CURRICULUM VITAE

Victor Y. Pan

Distinguished Professor

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1 PERSONAL DATA AND EDUCATION

1.1 PERSONAL DATA

- Born in Moscow, USSR, on September 8, 1939 in the family of Yakov Solomonovich Pan, 1906-1941, the author of a bestseller of 1940 about scientific discoveries, republished in the 21st century in England and France – see Wikipedia article: Яков Соломонович Пан ("Yakov Solomonovich Pan", in Russian), and Rievka Kalmanovna Kogan, 1904-1965
- Immigrated to the U.S. in 1977
- U.S. Citizen since 1982
- Married to Lidia Perelman (Pan), literary critic – see Wikipedia article: Лиля Панн ("Lilya Pann", in Russian) by link from: Новая Карта Русской Литературы ("Novaya Karta Russkoy Literatury", in Russian)
- Hobbies: Reading and writing poetry, Mountaineering, Swimming, Skiing and Cross-Country Skiing
- Languages: English, Russian, French

1.2 HIGH SCHOOL EDUCATION

- 1946–1956: 59th High School in Moscow, USSR
- Moscow High School Olympiads in Mathematics: prizes in 1954, 1955 and 1956

1.3 HIGHER EDUCATION:

1956–1964: Department of Mechanics and Mathematics
Moscow State University (MGU)

- 1961: M.S. in Mathematics
- 1964: Ph.D. in Mathematics (Thesis Advisor: A. G. Vitushkin)

2 EMPLOYMENT AND CONSULTING:

2.1 EMPLOYMENT

- 1988 – Visiting Professor, Professor, and (since 2000) Distinguished Professor at the Department of Mathematics and Computer Science of Lehman College of the City University of New York (CUNY) and in the Ph.D. Programs in Computer Science and in Mathematics of the Graduate Center of CUNY
- 1979–80 and 1981–1991 – Professor at the Computer Science Department of the State University of New York at Albany (SUNYA)
- August 2002 – Visiting Scientist

  Ontario Research Center in Computer Algebra (ORCCA)

  Waterloo and London, Western Ontario, Canada
- June 2002 – Visiting Scientist

  Mathematics and Informatics Departments, University of Pisa, Italy
- August-September 1998 – Senior Key Scientist

  Mathematical Science Research Institute, Berkeley, California
- July 1998 – Visiting Scientist

  Fields Research Institute, Toronto, Canada
- March–August 1996 and March–June 1997 – Invited Scientist

  Project SAFIR, INRIA–Sophia Antipolis, France
- January 1991 and July–August 1992 — Visiting Scientist

  International Computer Science Institute, Berkeley, California
- 1989–90 – Visiting Professor

  Computer Science Department, Columbia University, New York
- July 1984 – Visiting Professor

  Department of Mathematics, University of Pisa and CNR, Italy
- April–June 1981 – Visiting Professor

  Computer Science Department, Stanford University, California

- 1980–81 – Visiting Member
  the Institute for Advanced Study, Princeton, New Jersey
- 1977–79 and August 1980 – Visiting Scientist
  IBM Research Center, Yorktown Heights, New York
- 1969–76 – Senior Researcher
  Department of Models for National Economy
  Institute of Economics, Academy of Science, Moscow, Russia
- 1965–69 – Senior Researcher
  Department of Computations for Economics
  Institute of Electronic Control Machines, Moscow, Russia
- 1964–65 – Junior Researcher
  Department of Computations for Economics
  Institute of Electronic Control Machines, Moscow, Russia

2.2 CONSULTING:

- ATT Bell Laboratories, Murray Hill, New Jersey, 1991–1993
- General Electric Research and Development Center, Schenectady, New York, 1980

3 PROFESSIONAL SOCIETIES; RESEARCH AREAS

3.1 MEMBERSHIP IN PROFESSIONAL SOCIETIES:

- American Mathematical Society, since 1977
  Designation of AMS Fellowship "For Contributions to the Mathematical Theory of Computation", 2014
- Association for Computing Machinery, since 1977
- Society for Industrial and Applied Mathematics, since 1977
- European Association for Theoretical Computer Science
- International Linear Algebra Society

3.2 AREAS OF RESEARCH SPECIALIZATION
Also see section 12: MY RESEARCH JOURNEY

- Design and Analysis of Algorithms
- Computational Complexity
- Polynomial Computations
- Computations with General, Data Sparse, and Random Matrices

- Numerical Algorithms
- Symbolic Algorithms
- Symbolic–Numerical Algorithms
- Parallel Algorithms
- Graph Algorithms

4 GRANTS AND AWARDS:

- *Special Creativity Extension Award from the Numeric, Symbolic, and Geometric Computation Program of the CCR Division in the Directorate CISE of NSF (1993)*
- *Best Paper Award 2000, Journal of Complexity:* $3,000 (shared)
- *NSF Grants (individual): $1,931,143 (1980–2016)*, including
- *NSF Grants (joint): $1,056,241 (2016–2021)*
- *26 PSC-CUNY Awards (individual): $135,077, 1989–2021*
- CUNY Institute for Software Design and Development Grants: $8,000, 2001–2002
- Shuster Foundation Award: $4,000, 1994–2000
- Lehman College CUNY, Faculty Award for Research and Scholarship: $1,000, 1994
- Institute for Advanced Study, Grant: $13,000, 1980–81
- SUNY University Award: $2,000, 1980

4.1 MOST RECENT:

- NSF Grant (individual) CCF–1116736,

  “Novel Methods for Fundamental Matrix and Polynomial Computations", $350,000

  (from 8/1/2011 to 12/31/2016)
- NSF Grant (joint: A. Ovchinnikov – PI, V. Pan – co-PI, and C. Yap – co-PI) CCF - 1563942 AF: Medium: Collaborative Research: Numerical Algebraic Differential Equations, $608,205 (from 7/1/2016 to 6/30/2021)
- NSF Grant (joint: Bo Yuan – PI, V. Pan – co-PI, and Xue Lin – co-PI) AitF, CCF-1733834, Medium: Collaborative Research: A Framework of Simultaneous Acceleration and Storage Reduction on Deep Neural Networks Using Structured Matrices, $448,086.00 (from 9/15/2017 to 12/31/2021)
- PSC CUNY AWARD 69813 00 48: New Progress in Matrix and Polynomial Computations, $11,998.92 (from July 1, 2017 to December 31, 2018)

- PSC CUNY AWARD 62797-00 50: $11,999.74 (from June 30, 2019 to December 31, 2020)
- PSC CUNY AWARD 63677-00 51:

  $5,999.87 (from July 1, 2020 to June 30, 2021)

4.2 PSC CUNY AWARDS (LISTING SINCE 2003):

- AWARD 65393–0034: "Algebraic and Numerical Algorithms",

  $3,297, 6/30/2003 – 7/1/2004
- AWARD 6643–7–0035: "Algebraic and Numerical Computing",

  $3,495, 6/30/2004 – 7/1/2005
- AWARD 67297–0036: "Matrix and Polynomial Computations",

  $2,805, 6/30/2005 – 7/1/2006
- AWARD 68291–0037: "Matrix and Polynomial Computations",

  $3,176, 6/30/2006 – 7/1/2007
- AWARD 69330–00–38: “Algebraic and Numerical Algorithms for Matrix and Polynomial Computations", $3,990, 6/30/2007 – 7/1/2008
- AWARD 61406–00–39: “Algebraic and Numerical Algorithms for Matrix and Polynomial Computations", $3,800, 6/30/2008 – 7/1/2009
- AWARD 62230–00–40: “Algebraic and Numerical Algorithms for Matrix and Polynomial Computations", $4,300, 6/30/2009 – 7/1/2010
- AWARD 63153–00–41 “Algebraic and Numerical Algorithms for Matrix and Polynomial Computations", $2,860, 6/30/2010 – 7/1/2011
- AWARD 64512–0042: “Matrix and Polynomial Computations",

  $6,000, 6/30/2011 – 7/1/2012
- AWARD 65792–0043: “Matrix and Polynomial Algorithms",

  $11,998.92, 6/30/2012 – 7/1/2013
- AWARD 67699–00 45:“Advancing Matrix and Polynomial Computations",

  $6,000, 6/30/2014 – 7/1/2015
- AWARD 68862–00 46: “Advancing Matrix and Polynomial Computations",

  $11,998, 7/1/2015–12/31/2016
- AWARD 69813 00 48: “New Progress in Matrix and Polynomial Computations", $11,998.92, 6/30/2017 – 7/1/2018
- AWARD 62797-00 50: $11,999.74

  7/1/2019 – 12/31/2020
- AWARD 63677-00 51,

  $5,999.87, July 1, 2020 – June 30, 2021

5 SERVICE TO PROFESSION

5.1 JOURNAL EDITING

Area Editor:

- Theoretical Computer Science (since 1985 to present)
- Computers and Mathematics (with Applications), (1980–2011)
- Calcolo (1999 –2020)

Special Issues (Corresponding and Managing Editor):

- I. Z. Emiris, B. Mourrain, V. Y. Pan, Guest Editors. Special Issue on Algebraic and Numerical Algorithms, Theoretical Computer Science, 315, 2–3, 307–672, 2004
- Special Issue on Symbolic–Numerical Algorithms (D. A. Bini, V. Y. Pan, and J. Verschelde editors), Theoretical Computer Science, 409, 2, 155–331, 2008
- Special Issue on Algebraic and Numerical Algorithms (I. S. Kotsireas, B. Mourrain, and V. Y. Pan, editors), Theoretical Computer Science, 412, 16, 1443–1543, 2011
- Special Issue on Algebraic and Numerical Algorithms (I. S. Kotsireas, B. Mourrain, V. Y. Pan, and Lihong Zhi, editors), Theoretical Computer Science, 479, 1–186, 2013

5.2 PROGRAM AND SCIENTIFIC COMMITTEES MEMBER

- ACM Annual International Symposium on Symbolic and Algebraic Computation (ISSAC 1999), Vancouver, British Columbia, Canada, July-August 1999
- ACM Annual International Symposium on Symbolic and Algebraic Computation (ISSAC 2007), Waterloo, Ontario, Canada, July-August 2007
- The 2nd International Workshop on Symbolic-Numeric Computation (SNC 2007), London, Ontario, Canada, July 2007
- The Annual International Conference on Polynomial Computer Algebra, St. Petersburg, Russia, Aprils of 2008–2021 (Fourteen Committees)
- The 4th International Workshop on Symbolic-Numeric Computation (SNC 2011), San Jose, California, June 2011
- International Symposium on Linear Algebra (ILAS 2013), Providence, RI, June 2013
- The 5th International Workshop on Symbolic-Numeric Computation (SNC 2014), Shanghai, China, July 2014

5.3 LOCAL ARRANGEMENTS CHAIR

ACM Annual International Symposium on Symbolic and Algebraic Computation (ISSAC 2018), New York, NY, the Graduate Center of CUNY, July 2018

5.4 OTHER PROFESSIONAL ACTIVITIES

- Organization of Conferences and Conference Minisymosia (latest – two Minisymposia at SIAMLA 2021)
- Refereeing and Reviewing for Professional Journals, Conferences and Surveys
- Lectures and Invited Lectures at Conferences in Computer Science, Mathematics, and Applied Mathematics in North and South Americas, Europe, Asia, and Australia (see the Lists of Publications and Talks at the Conferences)
- Colloquium Lectures at the Universities and Research Centers

6 SERVICE TO LEHMAN COLLEGE AND CUNY

6.1 SERVICE TO LEHMAN COLLEGE:

- Personnel and Budget Committee Member, 2017–2021
- Supervising Syllabus in Computer Science
- Advising students in Mathematics and Computer Science
- Observing Junior Instructors in Mathematics and Computer Science

6.2 SERVICE TO CUNY:

- Teaching at the Graduate School and University Center (1989–2021, except for the sabbatical year of 1996–97)
- Advising Ph.D. Students: 27 Ph.D. Defenses (see the List of Ph.D. Defenses)
- Serving as the Chair of 27 PhD Defense Committees in Mathematics and Computer Science (since 1991)
- Member of Distinguished Professor Selection Committee (2005-2007, 2013 and 2016)
- Member of the Leadership Committee of PhD Program in Computer Science (member, 2012–2013)
- Member of the PhD Defense Committees in Mathematics (18) and Computer Science (23) since 1991

7 Ph.D. STUDENTS OF CUNY SUPERVISED AND MENTORED BY VICTOR PAN (27 students by 2023)

STUDENT NAME, PhD THESIS DEFENSE, GRADUATION DATE, Ph.D. PROGRAM

- Atinkpahoun, A., April 11, 1995; June 1995, Computer Science
- Cebecioglu, H., May 23, 2001; October 2001, Mathematics
- Chakraborty, H., April 16, 2021; June 2021, Computer Science

- Chen, Z.Q., November 9, 1999; February 2000, Mathematics
- Dias, O., November 26, 1996; January 1997, Mathematics
- Huang, X., July 1997; October 1997, Mathematics
- Landowne, E., November 1995; February 1996, Computer Science
- Lin, Y., March 1991; June 1991, Computer Science
- Luan, Q., March 27, 2020; August 2020, Mathematics
- Murphy, B., March 27, 2007; May 2007, Computer Science
- Providence, S., December 14, 1999; February 2000, Computer Science
- Rami, Y., February 22, 2000; June 2000, Mathematics
- Retamoso Urbano, I.O., December 17, 2014; February 2015, Mathematics
- Rosholt, R.E., April 4, 2003; May 2003, Computer Science
- Sadikou, A., January 12, 1996; October 1996, Computer Science
- Serme, A., February 2008; May 2008, Mathematics
- Sobze, I., April 12, 1994; June 1994, Computer Science
- Stuart, C., April 1998; June 1998, Computer Science
- Svadlenka, J., April 3, 2020; June 2020, Computer Science
- Abu Tabanjeh, M.A., November 9, 1999; February 2000, Mathematics
- Taj–Eddin, I., March 27, 2007; September 2007, Computer Science
- Wang, X., April 4, 2003; May 2003, Mathematics
- Wolf, J., January 7, 2015; May 2015, Mathematics
- Yan, X., January 29, 2015; February 2015, Computer Science
- Yu, Y., April 1998; June 1998, Computer Science
- Zhao, L., April 6, 2017, June 2017, Mathematics
- Zheng, A., October 16, 1997; January 1998, Mathematics

A. Atinkpahoun, O. Dias, S. Providence, A. Sadikou, A. Serme, and I. Sobze are African–Americans. H. Celecioglu, O. Dias, Y. Lin, and H. Chakraborty are females. At all the listed defenses, Victor Pan has served as the Mentor, the Adviser and the Chair of the Examination Committees, except that for H. Chakraborty he was a co-Adviser and a co-Chair.

8 PUBLICATIONS BY SUBJECTS

Also see PUBLICATIONS and RESEARCH in sections 9, 10, and 12

8.1 POLYNOMIALS: EVALUATION, INTERPOLATION, MULTIPLICATION, DIVISION, GCDs

BOOKS

1. “Polynomial and Matrix Computations", Volume 1: “Fundamental Algorithms" (XVI + 415 pages) (by D. Bini and V. Y. Pan), in the series Progress in Theoretical Computer Science (R.V. Book editor), Birkhäuser, Boston (1994).

2. “Structured Matrices and Polynomials: Unified Superfast Algorithms" (XXV + 278 pages), Birkhäuser/Springer

REVIEW ARTICLES AND BOOK CHAPTERS

1. "On Methods of Computing the Values of Polynomials", Uspekhi Matematicheskikh Nauk (in Russian), 21, 1 (127), 103–134 (1966). (Transl. Russian Mathematical Surveys, 21, 1 (127), 105–137 (1966).)
2. "Complexity of Computations with Matrices and Polynomials," SIAM Review, 34, 2, 225–262 (1992).
3. "Algebraic Algorithms" (by A. Diaz, E. Kaltofen and V. Y. Pan), Chapter 10 in the Computer Science and Engineering Handbook (Allen B. Tucker, Jr., editor), 226-249, CRC Press Inc., Boca Raton, Florida (1997) and Chapter 8 in the Computer Science and Engineering Handbook (Allen B. Tucker, editor), pp. 8–1 to 8–24, Chapman and Hall/CRC Press, 2004.
4. "Some Recent Algebraic/Numerical Algorithms", Electronic Procs. IMACS/ACA’98 (1998). Available at http:www-troja.fjfi.cvut.cz/aca98/sessions/approximate
5. "Algebraic Algorithms" (by A. Diaz, I. Z. Emiris, E. Kaltofen and V. Y. Pan), Chapter 16 in Handbook "Algorithms and Theory of Computations", pp. 16–1 to 16–27 (M. Atallah, editor), CRC Press Inc., Boca Raton, Florida (1999).
6. . "Fast Fourier Transform and Its Applications" (by I. Z. Emiris and V. Y. Pan), Chapter 17 in Handbook "Algorithms and Theory of Computations", pp. 17–1 to 17–30 (M. Atallah, editor), CRC Press Inc., Boca Raton, Florida (1999).
7. “Algebraic and Numerical Algorithms" (by I. Z. Emiris, V. Y. Pan, and E. Tsigaridas), in “Algorithms and Theory of Computations Handbook", Second Edition, Volume 1 (1016 pages): General Concepts and Techniques, pages 1–34 in Chapter 17 (Mikhail J. Atallah and Marina Blanton, editors), CRC Press Inc., Boca Raton, Florida (2009).
8. "Fast Fourier Transform and Its Applications" (by I. Z. Emiris and V. Y. Pan), in “Algorithms and Theory of Computations Handbook", Second Edition, Volume 1 (1016 pages): General Concepts and Techniques, pages 1–31 in Chapter 18 (Mikhail J. Atallah and Marina Blanton, editors), CRC Press Inc., Boca Raton, Florida (2009).
9. “Algebraic Algorithms" (by I. Z. Emiris, V. Y. Pan, and E. Tsigaridas), Chapter 10 (pages from 10–1 to 10-40) of Computing Handbook (Third edition), Volume I: Computer Science and Software Engineering (Allen B. Tucker, Teo Gonzales, and Jorge L. Diaz-Herrera, editors), Taylor and Francis Group, 2014. Available at arXiv 1311.3731 [cs.DS]

RESEARCH PAPERS (in journals and refereed proceedings of conferences).

1. "Some Schemes for the Evaluation of Polynomials with Real Coefficients", Doklady Akademii Nauk SSSR (in Russian), 127, 2, 266–269 (1959).
2. "Some Schemes for the Evaluation of Polynomials with Real Coefficients" Problemy Kibernetiki (in Russian), (edited by A.A. Lyapunov), 5, 17–29 (1961). (Transl. Problems of Cybernetics, USSR, 5, 14–32, Pergamon Press (1961).)
3. "On Some Methods of Computing Polynomial Values", Problemy Kibernetiki (in Russian), (edited by A.A. Lyapunov), 7, 21–30 (1962). (Transl. Problems of Cybernetics, USSR, 7, 20–30, U.S. Dept. of Commerce (1962).)
4. "Schemes with Preconditioning for the Evaluation of Polynomials and a Program for Automatic Preconditioning", Zhurnal Vychislitel'noy Matematiki i Matematicheskoy Fiziki (in Russian), 2, 1, 133–140 (1962). (Transl. from USSR Computational Mathematics and Mathematical Physics, 1, 137–146 (1963).)
5. "Methods for Computing Polynomials" (in Russian), Ph.D. thesis, Dept. of Mechanics and Mathematics, Moscow State University (1964).
6. "The Evaluation of Polynomials of the Fifth and Seventh Degrees with Real Coefficients", Zhurnal Vychislitel'noy Matematiki i Matematicheskoy Fiziki (in Russian), 5, 1, 116–118 (1965). (Transl. USSR Computational Mathematics and Mathematical Physics, 5, 1, 159–161 (1965).)
7. "On Simultaneous Evaluation of Several Polynomials of Low Degree (Two to Five)", Zhurnal Vychislitel'noy Matematiki i Matematicheskoy Fiziki (in Russian), 6, 2, 352–357 (1966). (Transl. USSR Computational Mathematics and Mathematical Physics, 6, 2, 222–227 (1966).)
8. "Computational Complexity of Computing Polynomials over the Fields of Real and Complex Numbers", Proceedings of the Tenth Annual ACM Symposium on Theory of Computing (STOC'78), 162–172, ACM Press, New York (1978).
9. "Convolution of Vectors over the Real Field of Constants", J. of Algorithms, 1, 297–300 (1980).
10. "Fast Parallel Polynomial Division via Reduction to Polynomial Inversion Modulo a Power" (by D. Bini and V. Y. Pan), Information Processing Letters, 21, 79–81 (1985).
11. "Algorithms for Polynomial Division" (by D. Bini and V. Y. Pan), Proc. European Conference on Computer Algebra, Linz, Austria, Lecture Notes in Computer Science, 204, 1–3, Springer (1985).
12. "A Logarithmic Boolean Time Algorithm for Parallel Polynomial Division" (by D. Bini and V. Y. Pan), VLSI Algorithms and Architectures, Lecture Notes in Computer Science, 227, 246–251, Springer, Berlin (1986).
13. "Polynomial Division and Its Computational Complexity" (by D. Bini and V. Y. Pan), Journal of Complexity, 2, 179–203 (1986).

14. "Fast Parallel Algorithms for Polynomial Division over Arbitrary Field of Constants" (by D. Bini and V. Y. Pan), Computers and Mathematics (with Applications), 12A, 11, 1105–1118 (1986).

15. "Fast Evaluation and Interpolation at the Chebyshev Sets of Points", Applied Math. Letters, 2, 3, 255–258 (1989).

16. "Univariate Polynomial Division with a Remainder by Means of Evaluation and Interpolation" (by V. Y. Pan, E. Landowne, and A. Sadikou), Proc. of 3rd IEEE Symp. on Parallel and Distributed Processing, 212–217, IEEE Computer Society Press, Los Alamitos, California (1991).

17. "Polynomial Division with a Remainder by Means of Evaluation and Interpolation" (by V. Y. Pan, E. Landowne, and A. Sadikou), Information Processing Letters, 44, 149–153 (1992).

18. "The Power of Combining the Techniques of Algebraic and Numerical Computing: Improved Approximate Multipoint Polynomial Evaluation and Improved Multipole Algorithms" (by V. Y. Pan, J. Reif, and S. Tate), Proc. of 33rd Ann. IEEE Symp. on Foundations of Computer Science (FOCS '92), 703–713, IEEE Computer Society Press, Los Alamitos, California (1992).

19. "Improved Parallel Polynomial Division and Its Extension" (by D. Bini and V. Y. Pan), Proc. of 33rd Ann. IEEE Symp. on Foundations of Computer Science (FOCS'92), 131–136, IEEE Computer Society Press, Los Alamitos, California (1992).

20. "A New Approach to Fast Polynomial Interpolation and Multipoint Evaluation" (by V. Y. Pan, A. Sadikou, E. Landowne, and O. Tiga), Computers and Math. (with Applications), 25, 9, 25–30 (1993)

21. “Improved Parallel Polynomial Division" (by D. Bini and V. Y. Pan), SIAM J. on Computing, 22, 3, 617–627 (1993).

22. "Simple Multivariate Polynomial Multiplication", J. Symbolic Computation, 18, 183–186 (1994).

23. "Algebraic Improvement of Numerical Algorithms: Interpolation and Economization of Taylor Series", Mathematical and Computer Modeling, 20, 1, 23–26 (1994).

24. "An Algebraic Approach to Approximate Evaluation of a Polynomial on a Set of Real Points", Advances in Computational Mathematics, 3, 41–58 (1995).

25. "Parallel Computation of Polynomial GCD and Some Related Parallel Computations over Abstract Fields", Theoretical Computer Science, 162, 2, 173–223 (1996).

26. "Computing $x^n \mod p(x)$ and an Application to Splitting a Polynomial into Factors over a Fixed Disc", Journal of Symbolic Computations, 22, 377–380 (1996).

27. "Fast Multipoint Polynomial Evaluation and Interpolation via Computation with Structured Matrices" (by V. Y. Pan, A. Zheng, X. Huang, and Y. Yu), Annals of Numerical Math., 4, 483–510 (1997).

28. "New Fast Algorithms for Polynomial Interpolation and Evaluation on the Chebyshev Node Set", Computers and Math. (with Applications), 35, 3, 125–129 (1998).
29. "Approximate Polynomial Gcds, Padé Approximation, Polynomial Zeros, and Bipartite Graphs", Proc. 9th Ann. ACM-SIAM Symp. on Discrete Algorithms (SODA'98), 68–77, ACM Press, New York, and SIAM Publications, Philadelphia (1998).
30. “Approximate Real Polynomial Division via Approximate Inversion of Real Triangular Toeplitz Matrices" (by V. Y. Pan and Z. Q. Chen), Applied Math. Letters, 12, 1–2 (1999).
31. “Polynomial and Rational Interpolation and Multipoint Evaluation (with Structured Matrices)" (by V. Olshevsky and V. Y. Pan), Proc. 26th Intern. Colloquium on Automata, Languages and Programming (ICALP'99), 1644, 585–594, Springer's Lecture Notes in Computer Science, Springer, Berlin (July 1999).
32. “Numerical Computation of a Polynomial GCD and Extensions", Information and Computation, 167, 2, 71–85 (2001).
33. “Polynomial Evaluation and Interpolation and Transformations of Matrix Structures", Proceedings of the 15th International Workshop on Computer Algebra in Scientific Computing (CASC'2013), (V. P. Gerdt, V. Koepf, E. W. Mayr, and E. V. Vorozhtsov, editors), Lecture Notes in Computer Science, 8136, 273–287, Springer, Heidelberg (2013).
34. “Fast Approximate Computations with Cauchy Matrices, Polynomials and Rational Functions", Proc. of the Ninth International Computer Science Symposium in Russia (CSR'2014), (E. A. Hirsch et al., editors), Moscow, Russia, June 2014, Lecture Notes in Computer Science (LNCS), 8476, pp. 287–300, Springer International Publishing, Switzerland (2014).
35. “Nearly Optimal Computations with Structured Matrices" by Victor Y. Pan and Elias Tsigaridas, Proc. of the International Conference on Symbolic–Numeric Computation (SNC 2014), (edited by S. Watt and J. Verschelde), 21–30, ACM Press, New York, 2014.

    Also April 18, 2014, arXiv:1404.4768 [math.NA] and http://hal.inria.fr/hal-00980591
36. “Transformations of Matrix Structures Work Again", Linear Algebra and Its Applications, 465, 1–32 (2015).
37. “How Bad Are Vandermonde Matrices?", SIAM Journal of Matrix Analysis and Applications, 37, 2, 676–694 (2016).
38. “Fast approximate computations with Cauchy matrices and polynomials", Math. of Computation, 86, 2799–2826, 2017. DOI: https://doi.org/10.1090/mcom/3204

8.2 UNIVARIATE POLYNOMIAL ROOT-FINDING AND FACTORIZATION

A BOOK

“Numerical Methods for Roots of Polynomials" (by J. M. McNamee and V. Y. Pan), Part 2 (XXII + 718 pages), Elsevier (2013).

REVIEW ARTICLES AND BOOK CHAPTERS

1. "Solving a Polynomial Equation: Some History and Recent Progress", SIAM Review, 39, 2, 187–220 (1997).
2. "Solving Polynomials with Computers", American Scientist, 86, 62–69 (January-February 1998).
3. "Some Recent Algebraic/Numerical Algorithms", Electronic Procs. IMACS/ACA'98 (1998). Available at http:www-troja.fjfi.cvut.cz/aca98/sessions/approximate
4. "Algebraic Algorithms" (by A. Diaz, I. Z. Emiris, E. Kaltofen and V. Y. Pan), Chapter 16 in Handbook "Algorithms and Theory of Computations", pp. 16–1 to 16–27 (M. Atallah, editor), CRC Press Inc., Boca Raton, Florida (1999).
5. “Root-finding with Eigen-solving" (by V. Y. Pan, D. Ivolgin, B. Murphy, R. E. Rosholt, Y. Tang, X. Wang, and X. Yan), pages 185–210 in Symbolic-Numeric Computation (Dongming Wang and Lihong Zhi, editors), Birkhaüser, Basel/Boston (2007).
6. “Algebraic and Numerical Algorithms" (by I. Z. Emiris, V. Y. Pan, and E. Tsigaridas), in “Algorithms and Theory of Computations Handbook", Second Edition, Volume 1 (1016 pages): General Concepts and Techniques, pages 1–34 in Chapter 17 (Mikhail J. Atallah and Marina Blanton, editors), CRC Press Inc., Boca Raton, Florida (2009).
7. “Algebraic Algorithms" (by I. Z. Emiris, V. Y. Pan, and E. Tsigaridas), Chapter 10 (pages from 10–1 to 10-40) of Computing Handbook (Third edition), Volume I: Computer Science and Software Engineering (Allen B. Tucker, Teo Gonzales, and Jorge L. Diaz-Herrera, editors), Taylor and Francis Group, 2014. Available at arXiv 1311.3731 [cs.DS]

RESEARCH PAPERS (in journals and refereed proceedings of conferences).

1. "On Application of Some Recent Techniques of the Design of Algebraic Algorithms to the Sequential and Parallel Evaluation of the Roots of a Polynomial and to Some Other Numerical Problems", Computers and Math. (with Applications), 11, 9, 911–917 (1985).
2. "Fast and Efficient Algorithms for Sequential and Parallel Evaluation of Polynomial Zeros and of Matrix Polynomials," Proc. 26th Ann. IEEE Symp. on Foundations of Computer Science (FOCS'85), 522–531, IEEE Computer Society Press, Los Angeles, California (1985).
3. "Algebraic Complexity of Computing Polynomial Zeros", Computers and Math. (with Applications), 14, 4, 285–304 (1987).
4. "Sequential and Parallel Complexity of Approximate Evaluation of Polynomial Zeros", Computers and Mathematics (with Applications), 14, 8, 591–622 (1987).
5. "Fast and Efficient Parallel Evaluation of the Zeros of a Polynomial Having Only Real Zeros", Computers and Mathematics (with Applications), 17, 11, 1475–1480 (1989).

6. "New Resultant Inequalities and Complex Polynomial Factorization", Proc. 1st Israel Symp. on Theory of Computing and Systems (ISTCS '92), Lecture Notes in Computer Science, 601, 122–136, Springer, Berlin (1992).
7. "New Resultant Inequalities and Complex Polynomial Factorization", SIAM Journal on Computing 23, 5, 934–950 (1994).
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8.11 PARALLEL AND VLSI COMPUTATIONS

CHAPTERS IN BOOKS AND SURVEY ARTICLES, including prefaces

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2. "Parallel Solution of Sparse Linear and Path Systems", in Synthesis of Parallel Algorithms (J. H. Reif, editor), Chapter 14, pp. 621–678. Morgan Kaufmann publishers, San Mateo, CA (1993).

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2. "Improved Processor Bounds for Algebraic and Combinatorial Problems in RNC" (by Z. Galil and V. Y. Pan), Proc. 26th Ann. IEEE Symp. on Foundations of Computer Science (FOCS'85), 490–495, IEEE Computer Society Press, Los Angeles, California (1985).

3. . "Fast and Efficient Algorithms for Sequential and Parallel Evaluation of Polynomial Zeros and of Matrix Polynomials," Proc. 26th Ann. IEEE Symp. on Foundations of Computer Science (FOCS'85), 522–531, IEEE Computer Society Press, Los Angeles, California (1985).

4. "Fast and Efficient Parallel Algorithms for the Exact Inversion of Integer Matrices", Proc. Fifth Conf. on Foundations of Software Technology and Theoretical Computer Science (FST and TCS'85), (edited by K. V. Nori), Lecture Notes in Computer Science, 206, 504–521, Springer, Berlin (1985).
5. "Fast Parallel Polynomial Division via Reduction to Polynomial Inversion Modulo a Power" (by D. Bini and V. Y. Pan), Information Processing Letters, 21, 79–81 (1985).
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9. "Extension of the Parallel Nested Dissection Algorithm to the Path Algebra Problems" (by V. Y. Pan and J. Reif), Proc. Sixth Conference on Foundations of Software Technology and Theoretical Computer Science (FST and TCS'86), (New Delhi, India), Lecture Notes in Computer Science, 241, 470–487, Springer, Berlin (1986).
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11. "Efficient Parallel Linear Programming" (by V. Y. Pan and J. Reif), Operations Research Letters, 5, 3, 127–135 (1986).
12. "A Logarithmic Boolean Time Algorithm for Parallel Polynomial Division" (by D. Bini and V. Y. Pan), Information Processing Letters, 24, 233–237 (1987). 60. "Complexity of Parallel Matrix Computations", Theoretical Computer Science, 54, 65–85 (1987).
13. "Complexity of Parallel Matrix Computations", Theoretical Computer Science, 54, 65–85 (1987).
14. "Sequential and Parallel Complexity of Approximate Evaluation of Polynomial Zeros", Computers and Mathematics (with Applications), 14, 8, 591–622 (1987).
15. "Some Polynomial and Toeplitz Matrix Computations" (by V. Y. Pan and J. Reif), Proc. 28th Ann. IEEE Symp. on Foundations of Computer Science (FOCS'87), 173–184, IEEE Computer Society Press, Los Angeles, California (1987).
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19. "Fast and Efficient Parallel Evaluation of the Zeros of a Polynomial Having Only Real Zeros", Computers and Mathematics (with Applications), 17, 11, 1475–1480 (1989).

20. "Fast and Efficient Parallel Solution of Dense Linear Systems" (by V. Y. Pan and J. Reif), Computers and Math. (with Applications), 17, 11, 1481–1491 (1989).

21. "Fast and Efficient Parallel Inversion of Toeplitz and Block Toeplitz Matrices", Operator Theory: Advances and Applications, 40, 359–389, Birkhäuser, Basel, Switzerland (1989).

22. "Parallel Complexity of Tridiagonal Symmetric Eigenvalue Problem" (by D. Bini and V. Y. Pan), Proc. 2nd Ann. ACM-SIAM Symp. on Discrete Algorithms (SODA'91), 384–393, ACM Press, New York, and SIAM Publications, Philadelphia (1991).

23. "Improved Parallel Computations with Matrices and Polynomials" (by D. Bini, L. Gemignani and V. Y. Pan), Proc. 18th Intern. Colloquium on Automata, Languages and Programming (ICALP'91), Lecture Notes in Computer Science, 510, 520–531, Springer, Berlin (1991).

24. "Processor Efficient Parallel Solution of Linear Systems over an Abstract Field" (by E. Kaltofen and V. Y. Pan), Proc. 3rd Ann. ACM Symp. on Parallel Algorithms and Architectures (SPAA'91), 180–191, ACM Press, New York (1991).

25. "The Parallel Computation of the Minimum Cost Paths in Graphs by Stream Contraction" (by V. Y. Pan and J. Reif), Information Processing Letters, 40, 79–83 (1991).

26. "On Parallel Complexity of Integer Linear Programming, GCD and the Iterated Mod Function" (by Yu Lin-Kriz and V. Y. Pan), Proc. 3rd Ann. ACM-SIAM Symposium on Discrete Algorithms (SODA'92), 124–137, ACM Press, New York and SIAM Publications, Philadelphia (1992).

27. "Efficient Parallel Algorithms for Computing All Pair Shortest Paths in Directed Graphs" (by Y. Han, V. Y. Pan and J. Reif), Proc. 4th Ann. ACM Symp. on Parallel Algorithms and Architectures (SPAA'92), 353–362, ACM Press, New York (1992).

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8.13 COMPUTATIONS WITH INTEGERS, OVER INTEGERS AND RATIONALS, AND IN FINITE FIELDS

RESEARCH PAPERS (in journals and refereed proceedings of conferences).

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2. "The Bit Operation Complexity of Approximate Evaluation of Matrix and Polynomial Products Using Modular Arithmetic", Computers and Math. (with Applications), 8, 2, 137–140 (1982).
3. "Fast and Efficient Parallel Algorithms for the Exact Inversion of Integer Matrices", Proc. Fifth Conf. on Foundations of Software Technology and Theoretical Computer Science (FST and TCS'85), (edited by K. V. Nori), Lecture Notes in Computer Science, 206, 504–521, Springer, Berlin (1985).
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7. "Extended Concept of Significant Digits and Lower Precision Computations", Applied Mathematics Letters, 5, 2, 3–6 (1992).
8. "Binary Segmentation for Matrix and Vector Operations", Computers and Math. (with Applications), 25, 3, 69–71 (1993).
9. "Faster Solution of the Key Equation for Decoding the BCH Error-Correcting Codes", Proc. 29th ACM Symposium on Theory of Computing (STOC'97), 168–175, ACM Press, New York (1997).
10. "Computing Exact Geometric Predicates Using Modular Arithmetic with Single Precision" (by H. Brönnimann, I. Z. Emiris, V. Y. Pan and S. Pion), Proc. 13th Ann. ACM Symp. on Computational Geometry, 174–182, ACM Press, New York (1997).
11. "Modular Arithmetic for Linear Algebra Computations in the Real Field" (by I. Z. Emiris, V. Y. Pan and Y. Yu), J. of Symbolic Computation, 21, 1–17 (1998).

12. "Single Precision Computation of the Sign of Algebraic Predicates", Applied Math. Letters, 11, 6, 49 –50 (1998).

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14. “Certified Computation of the Sign of a Matrix Determinant" (by V. Y. Pan and Y. Yu), Proc. 10th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA’99), 715–724, ACM Press, New York, and SIAM Publications, Philadelphia (1999).

15. “New Techniques for the Computation of Linear Recurrence Coefficients", Finite Fields and Their Applications, 6, 93–118 (2000).

16. “On Theoretical and Practical Acceleration of Randomized Computation of the Determinant of an Integer Matrix", Zapiski Nauchnykh Seminarov POMI (in English), Vol. 316, 163–187, St. Petersburg, Russia (2004).

17. “Degeneration of Integer Matrices Modulo an Integer" (by V. Y. Pan and X. Wang), Linear Algebra and Its Applications, 429, 2113–2130 (2008).

18. “A New Error–free Floating-Point Summation Algorithm" (by V. Y. Pan, B. Murphy, G. Qian, and R. E. Rosholt), Computers and Mathematics with Applications, 57, 560–564 (2009).

19. “Nearly Optimal Symbolic-Numerical Algorithms for Structured Integer Matrices and Polynomials" (by V. Y. Pan, B. Murphy, and R. E. Rosholt), Proc. Intern. Symp. Symbolic-Numerical Comp. (SNC’2009), Kyoto, Japan, August 2009, (edited by Hiroshi Kai and Hiroshi Sekigawa), 105–113, ACM Press, New York (2009).

20. “Unified Nearly Optimal Algorithms for Structured Matrices" (by V. Y. Pan, B. Murphy, and R. E. Rosholt), Operator Theory: Advances and Applications, 199, 359–375, Birkhaüser, Basel (2010).

21. "Nearly Optimal Solution of Rational Linear Systems of Equations with Symbolic Lifting and Numerical Initialization", Computers and Mathematics with Applications, 62, 1685–1706 (2011).

8.14 LOWER BOUNDS

REVIEW ARTICLE

"On Methods of Computing the Values of Polynomials", Uspekhi Matematicheskikh Nauk (in Russian), 21, 1 (127), 103–134 (1966). (Transl. Russian Mathematical Surveys, 21, 1 (127), 105–137 (1966).)

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3. "The Additive and Logical Complexities of Linear and Bilinear Algorithms", J. of Algorithms, 4, 1–34 (1983).
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8.15 THEORY OF REAL AND COMPLEX FUNCTIONS

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2. "On Approximation of Analytic Functions by Rational Ones", Uspekhi Matematicheskikh Nauk (in Russian), 16, 5 (101), 195–197 (1961).

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1. "Calculus of Rational Costs Based on Modern Economic Information" (by V. Belkin, A. Kronrod, Y. Nazarov and V. Y. Pan), Ekonomika i Matematicheskie Metody (in Russian), Akademiya Nauk SSSR, 1, 5, 699–717 (1965).
2. "A Linear Model and Algorithm for Optimizing Foreign Trade", Tezisy Dokladov i Vystupleniy na Simpoziume po Modelirovaniyu Narodnogo Khozyaistva, Institut Ekonomiki AN SSSR (Proceedings of the Symposium on Models of Public Economy, Institute of Economics, Academy of Sciences of USSR), (in Russian), Moscow, 29–37 (1970).
3. "On Solving a Distribution Problem with Upper Bounds on the Variables and a Simplified Criterion for Optimizing Foreign Trade", Trudy 4-oy Zimney Schkoly po Matematicheskomu Programmirovaniyu i Smezhnym Voprosam (in Russian), (Transactions of the 4-th Winter School on Mathematical Programming and Adjacent Problems), (edited by S. I. Zukhovitskiy), Iss. 5, 26–49, Drogobych (1972).
4. "Models for Planning Costs with Optimization of Foreign Trade of Several Countries under the Economic Integration", Primenenie Ekonomiko-Matematicheskikh Modeley i EVM pri Planirovanii i Prognozirovanii Tsen (in Russian), 5 (1973).
5. "A Model for the Optimization of Foreign Economic Relations Under the Economic Integration of the Socialist Countries", Ekonomika i Matematicheskie Metody (in Russian), Akademiya Nauk SSSR, 10, 2, 255–266 (1974). (Transl. USSR Trade and Services, 755, 1–16 (1974).)
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7. "A Modification of a Balanced Model of Income-Commodities into an Equilibrium Model" (by V. Belkin, V. Ivanter, N. Konstantinov and V. Pan), Ekonomika i Matematicheskie Methody, Akademiya Nauk SSSR (in Russian), 11, 6, 1037–1049 (1975).

9 SELECTED PUBLICATIONS

Also see PUBLICATIONS and RESEARCH in sections 8, 10 and 12

9.1 BOOKS

1. “How to Multiply Matrices Faster", Lecture Notes in Computer Science, vol. 179 (XI + 212 pages), Springer, Berlin (1984).

2. “Polynomial and Matrix Computations", Volume 1: “Fundamental Algorithms" (XVI + 415 pages) (by D. Bini and V. Y. Pan), in the series Progress in Theoretical Computer Science (R.V. Book editor), Birkhäuser, Boston (1994).

3. “Structured Matrices and Polynomials: Unified Superfast Algorithms" (XXV + 278 pages), Birkhäuser/Springer, Boston/New York (June 2001).

4. “Numerical Methods for Roots of Polynomials" (by J. M. McNamee and V. Y. Pan), Part 2 (XXII + 718 pages), Elsevier (2013).

9.2 CHAPTERS IN BOOKS AND SURVEY ARTICLES (12 ITEMS SELECTED OUT OF 24). *Items 1, 2, 3-5, 8, and 9 included new research results.*

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5. "Solving a Polynomial Equation: Some History and Recent Progress", SIAM Review, 39, 2, 187–220 (1997).

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8. “Newton’s Iteration for Structured Matrices and Linear Systems of Equations" (by V. Y. Pan, S. Branham, R. Rosholt, and A. Zheng), SIAM volume on Fast Reliable Algorithms for Matrices with Structure (T. Kailath and A. H. Sayed, editors), chapter 7, pages 189–210, SIAM Publications, Philadelphia (1999).

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11. “Algebraic Algorithms" (by I. Z. Emiris, V. Y. Pan, and E. Tsigaridas), Chapter 10 (pages from 10–1 to 10-40) of Computing Handbook (Third edition), Volume I: Computer Science and Software Engineering (Allen B. Tucker, Teo Gonzales, and Jorge L. Diaz-Herrera, editors), Taylor and Francis Group (2014).

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3. "Methods of Aggregations" (by W. L. Miranker and V. Y. Pan), Linear Algebra and Its Applications, 29, 231–257 (1980).

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9.4 RESEARCH PAPERS (in journals and refereed proceedings of conferences). 80 SELECTED FROM 277

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10 PUBLICATIONS (COMPLETE LIST CHRONOLOGICALLY)

Also see PUBLICATIONS and RESEARCH in sections 8, 109 and 12
LISTS OF PAN'S PUBLICATIONS IN GOOGLE SCHOLAR AND DBLP INCLUDE

- 4 research monographs
- over 20 book chapters and survey articles
- over 170 refereed publications in journals
- over 80 refereed publications in conference proceedings
- OVER 12,500 CITATIONS

10.1 CLASSIFICATION BY RESEARCH SUBJECTS

ENUMERATION BELOW IS ACCORDING TO THE ORDER OF (i) THE BOOKS, (ii) SURVEYS AND BOOKS CHAPTERS AND (iii) RESEARCH PAPERS IN THE COMPLETE PUBLICATION LIST.

1. REAL AND COMPLEX FUNCTIONS: papers 1, 3.

2. ECONOMICS: papers 11-13, 15-18

3. LOWER BOUNDS IN ALGEBRAIC COMPUTATIONS: papers 5, 7, 10, 29, 49.

4. FUNDAMENTAL POLYNOMIAL OPERATIONS.
a) EVALUATION: survey paper 1 (containing also research results), research papers 2, 4, 6-10, 19, 62, 70, 101, 105, 121, 140, 148, 166, 247-249, 253, 263, 267.
b) INTERPOLATION: papers 62, 70, 105, 120, 140, 148, 159, 166, 247-249, 253, 263, 267 and survey paper 12.
c) MULTIPLICATION: papers 24, 118 (multivariate case), 249, 263.
d) DIVISION: papers 42, 48, 51-53, 58, 75, 86, 97, 103, 111, 249, 263.

5. MATH PROGRAMMING.
a) LINEAR PROGRAMMING: papers 13, 38, 39, 43, 50, 55, 57.
b) INTEGER LINEAR PROGRAMMING: papers 89, 93, 113, 152.
c) NONLINEAR PROGRAMMING: paper 79.

6. FAST MATRIX MULTIPLICATION: book 1, survey papers 2 and 24, and papers 14, 20, 21, 23, 25, 30, 32, 33, 36, 37, 40, 95, 145, 157, 163, 222.

7. MULTIGRID ALGORITHMS.

a) ALGEBRAIC MULTIGRID: paper 22.

b) COMPACT MULTIGRID: papers 73, 77, 93, 109.

8. PARALLEL COMPUTATIONS (ALSO SEE RELEVANT ITEMS IN PARTS 9-14).

a) PROCESSOR EFFICIENT ALGORITHMS IN NC: book 2 (chapter 4) and papers 44-47, 50-58, 60-64, 66-69, 72, 74, 75, 80-82, 85, 88, 90, 93, 100, 102, 103, 106, 107, 111, 112, 115, 117, 119, 123, 125, 126, 129, 131-133, 138, 147, 163, 175.

b) NC EQUIVALENCE OF LINEAR PROGRAMMING AND EUCLIDEAN GCD: papers 89, 113, 152.

c) WORK-PRESERVING SPEED-UP: papers 91, 115, 122.

9. GRAPH ALGORITHMS.

a) MATCHING: papers 45, 63.

b) PATHS: item 6 in the list of book chapters; papers 54, 56, 66, 85, 90, 91, 122, 138, 147.

10. LINEAR SYSTEMS OF EQUATIONS AND MATRIX INVERSION (GENERAL INPUT MATRICES).

a) NEWTON'S ITERATION AND RESIDUAL CORRECTION PROCESSES: book 3 (chapter 6), item 9 in the list of reviews and book chapters, and papers 44, 69, 83, 175, 178, 211, 216, 226, 231, 251, 268.

b) RANDOMIZED ALGORITHMS: see section 18.

c) PARALLEL ALGORITHMS: book 2 and papers 44, 47, 60, 67, 74, 81, 82, 91, 122, 175, 238.

11. LINEAR SYSTEMS OF EQUATIONS, MATRIX INVERSION (TRIANGULAR, BANDED OR SPARSE INPUT), AND LOW RANK APPROXIMATION OF MATRICES: item 6 in the list of reviews and book chapters and papers 44, 107, 115, 117, 125, 272, 273.

12. LINEAR SYSTEMS OF EQUATIONS AND MATRIX INVERSION (STRUCTURED INPUT).

a) DISPLACEMENT TRANSFORMATION OF MATRIX STRUCTURE; APPLICATIONS TO POLYNOMIAL EVALUATION AND INTERPOLATION: book 3 and papers 71, 76, 140, 150, 156, 203, 248, 253, 259, 267.

b) NEWTON'S ITERATION AND RESIDUAL CORRECTION PROCESSES: book 3 (chapter 6), item 9 in the list of reviews and book chapters and papers 72, 83, 88, 93, 106, 132, 141, 178, 179, 187, 200, 201, 204, 211, 216, 229, 231, 251.

c) COMPRESSION OF THE DISPLACEMENTS: book 3 and papers 88, 93, 106, 108, 141, 165, 168, 175, 187, 211.

d) HOMOTOPIC/CONTINUATION TECHNIQUES: book 3 (chapter 6) and papers 93, 106, 178, 187, 200, 201, 211, 216, 231.

e) INVERSION OF DISPLACEMENT OPERATORS: book 3 and paper 194.

f) SOLUTION WITH LIFTING TECHNIQUES: papers 192, 226, 238.

g) SOLUTION WITH PRECONDITIONED CONJUGATE GRADIENT METHOD: papers 94, 128.

h) UNIFICATION OF SUPERFAST ALGORITHMS: book 3 and papers 71, 76, 150, 156, 159, 168.

i) OTHER METHODS: books 2 and 3 and papers 60, 62, 72, 74, 81, 102, 131-133, 168, 248, 249, 263.

j) APPLICATIONS TO POLYNOMIAL GCD AND RATIONAL INTERPOLATION: papers 133, 149, 159, 166, 195, 267.

k) NORM ESTIMATION: papers 254, 259.

13. DETERMINANT AND CHARACTERISTIC POLYNOMIAL: papers 60, 65, 67, 143, 146, 158, 160, 180, 197, 205, 208, 221.

14. ROOT-FINDING FOR POLYNOMIALS.

a) BOOK 4 and items 8, 10, 13, 18 and 22 in the list of survey articles and book chapters.

b) NEARLY OPTIMAL DIVIDE-AND-CONQUER ALGORITHMS: papers 126, 129, 183, 184, 186, 191 and book 4 (chapter 15).

c) OTHER NEARLY OPTIMAL ALGORITHMS: papers: 68, 80, 153, 169, 246, 250, 258, 262, 264, 269, 270, 274.

d) STRUCTURED MATRIX METHODS: item 17 in the list of surveys and book chapters; papers 198, 202, 207, 210, 212, 227, 233, 235, 239, 243, 246, 250, 252.

e) REAL POLYNOMIAL ROOT-FINDERS: papers 68, 80, 153, 213, 235, 246, 252, 258, 261.

g) OTHER ROOT-FINDING ALGORITHMS: papers 41, 46, 59, 61, 99, 114, 116, 124, 130, 134, 135, 171, 177, 206, 210, 233-236, 239, 241, 242, 264, 271.

h) APPLICATION TO APPROXIMATE POLYNOMIAL GCD: papers 149, 182.

15. ROOT-FINDING FOR SYSTEMS OF POLYNOMIALS: papers 136, 137, 139, 144, 151, 155, 170, 176, 185, 189, 193, 197, 208.

16. EIGEN-SOLVING: papers 64, 78, 80, 84, 96, 98, 110, 153, 167, 206, 207, 212, 218, 223, 227, 243.

17. SYMBOLIC-NUMERICAL COMPUTATIONS (ALSO SEE PARTS 8, 12-15, and 19).

a) BOOKS AND SURVEYS: books 2 and 3 and 4, 5, 8-14, 16-18 and 22 in the list of SURVEY ARTICLES AND BOOK CHAPTERS.

b) APPROXIMATE POLYNOMIAL GCD: papers 149, 182.

c) NUMERICAL COMPUTATION OF DETERMINANTS: papers 160, 180, 221.

d) RECOVERY OF A RATIONAL NUMBER FROM ITS NUMERICAL APPROXIMATION: paper 199.

e) NUMERICAL COMPUTATIONS WITH ERROR-FREE OUTPUT: papers 154, 224.

18. RANDOMIZED MATRIX ALGORITHMS: papers 214, 215, 217, 219, 221, 223, 225, 228, 230, 232, 234, 237, 244, 245, 255, 257, 260, 265, 266.

19. DEGENERACY AND CONDITIONING: 220, 254, 259.

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238. “Nearly Optimal Solution of Rational Linear Systems of Equations with Symbolic Lifting and Numerical Initialization", Computers and Mathematics with Applications, 62, 1685–1706 (2011).

239. “Root–finding by Expansion with Independent Constraints" (by V. Y. Pan and A.–L. Zheng), Computers and Mathematics with Applications, 62, 3164–3182 (2011).

240. “A Note on the Paper by Murat Cenk and Ferruh Ozbudak “Multiplication of Polynomials Modulo x^n", Theoretical Computer Science, 412 (2011) 3451–3462", T, Theoretical Computer Science, 428, page 91 (2012).

241. “Efficient Polynomial Root–refiners: A Survey and New Record Efficiency Estimate" (by J. M. McNamee and V. Y. Pan), Computers and Mathematics with Applications, 63,

239–254 (2012).

242. “Root–refining for a Polynomial Equation", Proceedings of the 14th International Workshop on Computer Algebra in Scientific Computing (CASC'2012), (V. P. Gerdt, V. Koepf, E. W. Mayr, and E. V. Vorozhtsov, editors), Lecture Notes in Computer Science, 7442, 271–282, Springer, Heidelberg (2012).

243. “Real and Complex Polynomial Root–finding via Eigen–solving and Randomization" (by V. Y. Pan, G. Qian, and A.–L. Zheng), Proceedings of the 14th International Workshop on Computer Algebra in Scientific Computing (CASC'2012), (V. P. Gerdt, V. Koepf, E. W. Mayr, and E. V. Vorozhtsov, editors), Lecture Notes in Computer Science, 7442, 283–293, Springer, Heidelberg (2012).

244. “Solving Linear Systems of Equations with Randomization, Augmentation and Aggregation" (by V. Y. Pan and G. Qian), Linear Algebra and Its Applications, 437, 2851–2876 (2012).

245. “Randomized Preconditioning versus Pivoting" (by V. Y. Pan, G. Qian, and A.–L. Zheng), Linear Algebra and Its Applications, 438, 4, 1883–1889 (2013).

246. “On the Boolean Complexity of the Real Root Refinement" (by V. Y. Pan and E. P. Tsigaridas), in Proc. International Symposium on Symbolic and Algebraic Computations (ISSAC'2013), Boston, Massachusetts, June 2013 (M. Kauers, editor), 299–306, ACM Press, New York (2013).

247. “Polynomial Evaluation and Interpolation and Transformations of Matrix Structures", Proceedings of the 15th International Workshop on Computer Algebra in Scientific Computing (CASC'2013), (V. P. Gerdt, V. Koepf, E. W. Mayr, and E. V. Vorozhtsov, editors), Lecture Notes in Computer Science, 8136, 273–287, Springer, Heidelberg (2013).

248. “Fast Approximate Computations with Cauchy Matrices, Polynomials and Rational Functions", Proc. of the Ninth International Computer Science Symposium in Russia (CSR'2014), (E. A. Hirsch et al., editors), Moscow, Russia, June 2014, Lecture Notes in Computer Science (LNCS), 8476, pp. 287–300, Springer International Publishing, Switzerland (2014).

249. “Nearly Optimal Computations with Structured Matrices" (by Victor Y. Pan and Elias Tsigaridas), Proc. of the International Conference on Symbolic–Numeric Computation (SNC 2014), (edited by S. Watt and J. Verschelde), 21–30, ACM Press, New York, 2014.

250. “Accelerated Approximation of the Complex Roots of a Univariate Polynomial" (by Victor Y. Pan and Elias Tsigaridas), Proc. of the International Conference on Symbolic Numeric Computation (SNC 2014), (edited by S. Watt and J. Verschelde), pages 132–134, ACM Press, New York, 2014.

251. “Global Newton Iteration over Archimedean and non-Archimedean Fields" (by Jonathan D. Hauenstein, Victor Pan, and Agnes Szanto), Proceedings of the 16th International Workshop on Computer Algebra in Scientific Computing (CASC'2014), (V.P. Gerdt, V. Koepf, W.M. Zeiler, and E.V. Vorozhtsov, editors), Lecture Notes in Computer Science, 8660, 202–217, Springer, Cham (2014). Also April 17, 2014, arXiv:1404.5525 [math.NA]

252. “Real Polynomial Root–finding by Means of Matrix and Polynomial Iterations", Proceedings of the 16th International Workshop on Computer Algebra in Scientific Computing (CASC'2014), (V.P. Gerdt, V. Koepf, W.M. Zeiler, and E.V. Vorozhtsov, editors), Lecture Notes in Computer Science, 8660, 335–349, Springer, Cham (2014).

253. “Transformations of Matrix Structures Work Again", Linear Algebra and Its Applications, 465, 1–32 (2015).

254. “Estimating the Norms of Circulant and Toeplitz Random Matrices and Their Inverses" (by V. Y. Pan, J. Svadlenka, and L. Zhao), Linear Algebra and Its Applications,

468, 197–210 (2015)

255. “Random Multipliers Numerically Stabilize Gaussian and Block Gaussian Elimination: Proofs and an Extension to Low-rank Approximation" (by V. Y. Pan, G. Qian, and X. Yan), Linear Algebra and Its Applications, 481, 202–234 (2015).

256. “Real Root Isolation by Means of Root Radii Approximation" (by V. Y. Pan and L. Zhao), Proceedings of the 17th International Workshop on Computer Algebra in Scientific Computing (CASC'2015), (V. P. Gerdt, V. Koepf, and E. V. Vorozhtsov, editors), Lecture Notes in Computer Science, 9301, 347–358, Springer, Heidelberg (2015). Also arXiv:1501.05386 [math.NA] (36 pages, 12 tables), 22 January 2015, revised October 21, 2015.

257. “ Randomized Circulant and Gaussian Preprocessing" (by V. Y. Pan and L. Zhao), Proceedings of the 17th International Workshop on Computer Algebra in Scientific Computing (CASC'2015), (V. P. Gerdt, V. Koepf, and E. V. Vorozhtsov, editors), Lecture Notes in Computer Science, 9301, 359–373, Springer, Heidelberg (2015).

258. “Nearly Optimal Refinement of Real Roots of a Univariate Polynomial" (by V. Y. Pan and E. P. Tsigaridas), J. of Symbolic Computation, 74, 181–204 (2016)

259. “How Bad Are Vandermonde Matrices?", SIAM Journal of Matrix Analysis and Applications, 37, 2, 676–694 (2016).

260. “Low-rank Approximation of a Matrix: Novel Insights, New Progress, and Extensions" (by Victor Y. Pan and Liang Zhao), Proc. of the Eleventh International Computer Science Symposium in Russia (CSR'2016), (Alexander Kulikov and Gerhard Woeginger, editors), St. Petersburg, Russia, June 2016, Lecture Notes in Computer Science (LNCS), Volume 9691, 352–366, Springer International Publishing, Switzerland (2016).

261. “Real Polynomial Root–finding by Means of Matrix and Polynomial Iterations" (by Victor Y. Pan and Liang Zhao), Theoretical Computer Science, Special Issue on Symbolic–Numerical Algorithms (Stephen Watt, Jan Verschelde, and Lihong Zhi, editors), 681, 101-116 (2017), http://dx.doi.org/10.1016/j.tcs.2017.03.032.

262. “Accelerated Approximation of the Complex Roots and Factors of a Univariate Polynomial" (by V. Y. Pan and E. P. Tsigaridas), Theoretical Computer Science, Special Issue on Symbolic–Numerical Algorithms (Stephen Watt, Jan Verschelde, and Lihong Zhi, editors), 681, 138–145 (2017). http://dx.doi.org/10.1016/j.tcs.2017.03.030.

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264. “Simple and Nearly Optimal Polynomial Root–Finding by Means of Root Radii Approximation", Springer International Publishing (I.S. Kotsireas and E. Martinez- Moro, editors), Applications of Computer Algebra, Springer, Chapter 23, Proceedings in Mathematics and Statistics, 198 AG (2017). Chapter DOI.10.1007/978-3-319-56932-1_23

265. “New Studies of Randomized Augmentation and Additive Preprocessing" (by Victor Y. Pan and Liang Zhao), Linear Algebra and Its Applications, 512, 256–305 (2017). Available at http://dx.doi.org/10.1016/j.laa.2016.09.035.

266. "Numerically Safe Gaussian Elimination with No Pivoting" (by Victor Y. Pan and Liang Zhao), Linear Algebra and Its Applications, 527, 349–383 (2017).
http://dx.doi.org/10.1016/j.laa.2017.04.007

267. “Fast Approximate Computations with Cauchy Matrices and Polynomials", Mathematics of Computation, 86, 2799–2826, 2017.
DOI: https://doi.org/10.1090/mcom/3204

268. “An Efficient Computation of Generalized Inverse of a Matrix" (by V.Y. Pan, F. Soleymani and L. Zhao), Applied Mathematics and Computation, 316, 89–101, 2018. http://dx.doi.org/10.1016/j.amc.2017.08.010

269. “Implementation of a Near-Optimal Complex Root Clustering Algorithm" (by R. Imbach, V.Y. Pan, C. Yap), Proc. of International Congress on Math Software (ICMS 2018), 235–244, 2018.

270. “Old and New Nearly Optimal Polynomial Root-Finders", In: Proceedings of the 21st International Workshop on Computer Algebra in Scientific Computing (CASC’2019), (M. England, W. Koepf, T.M. Sadikov, W.M. Seiler, and E. V. Vorozhtsov, editors), Lecture Notes in Computer Science, **11661**, 393–411, Springer, Nature Switzerland (2019), doi: 10.1007/978-3-030-26831-2 and arXiv:1805.12042 Submitted on 30 May 2018

271. “Root-Finding with Implicit Deflation" (with R. Imbach, C., Yap, I.S. Kotsireas, V. Zaderman), In: Proceedings of the 21st International Workshop on Computer Algebra in Scientific Computing (CASC’2019), (M. England, W. Koepf, T.M. Sadikov, W.M. Seiler, and E. V. Vorozhtsov, editors), Lecture Notes in Computer Science, **11661**, 236–245, Springer, Nature Switzerland (2019), doi: 10.1007/978-3-030-26831-2 and arxiv:1606.01396, submitted on 21 May (2019)

272. “Sublinear Cost Low Rank Approximation via Subspace Sampling" (by V. Y. Pan, Q. Luan, J. Svadlenka, and L. Zhao), In LNCS 11989, Book: Mathematical Aspects of Computer and Information Sciences (MACIS 2019), D. Salmanig et al (Eds.), Springer Nature Switzerland AG 2020, Chapter No: 9, pages 1– 16, Springer Nature Switzerland AG 2020 Chapter DOI:10.1007/978-3-030-43120-4_9

273. “CUR LRA at Sublinear Cost Based on Volume Maximization" (by Q. Luan, V. Y. Pan), LNCS 11989, In Book: Mathematical Aspects of Computer and Information Sciences (MACIS 2019), D. Salmanig et al (Eds.), Springer Nature Switzerland AG 2020, Chapter No: 10, pages 1– 17, Chapter DOI:10.1007/978-3-030-43120-4_10

274. “New Practical Advances in Polynomial Root Clustering" (by R. Imbach, V. Y. Pan), LNCS 11989, In Book: Mathematical Aspects of Computer and Information Sciences (MACIS 2019), D. Salmanig et al (Eds.), Springer Nature Switzerland AG 2020, Chapter No: 11, pages 1– 16, Chapter DOI:10.1007/978-3-030-43120-4_11

275. “New Progress in Univariate Polynomial Root-finding" (by R. Imbach, V. Y. Pan), Proceedings of ACM-SIGSAM ISSAC 2020, ACM ISBN 978-1-4503-7100-1/20/07 https://doi.org/10.1145/3373207.3403979

276. “Acceleration of Subdivision Root-Finding for Sparse Polynomials", In: Computer Algebra in Scientific Computing (CASC’20), Springer Nature Switzerland AG 2020, F. Boulier et al. (Eds.): CASC 2020, LNCS 12291, Ch. 27, pp. 1 – 17, 2020 https://doi.org/10.1007/978 − 3 − 030 − 60026 − 6_27

277. “Faster Numerical Univariate Polynomial Root-Finding by Means of Subdivision Iterations" (by Qi Luan, Victor Y. Pan, Wongeun Kim, and Vitaly Zaderman), In: Computer Algebra in Scientific Computing (CASC’20), Springer Nature Switzerland AG 2020, F. Boulier et al. (Eds.): CASC 2020, LNCS 12291, Ch. 25, pp. 1 – 16, 2020 https://doi.org/10.1007/978 − 3 − 030 − 60026 − 6_25

278. “Root Radii and Subdivision for Polynomial Root-Finding" (by R. Imbach, V. Y. Pan), In: Computer Algebra in Scientific Computing (CASC’21), Springer Nature Switzerland AG 2021, F. Boulier et al. (Eds.): CASC 2021, LNCS 12865, pp. 1–21, 2021. *https* : //*doi.org*/10.1007/978 − 3 − 030 − 85165 − 1_9

279. “New Progress in Sparse Polynomial Root-finding" (by V.Y. Pan), In: Sirius University of Science and Technology, Sirius Mathematics Center, International Conference:

Computer Algebra in Scientific Computing, September 13 – 17, 2021, pages 85 – 91, Sirius Federal Territory, 2021.

280. “Accelerated subdivision for clustering roots of polynomials given by evaluation oracles" (by R. Imbach, V. Y. Pan), In: Computer Algebra in Scientific Computing (CASC’22), Springer Nature Switzerland AG 2022, F. Boulier et al. (Eds.): CASC 2022, LNCS 13366, pp. 143–164, 2022. arXiv preprint 2206.08622 (2022)

281. “Fast approximation of polynomial zeros and matrix eigenvalues" (by V.Y. Pan, Soo Go, Qi Luan, and Liang Zhao),V.Y. accepted by 13th International Symposium on Algorithms and Complexity (CIAC 2023), Springer’s Lecture Notes in Computer Science, Springer (2023)

11 TALKS AND PRESENTATIONS AT PROFESSIONAL MEETINGS SINCE 1991

1991

2nd Annual ACM-SIAM Symposium on Discrete Algorithms (SODA’91), San Francisco, California, January 1991. Refereed paper was accepted by Program Committee.

Fifth Biennial Copper Mountain Conference on Multigrid Methods, Copper Mountain, Colorado, April 1991. Refereed paper was accepted by Program Committee.

18th International Colloquium on Automata, Languages and Programming (ICALP’91), Madrid, Spain, July 1991. Refereed paper was accepted by Program Committee.

3rd Annual ACM Symposium on Parallel Algorithms and Architectures (SPAA’91), Hilton Head, South Carolina, July 1991. Refereed paper was accepted by Program Committee.

4th SIAM Conference on Applied Linear Algebra, Minneapolis, Minnesota, September 1991. Two talks at mini-symposia.

3rd IEEE Symposium on Parallel and Distributed Algorithms, Dallas, Texas, December 1991. Refereed paper was accepted by Program Committee.

1992

3rd Annual ACM-SIAM Symposium on Discrete Algorithms, Orlando, Florida, January 1992. Refereed paper was accepted by Program Committee.

Israel Symposium on the Theory of Computing and Systems (ISTCS’92), Haifa, Israel, May 1992. Refereed paper was accepted by Program Committee.

4th Annual ACM Symposium on Parallel Algorithms and Architectures (SPAA’92), San Diego, California, June-July 1992. Two refereed papers were accepted by Program Committee.

33rd Annual IEEE Conference on Foundations of Computer Science (FOCS’92), Pittsburgh, Pennsylvania, October 1992. Three refereed papers were accepted by Program Committee.

Second Biennial Copper Mountain Conference on Iterative Methods, Copper Mountain, Colorado, April 1992. Refereed paper was accepted by Program Committee.

1993

Panamerican Workshop for Applied and Computational Mathematics, Caracas, Venezuela, January 1993. Three refereed papers were accepted by Program Committee.

Workshop on Applicable Algebra, Obervolfach, Germany, February 1992. Invited talk (30 minutes).

Annual ACM International Symposium on Symbolic and Algebraic Computations (ISSAC'93), Kiev, Ukraine, July 1993. Refereed paper was accepted by Program Committee.

3rd SIAM Conference on Linear Algebra, Seattle, Washington, August 1993. Invited talk at mini-symposium (30 minutes).

884th Meeting of the American Mathematical Society, Syracuse, New York, September 1993. Invited talk (30 minutes).

34th Annual IEEE Conference on Foundations of Computer Science, Palo Alto, California, November 1993. Refereed paper was accepted by Program Committee.

Workshop on Parallel Algorithms, DIMACS, Rutgers University, New Jersey, November 1993. Invited talk (30 minutes).

1994

5th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA'94). Two refereed papers were accepted by Program Committee.

Third Biennial Colorado Conference on Iterative Methods (CCIM'94), Breckenridge, Colorado, April 1994. Refereed paper was accepted by Program Committee.

5th SIAM Conference on Applied Linear Algebra, Snowbird, Utah, June 1994. Three refereed papers were accepted by Program Committee.

First Intern. Symposium on Parallel Algebraic and Symbolic Computation (PASCO'94), Linz, Austria, September 1994. Refereed paper was accepted by Program Committee.

35th Annual IEEE Conference on Foundation of Computer Science (FOCS'94), Santa Fe, New Mexico, November 1994. Refereed paper was accepted by Program Committee.

1995

Annual ACM Symposium on Theory of Computing (STOC'95), Las Vegas, Arizona, May 1995. Refereed paper was accepted by Program Committee.

25th AMS-SIAM Summer Seminar on Mathematics of Numerical Analysis, Park City, Utah, July-August 1995. Invited plenary talk (1 hour).

Seminar on Real Computation and Complexity, Schloss Dagstuhl, Germany, November 1995. Invited talk (45 minutes).

1996

7th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA'96), Atlanta, Georgia, January 1996. Refereed paper was accepted by Program Committee.

Fourth Biennial Copper Mountain Conference on Iterative Methods, Copper Mountain, Colorado, April 1996. Refereed paper was accepted by Program Committee.

NATO Advanced Study Workshop on Algorithms for Sparse Large Scale Linear Systems, Las Palmas de Grand Canaria, Spain, June 1996. Invited Talk (1 hour).

Workshop on Symbolic - Numeric Algebra for Polynomials (SNAP'96), INRIA Sophia Antipolis, France, July 1996. Invited talk (45 minutes).

International Conference on Structured Matrices, Cortona, Italy, September 1996. Two refereed papers were accepted by Program Committee.

1997

International Conference on Foundation of Computational Mathematics (FoCM), Rio de Janeiro, Brazil, January 1997. Invited semi-plenary talk (50 minutes) and invited talk (30 minutes).

FRISCO Open Workshop 97, INRIA Sophia Antipoles, France, March 1997. Invited talk (20 minutes).

The 29th Annual ACM Symposium of Theory of Computing (STOC'97), El Paso, Texas, May 1997. Refereed paper was accepted by Program Committee.

The 13th Annual ACM Symposium on Computational Geometry, Nice, France, June 1997. Refereed paper was accepted by Program Committee.

Faddeev Memorial International Algebraic Conference, St. Petersburg, Russia, June 1997. Invited talk (45 minutes).

Annual ACM International Symposium on Symbolic and Algebraic Computation (ISSAC'97), Maui, Hawaii, August 1997. Refereed paper was accepted by Program Committee.

Second ACM International Symposium on Parallel Symbolic Computation (PASCQ'97), Maui, Hawaii, August 1997. Refereed paper was accepted by Program Committee.

1998

9th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA'98), January 1998, San Francisco, California. Refereed paper was accepted by Program Committee.

Fifth Biennial Copper Mountain Conference on Iterative Methods, March 1998. Copper Mountain, Colorado. Refereed paper was accepted by Program Committee.

933rd AMS Meeting, April 1998, Philadelphia. Invited talk at mini-symposium.

30th Annual ACM Symposium on Theory of Computing (STOC'98), May 1998, Dallas, Texas. Refereed paper was accepted by Program Committee.

Kurosh Memorial Algebraic Conference, June 1998, Moscow, Russia. Invited talk at mini-symposium.

International Seminar on Real Computation and Complexity, June 1998, Dagstuhl, Germany. Invited talk (45 minutes).

SIAM Annual Meeting, July 1998, Toronto, Canada. Invited talk at mini-symposium.

Annual International Conference IMACS on Application of Computer Algebra (ACA), August 1998, Praha, Czech Republic. Two invited talks at two mini-symposia.

Annual ACM International Symposium on Symbolic and Algebraic Computations (ISSAC'98), August 1998, Rostock, Germany. Refereed paper was accepted by Program Committee.

5th International Symposium on Solving Irregularly Structured Problems Parallel (IRREGULAR'98), August 1998, Berkeley, California. Refereed paper was accepted by Program Committee.

MSRI Workshop on Solving Systems of Equations, September 1998, Berkeley, California. Invited talk (30 minutes).

39th Annual IEEE Conference on Foundations of Computer Science (FOCS'98), October 1998, Palo Alto, California. Refereed paper was accepted by Program Committee.

1999

10th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA'99), January 1999, Baltimore, Maryland. Refereed paper was accepted by Program Committee.

13th International Parallel Processing Symposium and 10th Symposium on Parallel and Distributed Computing (IPPS/SPDP'99), San Juan, Puerto Rico, April 1999. Refereed paper was accepted by Program Committee.

31st Annual ACM Symposium on Theory of Computing (STOC'99), May 1999, Atlanta, Georgia. Refereed paper was accepted by Program Committee.

2nd International Workshop on Computer Algebra in Scientific Computing (CASC'99), June 1999, Munich, Germany. Invited lecture (45 minutes).

Annual International Conference IMACS on Application of Computer Algebra (ACA), June 1999, El Escorial, Madrid, Spain. Two invited lectures at two mini-symposia.

1999 AMS-IMS-SIAM Summer Research Conference on Structured Matrices in Operator Theory, Numerical Analysis, Control, Signal and Image Processing, June-July 1999, Boulder, Colorado. Invited lecture (45 minutes).

Annual International Colloquium on Automata, Languages, Programming (ICALP), July 1999, Praha, Czech Republic. Refereed paper was accepted by Program Committee.

International Symposium on Foundations of Computational Mathematics (FoCM'99), July 1999, Oxford, England. Four invited talks at three mini-symposia.

2000

11th Annual ACM-SIAM Symposium on Discrete Algorithm (SODA'2000), January 2000, San Francisco. Refereed paper was accepted by Program Committee.

Sixth Biennial Copper Mountain Conference on Iterative Methods (Copper'2000), April 2000, Copper Mountain, Colorado. Refereed paper was accepted by Program Committee.

2nd Conference on Numerical Analysis and Applications (NAA'2000), June 2000, Rousse, Bulgaria. Invited plenary talk (1 hour).

Annual International Conference IMACS on Application of Computer Algebra (ACA), June 2000, St. Petersburg, Russia. Invited plenary talk (50 minutes) and invited talk at mini-symposium.

14th International Symposium on Mathematical Theory of Network and Systems (MTNS'2000), June 2000, Perpignan, France. Invited talk at mini-symposium.

The Smalefest Conference in Hong Kong, July 2000. Two papers were refereed and accepted for the proceedings.

Annual ACM International Symposium on Symbolic and Algebraic Computation (ISSAC'2000), August 2000, St. Andrew's, Scotland. Refereed paper was accepted by Program Committee.

2001

International Conference on Complex Analysis and Applications. Moscow, Russia, June 2001. Invited talk (45 minutes) and a refereed paper accepted for the proceedings.

SIAM Annual Meeting, San Diego, California, July 2001. Invited talk at mini-symposium.

Annual ACM International Symposium on Symbolic and Algebraic Computations (ISSAC'2001), London, Ontario, Canada, July 2001. Refereed paper was accepted by the Program Committee.

2001 AMS-IMS-SIAM Summer Research Conference on Fast Algorithms in Mathematics, Computer Science, and Engineering. S. Hadley, Massachusetts, August 2001. Invited Lecture (45 minutes).

2002

Annual International Symposium on Theoretical Aspects of Computer Science (STACS). March 2002, Juan Les Pins, France. Refereed paper was accepted by the Program Committee.

Seventh Biennial Copper Mountain Conference on Iterative Methods (Copper'2002), March-April 2002, Copper Mountain, Colorado. Refereed paper was accepted by the Program Committee.

International Conference on Structured Matrices, May-June 2002, Hong Kong, China. Invited talk at a mini-symposium.

First Joint Meeting of the American Mathematical Society and Unione Matematica Italiana (AMS/UMI'2002), Pisa, Italy, June 2002. Invited talks at a session.

Annual International Conference IMACS on Application of Computer Algebra (ACA), Volos, Greece, June 2002. Two invited talks at two mini-symposia.

Annual ACM International Symposium Symbolic and Algebraic Computation (ISSAC'2002), Lille, France, July 2002. Refereed paper was accepted by the Program Committee.

International Symposium on Foundations of Computational Mathematics (FoCM'2002), Minneapolis, Minnesota, August 2002. Two invited talks at a mini-symposium.

5th Annual Conference on Computer Algebra in Scientific Computing (CASC'2002), Yalta, Crimea, Ukrain, September 2002. Refereed paper was accepted by the Program Committee.

2003

International Seminar on Matrix Methods and Operator Equations, Moscow, Russia, June 2003. Invited talk.

Workshop on Nonlinear Approximation in Numerical Analysis, Moscow, Russia, June 2003. Invited talk.

SIAM Conference on Linear Algebra (LA'03), Williamsburg, Virginia, July 2003. Invited talk at a mini-symposium and a contributed talk.

9th Annual International Conference on Applications of Computer Algebra (ACA'2003), Raleigh, North Carolina, July 2003. An invited talk at mini-symposium.

6th Annual Conference on Computer Algebra in Scientific Computing (CASC'2003), Passau, Germany, September 2003. Refereed paper was accepted by the Program Committee.

2004

Eighth Biennial Copper Mountain Conference on Iterative Methods (Copper'2004), March-April 2004, Copper Mountain, Colorado. Refereed paper was accepted by the Program Committee.

Mathematics of Computer Algebra and Analysis (MOCAA'2004). A talk by invitation by Program Committee.

16th International Symposium on Mathematical Theory of Network and Systems (MTNS'2004), July 2004, Leuven, Belgium. Refereed paper was accepted by the Program Committee.

6th Annual Conference on Computer Algebra in Scientific Computing (CASC'2003), July 2004, St. Petersburg, Russia. Refereed paper was accepted by the Program Committee.

6th International Mathematica Symposium (IMS 2004), August 2004, Banff, Canada, Refereed paper was accepted by the Program Committee.

2nd International Conference on Structured Numerical Linear Algebra Problems: Algorithms and Applications (Cortona 2004), September 2004, Cortona, Italy. Invited talk (30 minutes).

2005

International Conference on Matrix Methods and Operator Equations, Moscow, Russia, June 2005. Invited talk (30 minutes).

16th Annual ACM-SIAM Symposium on Discrete Algorithm (SODA'2005), January 2005, Vancouver, Canada. Refereed paper was accepted by Program Committee.

International Conference on Foundation of Computational Mathematics (FoCM'2005), July 2005, Santander, Spain. Two invited talks (50 minutes and 25 minutes) at two mini-symposia.

International Workshop on Symbolic-Numeric Computation, July 2005, Xi'an, China. Invited plenary talk (one hour).

Conference on Applications of Computer Algebra, July-August 2005, Nara, Japan. Invited talk at mini-symposium.

2006

Nineth Biennial Copper Mountain Conference on Iterative Methods (CMCIM'06), April 2006, Copper Mountain, Colorado. Refereed paper was accepted by the Program Committee.

International Conference on Algebraic Computational Geometry, Nice, France, June 2006. Invited talk (30 minutes).

Conference on Applications of Computer Algebra, Varna, Bulgaria, June 2006. Two invited talks at a mini-symposium.

SIAM Annual Meeting, Boston, Massachusetts, July 2006. Refereed paper was accepted by the Program Committee.

2007

The 6th International Congress on Industrial and Applied Mathematics (ICIAM'2007), Zurich, Switzerland, July 2007. Invited talk at a mini-symposium.

2nd International Conference on Matrix Methods and Operator Equations, Moscow, Russia, July 2007. Invited talk (30 minutes).

International Workshop on Symbolic-Numerical Computations (SNC'2007), London, Ontario, Canada, July 2007. Three refereed papers were accepted by the Program Committee.

2008

Tenth Biennial Copper Mountain Conference on Iterative Methods (CMCIM'06), April 2008, Copper Mountain, Colorado. Refereed paper was accepted by the Program Committee.

Third International Computer Science Symposium in Russia (CSR'2008), June 2008, Moscow, Russia. Refereed paper was accepted by the Program Committee.

The XIX International Workshop on Operator Theory and its Applications, July 2008, Williamsburg, Virginia. Invited talk at a mini-symposium.

Structured Linear Algebra Problems: Analysis, Algorithms, and Applications, Cortona, Italy, September, 2008. Invited talk, 30 minutes.

2009

International Conference on Polynomial Computer Algebra, St. Petersburg, Russia, April 2009. Invited Speaker.

The 3rd International Workshop on Symbolic-Numeric Computation (SNC 2009), Kyoto, Japan, August 2009. Invited talk (1 hour) and a refereed paper was accepted by the Program Committee.

SIAM Conference on Applied Linear Algebra, Oct. 26-29, Seaside, California, Oct. 26-29. Two invited talks at two mini-symposia.

2010

International Conference on Polynomial Computer Algebra, St. Petersburg, Russia, April 2010. Invited Speaker.

The Fifth International Computer Science Symposium in Russia (CSR'2010), June 2010, Kazan, Russia. Refereed paper was accepted by the Program Committee.

The 16-th ILAS Conference, Pisa, Italy, June 2010. Invited talk, 30 minutes.

Annual ACM International Symposium on Symbolic and Algebraic Computation (ISAAC'2001), Munich, Germany, July 2010. Refereed paper was accepted by the Program Committee.

2011

Annual ACM SIGSAM International Symposium on Symbolic and Algebraic Computation (ISAAC'2011), San Jose, CA, June 8-11, 2011. Refereed paper was accepted by the Program Committee.

The 4th International Workshop on Symbolic-Numeric Computation (SNC'2011), San Jose, CA, June 7-9, 2011. Refereed paper was accepted by the Program Committee.

3rd International Conference on Matrix Methods in Mathematics and Applications, Moscow, Russia, June 22-25, 2011. Plenary talk (1 hour) and invited talk (30 minutes).

The 7th International Congress on Industrial and Applied Mathematics (ICIAM'2011), Vancouver, British Columbia, Canada, July 18-22, 2011. Invited talk at a mini-symposium (30 minutes).

2012

SIAM International Conference on Linear Algebra, Valencia, Spain, June 18-22, 2012. Invited talk at a mini-symposium (30 minutes).

14th Annual Conference on Computer Algebra in Scientific Computing (CASC'2012), September 3-6, 2012, Maribor, Slovenia. Two refereed papers were accepted by the Program Committee.

2nd International Conference on Structured Numerical Linear Algebra Problems: Algorithms and Applications (Leuven 2012), September 10-14, 2012, Leuven, Belgium. Invited talk (30 minutes).

2013

The 17-th ILAS Conference, Providence, R.I., June 3-7, 2013. Four invited talks at three mini-symposia (30 minutes each).

Annual ACM SIGSAM International Symposium on Symbolic and Algebraic Computation (ISAAC'2013), Boston, Massachusetts, June 23-26, 2013. Refereed paper was accepted by the Program Committee.

15th Annual Conference on Computer Algebra in Scientific Computing (CASC'2013), September 9-13, 2013, Berlin, Germany. A refereed paper was accepted by the Program Committee.

2014

The Ninth International Computer Science Symposium in Russia (CSR'2014), June 2014, Moscow, Russia. Refereed paper was accepted by the Program Committee.

The 5th International Workshop on Symbolic-Numeric Computation (SNC'2014), July 2014, Shanghai, China. Two refereed paper were accepted by the Program Committee.

16th Annual Conference on Computer Algebra in Scientific Computing (CASC'2014), September 8-12, 2014, Warsaw, Poland. Two refereed papers have been accepted by the Program Committee.

3rd International Conference on Structured Numerical Linear Algebra Problems: Algorithms and Applications, September 8-12, 2012, Kalamata, Greece. Invited talk (30 minutes).

2015

The 26th International Workshop on Operator Theory and its Applications, July 6–10, 2015, Tbilisi, Georgia. Invited talk at a mini-symposium (30 minutes).

Conference on Applications of Computer Algebra, Kalamata, Greece, July 20-23, 2016. Invited talk at a mini-symposium (30 minutes).

17th Annual Conference on Computer Algebra in Scientific Computing (CASC'2014), September 10–14, 2015, Aachen, Germany. Two refereed papers have been accepted by the Program Committee.

4th International Conference on Matrix Methods in Mathematics and Applications (MMMA-2015), August 24–28, 2015, Skolkovo/Moscow, Russia. Invited talk at a mini-symposium (30 minutes).

2015 SIAM Conference on Applied Linear Algebra, October 26–30, 2015, Atlanta, Georgia, USA. Invited talk at a mini-symposium (30 minutes).

2016

The Eleventh International Computer Science Symposium in Russia (CSR'2016), June 2016, Moscow, Russia. Refereed paper was accepted by the Program Committee.

Milestones in Computer Algebra (MICA 2016), July 16–18, 2016, University of Waterloo, Canada. Invited talk at a mini-symposium (30 minutes).

Workshop on Fast Direct Solvers, November 12–13, 2016, Purdue University, West Lafayette, Indiana. Invited talk (50 minutes).

2017

SIAM Conference on Computational Science and Engineering, February–March 2017, Atlanta, Georgia, USA. Invited talk at a mini-symposium (30 minutes).

INdAM Meeting –Structured Matrices in Numerical Linear Algebra: Analysis, Algorithms and Applications, Cortona, Italy, September 4-8, 2017. Invited talk (30 minutes).

2019

SIAM Conference on Computational Algebraic Geometry (SIAM ACG 2019), Bern, Switzerland, July 2019 (invited talk at a minisymposium (30 minutes).

The 5th International Conference on Matrix Methods in Mathematics and Applications (MMMA 2019) Moscow, Russia, August 19-23, 2019 (an invited talk, 30 minutes).

Computer Algebra in Scientific Computing, Moscow (CASC 2019), Russia, August 26-30, 2019 (2 contributed talks, 30 minutes each, accepted by the Program Committee).

Biennial Conference on Mathematical Aspects of Computer and Information Sciences (MACIS 2019), Gebze-Istanbul, Turkey, November 13-15, 20193 (3 contributed talks, 30 minutes each, accepted by the Program Committee).

2020

Annual ACM SIGSAM International Symposium on Symbolic and Algebraic Computation (ISSAC'2020), Kalamata, Greece, July 20 – 23, 2020. Refereed paper was accepted by the Program Committee.

Computer Algebra in Scientific Computing (CASC 2020), Linz, Austria, September 14–18, 2020 (2 contributed talks, 30 minutes each, accepted by the Program Committee).

Polynomial Computer Algebra (PCA'2020), 12 - 17 Oct., 2020, Euler International Mathematical Institute, Saint Petersburg, Russia (a contributed talk, 30 minutes, accepted by the Program Committee).

2021

SIAM Conference on Applied Linear Algebra (LA21), Virtual Conference – Originally scheduled in New Orleans, Lousiana, USA; May 17 - 21, 2021 (an invited talk at a Minisymposium, 20 minutes).

Computer Algebra in Scientific Computing (CASC 2021), Sochi, Russia, September 13 – 17, 2021 (2 contributed talks, 30 minutes each, accepted by the Program Committee).

2022

Computer Algebra in Scientific Computing (CASC 2022), Gebze, Turkey, August 22 – 26, 2022 (a contributed talk, 30 minute, accepted by the Program Committee).

13th International Conference on Algorithms and Complexity, 13 – 16 June, 2023 Larnaca, Cyprus (a contributed talk, 30 minutes, accepted by the Program Committee).

25th Conference of International Linear Algebra Society, June 20-24, 2023, Madrid, Spain, contributed talk, 30 minutes, accepted by the Program Committee).

2023

10th International Congress on Industrial and Applied Mathematics (ICIAM 2023), Tokyo : August 20-25, 2023 Invited talk at Minisymposium on Randomized methods for solving linear systems and eigenvalue problems (30 minute talk, accepted by the Program Committee)

12 RESEARCH

I will begin with my research Manifesto, then will briefly cover my education and my research in ten major subject areas of Computer Science and Computational Mathematics (omitting my work of 1965–75 in Economics in the USSR and a number of my more sporadic research excursions into other areas). I will end with a summary and concluding remarks. I will use the *acronyms* listed in Section 12.16 and followed by the list of the references cited in this section, and I will also refer to my works cited in Section 10 – PUBLICATIONS (COMPLETE LIST).

12.1 MANIFESTO

I have been working in Mathematics, Computational Mathematics, and Computer Science for more than five decades, facing research challenges and seeking new insights and novel methods. I was thrilled whenever I discovered new keys that opened challenging scientific locks, particularly when *a single key opened a number of locks*, as this was the case with my techniques of active operation/linear substitution, trilinear aggregation, and transformation of matrix structures.

My work has contributed to the creation of the fields of the *Complexity of Algebraic Computations* and *Algebraic Multigrid* and to significantly advancing some other research areas such as *Computations with Structured Matrices*, *Symbolic-Numerical Computations*, and *Fast and Processor-Efficient Parallel Algorithms.* My techniques, insights, concepts and definitions are commonly used, sometimes as folklore.

I was lucky to reveal a number of important but hidden links among apparently distant subjects. I helped bring together research in various areas of computing such as symbolic computations, numerical computations, theoretical computer science, and applied linear algebra – in many cases I achieved synergy.

I am grateful for recognition and support of my research by leading experts, foundations, journals, professional societies, research centers, and universities. The National Science Foundation (NSF) has awarded me with Grants for over $2,500,000 for 1980–2021, including Special Creativity Extension Award from the Numeric, Symbolic, and Geometric Computation Program of the CCR Division in the Directorate CISE of NSF in 1993 and over $1,000,000 in grants for 2016–2021. My Awards from Professional Staff Congress of the City University of New York (PSC CUNY) for 1989–201218 exceed $130,000.

I was encouraged by enthusiastic reviews and citations of my work in books, journals, and magazines and by designation of a Fellow of American Mathematical Society of 2013 *"For Contributions to the Mathematical Theory of Computation"*.

According to Google Scholar, I published four books (1623+LXXIV pages overall), over 20 surveys in journals and book chapters, over 180 research articles in journals and over 100 in refereed conference proceedings and was cited over 12,000 times. Almost all my publications are in *Computer Science* and *Computational and Applied Mathematics.*

I have also disseminated my research findings in my lectures at the universities, research centers, and professional conferences worldwide as well as through my research reports, the Internet, and personal communication.

I guided 26 students to their PhD Defenses in Math and Compute Science (two in 2020) and published dozens of papers jointly with my current and former students; with some of them more than a decade after their defense.

12.2 Education and research areas

My scientific destiny was decided in the 59th high school in Moscow, Russia, celebrated for having excellent teachers in mathematics. I was among many of its graduates who went to the famous MechMat Department of Moscow State University (MGU), headed by *Andrey Nikolaevich Kolmogorov.* He was one of the greatest mathematician of his time, and so was his student Vladimir Igorevich Arnold, also a graduate from the 59th school in Moscow.

My adviser *Anatoli Georgievich Vitushkin*, a renowned expert in the theory of functions of real and complex variables and a member of the Russian Academy of Sciences, was among Kolmogorov's distinguished disciples. He also worked with a versatile scientist Alexander Semenovich Kronrod and like Kolmogorov and Kronrod had broad scientific interests.

From 1956 to 1961 I enjoyed learning mathematics in the MechMat Department of MGU. My first journal paper appeared in 1958 and was on the real function theory, but at that time Vitushkin guided me into *research in Computational Mathematics*, and from 1959 to 1964 almost all my publications as well as my PhD Thesis were in that field. I defended the thesis in 1964, and then up to the Fall of 1976 had been making living by working in

Economics rather than Mathematics because job market in the USSR was quite restricted for people of Jewish ethnicity, like myself. In 1976 I emigrated to the USA and since 1977 have been working entirely in Computer Science and Computational Mathematics.

12.3 My first scientific breakthrough: polynomial evaluation

In 1962, by introducing a novel technique of active operation/linear substitution, I proved *optimality of the classical algorithm for polynomial evaluation*, commonly called Horner's. This gave positive answer to a question asked by Alexander Markowich Ostrowsky in 1955. Volker Strassen and Shmuel Winograd adopted my technique for proving the optimality of the classical algorithms for some fundamental matrix computations (see [BM75, Section 2.3]).

My work has been surveyed in my paper [P66] and in the most fundamental Computer Science book [K81/97] by Donald E. Knuth, which cites my work and that of Richard P. Brent most extensively among all its cited authors. The paper [P66] has been highly recognized in the West, has led to the emergence of the field of *Complexity of Algebraic Computations*, and made me known as *"polynomial Pan"*.

12.4 My second scientific breakthrough: fast matrix multiplication by means of trilinear decomposition and aggregation

Matrix multiplication (hereafter referred to as MM) is one of the central subjects of the theory and practice of computing, and the scientific world was tremendously impressed in 1969, when Strassen decreased the classical exponent 3 of MM to $\log_2 7 \approx 2.808$, that is, performed MM by using less than cubic time. In my book and my review article in SIAM Review in 1984, both much cited at that time, I praised his discovery as well as his subsequent extensive work on algebraic computations, while he himself has been attracted to this field by my paper [P66] and has paid tribute to my work in his chapters, both called *"Pan's method"*, in [S72] and [S74].

Further progress toward performing MM in quadratic time was expected to come shortly, but all attempts to decrease the exponent 2.808 defied worldwide effort for almost a decade, until I decreased it in 1978. This work of 1978 was recognized worldwide as a long-awaited breakthrough.

I quote the following excerpt from a letter by Donald E. Knuth with his permission:

"I am convinced that his research on matrix multiplication was the most outstanding event in all of theoretical computer science during 1978. The problem he solved, to multiply $n \times n$ matrices with less than $O(n^{\log_2 7})$ operations, was not only a famous unsolved problem for many years, it also was worked on by all of the leading researchers in the field, worldwide. Pan's breakthrough was based on combination of brilliant ideas, and there is no telling what new avenues this will open."

Indeed my techniques prompted fast new progress, with my participation. I have become widely known as *"matrix Pan"* and to the experts as *"matrix and polynomial Pan"*.

I devised my fast MM algorithms by means of

(i) reducing the bilinear problem of matrix multiplication to the equivalent problem of trilinear (tensor) decomposition and

(ii) nontrivially exploiting cyclic symmetry in the tensor of matrix multiplication.

In [P78] I called my combination of the two techniques *trilinear aggregation* in [P78], but I introduced it already in the paper [P72] (in Russian), translated into English only in 2014, in arXiv:1411.1972, and little known in the West until 1978.

Actually my trilinear aggregation technique of 1972 was a historic landmark on a wider scale. *It produced the first nontrivial decomposition of a tensor and the associated trilinear form that defined a new efficient algorithm for matrix computations.* Subsequently tensor decomposition has become a popular tool for devising highly efficient matrix algorithms in many areas of scientific computing. Says Eugene E. Tyrtyshnikov, a renowned expert in tensor decomposition:

“We should be especially grateful to Victor Pan for the link between the bilinear algorithms and trilinear tensor decompositions. Although it looks simple and even might be regarded as a folklore by now, this observation still has its creator, and by all means and for all I know it is due to the work of Victor Pan."

Lately experts pointed me out that Richard Brent had report of 1970 where he also expressed matrix multiplication as a similar tensor decomposition. Not to diminish the value of that work, it has not gone beyond stating the link of MM to tensors but showed no application to devising new faster algorithms. Also in my extensive discussions of fast MM with all leading experts from the 1970s and throughout the 1990s Brent’s report was never cited and apparently was not known; certainly it was not known in the Soviet Union in 1972, when I published my paper [P72].

Since 1978 my trilinear aggregation has been routinely employed by myself and my successors for devising new fast MM algorithms. After the stalemate from 1969 to 1978 the MM exponent was decreased a number of times in 1979–1981 and then again twice in 1986, reaching the record value 2.376 in [CW86/90]. It was decreased again in 2010–2014, but only nominally. Every decrease relied on amazing novel techniques built on the top of the previous ones, always employing the reduction of the MM problem to trilinear aggregation, frequently by default, as this has been pointed out on page 255 of the celebrated paper [CW86/90] about its immediate predecessor [S86]: “Strassen uses the following basic trilinear identity, related to Victor Pan’s “trilinear aggregation" (1978)."

As Arnold Schönhage has written at the end of the introduction of his seminal paper [S81], however, *all these exponents of MM have been just "of theoretical interest". They hold only for inputs "beyond any practical size", and "Pan’s estimates of 1978 for moderate" input sizes were "still unbeaten".* Actually in [P79], [P80], [P81], and [P82], I successively decreased my record exponent for all feasible MM (that is, for MM of moderate sizes $n \times n$, say, up to $n \leq 1,000,000,000$). My exponent of [P82], below 2.7734, still remains the record in 2021. All smaller exponents rely on ignoring the *curse of recursion* – they have been obtained only at the end of a long recursive processes, whose each recursive step squared the input size. The resulting algorithms beat the classical MM only for inputs of immense sizes.

My algorithms promise to be highly efficient in practice: the implementations by Igor Kaporin of an algorithm from [P84a] in [K99] and of that of [LPS92] in [K04] use substantially smaller computer memory and are more stable numerically than Strassen’s algorithm.

I surveyed the progress up to the date in [P84b] and [P84a]. In both cases I focused on the decrease of the exponent of MM because this was the focus of the research community in 1984; presently I pay more attention to the acceleration of feasible MM.

In [HP98], jointly with my student Xiaohan Huang, I accelerated rectangular MM, which implied new record asymptotic complexity estimates for the computations of the composition and factorization of univariate polynomials over finite fields.

12.5 Hierarchical aggregation as a springboard for the Algebraic Multigrid (1980). Compact Multigrid (1990–1993)

In [MP80], jointly with Willard L. Miranker, I introduced hierarchical aggregation/disaggregation processes, substantially responsible for the emergence of the popular field of *Algebraic Multigrid.*

Jointly with John H. Reif, in SPAA 1990, SIAM J. of Scientific and Statistical Computing 1992 and CAMWA 1990 and 1993, I proposed a simple but novel acceleration technique of *Compact Multigrid.*

12.6 Parallel algebraic and graph algorithms (1985–2001)

Throughout the years of 1985–2001, prompted by high recognition of my joint paper with Reif at STOC 1985, I proposed, both by myself and jointly with coauthors, a variety of new efficient parallel algorithms and in particular a number of fast and processor-efficient parallel algorithms for computations with matrices, polynomials, and graphs. They relied on a number of our novel nontrivial techniques; I regularly presented my work at the most competitive conferences in this field such as ACM STOC, IEEE FOCS, ICALP, and ACM-SIAM SODA and published them in leading journals such as SICOMP, JCSS, Algorithmica, and Information and Computation. The study of processor efficiency is critical for the practice of parallel computation but was a novelty in 1985 for the researchers in the Theory of Computing.

a) *Fast and processor efficient algorithms for matrix and polynomial computations.* In STOC 1985, jointly with Reif, I introduced fast and processor efficient parallel algorithms for the solution of dense and sparse linear systems of equations. The algorithm for sparse linear systems of equations has been implemented *on the supercomputers of NASA and Thinking Machines Corp.* By myself and jointly with coauthors I continued working on parallel matrix and polynomial computations for more than a decade. We proposed nontrivial novel techniques, extended the list of the known fast and processor efficient parallel algorithms, and improved the known complexity bounds for the following fundamental computational problems: (i) the solution of general and structured linear systems of equations with integer input (see my papers in TCS 1987, IPL 1989, and SICOMP 2000) and over abstract fields (see my paper in CAMWA 1992 and my joint papers with Dario A. Bini and Luca Gemignani in ICALP 1991 and with Erich Kaltofen in SPAA 1991 and FOCS 1992), (ii) the computation of polynomial greatest common divisors (GCDs), least common multiples, and Padé approximations (see my papers in CAMWA 1992 and TCS 1996), (iii) polynomial division (see my joint papers with Bini in J. of Complexity 1986, FOCS 1992, and SICOMP 1993), and (iv) the computation of the determinant, the characteristic polynomial, and the inverse of a matrix (see my joint papers with Zvi Galil in IPL 1989 and Xiohan Huang in J. of Complexity 1998). In 1985–86 part of my work on parallel algorithms was covered in the magazines Science, Science News, and Byte.

b) *Graph algorithms.* By myself and jointly with coauthors, I published a number of fast and processor efficient parallel algorithms for the computation of matching and paths in graphs. They relied on combining some novel techniques and nontrivial known reductions to matrix computations. I published these results in FOCS 1985 and Combinatorica 1988 jointly with Galil, in JCSS 1989, IPL 1991, and SICOMP 1993 jointly with Reif, in SICOMP 1995 jointly with Franco Preparata, in Algorithmica of 1997 jointly with Yijie Han and Reif, and in my own chapter in the Handbook on Computer Science of 1993.

c) In my joint works with David Shallcross and my student Yu Lin–Kriz, published in SODA 1992, FOCS 1993, and SICOMP 1998, I proved *NC-equivalence* of the integer GCD and planar integer linear programming problems, which was a well-known theoretical challenge.

12.7 Univariate polynomial root-finding (1985–2017). Nearly optimal solution of a four millennia old problem

Univariate polynomial root-finding has been central in mathematics and computational mathematics for four millennia. It was studied already on Sumerian clay tablets and Egyptian papyrus scrolls but also has modern applications to signal processing, financial mathematics, control theory, computational algebraic geometry, computer algebra and geometric modeling.

Hundreds of efficient algorithms have been proposed for its solution. Two-part book published with Elsevier, by John M. McNamee in 2007 (354 pages) and jointly by J.M. McNamee and myself in 2013 (728 pages), covers nearly all of them up to the date, in a *unique comprehensive coverage of this popular subject area.*

Since 1985 I have been doing research in that area and in the related areas of computation of approximate polynomial GCDs, matrix eigenvalues and eigenvectors, and the solution of a system of multivariate polynomial equations. Next I briefly outline some of my results. See further information in my papers cited below – in parts (a)–(g) – and the papers (individual and joint with my students) in FOCS 1985 and 1987, CAMWA 1985, 1987, 1995, 1996, 2011 (two papers), and 2012 (two papers, one of them joint with McNamee), SICOMP 1994, J. of Complexity 1996 and 2000 (four papers), JSC 1996, ISSAC 2010 and 2011, and SNC 2011 and 2014 (two papers).

a) In STOC 1995 (and also in CAMWA 1996, ISSAC 2001, and JSC 2002) I combined the advanced techniques by Schönhage and by Andy C. Neff and Reif with my novelties in exploiting the geometry of the complex plane, precision control by using Padé approximation, and recursive lifting and descending. As a result I have substantially accelerated the known algorithms. My divide-and-conquer algorithm of STOC 1995 approximates all roots of a univariate polynomial nearly as fast as one can access the input coefficients – in record and (up to a polylogarithmic factor) *optimal Boolean time.* I have surveyed my work up to the date in SIAM Review 1997 [P97] and more informally in American Scientist 1998 [P98]. I cover it in some detail in JSC 2002 [P02] and Chapter 15 of my book of 2013, joint with McNamee and already cited.

b) Hermann Weyl's Quad-tree construction of 1924 enables the solution of a univariate polynomial equation in roughly quartic arithmetic time. James Renegar decreased the time bound to cubic in 1987, and I reached quadratic arithmetic time bound in J. of Complexity 2000. Most of the computations of my algorithm require low precision, which suggested that the extension of this work can yield *nearly optimal Boolean time.* This involved substantial technical challenges, eventually simplified in the process of studying the so called subdivision root-finders for real and complex root-finding; in the complex case they were precisely the Quad-tree construction. In [BSSXY16] and [BSSY18] Ruben Becker, Michael Sagraloff, Vikram Sharma, and Chee Yap obtained nearly optimal complex subdivision root-finder. Their work boosted interest to that direction because the approach promises to be highly efficient in practice. Our paper [IPY18] has presented the first implementation of this algorithm. In my papers in CASC 2019 (two papers), CASC 2020 (two papers), ISSAC 2020 (joint with Imbach), and in arXiv preprint 1805.12042, I presented a novel version of subdivision root-finder, which is significantly faster than [BSSXY16] and [BSSY18]. This acceleration becomes dramatic in the case where an input polynomial is given by a black box for its evaluation, which includes highly important classes of sparse polynomials, polynomials in Bernstein basis, and ones given by recurrence (such as Mandelbrot's polynomials) or in compressed form, such as $c_1(x-a)^d + c_2(x-b)^d$.

c) *Approximation of the real roots* of a polynomial is an important goal because in many applications, for example, to algebraic optimization, only r real roots are of interest and because frequently they are much less numerous than all n complex roots. In my joint papers with my students in SNC 2007, CAMWA 2011, CASC 2012 and 2014, and TCS 2017 I accelerated the known algorithms for this problem by a factor of n/r.

d) My algorithm in ISSAC 2013 and JCS 2016 (joint with Elias P. Tsigaridas) is nearly optimal for a more narrow goal of real *polynomial root-refining* rather than root-finding. Likewise my algorithm (also joint with him) in SNC 2014 and TCS 2017 refines all complex roots at a nearly optimal Boolean complexity bound.

e) Together with Bini in J. of Complexity 1996, with Bini and Gemignani in CAMWA 2004, ETNA 2004, and Numerische Mathematik 2005, with McNamee in CAMWA 2012, by myself in CAMWA 2005, and jointly with my present and former students in ISSAC 2010, CAMWA 2011, LAA 2011, CASC 2012, SNC 2014, TCS 2017, and a chapter in the SNC volume of 2007, published by Birkhäuser, I proposed *novel matrix methods for polynomial root-finding.* Unlike many previous companion matrix methods, we preserve and exploit the structure of the associated companion and generalized companion matrices and yield numerically stable solution, while keeping the arithmetic cost at a low level.

I further extended these algorithms to the solution of the eigenproblem for a general matrix in SODA 2005 and CAMWA 2006 and 2008.

f) Jointly with Bini, I proposed and elaborated upon an algorithm that *approximates all eigenvalues of a real symmetric tridiagonal matrix by using nearly optimal Boolean time.* This is a popular and important problem of matrix computations. We proposed the first algorithm of this kind, presented in some detail in SODA 1991 and then in Computing 1992 and SICOMP 1998.

g) Computation of *approximate polynomial GCDs* has important applications to control and signal processing. My papers in SODA 1998 and Information and Computation of 2001 yielded a new insight into this computational problem by exploiting its links to polynomial root-finding, matching in a graph, and Padé approximation.

h) Both divide and conquer and Quad-tree (subdivision) root-finders involve isolation of some sets of polynomial roots from each other. In particular the isolation of roots lying in a fixed disc on the complex plane from the other roots implies quadratic (rather than linear) convergence of Newton's iterations right from the start. The computational cost of achieveing isolation can be considerable, however, and the paper [PT13] proposed to decrease it by means of *testing isolation by action*, that is, by means of applying Newton's iterations and then verifying isolation by monitoring the behavior of the iterations. This recipe was later adopted in [BSSY18]. In divide and conquer algorithm of [P95] one has to increase the isolation of the roots in the unit disc $D(0,1) = \{x: \ |x| \le 1\}$ or in the annuli $\{x: \ 1/q \le x| \le q\}$ for a fixed $q > 1$ and achieves this by means of repeated squaring of the roots. This process is not costly but recursively increases the approximation errors. [P95] counters such a deficiency by combining the recursive *lifting process* of repeated squaring with *recursive descending.*

12.8 A system of multivariate polynomial equations (1996-2005). Best Paper Award

My joint papers with Bernard Mourrain in Calcolo 1996, STOC 1998 and J. of Complexity *(Best Paper Award for 2000)*, with Didier Bondifalat and Mourrain in ISSAC 1998 and LAA 2000, with Mourrain and Olivier Ruatta in SICOMP 2003, and with Ioannis Z. Emiris in ISSAC 1997, JSC 2002, CASC 2003, and J. of Complexity 2005 introduced and analyzed a number of novel and now popular techniques and algorithms for the approximation of the roots of dense and sparse *systems of multivariate polynomials.* The algorithms exploits the structure of the associated matrices.

12.9 Matrix structures: unification and benefits (1987–2017)

This area is highly important for both theory and practice of computing. It was studied already in the 19th century and with increased intensity in the recent decades because of important applications to a variety of areas of modern computing, including the hot subject of handling Big Data.

My contributions can be traced back to 1987 and include the results in the following directions, besides the applications to polynomial root-finding, already cited.

a) *Unification of structured matrix computations by using their displacement representation and the transformation of matrix structures.* The four most popular matrix structures of Toeplitz, Hankel, Vandermonde, and Cauchy types have different features, which allow different computational benefits. In particular, the Cauchy matrix structure, unlike the three other ones, is invariant in both row and column interchange and allows approximation by rank structured matrices, which can be very efficiently handled by means of the Fast Multipole Method – one of the Top 10 Algorithms of the 20th century [C00].

The matrices of all four classes share, however, an important feature: they can be represented in compressed form through their displacements of low rank. Every matrix M can be expressed via its displacements $AM-MB$ and $M-AMB$ under mild restriction on operator matrices A and B, and for each of the four classes of structured matrices and a proper pair of operator matrices of shift and/or diagonal scaling, the displacement has small rank and therefore can be represented with fewer parameters, typically with $O(n)$ parameters for an $n \times n$ structured matrix, having n^2 entries. By properly exploiting this representation and using advanced techniques, one can dramatically decrease the amount of computer memory and time required in computations with such matrices.

The approach was proposed in [KKM79] by Thomas Kailath, Sun-Yuan Kung, and Martin Morf, who demonstrated its power by multiplying by a vector an $n \times n$ Toeplitz-like matrix (having structure of Toeplitz type) by using $O(n)$ memory cells and $Q(n \log n)$ flops (floating point arithmetic operations). The MBA divide-and-conquer algorithm of 1980 by Morf and by Robert R. Bitmead and Brian D. O. Anderson has extended this KKM 1979 progress to the inversion of Toeplitz-like matrices and the solution of Toeplitz-like linear system of equations, and the natural challenge was the extension of these algorithms of 1979 and 1980 to the computations with important classes of matrices having structures of the three other types.

I contributed to further progress with my two books – of 1994 (with Bini) and 2001 – and dozens of papers by myself and joint with coauthors.

In ISSAC 1989 and MC 1990, I unified fast computations with the four listed matrix classes in a rather unexpected way. Namely, I observed that one can transform matrix structure at will by transforming the associated operator matrices, and moreover can do this just by multiplying a given structured matrix by Hankel and Vandermonde matrices and their transposes. By applying such transformations of matrix structures one can *extend any successful algorithm for the inversion of the structured matrices of any of the four classes to the inversion of the matrices of the three other classes, and similarly for solving linear systems of equations.*

Moreover one can always use the simple reversion matrix as a Hankel multiplier and frequently can use the matrix of the discrete Fourier transform or its Hermitian transpose as a Vandermonde multiplier. In some cases such transformations enable dramatic improvement of the known algorithms.

For example, in 1989 cubic time was required for the inversion of Cauchy-like matrices and for the Nevanlinna–Pick fundamental problem of rational approximation, closely linked to this task. *My transformations immediately decreased the known cubic upper bounds on the time-complexity of these highly important computational problems to nearly linear.*

Unlike the multiplication algorithm of [KKM79], the MBA inversion algorithm is numerically unstable, however, and this limits applications of the latter recipe. Later, however, *my approach has become basic for a stream of highly efficient practical numerical algorithms* for Toeplitz linear systems of equations: the algorithms begin computations with the converse reduction to the Cauchy-like case and then exploit either the invariance of Cauchy structure in row and column interchange (cf. [GKO95]) or the link of this structure to the *rank structure* of matrices and consequently to the Fast Multipole Method (cf. [CGS07], [MRT05], [XXG12]). In view of such a link one is challenged to extend my approach to the unification of computations with matrices having displacement and rank structures, which could be highly important for both theory and practice of matrix computations. Recent progress towards meeting this unification challenge was reported in [BT17].

In 2013–2017 I extended my method to Vandermonde and Cauchy matrix-by-vector multiplication, the solution of Vandermonde and Cauchy linear systems of equations, and polynomial and rational interpolation and multipoint evaluation. For all these classical problems, the known numerical algorithms, running with bounded precision (for example, the IEEE standard double precision), required quadratic arithmetic time, and I decreased it to nearly linear (see my papers in CASC 2013, LAA 2015 and MC 2017).

For another application of my techniques, in [P16] I formally supported empirical observation of many researchers (which *remained with no proof for decades*) that a Vandermonde matrix is ill-conditioned (that is, close to singular) unless it is close (up to scaling) to the matrix of discrete Fourier transform, whose knots are nearly equally spaced on or near the unit circle centered in the origin.

b) For *alternative and more direct unification* of computations with structured matrices of the four classes, one can express them in terms of operations with the displacements. The MBA algorithm of 1980 does this for Toeplitz-like matrices. I extend it to Cauchy-like matrices first jointly with my student Ai-Long Zheng in LAA 2000 (submitted in 1996) and then jointly with Vadim Olshevsky in FOCS 1998. In SODA 2000 and in chapter 5 of my book of 2001 I extended the MBA algorithm in a unified way for computations with various structured matrices.

c) *Efficient algorithms for structured matrices and links to polynomial and rational computations.* In SIAM Review 1992 [P92], CAMWA 1992, 1993 (jointly with my students), TCS 1996, and Annals of Numerical Mathematics 1997 (by myself), and ICALP 1999, jointly with Olshevsky, I presented new efficient algorithms for various fundamental computations with structured matrices such as computing their ranks, characteristic and minimum polynomials, bases for their null spaces, and the solutions of structured linear systems of equations. Furthermore I have also extended successful methods for computations with structured matrices to some fundamental computations with polynomials and rational functions. Conversely, in SNC 2014 and TCS 2017, jointly with Tsigaridas, I deduced nearly optimal estimates for the Boolean complexity of some fundamental computations with Vandermonde and Cauchy matrices by reducing these computations to the ones for polynomials and modifying the known fast algorithms for the latter problems.

12.10 Newton's iterations for general and structured matrix inversion

Newton's iterations reduce matrix inversion to matrix multiplications, which is attractive for parallel computations and for computations with structured matrices. My paper with Robert Schreiber in SISSC 1991 presents nontrivial initialization policies for these iterations and their variations that enhance performance. In Chapter 6 of my book of 2001 and in my paper with my students in MC 2006 I improved performance of the iterations by applying *homotopy continuation* techniques.

In the case of structured matrices the main challenge is the slow-down of the computations due to the recursive increase of the displacement rank of the approximations to the inverse computed in the iterative process. I recalled, however, that displacement rank of the inverse is shared with the input matrix, and so in J. of Complexity 1992, IEEE Transaction on Parellel and Distributed Systems 1993, and SIMAX 1993 I proposed and elaborated upon a remedy by means of *recursive re-compression*, that is, by recursively compressing displacements of the computed approximations (by means of truncation of their SVDs). My resulting *superfast solution algorithms* run in nearly linear arithmetic time and allow processor efficient parallel implementation and unification over various classes of structured matrices. I presented these results in Chapter 6 of my book of 2001, my paper of 2010 in Matrix Methods: Theory, Algorithms and Applications, and with coauthors in LAA 2002, TCS 2004, Numerical Algorithms 2004, and MC 2006.

12.11 Computation of the determinant of a matrix

This classical problem has important applications in modern computing, for example, to the computation of *convex hulls* and *resultants*, with further link to the solution of multivariate polynomial systems of equations.

a) In TCS 1987 (Appendix) and IPL 1988 I reduced the computation of the determinant of a matrix to the solution of linear systems of equations and then applied *p-adic lifting* to yield the solution efficiently. By extending this approach John Abbott, Manuel Bronstein and Thom Manders in ISSAC 1999, Wayne Eberly, Mark Giesbrecht and Gilles Villard in FOCS 2000, and myself jointly with Emiris in JSC 2003 obtained some of the most efficient known symbolic algorithms for the computation of the determinant of a matrix and the resultant of a polynomial system.

b) I published novel algorithms for computing determinants in TCS 1999, jointly with three coauthors from INRIA, France, and in Algorithmica of 2001, jointly with my student Yanqiang Yu. The algorithms perform computations with single or double IEEE standard precision, based on algebraic techniques (in the TCS paper) and on numerical techniques (in the Algorithmica paper), use small arithmetic time, and certify the output. The TCS paper has accelerated the computations by means of output sensitive and randomization methods, novel in this context.

12.12 Synergy of symbolic and numerical computations

Numerical and symbolic algorithms are the backbone of modern computations for Sciences, Engineering, and Signal and Image Processing, but historically these two subject areas have been developed quite independently of one another, while combination of symbolic and numerical techniques can be highly beneficial.

Since the early 1990s I have been promoting such benefits as an organizer of conferences, as a member of their Program Committees, and as the Managing Editor of four Special Issues of TCS on this subject in 2004, 2008, 2011 and 2013. Perhaps even stronger impact into this direction was from my books of 1994 (joint with Dario Bini), 2001 (by myself), and 2013 (joint with John M. McNamee) and from my surveys in SIAM Review 1992 and 1997, in NATO ASI Series published by Springer 1991, Academic Press 1992, and Kluwer 1998, in the electronic proceeding of IMACS/ACA 1998, and in my chapters (with co-authors) in four Handbooks of 1999, 2004, 2009, and 2014, as well as from dozens of my research papers. For example, the Special Issue of TCS on Symbolic-Numerical Algorithms in 2017 published my three joint papers – two with Tsigaridas and one with my student Liang Zhao – out of 13 papers of that Issue.

12.13 Randomized preprocessing (2007–2017). Addition of chaos stabilizes fundamental numerical matrix computations

Since 2007 I have been working on randomized pre-processing of matrix computations. I have contributed a new direction, new insight, and novel techniques to the popular area of randomized matrix computations. See my papers (some joint with my students) in SNC 2007 (two papers) and 2009, CSR 2008, 2010, and 2016, TCS 2008, CAMWA 2009, LAA of 2009, 2010 (two papers), 2011, 2012, 2013, 2015, and 2017 (two papers), ISSAC 2011, CASC 2015, and reports in arXiv: 1611.01391 and 1710.07946.

I have advanced the known numerical algorithms for both nonsingular and homogeneous singular linear systems of equations. In particular I proved that, with a probability near one, randomized multiplicative preprocessing numerically stabilizes Gaussian elimination with no pivoting (GENP) and block Gaussian elimination, and I obtained similar results for any nonsingular and well-conditioned (possibly sparse and structured) multiplicative preprocessor and for Gaussian random input. This should embolden the search for new efficient sparse and structured multipliers, and jointly with my students I proposed some new classes of them. Our extensive tests with real world inputs were in good accordance with our formal analysis. My work on this subject with my students appeared in TCS 2008, LAA 2012, LAA 2013, LAA 2015 and LAA 2017 (see [PZ17] and the references therein). GENP with randomized pre-processing should be practically valuable because pivoting (row/column interchange) is communication intensive and because Gaussian elimination is most used algorithm in matrix computations. Some implementation of GENP applied to an input preprocessed with ad hoc random multipliers appeared in a series of papers by Mark Baboulin et al. beginning in 2012. My study should help refine such implementations and provide formal support for this approach.

12.14 Superfast and accurate low rank approximation

By extending our techniques I obtained substantial progress for low rank approximation (hereafter referred to as *LRA*) of a matrix. This is a central problems of modern computing because of its highly important applications to numerical linear algebra, machine learning, neural networks, and Big Data mining and analysis. In CSR 2016 (jointly with my student Liang Zhao) I proposed a new insight into this subject, provided formal support for the empirical power of various known sparse and structured multipliers and defined some new classes of efficient multipliers.

Jointly with my students, I studied computation of LRA at *sublinear cost*, that is, by using much fewer flops and memory cells than the input matrix has entries. I call such algorithms *superfast*. They are indispensable in modern computations that access and handle matrices with billions entries, representing Big Data – too Big to access and handle otherwise.

It is easy to prove that any superfast algorithm fails to compute accurate LRA of the worst case input. We also proved, however, that with a high probability the well-known Cross-Approximation (C-A) iterations compute accurate LRAs superfast in the case of (i) a small-norm perturbation of a random matrix of low rank and (ii) any input matrix allowing LRA (that is, having low numerical rank) and pre-processed with a Gaussian random multiplier.

I began our LRA study by trying to prove the efficiency of C-A iterations, which has been consistently observed empirically, and indeed I have provided some missing formal support for this empirical phenomenon as well as for the efficiency of some known randomized algorithms for LRA, but I have simplified and accelerated these algorithms. Jointly with my present and former students I proposed another major class of recursive LRA algorithms based on random sketching and proved their convergence to LRA under some rather mild assumptions on the decay of singular values of an input matrix. I have also introduced new insight into this subject and novel techniques for LRA. I published some results of this work jointly with my present and former students in [LP20] and [PLSZ20] and in arXiv:1906.04929 (April 3 2021) and arXiv:1906.04327 (April 22 2021).

12.15 Concluding remarks

Throughout my career my work has advanced the state of the art of various fundamental subjects of Computational Mathematics and Computer Science such as computations with general and structured matrices, polynomials, integers and graphs, for example, polynomial evaluation, interpolation, division, factorization, and root-finding, solution of general and structured linear systems of equations, computation of linear recurrences, matching and paths in graphs, and the sign and the value of the determinant of a matrix.

While devising new efficient algorithms, I proposed novel techniques and new insights and revealed hidden links among various subject areas and computational problems, for example, (i) between the techniques of Symbolic and Numerical Computation, (ii) between the methods for low rank approximation (LRA) proposed and developed by researchers in Computer Science and Numerical Linear Algebra, (iii) between matrix multiplication and tensor decomposition, (iv) among matrices with various structures, and (v) between LRA and Fast Multiplole method (FMM). This list can be readily extended.

Most of my novelties have been immediately recognized, e.g., my results on polynomial evaluation in [P66], on fast and processor efficient parallel algorithms in [PR85] (joint with John H. Reif), and on nearly optimal polynomial root-finding in [P95], but each of my trilinear aggregation of 1972 and my transformation of matrix structures of 1989 waited for six years before they became widely known and appreciated. Likewise the value of my contribution of 2000 to the quadtree root-finding is only now becoming recognized, but even in such cases it was rewarding to witness the progress in the field resulted from my effort.

My long survey [P66] attracted attention of Volker Strassen, Shmuel Winograd, and other renowned researchers, who extended my work into a new field of *Algebraic Complexity of Computations.*[1] Their work in turn attracted me to this field again. For another striking example of *cross-fertilization*, my renewed interest to this field was prompted by the concise but far-fetching exposition in the book [BM75] by Allan Borodin and Ian Munro, which was the first book in Math in English that I have read after moving to the USA in 1977. In 1979 I learned from Borodin that his interest to the field was largely inspired by my paper [P66].

My paper with Willard L. Miranker [MP80] was pioneering for the field of the *Algebraic Multigrid*, now popular.

My survey in SIAM Review in 1992, my book with Dario Bini, published by Birkhäuser in 1994, and dozens of my subsequent research papers (individual and joint with Dario Bini and with my students) have demonstrated synergy in combining the techniques of *Symbolic and Numerical Computations.*

My book with Dario Bini (1994) is called *"Polynomial and Matrix Computations"* and includes a number of new research results by the authors. It covers its title subjects both thoroughly and comprehensively according to its reviews (see some excerpts below) and was frequently cited, as well as my three other books (also devoted to polynomial and matrix computations) and my surveys in SIAM Review on matrix multiplication (1984), polynomial and matrix computations (1992), and polynomial root-finding (1997). Google Scholar lists over 12,000 citations of my work overall.

Excerpts from *SIGACT News*, ACM Press, 26, 2, pages 26–27, June 1995, by Steve Tate: “We are now greeted with the release of a book covering the basic, foundational material of the algebraic algorithm field, written by the authors who are leading researchers in the field and are responsible for many of the current best algorithms...... For researchers in the field of algebraic algorithms, this is a “must-have" book, both as a reference and the review of basic material...... In conclusion, for researchers in the field of algebraic computing, I highly recommend this book as an essential addition to your bookshelf."

Excerpts from *SIGSAM Bulletin,* ACM Press, 30, 3, pages 21–23, September 1996, by Ioannis Emiris and Andre Galligo: “The book covers an impressive range of algorithmic issues in Theoretical Computer Science, Symbolic Computer Algebra and Numerical Computation, and the presence of several latest methods and results makes it exciting to read. It would be useful to a specialist in any of the above areas who wishes to undergo a rigorous study of polynomial or matrix operations for large problems using exact or approximate arithmetic...... The book is outstanding...... We would strongly recommend this book as a reference for graduate course in symbolic computation or computer algebra. It can also supplement the reading in a course on scientific computing, computer science theory or applied mathematics. In conclusion, the book by Bini and Pan is an excellent companion for researchers and advanced students. Given, moreover, that it is a handy reference book, it should be present in every good library."

12.16 Acronyms

"CACS" stands for "Proceedings of Conference on Applications of Computer Algebra"

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[1] The next and seminal paper [W67] in this subject area begins with: “Introduction.-In reference [1], V. Ya. Pan summarized the results about the minimum number of multiplications and additions required to compute a polynomial. In particular, Pan proved that the minimum number of multiplications/divisions required to compute $P_n(x)x = a_0 + a_1 x + \cdots + a_n x^n$ is n. The theorem of this note includes this result of Pan’s as a special case, and also shows that the minimum number of multiplications/divisions required to compute the product of an $n \times n$ matrix by a vector is $m \cdot n$."

"CAMWA" stands for "Computers and Mathematics (with Applications)"

"CSR" stands for "Proceedings of Computer Science in Russia"

"FOCS" stands for "Proceedings of IEEE Symposium on Foundations of Computer Science"

"ICALP" stands for "Proceedings of International Colloquium on Automata Languages and Programming"

"IPL" stands for "Information Processing Letters"

"ISSAC" stands for "Proceedings of ACM International Symposium on Symbolic and Algebraic Computation"

"JCSS" stands for "Journal of Computer and System Sciences"

"JSC" stands for "Journal of Symbolic Computation"

"LAA" stands for "Linear Algebra and Its Applications"

"LNCS" stands for "Lecture Notes in Computer Science"

"MC" stands for "Mathematics of Computation"

"SICOMP" stands for "SIAM Journal on Computing"

"SIMAX" stands for "SIAM Journal on Matrix Analysis and Applications"

"SNC" stands for "Symbolic-Numerical Computations" or "Proceedings of Workshop on Symbolic-Numerical Computations"

"SODA" stands for "Proceedings of ACM-SIAM Symposium on Discrete Algorithms"

"SPAA" stands for "Proceedings of ACM Symposium on Parallel Algorithms and Architecture"

"STOC" stands for "Proceedings of ACM Symposium on Theory of Computing"

"TCS" stands for "Theoretical Computer Science"

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