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Edited by G. Goos and J. Hartmanis

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PREFACE

EUROCAL '83 is the second major conference which is organized by the European computer algebra community. However, there is a remarkable difference with the previous symposium, EUROCAL '82, held in Marseille in April 1982 (this Series, nr. 144). In view of the success EUROCAM '82 certainly was, it was decided during this meeting to formally establish a European organization, called SAME, Symbolic and Algebraic Manipulation in Europe. This decision naturally evolved from the increasing interest in algebraic computation and symbolic manipulation in Europe during the past decade. The main motivation behind the creation of SAME was the wish to be able to easily coordinate the activities of different smaller groups, some of which had already a "long" history, at least in terms of computer science. Hence EUROCAL '83 is the first reflection of the existing intentions to annually organize meetings in Europe.

It is fair to state that ACM's Special Interest Group on Symbolic and Algebriac Manipulation (SIGSAM), the major world-wide organization in this area of computer science, had a stimulating and constructive influence on these European developments. Its regularly held and excellent conferences also served to bring interested Europeans together. In fact SAME can be considered as a credit for SIGSAM. This in view of the willingness of SIGSAM officials to regularly organize symposia in Europe, always in cooperation with the European groups: EUROSAM '74 and EUROSAM '79 (this Series nr. 72) will be followed by EUROSAM '84, to be held in Cambridge, England, during July 9-11, 1984. This forthcoming meeting is a joint effort of SAME and SIGSAM, with the latter organization having the main responsibility. And like its predecessor, EUROCAL '83 was organized in cooperation with SIGSAM, with official approval of ACM. This cooperation serves our computer algebra community as a whole. It motivated the Europeans to decide not to organize an official conference in those years SIGSAM is having its official symposia.

A conference like EUROCAL '83 can only be successful when many individuals are willing to spend part of their time and efforts in its preparation. Sincere thanks are due to A.C. Hearn, past SIGSAM chairman, and M. Mignotte, my predecessor as chairman of SAME, who gave their support and advice, to J. Åman, SAME secretary, who spend a lot of time in distributing information and announcements, to the members of the program committee, who devoted many hours to the submissions and the referee reports before the final program was settled, and last, but certainly not least to Patricia D. Pearce, who was responsible for the local arrangements. She did a

marvellous job. The enjoyable hospitality of Kingston Polytechnic largely contributed to the success of the Conference. I owe a special word of thanks to mrs. Therese ter Heide-Noll. Without her secretarial support, given during all stages of preparing EUROCAL '83, I would have been helpless.

J.A. van Hulzen

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INTRODUCTION

This is the third volume, appearing in the Lecture Notes in Computer Science Series of Springer Verlag, which is dedicated to a computer algebra conference. Traditionally European Computer Algebra Symposia not only provide a platform for presenting well qualified research results, as reflected by the contents of this volume. They also serve to discuss thoughts and ideas about ongoing research and future trends. Hence the conference programs contain official sessions, as well as more informal sessions about work in progress. To show the flavour of these meetings, the complete EUROCAL '83 program is given in an appendix.

The contents of this volume again shows a rich diversity of research contributions. Supplementum 4 of Computing, published by Springer Verlag in 1982, was also dedicated to computer algebra. This volume consists of sixteen survey articles and covers most of the important theoretical results, algorithms, software methods and recent applications, together with systematic references to literature, than known. It is thus a good source for obtaining a first impression of computer algebra and consequently also for situating the material presented in these proceedings.

Computer algebra has many facinating aspects and might have numerous applications. Although such applications can be straightforward in nature, at least in terms of computer algebra, the use of one of the existing systems might be instrumental or surprisingly in the context of another discipline. Consequently such applications ought to be presented in their own context. Here an application is intuitively understood to be a contribution to a further development of either the theory or the underlying software. These considerations serve, as usual, to enlighten discussions about future trends in computer algebra or, attempting at being more precisely, about a transparent definition of the field itself. One of the charmes of computer algebra is that such a definition is hard to give. This reflects, like these proceedings, the vivid interest of both "pure" mathematicians and those attracted by its hardware or software aspects, when just mentioning two "extrema". It underlines the three recommendations, given by Paul S. Wang during his banquet address. The first is education, the second is education and the third is education too. Many of the conference participants recognized that publication of real lecture notes about fundamental aspects and use of computer algebra, for instance in this Series, might largely contribute in establishing the user community and the more general interest computer algebra deserves, at least according to its adepts. This will certainly contribute to a communis opinio, and probably also to a "definition".

J.A. van Hulzen

Integration - What do We Want from the Theory?

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Abstract. The theory of integration has moved a long way in the last fourteen years, though not far enough to satisfy the demands placed on it by its customers. This paper outlines what problems have yet to be solved, and tries to explain why they are not trivial.

Introduction

This paper considers the theory of integration, what algorithms are known, and what the stumbling blocks are in the way of a wider range of integration algorithms. We also look at the types of functions covered by existing algorithms, and ask whether we can expect better algorithms. The author's view of the subject has been largely shaped by his discussions with B. Buchberger, J.P. Fitch and B.M. Trager; however only the author can be blamed for any difficulties or bad predictions.

Rational Functions

The integration of rational functions can almost be regarded as a solved problem. We have [Yun, 1977 and the references cited therein] algorithms for finding the rational part of such a function about as efficiently as can be expected - O(gcd). It remains to be proved that integration can not be more efficient (in O terms) than the gcd operation, but this is more of a problem of complexity theory than of integration.

For the logarithmic part, we know [Trager, 1976] how to compute the logarithmic part of the integral while working in the smallest possible extension field. This brings us, however, to the reason why the word "almost" was used above - the general

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