis and Scientific Computing* Nabil Nassif,Dolly Fayyad,2016 Designed for a one semester course Introduction to Numerical Analysis and Scientific Computing presents fundamental concepts of numerical mathematics and explains how to implement and program numerical methods The classroom tested text helps students understand floating point number representations particularly those pertaining to IEEE simple an **Introduction to Computation and Modeling for Differential Equations** Lennart Edsberg,2015-10-26 Uses mathematical numerical and programming tools to solve differential equations for physical phenomena and engineering problems Introduction to Computation and Modeling for Differential Equations Second Edition features the essential principles and applications of problem solving across disciplines such as engineering physics and chemistry The Second Edition integrates the science of solving differential equations with mathematical numerical and programming tools specifically with methods involving ordinary differential equations numerical methods for initial value problems IVPs numerical methods for boundary value problems BVPs partial differential equations PDEs numerical methods for parabolic elliptic and hyperbolic PDEs mathematical modeling with differential equations numerical solutions and finite difference and finite element methods The author features a unique Five M approach Modeling Mathematics Methods MATLAB and Multiphysics which facilitates a thorough understanding of how models are created and preprocessed mathematically with scaling classification and approximation and also demonstrates how a problem is solved numerically using the appropriate mathematical methods With numerous real world examples to aid in the visualization of the solutions Introduction to Computation and Modeling for Differential Equations Second Edition includes New sections on topics including variational formulation the finite element method examples of discretization ansatz methods such as Galerkin s method for BVPs parabolic and elliptic PDEs and finite volume methods Numerous practical examples with applications in mechanics fluid dynamics solid mechanics chemical engineering heat conduction electromagnetic field theory and control theory some of which are solved with computer programs MATLAB and COMSOL Multiphysics Additional exercises that introduce new methods projects and problems to further illustrate possible applications A related website with select solutions to the exercises as well as the MATLAB data sets for ordinary differential equations ODEs and PDEs Introduction to Computation and Modeling for Differential Equations Second Edition is a useful textbook for upper undergraduate and graduate level courses in scientific computing differential

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Introduction to Numerical Computation Lars Eldén,Linde Wittmeyer-Koch,Hans Bruun Nielsen,2004-01-01 This book is a translation and revision of an earlier textbook in Swedish by the first two authors It is intended as a textbook for an introductory course in scientific computation at an advanced undergraduate level In a modern programming environment such as MATLAB it is possible by means of simple commands to perform advanced calculations on a personal computer In order to use such a powerful tool efficiently it is necessary to have a good knowledge of numerical methods and algorithms and to know about their properties The book describes and analyses numerical methods for error analysis differentiation integration interpolation and approximation and the solution of non linear equations linear systems of algebraic equations and systems of ordinary differential equations Principles and algorithms are illustrated by examples in MATLAB At the end of each chapter questions on theory and computer exercises are given Some of the MATLAB codes and supplementary material are available from the books web page **A Gentle Introduction to Scientific Computing** Dan Stanescu,Long Lee,2022-05-01 Scientific Computation has established itself as a stand alone area of knowledge at the borderline between computer science and applied mathematics Nonetheless its interdisciplinary character cannot be denied its methodologies are increasingly used in a wide variety of branches of science and engineering A Gentle Introduction to Scientific Computing intends to serve a very broad audience of college students across a variety of disciplines It aims to expose its readers to some of the basic tools and techniques used in computational science with a view to helping them understand what happens behind the scenes when simple tools such as solving equations plotting and interpolation are used To make the book as practical as possible the authors explore their subject both from a theoretical mathematical perspective and from an implementation driven programming perspective Features Middle ground approach between theory and implementation Suitable reading for a broad range of students in STEM disciplines Could be used as the primary text for a first course in scientific computing Introduces mathematics majors without any prior computer science exposure to numerical methods All mathematical knowledge needed beyond Calculus together with the most widely used Calculus notation and concepts is introduced in the text to make it self contained **Scientific Computing - An Introduction using Maple and MATLAB** Walter Gander,Martin J. Gander,Felix Kwok,2014-04-23 Scientific computing is the study of how to use computers effectively to solve problems that arise from the mathematical modeling of phenomena in science and engineering It is based on mathematics numerical and symbolic algebraic computations and visualization This book serves as an introduction to both the theory and practice of scientific computing with each chapter presenting the basic algorithms that serve as the workhorses of many scientific codes we explain both the theory behind these algorithms and how they must be implemented in order to work reliably in finite

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