
Book Reviews

K. O. GEDDES, S. R. CZAPOR AND G. LABAHN
Algorithms for Computer Algebra. Kluwer Academic Publishers, 1992, 585 pp hardbound, ISBN 0-7923-9259-0

While in the past computers were used mainly to perform numerical computations, nowadays the problems of precise and symbolic computations have become more common. Although there are many systems able to manipulate symbolic mathematical objects, the basic ideas behind these systems are often similar. This book gives a survey of basic algorithms used in algebraic computation. The book can be used as a textbook for computer algebra courses at either an advanced undergraduate or a graduate level.

The first chapter explains requirements for systems performing symbolic computations and shows possible ways of exploitation of such systems. The second chapter introduces basic notions of general algebra ranging from rings and fields to power series. The third chapter describes ways of representing basic symbolic objects. Various normal forms for multiprecision numbers, polynomials, rational functions and power series are described and their advantages and disadvantages compared. Chapter 4 deals with basic operations over polynomials, rational functions and power series. The Chinese remainder theorem and related algebraic notions are presented in Chapter 5 and algorithms for polynomial interpolation and inverting homomorphisms based on the Chinese remainder theorem are presented. Chapter 6 deals with Hensel construction and its modifications. It also shows how Hensel construction can substitute for the Chinese remainder algorithm and notably improve the performance of algorithms.

Chapter 7 concentrates on polynomial greatest common divisor computation. The greatest common divisor algorithm is often used by other computer algebra algorithms and therefore it is not surprising that this problem is studied in detail. Polynomial factorization is another problem that is often encountered in computer algebra. The famous Berlecamp factorization algorithms and its improvements are studied in Chapter 8. Chapter 9 gives algorithms for solving systems of equations; both linear and nonlinear systems are considered. A different approach to solve systems of nonlinear equations is given in Chapter 10 where Buchberger's algorithm for transforming an arbitrary ideal basis into a Gröbner basis and applications of this algorithm are presented.

The last two chapters are dedicated to symbolic computing of indefinite integrals. While Chapter 11 covers an integration of rational functions, Chapter 12 describes the Risch algorithm for integrating elementary functions.

The algorithms in the book are written in an easy-to-

read Pascal-like language and are accompanied by suitable examples. The background of algebra required is covered and mathematical results that form the basis for the algorithms are precisely proved. Every chapter of the book is followed by a set of suitable exercises. Unfortunately, the analysis of the complexity of the algorithms is not given and this makes comparing the efficiency of algorithms hard.

Since there are still not many books on the subject of computer algebra, this book should be considered by everyone with an interest in symbolic computation.

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D. A. WOLFRAM
The Clausal Theory of Types. Cambridge University Press, 1993, 124 pp hardbound, ISBN 0-521-39538-0

The Skolem–Herbrand–Godel theorem for first order logic (SHG Theorem, for short), the resolution principle and the effectiveness of unification together constitute the theoretical foundation for automated theorem-proving in first order logic and logic programming. This book attempts to provide a similar foundation for a higher order logic called the Clausal Theory of Types (CTT for short) defined by the author. Higher order analogues of the SHG theorem and resolution principle are proved and the equational unification of CTT terms with built-in equational theories is discussed in the book.

In what sense is CTT a higher order logic? It allows for embeddable predicates and enriches first order logic in the following ways: the terms may include λ -abstractions, the formulas include equality between terms and quantification can be over variables of propositional type. CTT is obtained as a restriction of Church's Simple Theory of Types (the restriction being for technical reasons).

The organization of this slim volume (105 pages of main text and 18 pages of bibliography and index) is as follows. Chapter 1 (14 pages) traces the development of logic programming to the SHG theorem. Chapter 2 (9 pages) defines the simply typed λ -calculus, α -conversion, β , η -reductions and normal forms. Chapter 3 (18 pages) defines CTT, its models and proves the SHG theorem for CTT. Chapter 4 (44 pages) is an extensive treatment of higher order unification theory. Chapter 5 (17 pages) proves the resolution theorem for CTT and shows the least model/least fixed-point semantics and a breadth-first procedure as operational semantics for CTT based logic programs.

I have specified the textual length of each chapter because it corresponds well with the depth of treatment accorded to the respective topics. Chapter 2 is more a set of definitions needed later on than a sketch of λ -