Publications by Erich Kaltofen

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1 Major Research Results

1.1 Polynomial Factorization

- Polynomial-time algorithms for multivariate polynomial factorization with coefficients from a field [5, 6, 25, 27] or the algebraic closure of a field [19, 85]; deterministic polynomial-time irreducibility testing [35] and distinct degree factorization [121] of multivariate polynomials over a large finite field; computing the nearest multivariate polynomial with factor of constant degree and complex coefficients in polynomial time [105].
- Polynomial-time sparse multivariate polynomial factorization algorithms by introducing the straight-line program [42, 39, 34, 31, 24, 20] and the black box representations of polynomials [57, 81].
- Subquadratic-time polynomial factorization of univariate polynomials over a finite field [82, 97]; asymptotically fastest polynomial factorization algorithm over high algebraic extensions of finite fields [93].
- Polynomial-time computation of small degree factors of supersparse (lacunary) multivariate polynomials over the rational and algebraic numbers [129, 127].

1.2 Linear Algebra

- Rank algorithm for a black box matrix via Wiedemann's method but without binary search [58].
- Processor-efficient parallel algorithms for solving general linear systems over a field [62, 66].
- Parallel algorithms for matrix canonical forms [32, 54].
- Probabilistic analysis [80] and implementation [76, 89, 102] of the block Wiedemann parallel sparse linear system solver.
- Asymptotically fast solution of Toeplitz-like linear systems over any field including a finite field [80, 77].
- Probabilistic analysis of the Lanczos sparse linear system solver over finite fields [94].
- Baby steps/giant steps algorithms for computing the determinant of an integer matrix [109, 112, 124]; fastest algorithm known in terms of bit operations for the characteristic polynomial.
- Analysis and fraction-free realization of the matrix Berlekamp/Massey algorithm [132, 141].

1.3 Sparse Polynomial Interpolation

- Asymptotically fast and modular versions of the Zippel and Ben-Or/Tiwari algorithms [38, 53, 148].
- Early termination versions of the Zippel and Ben-Or/Tiwari algorithms [107, 119].
- Algorithms for computing the sparsest shift of polynomials [113, 118].
- Recovery of multivariate sparse rational functions [135, 134].

1.4 Divisions and Algebraic Complexity Theory

- Polynomial-length separate computation of the numerator and denominator of a rational function given by a straight-line program [39].
- Asymptotically fast multiplication of polynomials over a ring [64].
- Fast division-free computation of the determinant and the characteristic polynomial of a matrix over a commutative ring [67, 109, 124].
- Integer division with remainder in residue number systems via Newton iteration [83].
- Removal of divisions of in fractions of determinants and formulas [138].
- Valiant universality of determinants of symmetric matrices for formulas [149].

1.5 Computational Number Theory

- Use of Weber equations for the Hilbert class fields arising in the Goldwasser-Kilian/Atkin primality prover [14, 12, 48, 60].

1.6 Hybrid Symbolic/Numeric Computation

- Stability of roots of polynomials with respect to coefficient perturbations [99, 105].
- Approximate factorization [137, 122] and numerical irreducibility testing [117] of multivariate polynomials over the complex numbers.
- Approximate multivariate polynomial greatest common divisor computation [125, 130] and computation of the nearest singular polynomial [130].
- Exact certification of global optima via semidefinite programming and rationalization of sums-of-squares [139, 140, 142],
- Well- and ill-conditionedness of polynomial inequalities [144].

1.7 Software

- DAGWOOD: a system for manipulating polynomials given by straight-line programs [40]. The archive directory of the Lisp program source code is at `BASE/../software/dagwood`.
- DSC: the distributed symbolic manipulation tool [61, 71, 75, 79]. The archive directory of the C, C++, Lisp, and Maple program source code is at `BASE/../software/dsc`.
- FoxBox: a plug-and-play symbolic system component for objects in black box representation [98]. The archive directory of the C++ program source code and the NTL and Saclib library binaries (solaris and linux elf) is at `BASE/../software/foxbox`.
- WiLiSS: an implementation of the block Wiedemann algorithm [84, 102]. The archive directory of the C program source code is at `BASE/../software/wiliss`.
- LinBox: a generic library for exact black box linear algebra [111, 126]. The homepage including downloads can be found at `www.linalg.org`.
- AppFac: a package for approximate multivariate complex polynomial factorization and GCD [130, 137, 122]. The directories of the Maple code and experiments are at `BASE/../software/appfac` and `BASE/../software/manystln`.
- *ArtinProver:* a Matlab+Maple package for computing exact sum-of-squares certificates for global accurate lower bounds.

1.8 Paper on Pedagogy and Significant Instructional Software

- Undergraduate abstract algebra from a computational point of view [92]. The Mathematica packages and notebooks are at `BASE/../courses/ComputAlgebra/Mathematica`.
- A demonstration implementation in Maple of the RSA public crypto system is at `BASE/../software/rsa`.
- A demonstration package in Maple of algorithms in linear algebra is at `BASE/../courses/LinAlgebra/Maple/RefPkg/` (see README.html).
- An STL-like implementation in C++ of the container class binary search tree is at `BASE/../courses/DataStruct/C++Examples/BinSearchTree`.
- A C++ implementation of common sorting algorithms is at `BASE/../courses/DataStruct/C++Examples/Sorting`.

1.9 Surveys

- Four surveys on polynomial factorization [116, 68, 56, 7].
- Three surveys on algebraic algorithms [101, 95, 33].
- A survey on sparse linear systems [90] and one on the computational complexity of matrix determinants [123].
- A list of open problems [106].
- A survey on parallelizing straight-line programs [70].
- The seven dwarfs of symbolic computation [146].

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