Jonathan D. Hauenstein

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Positions

Associate Professor (with tenure), University of Notre Dame, Notre Dame, IN, Fall 2016 – current.
Associate Professor (without tenure), University of Notre Dame, Notre Dame, IN, Fall 2015 – Spring 2016.
Assistant Professor, Fall 2014 – Summer 2015.
Department of Applied and Computational Mathematics and Statistics

Visiting Scientist, Simons Institute for the Theory of Computing, Berkeley, CA, Fall 2014.
Program on *Algorithms and Complexity in Algebraic Geometry*

Assistant Professor, North Carolina State University, Raleigh, NC, Fall 2012 – Summer 2014.
Department of Mathematics

Postdoctoral Fellow, Institut Mittag–Leffler, Djursholm, Sweden, January 2011 – June 2011.
Scientific Program on *Algebraic Geometry with a view towards applications*

Visiting Assistant Professor, Texas A&M University, College Station, TX, January 2010 – August 2012.
On leave January 2011 – June 2011.
Mentor: Frank Sottile

Fields Postdoctoral Fellow, Fields Institute, Toronto, Ontario, Canada, July 2009 – December 2009.
Thematic Program on the *Foundations of Computational Mathematics*

Visiting Scholar, University of Notre Dame, Notre Dame, IN, July 2009 – June 2014.
Department of Applied and Computational Mathematics and Statistics

Postdoctoral Research Associate, University of Notre Dame, Notre Dame, IN, May 2009 – June 2009.

Education

Ph.D. in Mathematics, University of Notre Dame, Notre Dame, IN, May 2009.
Thesis adviser: Andrew J. Sommese
Thesis title: *Regeneration, local dimension, and applications in numerical algebraic geometry*

M.S. in Mathematics, Miami University, Oxford, OH, August 2005.

B.S. *summa cum laude* in Mathematics and Math–Pre-Engineering Emphasis (Computer Science minor), University of Findlay, Findlay, OH, May 2003.

Research Grants

Oak Ridge Associated Universities: *Polynomials, Kinematics, and Robotics*, 2017, $4,000 (single PI).

Institute for Mathematics and its Applications: *Polynomials, Kinematics, and Robotics*, 2017, $1,000 (PI with co-PIs D. Brake and A. Sommese).

National Science Foundation DMS 1636087: *Quivers and Bipartite Graphs: Physics and Mathematics*, 2016–2017, $16,000 (co-PI with PI Michael Gekhtman).

Office of Naval Research Young Investigator Award: *Harnessing the Complex Numbers for Efficiently Solving Real Problems*, 2016–2019, $509,918 (single PI).

Institute for Mathematics and its Applications: *Workshop on Software and Applications of Numerical Algebraic Geometry*, 2016, $1,500 (PI with co-PIs D. Brake, A. Sommese, and C. Wampler).

National Science Foundation DMS 1547743: *Workshop on Software and Applications of Numerical Algebraic Geometry*, 2015–2017, $19,020 (PI with co-PIs D. Brake, A. Sommese, and C. Wampler).

Army Research Office Young Investigator Program (YIP) Award: *The Geometry of Multiscale Models:*

Identifiability, Reparameterization, Comparisons, and Parameter Space Exploration, 2015–2018, $181,715 (single PI).

National Science Foundation ACI 1440583 & ACI 1460032: *Symbolic-Numeric Approaches to Polynomials*, 2014–2017, $149,995 (single PI on this award – part of a collaborative project: $499,188).

Sloan Research Fellowship, 2014–2018, $50,000 (single PI).

DARPA Young Faculty Award (YFA): *Numerical Algebraic Geometric Methods for Data Analysis*, 2013 – 2015, $492,613 (single PI).

NCSU Faculty Research and Professional Development Fund: *Numerical Algebraic Geometry and Matrix Multiplication*, 2013 – 2014, $4,000 (single PI).

Air Force Office of Scientific Research FA8650-13-1-7317: *Real Numerical Algebraic Geometry: Finding all Real Solutions of a Polynomial System*, 2012 – 2013, $394,583 (co-PI with PI Daniel Bates and co-PI Andrew Sommese). NCSU subcontract: $103,192.

National Science Foundation DMS 1114336 & DMS 1262428: *Computational Methods in Numerical Algebraic Geometry*, 2011 – 2014, $94,000 (single PI).

Publications

Books

(1) D.J. Bates, J.D. Hauenstein, A.J. Sommese, and C.W. Wampler. *Numerically Solving Polynomial Systems with Bertini*. Volume 25 of *Software, Environments, and Tools*, SIAM, Philadelphia, 2013.

Published Articles

(2) D.J. Bates, J.D. Hauenstein, A.J. Sommese, and C.W. Wampler. Adaptive multiprecision path tracking. *SIAM J. Numer. Anal.*, 46(2), 722–746, 2008.

(3) D.J. Bates, J.D. Hauenstein, A.J. Sommese, and C.W. Wampler. Software for numerical algebraic geometry: a paradigm and progress towards its implementation. *Software for Algebraic Geometry*, edited by M.E. Stillman, N. Takayama, and J. Verschelde, Volume 148 of *IMA Volume in Mathematics and its Applications*, Springer Verlag, 2008, pp. 1–14.

(4) A.N. Al-Khateeb, J.M. Powers, S. Paolucci, A.J. Sommese, J.A. Diller, J.D. Hauenstein, and J.D. Mengers. One-dimensional slow invariant manifolds for spatially homogeneous reactive systems. *J. Chem. Phys.*, 131(2), 024118, 2009.

(5) D.J. Bates, J.D. Hauenstein, A.J. Sommese, and C.W. Wampler. Stepsize control for adaptive multiprecision path tracking. *Contemp. Math.*, 496, 21–31, 2009.

(6) J.D. Hauenstein, J.C. Migliore, C. Peterson, and A.J. Sommese. Numerical computation of the dimensions of the cohomology of twists of ideal sheaves. *Contemp. Math.*, 496, 235–242, 2009.

(7) D.J. Bates, J.D. Hauenstein, C. Peterson, and A.J. Sommese. A numerical local dimension test for points on the solution set of a system of polynomial equations. *SIAM J. Numer. Anal.*, 47(5), 3608–3623, 2009.

(8) D.J. Bates, J.D. Hauenstein, C. Peterson, and A.J. Sommese. Numerical decomposition of the rank-deficiency set of a matrix of multivariate polynomials. *Approximate Commutative Algebra*, edited by L. Robbiano and J. Abbott, *Texts and Monographs in Symbolic Computation*, Springer Verlag, 2010, pp. 55–77.

(9) J.D. Hauenstein. A counter example to an ideal membership. *Adv. Geom.*, 10(3), 557–559, 2010.

(10) J.D. Hauenstein and A.J. Sommese. Witness sets of projections. *Appl. Math. Comput.*, 217(7), 3349–3354, 2010.

(11) J.D. Hauenstein, A.J. Sommese, and C.W. Wampler. Regeneration homotopies for solving systems of polynomials. *Math. Comp.*, 80, 345–377, 2011.

(12) W. Hao, J.D. Hauenstein, B. Hu, Y. Liu, A.J. Sommese, and Y.-T. Zhang. Multiple stable steady states of a reaction-diffusion model on zebrafish dorsal-ventral patterning. *Discrete Cont. Dyn. S.*, 4(6), 1413–1428, 2011.

(13)C.W. Wampler, J.D. Hauenstein, and A.J. Sommese. Mechanism mobility and a local dimension test. *Mech. Mach. Theory*, 46(9), 1193–1206, 2011.

(14)J.D. Hauenstein, A.J. Sommese, and C.W. Wampler. Regenerative cascade homotopies for solving polynomial systems. *Appl. Math. Comput.*, 218(4), 1240–1246, 2011.

(15)W. Hao, J.D. Hauenstein, B. Hu, and A.J. Sommese. A three-dimensional steady-state tumor system. *Appl. Math. Comput.*, 218(6), 2661–2669, 2011.

(16)D.J. Bates, J.D. Hauenstein, and A.J. Sommese. A parallel endgame. *Contemp. Math.*, 556, 25–35, 2011.

(17)D.J. Bates, J.D. Hauenstein, and A.J. Sommese. Efficient path tracking methods. *Num. Algorithms*, 58(4), 451–459, 2011.

(18)W. Hao, J.D. Hauenstein, B. Hu, Y. Liu, A.J. Sommese, and Y.-T. Zhang. Bifurcation for a free boundary problem modeling the growth of a tumor with a necrotic core. *Nonlinear Anal. – Real World Appl.*, 13(2), 694–709, 2012.

(19)H. Tari, H.-J. Su, and J.D. Hauenstein. Classification and complete solution of the kinetostatics of a compliant Stewart-Gough platform. *Mech. Mach. Theory*, 49, 177–186, 2012.

(20)J.D. Hauenstein and F. Sottile. Algorithm 921: alphaCertified: Certifying solutions to polynomial systems. *ACM Trans. Math. Softw.*, 38(4), 28, 2012.

(21)W. Hao, J.D. Hauenstein, B. Hu, Y. Liu, A.J. Sommese, and Y.-T. Zhang. Continuation along bifurcation branches for a tumor model with a necrotic core. *J. Sci. Comput.*, 53(2), 395–413, 2012.

(22)D. Mehta, J.D. Hauenstein, and M. Kastner. Energy landscape analysis of the two-dimensional nearest-neighbor ϕ^4 model. *Phys. Rev. E*, 85, 061103, 2012.

(23)D. Mehta, Y.-H. He, and J.D. Hauenstein. Numerical algebraic geometry: a new perspective on string and gauge theories. *J. High Energy Phys.*, 2012(7), 18, 2012.

(24)G. Blekherman, J.D. Hauenstein, J.C. Ottem, K. Ranestand, and B. Sturmfels. Algebraic boundaries of Hilbert's SOS cones. *Compos. Math.*, 148(6), 1717–1735, 2012.

(25)W. Hao, J.D. Hauenstein, B. Hu, T. McCoy, and A.J. Sommese. Computing steady-state solutions for a free boundary problem modeling tumor growth by Stokes equation. *J. Comput. Appl. Math.*, 237(1), 326–334, 2013.

(26)J.D. Hauenstein and C.W. Wampler. Numerically intersecting algebraic varieties via witness sets. *Appl. Math. Comput.*, 219(10), 5730–5742, 2013.

(27)G.M Besana, S. DiRocco, J.D. Hauenstein, A.J. Sommese, and C.W. Wampler. Cell decomposition of almost smooth real algebraic surfaces. *Num. Algorithms*, 63(4), 645–678, 2013.

(28)J.D. Hauenstein. Numerically computing real points on algebraic sets. *Acta Appl. Math.*, 125(1), 105–119, 2013.

(29)J.D. Hauenstein and A.J. Sommese. Membership tests for images of algebraic sets by linear projections. *Appl. Math. Comput.*, 219(12), 6809–6818, 2013.

(30)D.J. Bates, J.D. Hauenstein, T.M. McCoy, C. Peterson, and A.J. Sommese. Recovering exact results from inexact numerical data in algebraic geometry. *Exp. Math.*, 22(1), 38–50, 2013.

(31)J.D. Hauenstein and C.W. Wampler. Isosingular sets and deflation. *Found. Comput. Math.*, 13(3), 371–403, 2013.

(32)D. Mehta, J.D. Hauenstein, and D.J. Wales. Certifying the potential energy landscape. *J. Chem. Phys.*, 138(17), 171101, 2013.

(33)W. Hao, J.D. Hauenstein, C.-W. Shu, A.J. Sommese, Z. Xu, and Y.-T. Zhang. A homotopy method based on WENO schemes for solving steady state problems of hyperbolic conservation laws. *J. Comput. Phys.*, 250, 332–346, 2013.

(34)J.D. Hauenstein, Y.-H. He, and D. Mehta. Numerical elimination and moduli space of vacua. *J. High Energy Phys.*, 2013(9), 83, 2013.

(35)J.D. Hauenstein, C. Ikenmeyer, and J.M. Landsberg. Equations for lower bounds on border rank. *Exp. Math.*, 22(4), 372–383, 2013.

(36)W. Hao, J.D. Hauenstein, B. Hu, and A.J. Sommese. A bootstrapping approach for computing multiple solutions of differential equations. *J. Comput. Appl. Math.*, 258, 181–190, 2014.

(37)D.J. Bates, W. Decker, J.D. Hauenstein, C. Peterson, G. Pfister, F.-O. Schreyer, A.J. Sommese, and C.W. Wampler. Comparison of probabilistic algorithms for analyzing the components of an affine algebraic variety. *Appl. Math. Comput.*, 231, 619–633, 2014.

(38)Z.A. Griffin, J.D. Hauenstein, C. Peterson, and A.J. Sommese. Numerical computation of the Hilbert function of a zero-scheme. *Connections Between Algebra, Combinatorics, and Geometry* (S.M. Cooper and S. Sather-Wagstaff, eds.), *Springer Proceedings in Mathematics & Statistics*, vol. 76, Springer New York, 235–250, 2014.

(39)J.D. Hauenstein and F. Sottile. Newton polytopes and witness sets. *Math. Comp. Sci.*, 8(2), 235–251, 2014.

(40)D. Mehta, J.D. Hauenstein, and D.J. Wales. Certification and the potential energy landscape. *J. Chem. Phys.*, 140, 224114, 2014.

(41)J.D. Hauenstein, I. Haywood, and A.C. Liddell, Jr. An *a posteriori* certification algorithm for Newton homotopies. In *Proceedings of the 39th International Symposium on Symbolic and Algebraic Computation*, ACM, New York, 2014, pp. 248–255.

(42)J.D. Hauenstein, J. Rodriguez, and B. Sturmfels. Maximum likelihood for matrices with rank constraints. *J. Alg. Stat.*, 5(1), 18–38, 2014.

(43)J.D. Hauenstein, V. Pan, and A. Szanto. A Note on Global Newton Iteration over Archimedian and non-Archimedian fields. *LNCS*, 8660, 202–217, 2014.

(44)D. Mehta, N.S. Daleo, J.D. Hauenstein, and C. Seaton. Gauge-fixing on the lattice via orbifolding. *Phys. Rev. D*, 90, 054504, 2014.

(45)D. Mehta, T. Chen, J.D. Hauenstein, and D.J. Wales. Newton homotopies for sampling stationary points of potential energy landscapes. *J. Chem. Phys.*, 141, 121104, 2014.

(46)D. Mehta, J.D. Hauenstein, M. Niemerg, N.J. Simm, and D.A. Stariolo. Energy landscape of the finite-size mean-field 2-spin spherical model and topology trivialization. *Phys. Rev. E*, 91, 022133, 2015.

(47)J.D. Hauenstein, R. Huang, D. Mehta, and Y. Zhang. Global structure of curves from generalized unitarity cut of three-loop diagrams. *J. High Energy Phys.*, 2015(2), 136, 2015.

(48)Z.A. Griffin and J.D. Hauenstein. Real solutions to systems of polynomial equations and parameter continuation. *Adv. Geom.*, 15(2), 173–187, 2015.

(49)J.D. Hauenstein, A. Lerario, E. Lundberg, and D. Mehta. Experiments on the zeros of harmonic polynomials using certified counting. *Exp. Math.*, 24(2), 133–141, 2015.

(50)D. Mehta, N.S. Daleo, F. Dörfler, and J.D. Hauenstein. Algebraic geometrization of the Kuramoto model: equilibria and stability analysis. *Chaos*, 25, 053103, 2015.

(51)J.D. Hauenstein, B. Mourrain, and A. Szanto. Certifying isolated singular points and their multiplicity structure. In *Proceedings of the* 40^{th} *International Symposium on Symbolic and Algebraic Computation*, ACM, New York, 2015, pp. 213–220.

(52)J.D. Hauenstein and A.C. Liddell, Jr. A hybrid symbolic-numeric approach to exceptional sets of generically zero-dimensional systems. In *Proceedings of the 2015 International Workshop on Parallel Symbolic Computation*, ACM, New York, 2015, pp. 53–60.

(53)N.S. Daleo and J.D. Hauenstein. Numerically deciding the arithmetically Cohen-Macaulayness of a projective scheme. *J. Symb. Comput.*, 72, 128–146, 2016.

(54)J.D. Hauenstein and A.C. Liddell, Jr. Certified predictor-corrector tracking for Newton homotopies. *J. Symb. Comput.*, 74, 239–254, 2016.

(55)N.S. Daleo, J.D. Hauenstein, and L. Oeding. Computations and equations for Segre-Grassmann

hypersurfaces. *Port. Math.*, 73(1), 71–90, 2016.

(56)D.A. Brake, J.D. Hauenstein, A.P. Murray, D.H. Myszka, and C.W. Wampler. The complete solution of Alt-Burmester synthesis problems for four-bar linkages. *J. Mechanisms Robotics*, 8(4), 041018, 2016.

(57)F. Gesmundo, J.D. Hauenstein, C. Ikenmeyer, and J.M. Landsberg. Complexity of linear circuits and geometry. *Found. Comp. Math.*, 16(3), 599–635, 2016.

(58)D.A. Brake, J.D. Hauenstein, and A.C. Liddell, Jr. Validating the completeness of the real solution set of a system of polynomial equations. In *Proceedings of the ACM on International Symposium on Symbolic and Algebraic Computation*, ACM, New York, 2016, pp. 143–150.

(59)J.D. Hauenstein, N. Hein, and F. Sottile. A primal-dual formulation for certifiable computations in Schubert calculus. *Found. Comp. Math.*, 16(4), 941–963, 2016.

(60)D.J. Bates, J.D. Hauenstein, M.E. Niemerg, and F. Sottile. Software for the Gale transform of fewnomial systems and a Descartes rule for fewnomials. *Num. Algorithms*, 73(1), 281–304, 2016.

(61)H. Sidky, A.C. Liddell, Jr., D. Mehta, J.D. Hauenstein, and J. Whitmer. An algebraic geometric method for calculating phase equilibria from fundamental equations of state. *Ind. Eng. Chem. Res.* 55(43), 11363–11370, 2016.

(62)J.D. Hauenstein and C.W. Wampler. Unification and extension of intersection algorithms in numerical algebraic geometry. *Appl. Math. Comput.*, 293, 226–243, 2017.

(63)J.D. Hauenstein and A.J. Sommese. What is numerical algebraic geometry? *J. Symb. Comput.*, 79(3), 499–507, 2017

(64)J.D. Hauenstein and V. Levandovskyy. Certifying solutions to square systems of polynomial-exponential equations. *J. Symb. Comput.*, 79(3), 575–593, 2017.

(65)J.D. Hauenstein, C.W. Wampler, and M. Pfurner. Synthesis of three-revolute spatial chains for body guidance. *Mech. Mach. Theory*, 110, 61–72, 2017.

(66)A. Mahdi, C. Pessoa, and J.D. Hauenstein. A symbolic-numerical approach to the center-focus problem. *J. Symb. Comput*, 82, 57–73, 2017.

(67)J.D. Hauenstein, B. Mourrain, and A. Szanto. On deflation and multiplicity structure. *J. Symb. Comput.*, 83, 228–253, 2017.

(68)D.A. Brake, D.J. Bates, W. Hao, J.D. Hauenstein, A.J. Sommese, and C.W. Wampler. Algorithm 976: Bertini_real: Numerical decomposition of real algebraic curves and surfaces. *ACM Trans. Math. Softw.*, 44(1), 10, 2017.

Accepted Articles

(69)J.D. Hauenstein, L. Oeding, G. Ottaviani, and A.J. Sommese. Homotopy techniques for tensor decomposition and perfect identifiability. To appear in *J. Reine Angew. Math.*

(70)T.A. Akoglu, J.D. Hauenstein, and A. Szanto. Certifying solutions to overdetermined and singular polynomial systems over $\mathbb{Q}$. To appear in *J. Symb. Comput.*

(71)J.D. Hauenstein, J.I. Rodriguez, and F. Sottile. Numerical computation of Galois groups. To appear in *Found. Comput. Math.*

Submitted Articles

(72)J.D. Hauenstein. Algebraic computations using Macaulay dual spaces.

(73)J.D. Hauenstein. Certification of Newton-invariant subspaces.

(74)D.J. Bates, D.A. Brake, J.D. Hauenstein, A.J. Sommese, and C.W. Wampler. Homotopies for connected components of algebraic sets with application to computing critical sets.

(75)J. Cleveland, J. Dzugan, J.D. Hauenstein, I. Haywood, D. Mehta, A. Morse, L. Robol, and T. Schlenk. Certified counting of roots of random univariate polynomials.

(76)J.D. Hauenstein and J.I. Rodriguez. Numerical irreducible decomposition of multiprojective varieties.

(77)D.K. Molzahn, M. Niemerg, D. Mehta, and J.D. Hauenstein. Investigating the maximum number of real solutions to the power flow equations: analysis of loseless four-bus systems.

(78)D.A. Brake, J.D. Hauenstein, and C. Vinzant. Computing complex and real tropical curves using monodromy.

(79)A. Bernardi, N.S. Daleo, J.D. Hauenstein, and B. Mourrain. Tensor decomposition and homotopy continuation.

(80)H.A. Harrington, D. Mehta, H.M. Byrne, and J.D. Hauenstein. Decomposing the parameter space of biological networks via a numerical discriminant approach.

(81)J.D. Hauenstein, S.N. Sherman, and C.W. Wampler. Exceptional Stewart-Gough platforms, Segre embeddings, and the special Euclidean group.

(82)O. Coss, J.D. Hauenstein, H. Hong, and D.K. Molzahn. Locating and counting equilibria of the Kuramoto model with rank one coupling.

(83)L. Chiantini, J.D. Hauenstein, C. Ikenmeyer, G. Ottaviani, and J.M. Landsberg. Polynomials and the exponent of matrix multiplication.

Extended Abstracts

(84)J.D. Hauenstein, N. Hein, C.J. Hillar, A. Martin Del Campo, F. Sottile, and Z. Teitler. The monotone secant conjecture in the real Schubert calculus. Accepted to MEGA2011 and presented by A. Martin Del Campo.

(85)J.D. Hauenstein, N. Hein, and F. Sottile. Certifiable numerical computations in Schubert calculus. Accepted to MEGA2013 and presented by N. Hein.

(86)D.A. Brake, D.J. Bates, W. Hao, J.D. Hauenstein, A.J. Sommese, and C.W. Wampler. Bertini_real: software for one- and two-dimensional real algebraic sets. *LNCS*, 8592, 175–182, 2014. Accepted to ICMS 2014 and presented by D. Brake.

(87)D.J. Bates, D.A. Brake, J.D. Hauenstein, A.J. Sommese, and C.W. Wampler. On computing a cell decomposition of a real surface containing infinitely many singularities. *LNCS*, 8592, 246–252, 2014. Accepted to ICMS 2014 and presented by J. Hauenstein.

(88)N.S. Daleo and J.D. Hauenstein. Numerically testing generically reduced projective schemes for the arithmetic Gorenstein property. *LNCS*, 9582, 137–142, 2016. Accepted to MACIS 2015 and presented by J. Hauenstein.

(89)D.A. Brake, J.D. Hauenstein, and A.J. Sommese. Numerical local irreducible decomposition. *LNCS*, 9582, 124–129, 2016. Accepted to MACIS 2015 and presented by D. Brake.

(90)D.A. Brake, J.D. Hauenstein, and A.C. Liddell, Jr. Decomposing solution sets of polynomial systems using derivatives. *LNCS*, 9725, 127–135, 2016. Accepted to ICMS 2016 and presented by J. Hauenstein.

Other Articles

(91)J.D. Hauenstein and J.M. McCarthy. Biologically-inspired linkage design: computing form from function. *SIAM News*, 48(8), 2015.

Software

(1) D.J. Bates, J.D. Hauenstein, A.J. Sommese, and C.W. Wampler. Bertini: Software for numerical algebraic geometry. Available at `bertini.nd.edu`.

(2) J.D. Hauenstein and F. Sottile. alphaCertified: Software for certifying numerical solutions to polynomial equations. Available at `math.tamu.edu/~sottile/research/stories/alphaCertified`.

Advising

Christopher Lembo, Undergraduate Student, University of Notre Dame, June 2017 – current.

Michael Semanek, Undergraduate Student, University of Notre Dame, August 2016 – current.

Patrick Tinsley, Undergraduate Student, University of Notre Dame, August 2016 – May 2017.

Mentored by Daniel Brake.

Samantha Sherman, Graduate Student, University of Notre Dame, August 2016 – current.
Supported by Schmitt Leadership Fellowship in Science and Engineering.

Yi Zhang, Postdoctoral Associate, University of Notre Dame, August 2016 – July 2017.
Supported by Office of Naval Research Young Investigator Award.

Hythem Sidky, Graduate Student, University of Notre Dame, August 2016 – May 2017.
Supported by NSF Graduate Research Fellowship.
PhD advisor: Jonathan Whitmer, Department of Chemical and Biomolecular Engineering.

Margaret Regan, Graduate Student, University of Notre Dame, April 2016 – current.
Supported by Schmitt Leadership Fellowship in Science and Engineering and NSF ACI 1460032.

Elizabeth Sudkamp, Undergraduate Research, University of Notre Dame, August 2015 – December 2016.
Supported by Sloan Research Fellowship and mentored by Daniel Brake.

Pierce Cunneen, Undergraduate Research, University of Notre Dame, July 2015 – December 2015.
Supported by Sloan Research Fellowship and mentored by Daniel Brake.

Michael Padala, Undergraduate Research, University of Notre Dame, February 2015 – May 2015.
Supported by Sloan Research Fellowship and mentored by Daniel Brake.

Jose Rodriguez, NSF Postdoctoral Fellow, University of Notre Dame, August 2014 – May 2015.
Supported by NSF Mathematical Sciences Postdoctoral Research Fellowship.

Matthew Niemerg, Research Fellow, Simons Institute for Theory of Computing, August – December 2014.

Daniel Brake, Postdoctoral Associate, University of Notre Dame, January 2014 – August 2017.
Supported by DARPA Young Faculty Award.

Dhagash Mehta, Research Assistant Professor, University of Notre Dame, August 2013 – July 2015.
Supported by DARPA Young Faculty Award.

Alan C. Liddell, Jr., Graduate Student, University of Notre Dame, August 2013 – August 2017.
Supported by DARPA Young Faculty Award and NSF ACI 1460032.
Current position: Junior Developer/CMS Administrator at University of New England.

Tulay A. Akoglu, Graduate Student, North Carolina State University, August 2013 – December 2016.
Co-advised with Agnes Szanto.

Noah Daleo, Graduate Student, North Carolina State University, January 2013 – August 2015.
Supported by DARPA Young Faculty Award and NSF DMS 1262428.
First position after PhD: Assistant Professor at Worcester State University.

Jonathan Page, Undergraduate Research, North Carolina State University, September 2012 – May 2013.
Supported by NSF DMS 1262428.

Zachary Griffin, Undergraduate Research, Texas A&M University, September 2011 – May 2012.
Supported by NSF DMS 1114336.

Ph.D. Committees

Francesco Pancaldi, University of Notre Dame, graduated 2017. (Ph.D. Advisors: Mark Alber & Andrew Sommese)

Tim McCoy, University of Notre Dame, graduated 2014. (Ph.D. Advisor: Andrew Sommese)

James Rohal, North Carolina State University, graduated 2014. (Ph.D. Advisor: Hoon Hong)

Thomas Wentworth, North Carolina State University, graduated 2014. (Ph.D. Advisor: Ilse Ipsen)

Master's Committees

Ashley White, North Carolina State University, graduated 2014.

Invited Presentations

Robotics, Kinematics, and Polynomials, "Math Day," University of Findlay, March 2017.

Mathematics of Synchronization, "Math Day," University of Findlay, March 2017.

Computing the real equilibrium points of the Kuramoto model, "Theory and Applications of Numerical Algebraic Geometry," 2017 Joint Mathematics Meetings, Atlanta, January 2017.

Decomposing the parameter space, "Applied Algebraic Geometry," AMS Fall Southeastern Sectional Meeting, North Carolina State University, November 2016.

Decomposing solution sets via derivatives, "Foundations of Numerical Algebraic Geometry," AMS Fall Western Sectional Meeting, University of Denver, October 2016.

Validating the completeness of the real solution set of a system of polynomial equations, ISSAC, Wilfred Laurier University, Waterloo, Ontario, Canada, July 2016.

Decomposing solutions sets of polynomial systems using derivatives, "Algebraic Geometry in Applications," ICMS, Zuse Institute Berlin, July 2016.

What is numerical algebraic geometry?, "Algebraic Vision," American Institute Mathematics, San Jose, California, May 2016.

Numerical computations in geometry, Texas Geometry and Topology Conference, Texas Christian University, February 2016.

Computing real solutions to systems of polynomial equations using numerical algebraic geometry, "Symbolic-Numeric Computing Seminar," CUNY Graduate Center, February 2016.

Tensor decomposition via numerical algebraic geometry, "Nonlinear Algebra," 2016 Joint Mathematics Meetings, Seattle, January 2016.

A variety of witness sets and applications, Algorithms and Complexity in Algebraic Geometry Reunion Workshop, Simons Institute, December 2015.

Local decomposition and local methods for analyzing real solutions, Workshop on Algebra, Geometry, and Proofs in Symbolic Computation, Fields Institute, December 2015.

Numerically testing generically reduced projective schemes for the arithmetic Gorenstein property, MACIS, Zuse Institute Berlin, November 2015.

A hybrid approach to the center-focus problem, Third Workshop on Hybrid Methodologies for Symbolic-Numeric Computation, ICIAM 2015, Beijing, China, August 2015.

Applications of numerical algebraic geometry, Plenary Talk, SIAM Conference on Applied Algebraic Geometry, Daejeon, Korea, August 2015.

Numerical algebraic geometry and physics, Applications of Computational Algebraic Geometry to Theoretical Physics, SIAM Conference on Applied Algebraic Geometry, Daejeon, Korea, August 2015.

A hybrid symbolic-numeric approach to exceptional sets of generically zero-dimensional systems, PASCO, University of Bath, July 2015.

Center-focus problem and algebraic geometry, "Numerical Algebraic Geometry," 2015 Meeting of the MAA Rocky Mountain Section, April 2015.

Nonlinear algebra, Colloquium, University of Findlay, April 2015.

Parameters and polynomials, Applied Interdisciplinary Mathematics Seminar, University of Michigan, April 2015.

The center-focus problem, "Homotopy continuation methods and their applications to science and engineering," AMS Spring Central Section Meeting, Michigan State University, March 2015.

Optimization and numerical algebraic geometry, "Trends in Optimization Seminar," University of Washington, October 2014.

Newton homotopies and applications, "Computational Algebraic Geometry and Applications to Science and Engineering," AMS Fall Western Section Meeting, San Francisco State University, October 2014.

Computing sparse solutions to polynomial systems using optimization, "Optimization," 42$^{\text{nd}}$ Annual Mathematics Conference, Miami University, September 2014.

Solving Polynomials, "Algebraic Geometry Boot Camp," Simons Institute, September 2014.

An introduction to software in numerical algebraic geometry, "Numerical Algebraic Geometry," ICMS, Hanyang University, August 2014.

Numerical algebraic geometric techniques for real curves and surfaces, "Curves and Surfaces," ICMS, Hanyang University, August 2014.

An a posteriori *certification algorithm for Newton homotopies*, ISSAC, Kobe University, July 2014.

Numerical real algebraic geometry, "Computational Nonlinear Algebra," ICERM, Brown University, June 2014.

Algorithms of numerical algebraic geometry, "Computational Nonlinear Algebra," ICERM, Brown University, June 2014.

Applications of numerical real algebraic geometry, "Applied Geometry, Topology, and Networks," IMSE Hot TIME Symposium, University of Illinois, February 2014.

The geometry of structural identifiability and inverse problems, Colloquium, University of Notre Dame, February 2014.

Numerical algebraic geometry, Colloquium, University of Tennessee, February 2014.

The mobility of mechanisms, Junior Colloquium, University of Tennessee, February 2014.

Homotopy continuation and decomposition, "Nonlinear Systems: Polynomial Equations, Nonlinear PDEs, and Applications," 2014 Joint Mathematics Meetings, Baltimore, January 2014.

Recovering exact results from approximate numerical computations, PolSys Seminar, University of Pierre and Marie Curie, November 2013.

Certifying solutions of an overdetermined system of equations, Numerical Methods and Efficient Computations, Centre International de Rencontres Mathematiques, October 2013.

Applications of Real Numerical Algebraic Geometry, SIAM Conference on Applied Algebraic Geometry, Colorado State University, August 2013.

Numerical Elimination Theory and Matrix Multiplication, SIAM Conference on Applied Algebraic Geometry, Colorado State University, August 2013.

Computing multiple solutions to discretizations of differential equations, MEGA2013: Effective Methods in Algebraic Geometry, Goethe University Frankfurt am Main, June 2013.

Polynomials, nonlinear algebraic differential equations, and applications, ACMS Colloquium, University of Notre Dame, February 2013.

A homotopy method based on WENO scheme for solving steady-state problems, Numerical Analysis Seminar, North Carolina State University, November 2012.

Gradient descent homotopies and real solving, MAA Mathfest 2012, Madison, August 2012.

Real solutions to parameterized polynomial systems, 2012 SIAM Annual Meeting, Minneapolis, July 2012.

Dietmaier's algorithm and numerical algebraic geometry, Seminar on Computational Algebraic Geometry, University of California, Berkeley, May 2012.

Software for numerical algebraic geometry, Simons Foundation Roundtable on Software for Research, New York City, May 2012.

Parameterized system of equations, Midwest Numerical Analysis Days 2012, University of Notre Dame, May 2012.

Certification and applications of solutions to polynomial-exponential systems, From Dynamics to Complexity: A Conference Celebrating the Work of Mike Shub, Fields Institute, May 2012.

Real solving and certification, Algebra Seminar, Georgia Tech, April 2012.

Symbolic–numeric methods for systems of polynomial equations, North Carolina State University, January 2012.

Numerical solving of polynomial equations and applications, Mathematics Colloquium, University of Wisconsin, December 2011.

Numerical solving of polynomial equations: from 3264 and 1442 to 83200 and 38475, University of California, Berkeley, December 2011.

Certifying solutions to systems of polynomial-exponential equations, "Computational and Algorithmic Algebraic Geometry," AMS Fall Western Section Meeting, University of Utah, October 2011.

Real solving and numerical algebraic geometry, "Advances in numerical algebraic geometry," SIAM Conference on Applied Algebraic Geometry, North Carolina State University, October 2011.

Real solving and certification, "Real-number complexity," Foundations of Computational Mathematics Conference, Budapest University of Technology and Economics, July 2011.

Computing real solutions using numerical algebraic geometry, RWTH Aachen University, June 2011.

Numerical algebraic geometry, Miami University, March 2011.

Multiplicity and a local dimension test, "Algebraic geometry: computations and applications," Royal Institute of Technology (KTH), February 2011.

Solving polynomial systems using regeneration, "Solving polynomial equations," CIAM Workshop, Royal Institute of Technology (KTH), February 2011.

Deflation and isosingular sets, Hybrid Methodologies for Symbolic-Numeric Computation, Mathematical Sciences Research Institute, November 2010.

Witness sets of projections, "Numerical Algebraic Geometry," AMS Fall Central Section Meeting, University of Notre Dame, November 2010.

Regeneration and differential equations, "Geometric and numeric tools for differential equations," Banff International Research Station, August 2010.

Regeneration and numerical algebraic geometry, "Kinematics and Numerical Algebraic Geometry," SIAM Annual Meeting, Pittsburgh, July 2010.

Multiplicity, local dimension, and mechanism mobility, FRAGMENT Seminar, Colorado State University, March 2010.

Regeneration and applications of numerical algebraic geometry, FRAGMENT Seminar, Colorado State University, March 2010.

Numerical algebraic geometry, "Convex Algebraic Geometry," Banff International Research Station, February 2010.

Applying numerical algebraic geometry to zebrafish patterning and tumor growth models, Numerical Analysis Seminar, Texas A&M University, February 2010.

Computing Hilbert functions using dual bases, "Applications of Algebraic Geometry," AMS National Meeting, San Francisco, January 2010.

Algebraic computations using numerical dual bases, "Oberwolfach Seminar: New Trends in Algorithms for Real Algebraic Geometry," Mathematisches Forschungsinstitut Oberwolfach, November 2009.

Finite games, homotopy continuation, and numerical algebraic geometry, Combinatorics and Probability Seminar, University of Pennsylvania, October 2009.

Homotopy continuation and numerical algebraic geometry, Postdoctoral Seminar Series, Fields Institute, October 2009.

Numerical algebraic geometry and its applications, University of Central Oklahoma, January 2009.

Algorithms of numerical algebraic geometry and Bertini, CIAM Tutorial, Royal Institute of Technology (KTH), June 2008.

Homotopy continuation and intersecting algebraic sets without defining equations, Graduate Student Seminar, University of Notre Dame, October 2007.

Regeneration, adaptive multiprecision, and Bertini, "Numerical and Symbolic Techniques in Algebraic Geometry and Its Applications," AMS Fall Central Section Meeting, DePaul University, October 2007.

Parallel solving of polynomial systems, Center for Research Computing Workshop on Scientific

Computing, University of Notre Dame, May 2007.

An introduction to multiobjective optimization and its application to finite games, "Optimization Theory and Applications," AMS Spring Central Section Meeting, Miami University, March 2007.

Editorial Boards

Guest editor (with A. Sommese) of *Numerical Algebraic Geometry*, a special issue of *Journal of Symbolic Computation* (Volume 79, Part 3), 2017.

Journal of Algebra and Its Applications (JAA), 2015 – current

Conferences, Seminars, and Sessions Organized

Semester program on *Nonlinear Algebra*, ICERM Brown University (with D. Bates, S. Di Rocco, A. Leykin, F. Sottile, M. Stillman, and C. Vinzant), Fall 2018.

Member of the *2018 SIAM Annual Meeting (AN18)* Organizing Committee, Portland, OR, July 2018.

Polynomials, Kinematics, and Robotics, University of Notre Dame (with D. Bates, D. Brake, and A. Sommese), June 2017.

Member of the *ECCAD 2017* Poster Committee, Wolfram Research, Champaign, IL, April 2017.

Member of the *ISSAC 2016* Program Committee, Waterloo, Ontario, Canada, July 2016.

Special session on *Software for numerically solving polynomial systems* (with D. Bates and D. Brake), 5^{th} *International Congress on Mathematical Software*, Zuse Institute Berlin, July 2016.

Minisymposium on *Applications of Algebraic Geometry* (with D. Bates and D. Brake), SIAM Annual Meeting, Boston, July 2016.

Workshop on Quivers and Bipartite Graphs, University of Notre Dame (London, UK), (with A. Hanany, Y.-H. He, and M. Gekhtman), May 2016.

Workshop on Software and Applications of Numerical Algebraic Geometry, University of Notre Dame (with D.A. Brake, A.J. Sommese, and C.W. Wampler), May 2016.

Member of the *MACIS 2015* Program Committee and organizer of the special session on *Applied Algebraic Geometry*, Berlin, Germany, November 2015.

Member of the *PASCO 2015* Program Committee, Bath, UK, July 2015.

Solving Polynomial Equations, Simons Institute for the Theory of Computing (with P. Koiran and F. Sottile), October 2014.

Polynomial Solving Seminar, Simons Institute (with G. Malajovich), Fall 2014.

Member of the 4^{th} *International Congress on Mathematical Software* Program Committee and organizer of the special session on *Software for Numerical Algebraic Geometry* (with A.J. Sommese), Hanyang University, August 2014.

Member of the *ISSAC 2014* Program Committee, Kobe, Japan, July 2014.

Member of the *ECCAD 2014* Organizing Committee, Duke University, April 2014.

Minisymposium on *Algorithms in Numerical Algebraic Geometry*, SIAM Conference on Applied Algebraic Geometry, Colorado State University, August 2013.

Symbolic Computation Seminar, North Carolina State University, Fall 2012 – Spring 2014.

Minisymposium on *Numerical algebraic geometric algorithms for kinematics and PDE applications*, 2012 SIAM Annual Meeting, Minneapolis, July 2012.

Minisymposium on *Advances in Numerical Algebraic Geometry*, SIAM Conference on Applied Algebraic Geometry, North Carolina State University, October 2011.

Algebraic Geometry Seminar, Texas A&M University, Spring 2012, Fall 2011, and Fall 2010.

Special session on *Numerical Algebraic Geometry* (with D.J. Bates, A.J. Sommese, and C.W. Wampler), AMS Fall Central Section Meeting, University of Notre Dame, November 2010.

Other Conferences and Workshops Attended

Texas Algebraic Geometry Symposium, Texas A&M University, April 2012.

MEGA2011: Effective Methods in Algebraic Geometry, Stockholm University, May 2011 – June 2011.

Texas Algebraic Geometry Symposium, University of Texas, April 2010.

Mathematical Developments Arising from Biology, Mathematical Biosciences Institute, November 2009.

Workshop on Complexity of Numerical Computation, Fields Institute, October 2009.

International Workshop on Model Reduction in Reacting Flows, University of Notre Dame, March 2009 – April 2009.

Joint Mathematics Meetings, Washington, D.C., January 2009.

International Conference on Scientific Computing, Las Vegas, Nevada, July 2008.

Foundations of Computational Mathematics Conference, City University of Hong Kong, June 2008.

Interactions of Classical and Numerical Algebraic Geometry, University of Notre Dame, May 2008.

SIAM Conference on Parallel Processing for Scientific Computing, Atlanta, Georgia, March 2008.

Spring Center for Applied Mathematics Workshop, University of Notre Dame, February 2008 – March 2008.

Symbolic-Numeric Computation International Workshop, University of Western Ontario, July 2007.

International Conference on Applications of Computer Algebra, Oakland University, July 2007.

Spring Center for Applied Mathematics Workshop, University of Notre Dame, March 2007.

Software for Algebraic Geometry Workshop, Institute for Mathematics and its Applications, October 2006.

Spring AMS Central Section Meeting, University of Notre Dame, April 2006.

Spring Center for Applied Mathematics Workshop, University of Notre Dame, March 2006.

Teaching Experience

Introduction to Probability, University of Notre Dame, Spring 2017, Fall 2016, and Spring 2016.

Numerical Analysis I, University of Notre Dame, Fall 2016 and Fall 2015.

Topics in Applied Mathematics: Nonlinear Equations, University of Notre Dame, Spring 2016 and Spring 2015.

Topics in Num. Analysis: Numerical Algebraic Geometry, North Carolina State University, Spring 2014.

Algebraic Geometry, North Carolina State University, Fall 2013.

Numerical Algebraic Geometry, Tutorials in the Mountains, Pingree Park mountain campus of Colorado State University, July 2013.

Engineering Mathematics I, Texas A&M University, Spring 2012 and Fall 2011.

Methods of Applied Mathematics I, Texas A&M University, Fall 2010.

Differential Equations, Texas A&M University, Spring 2010.

Principles of Finite Mathematics, University of Notre Dame, Spring 2008.

Calculus I, Miami University, Spring 2005 and Fall 2004.

Precalculus, Miami University, Spring 2004 and Fall 2003.

Pedagogical Training

University of Notre Dame Mathematics Teaching Seminar, 2006.

Miami University Seminar in the Teaching of First-Year Mathematics and Statistics, 2003.

Honors, Awards, Scholarships, and Fellowships

Secretary, International Congress on Mathematical Software, 2016 – current.

Office of Naval Research Young Investigator Award, 2016.

Secretary, SIAM Activity Group in Algebraic Geometry, January 2016 – December 2017.

Faculty Advisor, University of Notre Dame du Lac Chapter of SIAM, 2016 – current.

Distinguished Alumni Award, University of Findlay, 2015.

Army Young Investigator Program (YIP) Award, 2015.

2014 SIAM Bestseller list (#23).

The Journal of Chemical Physics: 2014 Editors' Choice.

Sloan Research Fellowship, 2014.

DARPA Young Faculty Award (YFA), 2013.

Student Led Award for Teaching Excellence ($5000 award), Texas A&M University, Spring 2010.

Outstanding Graduate Student Teacher Award for Excellence in Teaching, Kaneb Center for Teaching and Learning, University of Notre Dame, 2009.

Graduate Fellow of the Center for Applied Mathematics, University of Notre Dame, 2007 – 2008.

University of Notre Dame University Fellowship, 2005 – 2006.

Graduate Assistant Effective Teacher Award in Mathematics and Statistics, Miami University, 2005.

Graduate Faculty Prize in Mathematics and Statistics, Miami University, 2005.

Miami University Graduate Summer Scholarship, 2005 and 2004.

Miami University Graduate Assistantship, 2003 – 2005.

Miami University Graduate School Academic Achievement Assistantship, 2003.

Ohio Board of Regents Graduate/Professional Fellowship, 2003 – 2004.

Outstanding Senior Majoring in Mathematics, University of Findlay, 2003.

Mathematics and Computer Science Horizons Award, University of Findlay, 2002 and 2001.

Memberships

Association for Computing Machinery (ACM)
American Mathematical Society (AMS)
Society for Industrial and Applied Mathematics (SIAM)