



COMPUTER ALGEBRA ALGORITHMS

Erich Kaltofen

Department of Computer Science, Rensselaer Polytechnic Institute,
 Troy, New York 12180-3590

INTRODUCTION

The origins of the discipline of computer algebra can be found in Isaac Newton's *Universal Arithmetic* (1728), where methods for manipulating universal mathematical expressions (i.e. formulas containing symbolic indeterminates) and algorithms for solving equations built with these expressions are systematically discussed. One can interpret the mission of computer algebra as the construction of computer systems that enable scientific or engineering users, for instance, to carry out mathematical manipulation automatically. Indeed, systems with this goal already exist, among them MACSYMA, MAPLE, muMATH, REDUCE, SAC/2, SCRATCHPAD/II, and SMP. These systems carry out scientific computing tasks, whose results are distinguished from numerical computing in two principal aspects. (a) The results are symbolic rather than numerical, as the typical example of the inversion of a symbolic matrix demonstrates.

$$\text{FACTOR} \left(\begin{bmatrix} 1 & x_1 & x_1^2 & x_1^3 \\ 1 & x_2 & x_2^2 & x_2^3 \\ 1 & x_3 & x_3^2 & x_3^3 \\ 1 & x_4 & x_4^2 & x_4^3 \end{bmatrix} \right) =$$

$$\begin{bmatrix} \frac{x_2 x_3 x_4}{(x_2 - x_1)(x_3 - x_1)(x_4 - x_1)} & \frac{-x_2 x_3 x_4}{(x_2 - x_1)(x_3 - x_2)(x_4 - x_2)} & \frac{x_2 x_3 x_4}{(x_2 - x_1)(x_3 - x_2)(x_4 - x_2)} & \frac{-x_2 x_3 x_4}{(x_4 - x_1)(x_3 - x_2)(x_4 - x_2)} \\ \frac{-x_2 x_4 - x_3 x_4 - x_2 x_3}{(x_2 - x_1)(x_3 - x_1)(x_4 - x_1)} & \frac{x_2 x_4 + x_3 x_4 + x_2 x_3}{(x_2 - x_1)(x_3 - x_2)(x_4 - x_2)} & \frac{-x_2 x_4 - x_3 x_4 - x_2 x_3}{(x_2 - x_1)(x_3 - x_2)(x_4 - x_2)} & \frac{x_2 x_3 + x_3 x_4 + x_2 x_3}{(x_2 - x_1)(x_4 - x_2)(x_3 - x_2)} \\ \frac{x_2 + x_3 + x_4}{(x_2 - x_1)(x_3 - x_1)(x_4 - x_1)} & \frac{-x_2 - x_3 - x_4}{(x_2 - x_1)(x_3 - x_2)(x_4 - x_2)} & \frac{x_2 + x_3 + x_4}{(x_2 - x_1)(x_3 - x_2)(x_4 - x_2)} & \frac{-x_2 - x_3 - x_4}{(x_4 - x_1)(x_3 - x_2)(x_4 - x_2)} \\ \frac{-1}{(x_2 - x_1)(x_3 - x_1)(x_4 - x_1)} & \frac{1}{(x_2 - x_1)(x_3 - x_2)(x_4 - x_2)} & \frac{-1}{(x_3 - x_2)(x_2 - x_1)(x_4 - x_2)} & \frac{1}{(x_4 - x_1)(x_3 - x_2)(x_4 - x_2)} \end{bmatrix}$$

Algorithms For Computer Algebra

Roman Wölfel



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