

Daniel J. Bates

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Education

Ph.D. in mathematics, University of Notre Dame, South Bend, IN, May 2006.

Thesis adviser: Andrew Sommese.

Thesis title: Theory and applications in numerical algebraic geometry.

M.S. in mathematics, University of Notre Dame, South Bend, IN, May 2003.

B.A. *summa cum laude* in mathematics (minor in computer science), The College of Wooster, Wooster, OH, May 2001.

Areas of Interest

Numerical and computational algebraic geometry

Scientific computing

Numerical analysis

Optimal control theory

Related Work Experience

Assistant Professor of Mathematics, Colorado State University, Fall 2008 – present.

Postdoctoral Associate, Institute for Mathematics & its Applications (IMA), University of Minnesota, Fall 2006 – Summer 2008.

Visiting Scholar, University of Notre Dame, Summer 2006 - present.

Research Assistant to Duncan Chair of Mathematics, University of Notre Dame, Spring 2003 - Spring 2004.

Publications

Appeared or accepted (chronological order)

- (1) E. Allgower, D. Bates, A. Sommese, and C. Wampler. Solution of polynomial systems derived from differential equations. *Computing*, 76(1-2): 1–10, 2006.
- (2) D. Bates, C. Peterson, and A. Sommese. A numerical-symbolic algorithm for computing the multiplicity of a component of an algebraic set. *J. Complexity*, 22(4):475–489, 2006.
- (3) Y. Lu, D. Bates, A. Sommese, and C. Wampler. Finding all real points of a complex curve. *Algebra, geometry, and their interactions*, 183–205, Contemp. Math. 448, Amer. Math. Soc., Providence, RI, 2007.
- (4) D. Bates, J. Hauenstein, A. Sommese, and C. Wampler. Adaptive multiprecision path tracking. *SIAM J. Numer. Anal.* 46(2):722–746, 2008.
- (5) D. Bates, C. Peterson, and A. Sommese. Applications of Numerical Terracini’s Lemma. *Algorithms in algebraic geometry*, 1–14, IMA Vol. Math. Appl. 146, Springer, New York, 2008.

- (6) D. Bates, J. Hauenstein, A. Sommese, and C. Wampler. Software for numerical algebraic geometry: a paradigm and progress towards its implementation. *Software for algebraic geometry*, 1–14, IMA Vol. Math. Appl. 148, Springer, New York, 2008.
- (7) D. Bates, I. Fotiou, and P. Rostalski. A numerical algebraic geometry approach to non-linear constrained optimal control. Proceedings of the 2007 IEEE CDC (Conference on Decision and Control).
- (8) D. Bates, F. Bihan, and F. Sottile. Bounds on the number of real solutions to polynomial equations. *Int. Math. Res. Not. IMRN* 2007(23), Art. ID rnm114.
- (9) D. Bates, A. Beccuti, I. Fotiou, and M. Morari. An optimal control application in power electronics using numerical algebraic geometry. Proceedings of the 2008 ACC (American Control Conference).
- (10) D. Bates, J. Hauenstein, A. Sommese, and C. Wampler. Stepsize control for adaptive multiprecision path tracking. To appear in *Contemporary Mathematics*.
- (11) D. Bates, J. Hauenstein, C. Peterson, and A. Sommese. Numerical decomposition of the rank-deficiency set of a polynomial matrix. To appear in *Approximate Commutative Algebra* in the series *Texts and Monographs in Symbolic Computation*.
- (12) D. Bates, J. Hauenstein, C. Peterson, and A. Sommese. A local dimension test for numerically approximated points on algebraic sets. To appear in *SIAM J. Numer. Anal.*

Submitted (chronological order)

- (13) D. Bates, C. Peterson, A. Sommese, and C. Wampler. Computing the genus of a curve numerically. *Submitted*.
- (14) P. Rostalski, I. Fotiou, D. Bates, A. Beccuti, and M. Morari. Numerical algebraic geometry for optimal control applications. *Submitted*.
- (15) D. Bates and F. Sottile. Khovanskii-Rolle continuation for real solutions. *Submitted*.
- (16) D. Bates, J. Hauenstein, and A. Sommese. Efficient endgames and path tracking methods. *Submitted*.

Grants

- NSF-DMS-0914674 (Computational Mathematics): “Reality, exactness, and computation in numerical algebraic geometry” (PI), \$159,601, 7/30/09–08/1/11.
- NSF-DMS-0756904. “Interactions of classical and numerical algebraic geometry” (PI), \$22,530, 3/15/07–3/15/08.

Software Developed

- *Bertini: Software for Numerical Algebraic Geometry*, with J. Hauenstein, A. Sommese, and C. Wampler. Available at <http://www.nd.edu/~sommese/bertini>.
- *KhRo: Khovanskii-Rolle continuation*, with F. Sottile. Available at <http://www.math.tamu.edu/~sottile>.
- Proprietary software for Goodyear (2001) and United Titanium, Inc. (1999).

Presentations

- *Recovering exact results from numerical computation in algebraic geometry*, Joint Math Meetings, San Francisco, coming January 2010 (invited).
- *Khovanskii-Rolle continuation for real solutions of polynomial systems*, AMS Sectional Meeting, Baylor University, coming October 2009 (invited).
- *A numerical shortcut for symbolic computation in algebraic geometry*, North Carolina State University Symbolic Computation Seminar, September 2009 (invited).

- *Exact ideals from numerical data*, International Conference on Applications of Computer Algebra, ETS (Montreal), June 2009 (invited).
- *Numerical determination of the local dimension of a solution of a polynomial system*, International Conference on Applications of Computer Algebra, ETS (Montreal), June 2009 (invited).
- *Exactness in numerical algebraic computations*, MSRI Workshop on Algebraic Statistics, MSRI, December 2008 (invited).
- *Recovering exactness from numerical algebraic computations*, Colloquium, University of Notre Dame Center for Applied Mathematics, November 2008 (invited).
- *Numerical algebraic geometry in optimal control*, AMS Sectional Meeting, University of British Columbia, October 2008 (invited).
- *An optimal control application in power electronics using numerical algebraic geometry*, ACC (American Control Conference) 2008, Seattle, June 2008 (contributed).
- *Gale duality for bounding and locating real solutions of polynomial equations*, Enumeration and bounds in real algebraic geometry, EPFL (Lausanne, Switzerland), April 2008 (invited).
- *Bounding and finding the real solutions of fewnomial systems*, Colloquium, University of Notre Dame Center for Applied Mathematics, March 2008 (invited).
- *A new method of real root-finding using Gale duality*, AMS Sectional Meeting, DePaul University, October 2007 (invited).
- *Numerical algebraic geometry in control theory*, International Conference on Applications of Computer Algebra, Oakland University, July 2007 (invited).
- *Introduction to Bertini: a software package for numerical algebraic geometry*, IMA Workshop on Software for Algebraic Geometry, October 2006 (invited).
- *The numerical computation of the multiplicity of a component of an algebraic set*, IMA Workshop on Algorithms in Algebraic Geometry, September 2006 (invited).
- *Using Bertini*, AMS Sectional Meeting, University of Notre Dame, March 2006 (invited).
- *Berini: A new software package for computations in numerical algebraic geometry*, Workshop on Approximate Commutative Algebra during the Special Semester on Gröbner Bases, Johannes Kepler Institute (Linz, Austria), February 2006 (invited).
- *Adaptive precision in homotopy continuation*, Joint Mathematics Meetings, San Antonio, January 2006 (invited).
- *Symbolic representation of polynomial systems for efficient manipulation and evaluation*, International Conference on Applications of Computer Algebra, Nara Women's University (Nara, Japan), August 2005 (invited).
- *Solving boundary value problems with homotopy continuation*, Midwest Numerical Analysis Conference, University of Iowa, May 2005 (contributed).
- *Advantages of parsing polynomials into straight-line programs*, AMS Sectional Meeting, Northwestern University, October 2004 (invited).
- Various seminars at Notre Dame and Colorado State.

Conferences and Sessions Organized

- Applications of algebraic geometry, the inaugural conference of the SIAM Activity Group on Algebraic Geometry (with F. Sottile and S. Sullivant), North Carolina State University, coming in October 2011.
- Special session on *Computational algebra and convexity* (with T. Lee, S. Petrovic, and Z. Teitler), 2009 Joint Math Meetings, Washington, D. C., January 2009.
- Interactions of classical and numerical algebraic geometry (with G. Besana, S. Di Rocco, and C. Wampler), University of Notre Dame, May 2008.

Journal Volumes Edited

- *Iterations of classical and numerical algebraic geometry*, D. Bates, G. Besana, S. Di Rocco, and C. Wampler, eds., Contemp. Math. vol. 396, 2009.

Refereeing History

Refereed for journals *Advances in Geometry*, *IEEE Transactions on Automatic Control*, *IMA Volumes on Mathematics and its Applications*, *Journal of Computational and Applied Mathematics*, *Numerical Algorithms*, *Shock and Vibration*. Reviewed for *Mathematical Reviews*. Also refereed for *IEEE/ASME Conference on Advanced Intelligent Mechatronics*, *IEEE Conference on Decision and Control*.

Graduate Students

- Co-advisor of Tim McCoy (with C. Peterson), Colorado State University, M.S., expected Summer 2009.
- Committee member for Dan Brake (M.S., Math, CSU), Matthew Vogel (M.S., Physics, CSU), Ellen Ziliak (prelim, Math, CSU).

Teaching Experiences

Advisor (with E. Chong), Colorado State University CIMS Summer Fellowship, Summer 2009.

Running a two student/two faculty member study group on a project combining numerical algebraic geometry with optimal control. Matt Niemerg funded by the CIMS summer fellowship, Eric Miles funded as my personal GRA.

Independent study advisor, Colorado State University, Spring 2009.

Eric Miles (algebraic geometry).

Instructor, Colorado State University, Fall 2008–present.

Two version of linear algebra (229, 369), topics graduate course titled “Computational Algebraic Geometry” (designed from scratch), Algorithms in Maple lab course, undergraduate Complex Analysis.

REU Assistant (Summer 2006), Instructor (business calculus – Summer 2003, Special Admissions calculus – Fall 2004), Teaching Assistant (Calculus II – Fall 2002), University of Notre Dame.

Honors and Awards in Mathematics

Project NExT Fellow, 2008–2009 (red '08 dot).

Arthur J. Schmitt Foundation Fellowship, Fall 2001–Summer 2004, Fall 2005–Spring 2006.

Center for Applied Mathematics Fellowship, University of Notre Dame, Spring 2005.

Service

Organizer, Department of Mathematics Math Day, Colorado State University, Fall 2009.

Co-Organizer, ISTeC High School Day (Math Room), Colorado State University, 2008–2009.

Member, Graduate Student Union Council, University of Notre Dame, Fall 2002–Spring 2005.

Member, University Parking Appeals Board, University of Notre Dame, Fall 2002–Spring 2005.

Member, University *ad hoc* Parking Committee, University of Notre Dame, Fall 2002–Spring 2005.

Member, Department Graduate Recruiting Committee, University of Notre Dame, Spring 2005.

Judge, Northern Indiana Regional Science Fair, Spring 2003 and Spring 2004.

Memberships

American Mathematical Society (AMS).

Mathematical Association of America (MAA).

Society for Industrial and Applied Mathematics (SIAM).

Phi Beta Kappa.