Preface

In the fall of 1987, I taught a graduate computer science course entitled "Symbolic Computational Algebra" at New York University. A rough set of class-notes grew out of this class and evolved into the following final form at an excruciatingly slow pace over the last five years. This book also benefited from the comments and experience of several people, some of whom used the notes in various computer science and mathematics courses at Carnegie-Mellon, Cornell, Princeton and UC Berkeley.

The book is meant for graduate students with a training in theoretical computer science, who would like to either do research in computational algebra or understand the algorithmic underpinnings of various commercial symbolic computational systems: *Mathematica*, *Maple* or *Axiom*, for instance. Also, it is hoped that other researchers in the robotics, solid modeling, computational geometry and automated theorem proving communities will find it useful as symbolic algebraic techniques have begun to play an important role in these areas.

The main four topics–Gröbner bases, characteristic sets, resultants and semialgebraic sets–were picked to reflect my original motivation. The choice of the topics was partly influenced by the syllabii proposed by the Research Institute for Symbolic Computation in Linz, Austria, and the discussions in Hearn's Report ("Future Directions for Research in Symbolic Computation").

The book is meant to be covered in a one-semester graduate course comprising about fifteen lectures. The book assumes very little background other than what most beginning computer science graduate students have. For these reasons, I have attempted to keep the book self-contained and largely focussed on the very basic materials.

Since 1987, there has been an explosion of new ideas and techniques in all the areas covered here (e.g., better complexity analysis of Gröbner basis algorithms, many new applications, effective Nullstellensatz, multivariate resultants, generalized characteristic polynomial, new stratification algorithms for semialgebraic sets, faster quantifier elimination algorithm for Tarski sentences, etc.). However, none of these new topics could be included here without distracting from my original intention. It is hoped that this book will prepare readers to be able to study these topics on their own.

Also, there have been several new textbooks in the area (by Akritas, Davenport, Siret and Tournier, and Mignotte) and there are a few more on the way (by Eisenbaud, Robbiano, Weispfenning and Becker, Yap, and Zippel). All these books and the current book emphasize different materials, involve different degrees of depth and address different readerships. An instructor, if he or she so desires, may choose to supplement the current book by some of these other books in order to bring in such topics as factorization, number-theoretic or group-theoretic algorithms, integration or differential algebra.

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I would like to express my gratitude to Prof. Bill Wulf for his efforts to perform miracles on my behalf during many of my personal and professional crises. I would also like to thank my colleague Thomas Anantharaman for reminding me of the power of intuition and for his friendship. Thanks are due to Robin Mahapatra for his constant interest.

In the first draft of this manuscript, I had thanked my imaginary wife for keeping my hypothetical sons out of my nonexistent hair. In the interim five years, I have gained a wife Jane and two sons Sam and Tom, necessarily in that order–but, alas, no hair. To them, I owe my deepest gratitude for their understanding.

Last but not least, I thank Dick Aynes without whose unkind help this book would have gone to press some four years ago.

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