

TEXTS AND MONOGRAPHS IN COMPUTER SCIENCE

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# **ERROR-FREE POLYNOMIAL MATRIX COMPUTATIONS**

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**E.V. Krishnamurthy**



Springer-Verlag  
New York Berlin Heidelberg

# Error Free Polynomial Matrix Computations

**E.V. Krishnamurthy**



## **Error Free Polynomial Matrix Computations:**

*Error-Free Polynomial Matrix Computations* E.V. Krishnamurthy, 2012-12-06 This book is written as an introduction to polynomial matrix computations. It is a companion volume to an earlier book on *Methods and Applications of Error Free Computation* by R. T. Gregory and myself published by Springer Verlag New York 1984. This book is intended for seniors and graduate students in computer and system sciences and mathematics and for researchers in the fields of computer science, numerical analysis, systems theory and computer algebra. Chapter I introduces the basic concepts of abstract algebra including power series and polynomials. This chapter is essentially meant for bridging the gap between the abstract algebra and polynomial matrix computations. Chapter II is concerned with the evaluation and interpolation of polynomials. The use of these techniques for exact inversion of polynomial matrices is explained in the light of currently available error free computation methods. In Chapter III the principles and practice of Fourier evaluation and interpolation are described. In particular the application of error free discrete Fourier transforms for polynomial matrix computations is considered.

*Error Free Polynomial Matrix Computation* E. V. Krishnamurthy, 1985      *Fast Error-free Algorithms for Polynomial Matrix Computations* John S. Baras, David C. MacEnany, Robert L. Munach, University of Maryland at College Park. Systems Research Center, 1990 In this paper we develop highly efficient error free algorithms for most of the important computations needed in linear systems over fields or rings. We show that the structure of the underlying rings and modules is critical in designing such algorithms. We also discuss the importance of such algorithms for controller synthesis.      Polynomial and Matrix Computations Dario Bini, Victor Y. Pan, 2012-12-06 Our Subjects and Objectives This book is about algebraic and symbolic computation and numerical computing with matrices and polynomials. It greatly extends the study of these topics presented in the celebrated books of the seventies AHU and BM. These topics have been under represented in CLR which is a highly successful extension and updating of AHU. Otherwise compared to AHU and BM our volume adds extensive material on parallel computations with general matrices and polynomials, on the bit complexity of arithmetic computations including some recent techniques of data compression and the study of numerical approximation properties of polynomial and matrix algorithms and on computations with Toeplitz matrices and other dense structured matrices. The latter subject should attract people working in numerous areas of application in particular coding, signal processing, control, algebraic computing and partial differential equations. The authors' teaching experience at the Graduate Center of the City University of New York and at the University of Pisa suggests that the book may serve as a text for advanced graduate students in mathematics and computer science who have some knowledge of algorithm design and wish to enter the exciting area of algebraic and numerical computing. The potential readership may also include algorithm and software designers and researchers specializing in the design and analysis of algorithms, computational complexity, algebraic and symbolic computing and numerical computation.      *Methods and Applications of Error-Free Computation* R. T. Gregory, E. V.

Krishnamurthy,2012-12-06 This book is written as an introduction to the theory of error free computation In addition we include several chapters that illustrate how error free computation can be applied in practice The book is intended for seniors and first year graduate students in fields of study involving scientific computation using digital computers and for researchers in those same fields who wish to obtain an introduction to the subject We are motivated by the fact that there are large classes of ill conditioned problems and there are numerically unstable algorithms and in either or both of these situations we cannot tolerate rounding errors during the numerical computations involved in obtaining solutions to the problems Thus it is important to study finite number systems for digital computers which have the property that computation can be performed free of rounding errors In Chapter I we discuss single modulus and multiple modulus residue number systems and arithmetic in these systems where the operands may be either integers or rational numbers In Chapter II we discuss finite segment  $p$  adic number systems and their relationship to the  $p$  adic numbers of Hensel 1908 Each rational number in a certain finite set is assigned a unique Hensel code and arithmetic operations using Hensel codes as operands is mathematically equivalent to those same arithmetic operations using the corresponding rational numbers as operands Finite segment  $p$  adic arithmetic shares with residue arithmetic the property that it is free of rounding errors

*Polynomial and Matrix Computations: Fundamental algorithms* Dario Bini,1994 **Computing Handbook, Third Edition** Teofilo Gonzalez,Jorge Diaz-Herrera,Allen Tucker,2014-05-07 Computing Handbook Third Edition Computer Science and Software Engineering mirrors the modern taxonomy of computer science and software engineering as described by the Association for Computing Machinery ACM and the IEEE Computer Society IEEE CS Written by established leading experts and influential young researchers the first volume of this popular handbook examines the elements involved in designing and implementing software new areas in which computers are being used and ways to solve computing problems The book also explores our current understanding of software engineering and its effect on the practice of software development and the education of software professionals Like the second volume this first volume describes what occurs in research laboratories educational institutions and public and private organizations to advance the effective development and use of computers and computing in today's world Research level survey articles provide deep insights into the computing discipline enabling readers to understand the principles and practices that drive computing education research and development in the twenty first century

**Computing Handbook** Allen Tucker,Teofilo Gonzalez,Heikki Topi,Jorge Diaz-Herrera,2022-05-29 This two volume set of the Computing Handbook Third Edition previously the Computer Science Handbook provides up to date information on a wide range of topics in computer science information systems IS information technology IT and software engineering The third edition of this popular handbook addresses not only the dramatic growth of computing as a discipline but also the relatively new delineation of computing as a family of separate disciplines as described by the Association for Computing Machinery ACM the IEEE Computer Society IEEE CS and the Association for Information Systems AIS Both volumes in the set describe

what occurs in research laboratories educational institutions and public and private organizations to advance the effective development and use of computers and computing in today s world Research level survey articles provide deep insights into the computing discipline enabling readers to understand the principles and practices that drive computing education research and development in the twenty first century Chapters are organized with minimal interdependence so that they can be read in any order and each volume contains a table of contents and subject index offering easy access to specific topics The first volume of this popular handbook mirrors the modern taxonomy of computer science and software engineering as described by the Association for Computing Machinery ACM and the IEEE Computer Society IEEE CS Written by established leading experts and influential young researchers it examines the elements involved in designing and implementing software new areas in which computers are being used and ways to solve computing problems The book also explores our current understanding of software engineering and its effect on the practice of software development and the education of software professionals The second volume of this popular handbook demonstrates the richness and breadth of the IS and IT disciplines The book explores their close links to the practice of using managing and developing IT based solutions to advance the goals of modern organizational environments Established leading experts and influential young researchers present introductions to the current status and future directions of research and give in depth perspectives on the contributions of academic research to the practice of IS and IT development use and management

A Practical Theory of Programming Eric C.R. Hehner,2012-09-08 There are several theories of programming The first usable theory often called Hoare s Logic is still probably the most widely known In it a specification is a pair of predicates a precondition and postcondition these and all technical terms will be defined in due course Another popular and closely related theory by Dijkstra uses the weakest precondition predicate transformer which is a function from programs and postconditions to preconditions lones s Vienna Development Method has been used to advantage in some industries in it a specification is a pair of predicates as in Hoare s Logic but the second predicate is a relation Temporal Logic is yet another formalism that introduces some special operators and quantifiers to describe some aspects of computation The theory in this book is simpler than any of those just mentioned In it a specification is just a boolean expression Refinement is just ordinary implication This theory is also more general than those just mentioned applying to both terminating and nonterminating computation to both sequential and parallel computation to both stand alone and interactive computation And it includes time bounds both for algorithm classification and for tightly constrained real time applications

The Science of Programming David Gries,2012-12-06 Describes basic programming principles and their step by step applications Numerous examples are included

**Algorithmic Algebra** Bhubaneswar Mishra,2012-12-06 Algorithmic Algebra studies some of the main algorithmic tools of computer algebra covering such topics as Gr bner bases characteristic sets resultants and semialgebraic sets The main purpose of the book is to acquaint advanced undergraduate and graduate students in computer science engineering and mathematics with the

algorithmic ideas in computer algebra so that they could do research in computational algebra or understand the algorithms underlying many popular symbolic computational systems Mathematica Maple or Axiom for instance Also researchers in robotics solid modeling computational geometry and automated theorem proving community may find it useful as symbolic algebraic techniques have begun to play an important role in these areas The book while being self contained is written at an advanced level and deals with the subject at an appropriate depth The book is accessible to computer science students with no previous algebraic training Some mathematical readers on the other hand may find it interesting to see how algorithmic constructions have been used to provide fresh proofs for some classical theorems The book also contains a large number of exercises with solutions to selected exercises thus making it ideal as a textbook or for self study

**VLSI Placement and Routing: The PI Project** Alan T. Sherman, 2012-12-06 This book provides a superb introduction to and overview of the MIT PI System for custom VLSI placement and routing Alan Sherman has done an excellent job of collecting and clearly presenting material that was previously available only in various theses conference papers and memoranda He has provided here a balanced and comprehensive presentation of the key ideas and techniques used in PI discussing part of his own Ph D work primarily on the placement problem in the context of the overall design of PI and the contributions of the many other PI team members I began the PI Project in 1981 after learning first hand how difficult it is to manually place modules and route interconnections in a custom VLSI chip In 1980 Adi Shamir Leonard Adleman and I designed a custom VLSI chip for performing RSA encryption decryption 226 I became fascinated with the combinatorial and algorithmic questions arising in placement and routing and began active research in these areas The PI Project was started in the belief that many of the most interesting research issues would arise during an actual implementation effort and secondarily in the hope that a practically useful tool might result The belief was well founded but I had underestimated the difficulty of building a large easily used software tool for a complex domain the PI software should be considered as a prototype implementation validating the design choices made

**Predicate Calculus and Program Semantics** Edsger W. Dijkstra, Carel S. Scholten, 2012-12-06 This booklet presents a reasonably self contained theory of predicate transformer semantics Predicate transformers were introduced by one of us EWD as a means for defining programming language semantics in a way that would directly support the systematic development of programs from their formal specifications They met their original goal but as time went on and program derivation became a more and more formal activity their informal introduction and the fact that many of their properties had never been proved became more and more unsatisfactory And so did the original exclusion of unbounded nondeterminacy In 1982 we started to remedy these shortcomings This little monograph is a result of that work A possible and even likely criticism is that anyone sufficiently versed in lattice theory can easily derive all of our results himself That criticism would be correct but somewhat beside the point The first remark is that the average book on lattice theory is several times fatter and probably less self contained than this booklet The second remark is that the predicate

transformer semantics provided only one of the reasons for going through the pains of publication

**An Introduction to Kolmogorov Complexity and Its Applications** Ming Li, Paul Vitanyi, 2013-04-18 With this book the authors are trying to present in a unified treatment an introduction to the central ideas and their applications of the Kolmogorov Complexity theory dealing with the quantity of information in individual objects This book is appropriate for either a one or two semester introductory course in departments of computer science mathematics physics probability theory and statistics artificial intelligence and philosophy Although the mathematical theory of Kolmogorov complexity contains sophisticated mathematics the amount of math one needs to know to apply the notions in widely divergent areas is very little The authors purpose is to develop the theory in detail and outline a wide range of illustrative applications This book is an attempt to grasp the mass of fragmented knowledge of this fascinating theory Chapter 1 is a compilation of material on the diverse notations and disciplines we draw upon in order to make the book self contained The mathematical theory of Kolmogorov complexity is treated in chapters 2 4 the applications are treated in chapters 4 8

**String-Rewriting Systems** Ronald V. Book, Friedrich Otto, 2012-12-06 The subject of this book is string rewriting systems It is generally accepted that string rewriting was first introduced by Axel Thue in the early part of this century In the 1960 s and early 1970 s it received renewed attention due to interest in formal language theory In the 1980 s and 1990 s it has received more interest since it can be viewed as a special case of term rewriting a subject that has become important in the study of automated deduction Today string rewriting is studied by researchers in theoretical computer science and also by researchers interested in the foundations of artificial intelligence A sketch of the way that the subject has developed is contained in Chapter 0 and the reader is advised to begin with that chapter Both authors have been active in the field and have lectured on the subject in several universities Lecture notes have been produced and distributed This monograph is a result of revising and rewriting those notes It represents an attempt by the authors to present the concepts that the authors consider to be most fundamental and to gather together the most useful results in such a way that they can be understood and used in studies relating to more general rewriting to automated deduction and to algorithmic problems of algebraic structures This monograph is written for independent study by researchers in the theoretical computer science or in the foundations of artificial intelligence

**Computational Geometry** Franco P. Preparata, Michael I. Shamos, 2012-12-06 From the reviews This book offers a coherent treatment at the graduate textbook level of the field that has come to be known in the last decade or so as computational geometry The book is well organized and lucidly written a timely contribution by two founders of the field It clearly demonstrates that computational geometry in the plane is now a fairly well understood branch of computer science and mathematics It also points the way to the solution of the more challenging problems in dimensions higher than two Mathematical Reviews 1 This remarkable book is a comprehensive and systematic study on research results obtained especially in the last ten years The very clear presentation concentrates on basic ideas fundamental combinatorial structures and crucial algorithmic techniques The plenty

of results is clever organized following these guidelines and within the framework of some detailed case studies A large number of figures and examples also aid the understanding of the material Therefore it can be highly recommended as an early graduate text but it should prove also to be essential to researchers and professionals in applied fields of computer aided design computer graphics and robotics Biometrical Journal 2      Larch: Languages and Tools for Formal Specification

John V. Guttag, James J. Horning, 2012-12-06 Building software often seems harder than it ought to be It takes longer than expected the software's functionality and performance are not as wonderful as hoped and the software is not particularly malleable or easy to maintain It does not have to be that way This book is about programming and the role that formal specifications can play in making programming easier and programs better The intended audience is practicing programmers and students in undergraduate or basic graduate courses in software engineering or formal methods To make the book accessible to such an audience we have not presumed that the reader has formal training in mathematics or computer science We have however presumed some programming experience The roles of formal specifications Designing software is largely a matter of combining inventing and planning the implementation of abstractions The goal of design is to describe a set of modules that interact with one another in simple well defined ways If this is achieved people will be able to work independently on different modules and yet the modules will fit together to accomplish the larger purpose In addition during program maintenance it will be possible to modify a module without affecting many others Abstractions are intangible But they must somehow be captured and communicated That is what specifications are for Specification gives us a way to say what an abstraction is independent of any of its implementations      **STACS 88** Robert Cori, Martin Wirsing, 1988-01-27 This volume contains the presentations of the Fifth Symposium on Theoretical Aspects of Computer Science STACS 88 held at the University of Bordeaux February 11 13 1988 In addition to papers presented in the regular program the volume contains abstracts of software systems demonstrations which were included in this conference series in order to show applications of research results in theoretical computer science The papers are grouped into the following thematic sections algorithms complexity formal languages rewriting systems and abstract data types graph grammars distributed algorithms geometrical algorithms trace languages semantics of parallelism      **Specification and Transformation of Programs** Helmut A. Partsch, 2012-12-06 Specification and transformation of programs is short for a methodology of software development where from a formal specification of a problem to be solved programs correctly solving that problem are constructed by stepwise application of formal semantics preserving transformation rules The approach considers programming as a formal activity Consequently it requires some mathematical maturity and above all the will to try something new A somewhat experienced programmer or a third or fourth year student in computer science should be able to master most of this material at least this is the level I have aimed at This book is primarily intended as a general introductory textbook on transformational methodology As with any methodology reading and understanding is necessary but not sufficient Therefore most of the



chapters contain a set of exercises for practising as homework Solutions to these exercises exist and can in principle be obtained at nominal cost from the author upon request on appropriate letterhead In addition the book also can be seen as a comprehensive account of the particular transformational methodology developed within the Munich CIP project

**Mathematical System Theory** Athanasios C. Antoulas, 2013-04-17 Over the past three decades R E Kalman has been one of the most influential personalities in system and control theory His ideas have been instrumental in a variety of areas This is a Festschrift honoring his 60th birthday It contains contributions from leading researchers in the field giving an account of the profound influence of his ideas in a number of areas of active research in system and control theory For example since their introduction by Kalman in the early 60 s the concepts of controllability and observability of dynamical systems with inputs have been the corner stone of the great majority of investigations in the field

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