Tianran Chen

Curriculum Vitae

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Experience

2021 – **Associate Professor**, *Auburn University Montgomery*.
2017 – 2021 **Assistant Professor**, *Auburn University Montgomery*.
2016 **Lecturer**, *Auburn University Montgomery*.
2012 – 2016 **Postdoctoral Research Instructor**, *Michigan State University*.
2006 – 2012 **Research and Teaching Assistant**, *Michigan State University*.

Education

2012 **Ph.D. Applied Mathematics**, *Michigan State University*, (MI USA).
- Dissertation: *Projective path tracking for homotopy continuation method*
- Advisor: Tien-Yien Li

2005 **B.A. Computer Science**, *Western Connecticut State University*, (CT USA).
Secondary major in Mathematics

Grants

2019 – 2022 NSF Award No.1923099 *AMPS: Collaborative Research: A convex geometry and homotopy approach for power-flow equations*. (**$105,281**) Role: PI
(in collaboration with separately funded co-PI Robert Davis at Colgate University)
2019–2020 AUM Grant-In-Aid research grant (**$6,717**) Role: PI
2018–2019 AUM Grant-In-Aid research grant (**$3,950**) Role: PI
2016 AMS-Simons (American Mathematical Society & Simons Foundation) Travel Grant (**$4,000**)

Awards

2020 Outstanding Faculty Award
(*Department of Mathematics, Auburn University Montgomery*)
2014 A paper selected for Journal of Chemical Physics Editors' Choice for 2014
2010 Dr. Paul & Wilma Dressel endowed scholarship award (*Michigan State University*)
2005 Student leadership recognition award for outstanding leadership
(*Western Connecticut State University*)
2005 Sigma Xi research award in Physics, Astronomy & Meteorology
(*Western Connecticut State University*)
2004 Wohlever award in Computer Science (*Western Connecticut State University*)

Research Interests

- Numerical analysis
- Scientific/higher performance computing
- Numerical algebraic geometry
- Application of numerical methods in physics, chemistry, engineering

Publications

(20) 2021 The loss surface of deep linear networks viewed through the algebraic geometry lens
IEEE Transactions on Pattern Analysis and Machine Intelligence (with Dhagash Mehta, Tingting Tang and Jonathan Hauenstein)
https://doi.org/10.1109/TPAMI.2021.3071289.

(19) 2019 Three Formulations of the Kuramoto Model as a System of Polynomial Equations
2019 57th Annual Allerton Conference on Communication, Control, and Computing, pp. 810-815 (with Jakub Mareček, Dhagash Mehta and Matthew Niemerg)
https://doi.org/10.1109/ALLERTON.2019.8919934.

(18) 2019 Directed acyclic decomposition of Kuramoto equations
Chaos: An Interdisciplinary Journal of Nonlinear Science. 2019 Vol.29, Issue 9
https://doi.org/10.1063/1.5097826

(17) 2019 Unmixing the mixed volume computation
Discrete & Computational Geometry. 2019, 62:55–86
https://doi.org/10.1007/s00454-019-00078-x

(16) 2018 Counting equilibria of the Kuramoto model using birationally invariant intersection index
SIAM Journal on Applied Algebra and Geometry 2018 2:4, 489-507
(with Robert Davis and Dhagash Mehta)
https://doi.org/10.1137/17M1145665

(15) 2018 libtropicon: A Scalable Library for Computing Intersection Points of Generic Tropical Hypersurfaces. *In: Davenport J., Kauers M., Labahn G., Urban J. (eds) Mathematical Software – ICMS 2018. ICMS 2018. Lecture Notes in Computer Science, vol 10931. Springer, Cham* https://doi.org/10.1007/978-3-319-96418-8_13

(14) 2017 A Product Formula for the Normalized Volume of Free Sums of Lattice Polytopes. *Advances in Algebra: Research from the Southern Regional Algebra Conference 2017*
(with Robert Davis) https://arxiv.org/abs/1711.11130

(13) 2017 Fixed points of belief propagation: An analysis via polynomial homotopy continuation. *IEEE Transactions on Pattern Analysis and Machine Intelligence* Volume 40, Issue 9, 0162-8828, Sep. 2018, pp. 2124-2136
(with Christian Knoll, Dhagash Mehta, and Franz Pernkopf).
https://doi.org/10.1109/TPAMI.2017.2749575

(12) 2017 On the Network Topology Dependent Solution Count of the Algebraic Load Flow Equations.
IEEE Transactions on Power Systems (2017)
(with Dhagash Mehta). https://doi.org/10.1109/TPWRS.2017.2724030

(11) 2017 Mixed cell computation in Hom4PS-3.
Journal of Symbolic Computation Volume 79, Part 3, Mar.–Apr. 2017, pp. 516-534.
(with Tsung-Lin Lee and Tien-Yien Li).
http://dx.doi.org/10.1016/j.jsc.2016.07.017

(10) 2017 Parallel degree computation for binomial systems.
Journal of Symbolic Computation Volume 79, Part 3, Mar.–Apr. 2017, pp. 535-558.
(with Dhagash Mehta).
http://dx.doi.org/10.1016/j.jsc.2016.07.018

(9) 2015 Response to "Comment on 'Exploring the potential energy landscape of the Thomson problem via Newton homotopies"'.
The Journal of Chemical Physics 143, 247102, 2015.
(with Dhagash Mehta, John Morgan, and David Wales).
http://dx.doi.org/10.1063/1.4939011

(8) 2015 Homotopy continuation method for solving systems of nonlinear and polynomial equations.
Communications in Information and Systems 15(2):119–307, 2015.
(with Tien-Yien Li).
http://dx.doi.org/10.4310/CIS.2015.v15.n2.a1

(7) 2015 Exploring the potential energy landscape of the Thomson problem via Newton homotopies.
The Journal of Chemical Physics 142, 194113, 2015.
(with Dhagash Mehta, John Morgan, and David Wales).
http://dx.doi.org/10.1063/1.4921163

(6) 2014 Theoretical aspects of mixed volume computation via mixed subdivision.
Communications in Information and Systems 14(4):213–242, 2014.
(with Tien-Yien Li and Xiaoshen Wang).
http://dx.doi.org/10.4310/CIS.2014.v14.n4.a1

(5) 2014 Newton homotopies for sampling stationary points of potential energy landscapes. *The Journal of Chemical Physics* 141 (12), 121104, 2014.
(with Dhagash Mehta, Jonathan Hauenstein, and David Wales).
http://dx.doi.org/10.1063/1.4896657
(**Selected for a Journal of Chemical Physics Editors' Choice for 2014**)

(4) 2014 Solutions to systems of binomial equations.
Annales Mathematicae Silesianae 28:7–34, 2014.(with Tien-Yien Li).
http://www.sbc.org.pl/Content/129017/007-034.pdf

(3) 2014 Hom4PS-3: A parallel numerical solver for systems of polynomial equations based on polyhedral homotopy continuation methods *Mathematical Software – ICMS 2014 – 4th International Congress, Seoul, South Korea, August 5-9, 2014. Proceedings* 8592:183–190, 2014. (with Tsung-Lin Lee & Tien-Yien Li).
http://dx.doi.org/10.1007/978-3-662-44199-2_30

(2) 2014 Mixed cells computation in parallel.
Taiwanese Journal of Mathematics 18(1):93–114, 2014.
(with Tsung-Lin Lee & Tien-Yien Li).
http://dx.doi.org/10.11650/tjm.18.2014.3276

(1) 2012 Spherical projective path tracking for homotopy continuation methods.
Communications in Information and Systems 12(3):195–220, 2012.
(with Tien-Yien Li).
http://dx.doi.org/10.4310/CIS.2012.v12.n3.a2

Preprints

2021 Volume of convex polytopes equals mixed volume of simplices.
(http://arxiv.org/abs/2108.12875)

2021 (With Robert Davis and Evgeniia Korchevskaia) Facets and facet subgraphs of adjacency polytopes. (https://arxiv.org/abs/2107.12315)

2020 (With Robert Davis) Computing volumes of adjacency polytopes via draconian sequences.
(https://arxiv.org/abs/2007.11051)

2019 (With Evgeniia Korchevskaia) On the root count of algebraic Kuramoto equations in cycle networks with uniform coupling. (http://arxiv.org/abs/1912.06241)

2019 (With Evgeniia Korchevskaia) Graph edge contraction and adjacency polytopes.
(https://arxiv.org/abs/1912.02841)

2018 On the equality of BKK bound and birationally invariant intersection index.
(http://arxiv.org/abs/1812.05408)

2018 (With Robert Davis) A toric deformation method for solving Kuramoto equations.
(http://arxiv.org/abs/1810.05690)

2018 (With Dhagash Mehta, Tingting Tang and Jonathan D. Hauenstein)
The loss surface of deep linear networks viewed through the algebraic geometry lens.
(http://arxiv.org/abs/1810.07716)

2015 (With Dhagash Mehta) An index-resolved fixed-point homotopy and potential energy landscapes. (http://arxiv.org/abs/1504.06622)

Scientific Software

- Core developer of Hom4PS-3 (http://www.hom4ps3.org): A parallel numerical solver for systems of polynomial equations based on the Polyhedral Homotopy Method.
- Lead developer of MixedVol-3 (http://www.hom4ps3.org): A parallel software package for computing volume of polytopes, mixed volume, BKK bound, and fine mixed cells.
- Developer of libtropicana (https://github.com/chentianran/libtropicana): A software package for computing regular triangulations for lattice polytopes.
- Developer of kap-cycle (https://github.com/chentianran/kap-cycle):
A Python package for generating geometric information related to the Adjacency Polytope associated with Kuramoto cycle networks.

Invited Presentations and Lectures

Apr. 2019 Meeting on Applied Algebraic Geometry
Georgia Institute of Technology, Atlanta, GA USA

Nov. 2018 American Mathematical Society Fall Southeastern Sectional Meeting.
University of Arkansas, Fayetteville, AR USA

Sep. 2018	ICERM 2018 Semester program on nonlinear algebra. Brown University. Providence, RI USA
Jul. 2018	International Congress on Mathematical Software. South Bend, IL USA
Jul. 2018	SIAM Annual Meeting. Portland, OR USA
Apr. 2018	Southern Regional Algebra Conference. Montgomery, AL USA
Oct. 2017	Auburn Unversity. Auburn, AL USA
Aug. 2017	2017 SIAM Conference on Applied Algebraic Geometry. Atlanda, GA USA
Mar. 2017	Georgia Institute of Technology. Atlanta, GA USA
Mar. 2017	Southern Regional Algebra Conference. Mobile, AL USA
Oct. 2016	Workshop on Numerical Algebraic Geometry (CSU). Fort Collins, CO USA.
Oct. 2016	American Mathematical Society Fall Western Sectional Meeting. Denver, CO USA.
Jul. 2016	SIAM Annual Meeting. Boston, MA USA.
Mar. 2015	American Mathematical Society Central Sectional Meeting Spring. Michigan State University. East Lansing, MI USA.
Aug. 2014	The 4th International Congress on Mathematical Software. Seoul, South Korea.
Jan. 2014	American Mathematical Society Joint Mathematics Meetings. Baltimore, MD USA.
Aug. 2013	SIAM Conference on Applied Algebraic Geometry. Colorado State University. Fort Collins, CO USA.
Jun. 2013	Chengdu Institute of Computer Applications. Sichuan, China.
Oct. 2011	SIAM Conference on Applied Algebraic Geometry. North Carolina State University. Raleigh, NC USA.
May 2011	Midwest Numerical Analysis Day. West Lafayette, IN USA.
Apr. 2011	Numerical algebraic geometry seminar. Colorado State University. Fort Collins, CO USA.
Nov. 2010	1064th American Mathematical Society Meeting. University of Notre Dame. Notre Dame, IN USA.

Undergraduate student Projects Supervised

2019	Adjacency polytopes (with Evgeniia Korchevskaia) Resulted in preprints: Graph edge contraction and adjacency polytopes. (`https://arxiv.org/abs/1912.02841`)
2019	3D printing in mathematical education (with Jamison Hood)
2019	Power-flow equations (with Matthew Little)
2018	Algebraic Kuramoto equations (with Evgeniia Korchevskaia) Resulted in preprints: On the root count of algebraic Kuramoto equations in cycle networks with uniform coupling. (`http://arxiv.org/abs/1912.06241`)
2013	Reliable communication in large scale parallel computing (with Nick Ovenhouse)
2012	A web interface for a scientific database based on Flask (with Jared Jonckheere)
2012	A JIT compiler for automatic differentiation based on LLVM (with Nick Ovenhouse)

Teaching Experience

2016 – **Instructor**, *Introduction to Programming for Engineers and Scientists, College algebra, Pre-calculus, Calculus I,II, Multivariable Calculus, Linear Algebra, Mathematical Modeling and Simulations, Modern Algebra I, Modern Algebra II, Ordinary Differential equations* .

2012 – 2016 **Instructor**, *College level algebra courses, Calculus sequence, Calculus sequence for business majors, Linear Algebra, Transition to Advanced Mathematics, Abstract algebra*.

2006 – 2011 **Teaching assistant**, *College Algebra, Finite Mathematics and Elements of College Algebra, Survey of Calculus with Applications I & II, Calculus I*.

Professional Services

2019 Co-organizer for the *Special Session on Applications of Algebraic Geometry* at the American Mathematical Society 2019 Southeastern Sectional Meeting

2018 Organizer for the Southern Regional Algebra Conference 2018

2017 Organizer for the *Special Session on Algorithms and Implementation in Numerical Algebraic Geometry*, 2017 SIAM Conference on Applied Algebraic Geometry

2015 Co-organizer for the *Special Session on Homotopy Continuation Methods and Their Applications to Science and Engineering* at the American Mathematical Society 2015 Central Spring Sectional Meeting

Reviewer for

- ACM Transactions on Mathematical Software
- International Symposium on Symbolic and Algebraic Computation
- Journal of Discrete & Computational Geometry
- LMS Journal of Computation and Mathematics
- IEEE Transactions on Power Systems
- IEEE Power Engineering Letters
- SIAM Journal on Applied Dynamical Systems