

# 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 algebraic geometry (numerical methods for solving polynomial systems)

Scientific computing

Numerical analysis

Optimization, particularly optimal control

## Related Work Experience

Associate Professor of Mathematics, Colorado State University, Fall 2014 – present

Assistant Professor of Mathematics, Colorado State University, Fall 2008 – Spring 2014.

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.

## Editorial Board Membership

*SIAM Journal on Applied Algebra and Geometry (SIAGA)*, Associate Editor, 2016–2018.

## Publications

- (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, 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).
- (5) 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.
- (6) D. Bates, J. Hauenstein, A. Sommese, and C. Wampler. Adaptive multiprecision path tracking. *SIAM J. Numer. Anal.* 46(2):722–746, 2008.
- (7) D. Bates, C. Peterson, and A. Sommese. Applications of a numerical version of Terracini’s lemma for secants and joins. *Algorithms in algebraic geometry*, 1–14, IMA Vol. Math. Appl. 146, Springer, New York, 2008.
- (8) 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.
- (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. Step-size control for path tracking. *Contemporary Mathematics* 496:21–31, 2009.
- (11) D. Bates, J. Hauenstein, C. Peterson, and A. Sommese. A numerical local dimension test for points on the solution set of a system of polynomial equations. *SIAM J. Numer. Anal.* 47:3608–3623, 2009.
- (12) D. Bates, J. Hauenstein, C. Peterson, and A. Sommese. Numerical decomposition of the rank-deficiency set of a matrix of multivariate polynomials. In *Approximate Commutative Algebra* in the series *Texts and Monographs in Symbolic Computation*, 2010.
- (13) D. Brake, D. Bates, V. Putkaradze, and T. Maciejewski. Illustration of numerical algebraic methods for workspace estimation of cooperating robots after joint failure. *Proc. of the IASTED Robotics and Applications (RA) 2010 conference*.
- (14) P. Rostalski, I. Fotiou, D. Bates, A. Beccuti, and M. Morari. Numerical algebraic geometry for optimal control applications. *SIAM J. on Optimization* 21(2):417–437, 2011.
- (15) D. Bates, C. Peterson, A. Sommese, and C. Wampler. Numerical computation of the genus of an irreducible curve within an algebraic set. *J. Pure and Applied Algebra* 215(8):1844–1851, 2011.
- (16) D. Bates and F. Sottile. Khovanskii-Rolle continuation for real solutions. *Foundations of Computational Mathematics* 11(5):563–587, 2011.
- (17) D. Bates, J. Hauenstein, and A. Sommese. Efficient path tracking methods. *Numerical Algorithms* 58(4):451–459, 2011.
- (18) D. Bates, J. Hauenstein, and A. Sommese. A parallel endgame. *Contemporary Mathematics* 556:25–35, 2011.
- (19) D. Bates and L. Oeding. Toward a salmon conjecture. *Experimental Mathematics* 20(3):358–370, 2011.
- (20) D. Bates, J. Hauenstein, T. McCoy, C. Peterson, and A. Sommese. Recovering exact results from inexact numerical data in algebraic geometry. *Experimental Mathematics* 22(1):38–50, 2013.
- (21) D. Bates, D. Eklund, and C. Peterson. Computing intersection numbers of Chern classes. *Journal of Symbolic Computation* 50:493–507, 2013.

- (22) D. Bates, W. Decker, J. Hauenstein, C. Peterson, G. Pfister, F. Schreyer, A. Sommese, and C. Wampler. Comparison of probabilistic algorithms for analyzing the components of an affine algebraic variety. *Applied Mathematics and Computation* 231:619–633, 2014.
- (23) D. Bates and M. Niemerg. Using monodromy to avoid high precision. *Mathematics in Computer Science* 8(2):253–262, 2014.
- (24) D. Bates, B. Davis, D. Eklund, E. Hanson, and C. Peterson. Perturbed homotopies for finding all isolated solutions of polynomial systems. *Applied Mathematics and Computation* 247:301–311, 2014.
- (25) D. Brake, D. Bates, W. Hao, J. Hauenstein, A. Sommese, and C. Wampler. Bertini\_real: Software for One- and Two-Dimensional Real Algebraic Sets. Proceedings of ICMS 2014: *Lecture Notes in Computer Science* 8592:175–182, 2014.
- (26) D. Bates, D. Brake, J. Hauenstein, A. Sommese, and C. Wampler. On Computing a Cell Decomposition of a Real Surface Containing Infinitely Many Singularities. Proceedings of ICMS 2014: *Lecture Notes in Computer Science* 8592:246–252, 2014.
- (27) D. Bates, B. Davis, M. Kirby, J. Marks, and C. Peterson. The max-length-vector line of best fit to a set of vector subspaces and an optimization problem over a set of hyperellipsoids. *Numerical Linear Algebra with Applications* 22(3):453–464, 2015.
- (28) D. Bates, A. Newell, and M. Niemerg. Decoupling highly structured polynomial systems. *Journal of Symbolic Computation* 79(3):508–515, 2017 (online, 2016).
- (29) D. Bates, A. Newell, and M. Niemerg. BertiniLab: A MATLAB interface for solving systems of polynomial equations. *Numerical Algorithms* 71(1):229–244, 2016.
- (30) D. Brake, D. Bates, V. Putkaradze, and T. Maciejewski. Workspace multiplicity and fault tolerance of cooperating robots. *Lecture Notes in Computer Science*, special issue for MACIS 2015, 109–123, 2016.
- (31) D. Bates, J. Hauenstein, M. Niemerg, and F. Sottile. Software for the Gale transform of fewnomial systems and a Descartes rule for fewnomials. *Numerical Algorithms* 73(1): 281–304, 2016.
- (32) E. Gross, B. Davis, K. Ho, D. Bates, and H. Harrington. Numerical algebraic geometry for model selection and its application to the life sciences. *Journal of the Royal Society Interface* 13:20160256, 2016.

#### Under review

- (32) D. Bates, E. Gross, A. Leykin, and J. Rodriguez. Bertini.m2: A Bertini interface to Macaulay2.
- (33) D. Bates, D. Brake, and M. Niemerg. Paramotopy: Parameter homotopies in parallel.
- (34) D. Bates, D. Brake, J. Hauenstein, A. Sommese, and C. Wampler, Homotopies for connected components of algebraic sets with application to computing critical sets.

#### Books/Volumes

- (36) D. Bates, G. Besana, S. Di Rocco, and C. Wampler. *Interactions of Classical and Numerical Algebraic Geometry*. Volume 496 of *Contemporary Mathematics*.
- (37) D. Bates, J. Hauenstein, A. Sommese, and C. Wampler. *Numerically Solving Polynomial Systems with the Software Package Bertini*, SIAM, 2013.

### Grants

- Total awarded: \$1,816,707 (CSU portion: \$983,489).
- Additional pending: approx. \$1,300,000 (CSU portion: \$549,915).

#### Pending

- NSF proposal (Computational Math): “FRG: Collaborative Research: Transforming Numerical Algebraic Geometry,” approx. \$1,000,000 requested (CSU portion: \$252,858, co-PI).
- NSF proposal (Computational Math): “Autmoated, secure homotopy continuation and parameter spaces exploration,” \$297,057 requested (sole PI).

#### Active

- NSF-ACI-1440467 (Advanced Cyberinfrastructure): “SI2-SSE: Collaborative Proposal: Symbolic-Numeric Approaches to Polynomials,” \$499,188 (CSU portion: \$149,346), 2014–2017 (co-PI).

#### Previous

- NSF-DMS-1115668 (Computational Mathematics): “Preconditioning, analysis, and applications of numerical algebraic geometry methods,” \$306,969, 2011–2014 (sole PI).
- NSF grant: “Tutorials on applicable algebraic geometry,” \$15,520, 2013 (sole PI).
- NSA grant to help support conference “SIAM AG13,” \$17,000, 2013 (sole PI).
- IMA grant to help support conference “SIAM AG13,” \$4,000, 2012–2013 (sole PI).
- NSF-DMS-1025564 (Collaborations in Mathematical Geophysics): “CMG Collaborative Research: Magnetic viscosity and thermoremanent magnetization in interacting single-domain ferromagnets,” \$380,316 (CSU portion: \$145,350), 2010–2013 (sole PI).
- Air Force grant FA8650-13-1-7317: “Real NAG: Finding all real solutions of a polynomial system,” \$394,583 (CSU portion: \$185,703), 2012–2013 (sole PI).
- IMA grant to help support conference “SIAM AG11,” \$4,000, 2010–2011 (co-PI, NC State award).
- NSA grant to help support conference “SIAM AG11,” \$13,000, 2010–2011 (co-PI, NC State award).
- NSF-DMS-0914674 (Computational Mathematics): “Reality, exactness, and computation in numerical algebraic geometry” (PI), \$159,601, 2009–2011 (sole PI).
- NSF-DMS-0756904. “Interactions of classical and numerical algebraic geometry” (sole PI), \$22,530, 3/15/07–3/15/08 (while at U. Minnesota).

### Software Developed

- *Bertini: Software for Numerical Algebraic Geometry*, with J. Hauenstein, A. Sommese, and C. Wampler. Available at <http://www.nd.edu/~sommese/bertini>.
- *BertiniLab*, with A. Newell and M. Niemerg. Available at <http://www.mathworks.com/matlabcentral/fileexchange/48536-bertinilab>.
- *KhRo: Khovanskii-Rolle continuation*, with F. Sottile. Available at <http://www.math.tamu.edu/~sottile>.
- *Paramotopy*, with D. Brake and M. Niemerg. Available at <http://www.paramotopy.com>.
- *BertiniReal*, with D. Brake, W. Hao, J. Hauenstein, A. Sommese, and C. Wampler. Available at <http://www.bertinireal.com>.
- Contributing to *NumericalAlgebraicGeometry*, by A. Leykin and others, a module of Macaulay2.
- Proprietary software for Goodyear (2001) and United Titanium, Inc. (1999).

### Extended Research Visits

Institut Mittag-Leffler, Djursholm, Sweden, January–March 2011.

MBI (Mathematical Biosciences Institute), Columbus, OH, July–December 2014.

### Presentations and Workshop Participation

- TBD, FoCM '17 (Foundations of Computational Mathematics), Barcelona, Spain, July 2017 (invited).
- TBD, SLAM '17 (Southwest Local Algebra Meeting), Albuquerque, March 2017 (invited plenary speaker).

#### Previous

- Tuning of tolerances in polynomial homotopy continuation, Joint Math Meetings, Atlanta, January 2017 (invited).
- Connecting to scientists and engineers, workshop on numerical algebraic geometry, Atlanta, January 2017 (invited discussion leader).
- Finding exceptional sets with fiber products, AMS Fall western sectional special session, Denver, October 2016 (invited, canceled due to family emergency).
- Numerical methods for exploring parameter spaces, SIAM AN16 minisymposium, Boston, July 2016 (invited).
- Numerical algebraic geometry boot camp, Workshop on software and applications of numerical algebraic geometry, Notre Dame, May 2016 (invited plenary speaker).
- Choosing a good path for homotopy continuation, AMS Spring Western sectional special session, Salt Lake City, April 2016 (invited).
- Numerical methods for investigating parameter spaces for parameterized polynomial systems, Symbolic-numeric computation seminar, CUNY, New York, March 2016 (invited).
- *Bertini 2.0 and BertiniLab: Software for Solving Polynomial Systems Numerically*, Workshop on Hybrid Methodologies for Symbolic-Numeric Computation (at ICIAM), Beijing, China, August 2015 (invited).
- *Numerical techniques for studying parameter spaces*, SIAM AG15, Daejeon, Korea, August 2015 (invited).
- *Solving polynomial systems, with applications in biology*, Visitors' Seminar, Mathematical Biosciences Institute, December 2014 (self-invited).
- *Robots in space, ill-gotten Norwegian stamps, and an Austrian castle: The benefits of solving polynomial systems*, Mathematics Colloquium, Kenyon College, November 2014 (invited).
- *How to solve a polynomial system (and why you might care to do so)*, Mathematics Colloquium, The College of Wooster, October 2014 (invited).
- *Paramotopy: Software for parameter homotopies*, International Congress of Mathematical Software, Seoul, August 2014 (invited).
- *Tutorials on numerical algebraic geometry*, M2 workshop, Champaign-Urbana, IL, June 2014 (invited).
- *Finding all real solutions of a polynomial system in complex curves and surfaces*, AMS Western Sectional, Lubbock, TX, April 2014 (invited).
- *Linkage disequilibrium between independently assorting loci, via numerical algebraic geometry*, JMM 2014, Baltimore, MD, January 2014 (invited).
- *Decoupling for highly structured polynomial systems*, SIAM AG13, Fort Collins, CO, August 2013 (invited).
- *Numerical algebraic geometry for biochemical reaction networks*, Harvard Medical School Systems Biology seminar, Harvard, MA, August 2013 (invited).

- *Searching for exceptional mechanisms via fiber products*, AMS Sectional Meeting, Boulder, CO, March 2013 (invited).
- *Numerical algebraic geometry for biochemical reaction networks*, AIM workshop on biochemical reaction networks, AIM, Palo Alto, CA, March 2013 (invited).
- *Finding exceptional mechanisms via fiber products*, Algebraic Geometry seminar, Texas A&M University, March 2012 (invited).
- *Numerical algebraic geometry*, Mathematics Summit, Lake Tahoe, NV, February 2012 (invited).
- *Numerical methods for solving polynomial systems*, University of Colorado–Denver Computational Math Colloquium, December 2011 (invited).
- *Basic notions of numerical algebraic geometry*, SIAM Conference on Applications of Algebraic Geometry 2011 (AG11), Raleigh, NC, October 2011.
- Participated in IMA workshop on Macaulay2, IMA, Minneapolis, MN, July 2011 (invited).
- *Khovanskii-Rolle continuation for finding real solutions of polynomial systems*, Foundations of Computational Mathematics 2011, Budapest, July 2011 (invited).
- *Numerical algebraic geometry: algorithms and applications*, University of Wyoming Math Colloquium, April 2011 (invited).
- *Receding horizon control via numerical algebraic geometry*, Linköpings universitet Automatic Control Seminar, Linköping, Sweden, March 2011 (invited).
- *Adaptive precision and lattice basis reduction in numerical algebraic geometry*, ÉNS Lyon Computer Science Laboratory seminar, Lyon, France, March 2011 (invited).
- *Introduction to numerical algebraic geometry*, with J. Hauenstein, KTH algebraic geometry course, Stockholm, Sweden, February 2011 (invited).
- *Current work and open problems in numerical algebraic geometry*, Institut Mittag-Leffler seminar, Djursholm, Sweden, January 2011 (invited).
- *Numerical consequences of symbolic choices in Gale Duality*, SIAM/MSRI workshop on Hybrid Methodologies for Symbolic-Numeric Computation, MSRI, November 2010 (invited).
- *Khovanskii-Rolle continuation for finding real solutions of polynomial systems* and Bertini demo, Banff workshop on Randomization, Relaxation, and Complexity, March 2010 (invited).
- *Recovering exact results from numerical computation in algebraic geometry*, Joint Math Meetings, San Francisco, January 2010 (invited).
- *Khovanskii-Rolle continuation for real solutions of polynomial systems*, AMS Sectional Meeting, Baylor University, 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, Sessions, and Seminars Organized**

- Co-organizer of ICERM Special Semester on *Nonlinear Algebra*, Providence, Fall 2018.
- Local organizing committee member for *3rd Annual Meeting of SIAM Central States Section*, Fort Collins, Fall 2017.
- Poster chair for *ISSAC 2017*, Kaiserslautern, Germany, July 2017.
- Workshop on *Numerical algebraic geometry*, Fort Collins, October 2016.
- Minisymposium on *Applications of algebraic geometry*, SIAM AN16, Boston, July 2016.
- Special session on *Software for numerical solving polynomial systems*, ICMS 2016, Berlin, July 2016.
- Program committee member for *PASCO (Parallel Symbolic Computation) 2015*, Bath, UK, July 2015.
- Special session on *Numerical algebraic geometry*, MAA Rocky Mountain Sectional, Colorado College, April 2015.
- Program committee member for *MCURCSM (Midstates Conference for Undergraduate Research in Computer Science and Mathematics) 2014*, The College of Wooster, November 2014.
- Co-organizer of *MBI Visitors' Seminar*, Mathematical Biosciences Institute, Ohio State University, Fall 2014.
- Local committee chair for *SIAM AG13: SIAM Conference on applications of algebraic geometry*, Colorado State University, August 2013.

- Minisymposium on *Numerical methods for solving polynomial systems*, SIAM 2012 Annual Meeting, Minneapolis, July 2012.
- Minisymposium on *Applications of numerical algebraic geometry* (with A. Leykin), SIAM AG11, North Carolina State University, October 2011.
- Program committee co-chair for *SIAM AG11: SIAM Conference on applications of algebraic geometry* (with F. Sottile), the inaugural conference of the SIAM Activity Group on Algebraic Geometry, North Carolina State University, October 2011.
- Program committee member for *SNC 11: Symbolic-Numeric Computation 2011*, San Jose, CA, July 2011.
- Minisymposium on *Kinematics and numerical algebraic geometry* (with C. Wampler), 2010 SIAM Annual Meeting, Pittsburgh, July 2010.
- 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), conference, University of Notre Dame, May 2008.

### Refereeing History

– Refereed for journals *ACM Transactions on Mathematical Software*, *Advances in Geometry*, *Arnold Mathematical Journal*, *BIT Numerical Mathematics*, *Experimental Mathematics*, *IEEE Transactions on Automatic Control*, *IMA Volumes on Mathematics and its Applications*, *Indian Journal of Pure and Applied Mathematics*, *Journal of Algebra*, *Journal of Algebra and its Applications*, *Journal of Computational and Applied Mathematics*, *Journal of Symbolic Computation*, *Mathematics of Computation*, *Numerical Algorithms*, *Shock and Vibration*, *SIAM Review*, *Theoretical Computer Science*.

– Also refereed for conferences *EuroSciPy*, *IEEE/ASME Conference on Advanced Intelligent Mechatronics*, *IEEE Conference on Decision and Control*, *ISSAC*, *MCURCSM*, *MACIS*.

– *Ad hoc* reviewer or panelist for various NSF programs, NSA programs, programs of the Netherlands Organisation for Scientific Research, and Canadian NSERC proposals.

– Reviewed for *Mathematical Reviews*.

### Graduate and undergraduate students

#### **Current students**

- Co-advisor of Brent Davis (with C. Peterson), Colorado State University, Ph.D., expected Spring 2017.
- Advisor of Tim Hodges, Colorado State University, Ph.D., expected Spring 2017.
- Co-advisor of Jesse Drendel (with P. Shipman), Colorado State University, Ph.D., expected Spring 2018.
- Advisor of Karleigh Cameron, Colorado State University, Ph.D., expected Spring 2019.

#### **Postdoc supervision**

- Supervised Dan Brake, 1/2013–12/2013. Now a postdoc at Notre Dame.
- Co-supervised David Eklund (with C. Peterson), 1/2012–12/2012. Now with Prover Technologies, Stockholm, Sweden.
- Co-supervised Dung Nguyen (with R. Cavalieri), 10/2011–6/2012. Now with Microsoft, Seattle, WA.

#### **Former students**



- Graduate: **Eric Hanson** (CSU PhD 2015, now with Texas Christian University (TCU)), **Steve Ihde** (CSU PhD 2015, now with State of Colorado), **Matt Niemerg** (CSU PhD 2014, postdoc at Berkeley, Tsingua, Fields Institute, now an IBM HPC postdoc), **Tim McCoy** (with C. Peterson, CSU MS 2009, now at SK hynix memory systems).
- Undergraduate: Nate Zbacnik (research, 2013–2014), Theresa Alanis (honors thesis, 2012), Amanda Zeringue (research, 2010–2011).

### **Committee membership, for students**

Committee member for Neda Adib (M.S., ECE), Robert Arn (Ph.D., Math), Jatin Bhikadiya (MS, CS), Dan Brake (M.S./Ph.D., Math/ECE), Nanda Chandrasekar (M.S., ECE), Sofya Chepush-tanovna (Ph.D., Math), Wimroy D’Souza (M.S., ECE), Noah Daleo (PhD, Math at NC State), Silvia Dinica (PhD, Math), Justin Hughes (M.S./Ph.D., Math), Yajing Liu (Ph.D., ECE), Tim Marrinan (Ph.D., Math), Justin Marks (Ph.D., Math), Sahil Mehta (M.S., ECE), Cory Previte (Ph.D., Math), Elin Smith (Ph.D. Math), Joel Steenis (Ph.D., ECE), Kyle Tarplee (M.S., ECE), Matthew Vogel (M.S., Physics).

### **Teaching Experiences**

Calculus 3 coordinator, Colorado State University, Fall 2015–present.

In charge of coordinating several sections per semester, typically around 350–450 students, worked closely with team of graduate student GTAs, wrote all exams, handled most administrative issues for students, supported the development (by a GTA) of a set of course notes.

Instructor, Colorado State University, Fall 2008–present.

graduate topics course titled “Computational Algebraic Geometry” (designed from scratch),  
graduate topics course titled “Numerical Algebraic Geometry” (designed from scratch),  
graduate Linear Algebra (qualifying exam course), graduate Complex Analysis (qualifying exam course),  
graduate Nonlinear Optimization, undergraduate Complex Analysis, undergraduate Abstract Algebra,  
undergraduate Real Analysis, Linear Algebra, Calculus III, Algorithms in Maple lab course,  
Numerical Analysis.

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

Ran 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.

Instructor, University of Minnesota, Fall 2007.

Re-developed and taught a math methods course for pre-service middle school teachers.

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**

CSU Department of Mathematics Outstanding Professor in Graduate Instruction, 2013.

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

Arthur J. Schmitt Foundation Fellow, University of Notre Dame, F. '01–Su. '04, F. '05–Sp. '06.

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

### Service

Member, SIAM Committee on Programs, 2015–present.  
 Member, Math Department Executive Committee, 2013–2014, 2015–2016, 2016–2017.  
 Member, AMS MCA Travel Grants Committee, 2016–2017.  
 Chair, Calculus Center Special Faculty search committee, 2015–2016.  
 Co-Organizer, NoCo Math Oval (weekend outreach for grades 8-12), 2012–2015.  
 Chair, Online M.S. in Math Ed. Committee, 2015.  
 Member, ISTeC Educational Activities Committee, 2012–2014.  
 Co-Organizer, ISTeC High School Day (Math Room), Colorado State University, 2008–2012.  
 Member, CSU Math ASC Search Committee, 2012–2013.  
 Member, AMS *Ad Hoc* Committee on Student Chapters, 2011–2012.  
 Member, AMS Committee on Committees, 2011–2012.  
 Member, CSU Math ACM Search Committee, 2011–2012.  
 Member, CSU Math Goals Committee, 2010.  
 Program Director, SIAM Activity Group on Algebraic Geometry, 2009–2011.  
 Member, AMS Working Group on the Nominee Program, 2009–2010.  
 Organizer, Department of Mathematics Math Day, Colorado State University, 2009 and 2010.  
 Chair, Math M519 syllabus committee, 2009–2010.  
 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).  
 Society for Industrial and Applied Mathematics (SIAM).  
 Association for Computing Machinery (ACM).  
*Phi Beta Kappa*.