

# ELIZABETH GROSS

ASSOCIATE PROFESSOR  
DEPARTMENT OF MATHEMATICS  
UNIVERSITY OF HAWAII AT MĀNOA

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## Education

- 2013 **PhD, Mathematics**, *University of Illinois at Chicago*.
- 2010 **MA, Mathematics**, *San Francisco State University*.
- 2003 **BS, Mathematics**, *California State University, Chico*.

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## Appointments

- 2021 – **Associate Professor**, *University of Hawai'i at Mānoa*.
- 2018 –2021 **Assistant Professor**, *University of Hawai'i at Mānoa*.
- 2014 – 2018 **Assistant Professor**, *San José State University*.
- 2013 – 2014 **NSF Postdoctoral Fellow**, *North Carolina State University*.
- 2011–2012 **Research Assistant**, *Penn State*.  
Visiting Student in the Statistics Department.
- 2009–2011 **Graduate Teaching Assistant**, *University of Illinois at Chicago*.
- 2008–2009 **Graduate Teaching Assistant**, *San Francisco State University*.

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## Visiting Positions

- Fall 2018 **Semester Participant**, *The Institute for Computational and Experimental Research in Mathematics, Brown University*, Program on Nonlinear Algebra.
- Fall 2014 **Visiting Scientist**, *Simons Institute of Computing, UC Berkeley*, Program on Algorithms and Complexity in Algebraic Geometry.

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## Grants, Travel Awards, and Research Support

### Research Grants

- 2020–2025 **Faculty Early Career Development Program (CAREER)**, \$464,828, Title: Identifiability and inference for phylogenetic networks using applied algebraic geometry, DMS - 1945584.
- 2016–2019 **NSF 14-579, Computational Mathematics**, \$133,547, Title: Computational algebraic geometry and combinatorial algorithms for neuroscience and biological networks, DMS-1620109.
- 2013–2016 **NSF Mathematical Sciences Postdoctoral Research Fellowship**, \$150,000, Title: Geometry and Algebra of Statistical Models, DMS-1304167.

### Research Collaborations

- 2020-2023 **Proposal selected for AIM SQuaRE**, *Three weeks of support (travel, housing, meeting space) over 3 years for a group collaboration*, awarded with Luis Garcia-Puente, Heather Harrington, Nicolette Meshkat, Anne Shiu.

- 2015-2017 **Proposal selected for AIM SQuaRE**, *Three weeks of support (travel, housing, meeting space) over 3 years for a group collaboration*, awarded with Luis Garcia-Puente, Heather Harrington, Nicolette Meshkat, Anne Shiu.

## Conferences

- 2020 **NSF Conference Grant**, \$34,200, Title: Algebraic Statistics 2020, awarded with Vishesh Karwa and Sonja Petrović, DMS-2004271.

## Publications

### Preprints

- [33] **One-connection rule for structural equation models**, with Bibhas Adhikari, Marc Härkönen, and Elias Tsigaridas, arXiv:2210.00239.
- [32] **Broken bracelets and Kostant's partition function**, with Mark Curiel and Pamela Harris, arXiv:2202.01416.
- [31] **Identifiability of linear compartmental tree models**, with Cashous Bortner, Nicolette Meshkat, Anne Shiu, and Seth Sullivant, arXiv:2104.03167.
- [30] **Random graphs with node and block effects: models, goodness-of-fit tests, and applications to biological networks**, with Sonja Petrović and Despina Stasi, arXiv:2104.03167.
- [29] **When do two networks have the same steady-state ideal?**, with Mark Curiel and Carlos Munoz, arXiv:2012.02251.
- [28] **Bertini for Macaulay2**, with Daniel J. Bates, Anton Leykin, and Jose Israel Rodriguez, arXiv:1310.3297.

### Research Articles

- [27] **Distinguishing level-1 phylogenetic networks on the basis of data generated by Markov processes**, with Leo van Iersel, Remie Janssen, Mark Jones, Colby Long, and Yukihiro Murakami, arXiv:2007.08782. *Journal of Mathematical Biology*, **83**, no. 3 (2021) 1–24.
- [26] **Identifiability of linear compartment models: the singular locus**, with Nicolette Meshkat and Anne Shiu, *Advances in Applied Mathematics* (2021) 102268.
- [25] **Binomial ideals of domino tilings**, with Nicole Yamzon, *Discrete Mathematics*, **344**, no. 11 (2021) 112530.
- [24] **Steady state degree and mixed volume of chemical reaction networks**, with Cvetelina Hill, *Advances in Applied Mathematics*, 131 (2021) 102254.
- [23] **Phylogenetic trees**, with Hector Baños, Nathaniel Bushek, Ruth Davidson, Pamela Harris, Robert Krone, Colby Long, Allen Stewart, and Robert Walker, *Journal of Software for Algebra and Geometry*, **11**, no. 1 (2021) 1–7.
- [22] **Joining and decomposing reaction networks**, with Heather Harrington, Nicolette Meshkat, and Anne Shiu, *Journal of Mathematical Biology* (2020) <https://doi.org/10.1007/s00285-020-01477-y>.
- [21] **Identifying the number of components in Gaussian mixture models using numerical algebraic geometry**, with Adel Alaeddini and Sara Shirinkam, *Journal of Algebra and Its Applications* (2020) <https://doi.org/10.1142/S0219498820502047>.
- [20] **Linear compartmental models: input-output equations and operations that preserve identifiability**, with Heather Harrington, Nicolette Meshkat, and Anne Shiu, *SIAM Journal on Applied Mathematics*, **79**, no. 4, (2019) 1423–1447.
- [19] **Algebraic signatures of convex and non-convex codes**, with Carina Curto, Jack Jeffries, Katherine Morrison, Zvi Rosen, Anne Shiu, and Nora Youngs, *Journal of Pure and Applied Algebra*, **223**, no. 9 (2019) 3919–3940..

- [18] **Dimensions of group-based mixtures**, with Hector Baños, Nathaniel Bushek, Ruth Davidson, Pamela Harris, Robert Krone, Colby Long, Allen Stewart, and Robert Walker, *Bulletin of Mathematical Biology*, **81**, no. 2 (2019) 316–336..
- [17] **The multiple roots phenomenon in maximum likelihood estimation for factor analysis**, with Sonja Petrovic, Donald Richards, and Despina Stasi, *Advanced Studies in Pure Mathematics, The 50th Anniversary of Gröbner Bases, Mathematical Society of Japan*, to appear, arXiv:1702.04477.
- [16] **Neural ideals and stimulus space visualization**, with Nida Obatake and Nora Youngs, *Advances in Applied Mathematics*, **95** (2018) 65–95.
- [15] **The maximum likelihood threshold of a graph**, with Seth Sullivant, *Bernoulli*, **24** no. 1 (2018) 386–407.
- [14] **Distinguishing phylogenetic networks**, with Colby Long, *SIAM Journal on Applied Algebra and Geometry*, **2** no. 1 (2018) 72–93.
- [13] **What makes a neural code convex?**, with Carina Curto, Jack Jeffries, Katherine Morrison, Mohamed Omar, Zvi Rosen, Anne Shiu, and Nora Youngs, *SIAM Journal on Applied Algebra and Geometry*, **1** (2017) 222–238.
- [12] **Goodness-of-fit for log-linear network models: Dynamic Markov bases using hypergraphs**, with Sonja Petrović and Despina Stasi, *Annals of the Institute of Statistical Mathematics* **69** no. 3 (2017) 673–704.
- [11] **Numerical algebraic geometry for model selection and its applications to the life sciences**, with Brent Davis, Kenneth L. Ho, Daniel J. Bates, and Heather A. Harrington, *Journal of the Royal Society Interface*, **13** no. 123 (2016) 20160256 .
- [10] **Algebraic systems biology: A case study for the Wnt Pathway**, with Heather Harrington, Zvi Rosen, and Bernd Sturmfels, *Bulletin of Mathematical Biology* **78** (2016) 21–51.
- [9] **Maximum likelihood geometry in the presence of data zeros**, with Jose Israel Rodriguez, *ISSAC 2014 Conference Proceedings*.
- [8] **Combinatorial degree bound for toric ideals of hypergraphs**, with Sonja Petrović, *Intl. Journal of Algebra and Computation* **23**, (2013), 1503–1520.
- [7] **Interfacing with PHCpack**, with Sonja Petrović and Jan Verschelde, *Journal of Software for Algebra and Geometry*, **5** (2013) 20–25.
- [6] **Maximum likelihood degree of variance component models**, with Mathias Drton and Sonja Petrović, *Electronic Journal of Statistics*, **6**, (2012), 993–1016.
- [5] **A proof of the set-theoretic version of the salmon conjecture**, with Shmuel Friedland, *Journal of Algebra* **356**, (2012), no.1, 374–379.

## Book Chapters

- [4] **Phylogenetic Networks**, with Colby Long and Joseph Rusinko, in *Foundations for Undergraduate Research in Mathematics*, eds. P. Harris, E. Insko, and A. Wootten.
- [3] **Social Networks of Mobile Money in Kenya**, with Sibel Kusimba and Gabriel Kunyu, in *Money at the margins: Global perspectives on technology, financial inclusion, and design (Vol. 6)*, eds. B. Maurer, S. Musaraj, and I. V. Small. (2018) Berghahn Books..

## Review Articles

- [2] **What are higher-order networks?**, with Christian Bick, Heather Harrington, and Michael Schaub, to appear, *SIAM Review*, arXiv:2104.11329.
- [1] **Algebraic statistics, tables, and networks: The Fienberg advantage**, with Vishesh Karwa and Sonja Petrović, to appear, *Springer Series in the Data Sciences, Statistics in the Public Interest: In Memory of Stephen E. Fienberg*, arXiv:1910.01692.

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## Software Packages

**Bertini.m2**, with Daniel J. Bates, Anton Leykin, and Jose Israel Rodriguez, A Macaulay2 interface for Bertini.

**PHCPack.m2**, with Sonja Petrović and Jan Verschelde, A Macaulay2 interface for PHCPack. Available with Macaulay2 v.1.4.

**PhylogeneticTrees.m2**, with Hector Baños, Nathaniel Bushek, Ruth Davidson, Pamela Harris, Robert Krone, Colby Long, Allen Stewart, and Robert Walker, A Macaulay2 package for phylogenetic algebra.

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## Organizing activities

### Semester Programs

Fall 2024 (Upcoming) **Algebraic Statistics and Our Changing World: New Methods for New Challenges**, *Institute for Mathematical and Statistical Innovation, University of Chicago, Chicago, IL*, Organizer with Mathias Drton, Lek-Heng Lim, Sonja Petrović, Elina Robeva, Jose Rodriguez, Bernd Sturmfels, and Piotr Zwiernik.

Fall 2023 (Upcoming) **Theory, Methods, and Applications of Quantitative Phylogenomics**, *The Institute for Computational and Experimental Research in Mathematics, Brown University, Providence, RI*, Organizer with Elizabeth Allman, Cécile Ané, Leo van Iersel, Laura Kubatko, Simone Linz, Siavash Mirarab, John Rhodes, and Sebastien Roch.

### Workshops

May 2022 **Workshop on Algebra of Phylogenetic Networks**, *UH Mānoa*.

Jun 2016 **AMS Mathematical Research Community Workshop on Algebraic Statistics**, *Snowbird, Utah*, Organizer with Mathias Drton, Serkan Hoşten, David Kahle, and Sonja Petrović.

Mar 2016 **Global Attractor Conjecture Workshop**, *SJSU*, Organizer with Matthew Johnston, Nicolette Meshkat, and Bernd Sturmfels.

### Conferences

May 2022 **Algebraic Statistics 2022**, *hosted by UH Mānoa*, Organized with Vishesh Karwa and Sonja Petrović.

June 2020 **Algebraic Statistics 2020, a virtual conference**, *hosted by UH Mānoa*, Organized with Vishesh Karwa and Sonja Petrović.

March 2019 **UH Mānoa Phylogenetics and Math Day**, *UH Mānoa*, Organized with Sean Harrington and Robert Thomson.

Spring 15–Spring 18 **Bay Area Discrete Math Day**, *Biannual conference in the San Francisco bay area*, Member of Organizing Committee.

April 17 **Bay Area Discrete Math Day**, *SJSU*, Local organizer.

### Virtual Seminars

Summer 20 – current **Algebraic Statistics Online Seminar**, Organizer with Carlos Améndola, Mathias Drton, Sonja Petrović, Elina Robeva, Piotr Zwiernik, [sites.google.com/view/algstatsonline](https://sites.google.com/view/algstatsonline).

Summer 20 – current **Zoom Algebraic Geometry Seminar**, Seminar has over 40 organizers, full list of organizers is available on website, [maths.ed.ac.uk/cheltsov/zag/](https://maths.ed.ac.uk/cheltsov/zag/).

## Colloquium and Seminar Series

- Fall 2020 **Careers-In-Industry Virtual Seminar**, UH Mānoa.  
Fall 14–Spring 18 **Math/Stats Research Seminar**, SJSU.  
Spring 2017 **Math/Stats Colloquium**, SJSU.

## Minisymposia and Special Sessions

- July 2019 **Minisymposium on Algebraic Statistics**, *SIAM Conference on Applied Algebraic Geometry*, Bern, Switzerland, Organized with Jose Rodriguez.  
July 2018 **Minisymposium on Algebraic Statistics**, *SIAM Annual Meeting*, Portland, OR, Organized with Jose Rodriguez.  
Aug 2017 **Minisymposium on Software and Computation in Algebraic Statistics**, *SIAM Conference on Applied Algebraic Geometry*, Atlanta, GA, Organized with David Kahle.  
July 2016 **Minisymposium on Algebraic Statistics**, *SIAM Annual Meeting*, Boston, MA, Organized with Jose Rodriguez.  
Aug 2015 **Minisymposium on Software and Applications in Numerical Algebraic Geometry**, *SIAM Conference on Applied Algebraic Geometry*, Dajeon, South Korea, Organized with Danielle Brake.  
Oct 2014 **Special Session on Algebraic Statistics**, *AMS Fall Western Sectional Meeting*, San Francisco State University, Organized with Kaie Kubjas.

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## PhD students

- current **Mark Curiel**, Research Topics: *Algebra of chemical reaction networks, Algebraic combinatorics*.  
current **Ikenna Nometa**, Research Topics: *Algebraic methods in phylogenetics*.

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## Master's students

- 2020 – 2021 **Morgan Gauvin**, Thesis: *Maximum likelihood thresholds for graphical models*.  
2019 – 2021 **Ikenna Nometa**, Thesis: *Algebraic tools for the analysis of trait evolution*.  
2019 – 2021 **JoeAnna McDonald**, Thesis: *Algebra of neural ideals*.  
2017 – 2019 **Travis Barton**, Thesis: *Invariants-based reconstruction for phylogenetic networks*.  
2017 – 2019 **Mark Curiel**, Thesis: *Operations that preserve steady-state ideals*.  
2017 – 2018 **Nicole Yamzon**, Co-advised with Federico Ardila, Thesis: *Toric ideals of domino tilings*.  
2015 – 2017 **Carson Sprock**, Thesis: *Non-convexity measures for detecting gerrymandering*.  
2014 – 2016 **Matthew Litrus**, Thesis: *Sampling zero-one tables using sequential importance sampling and graph theory*.  
2014 – 2016 **Nida Kazi Obatake**, Thesis: *Drawing place field diagrams of neural codes using toric ideals*.

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## Undergraduate projects

- Spring 2018 **Carlos Munoz**, Project title: *When are steady-state ideals monomial*.  
2016-2017 **Rodolfo Garcia and Ha Nguyen**, Project title: *Geometry of exponential random graph models*.

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## Postdocs mentored

- Fall 2014 **Kaie Kubjas**, While in residence at the Simons Institute of Computing.

Fall 2018 **Dane Wilburne**, While in residence at ICERM.

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## Teaching

- 2018–current **Assistant Professor**, *University of Hawai‘i at Mānoa*,  
Courses Taught:  
Fall 2022, Math 100, Survey of Mathematics  
Spring 2022, Math 372, Elementary Probability and Statistics  
Fall 2021, Math 611, Modern Algebra  
Spring 2021, Math 472, Statistical Inference  
Spring 2021, Math 242, Calculus II  
Fall 2020, Math 649K, Algebraic Statistics  
Spring 2020, Math 472, Statistical Inference  
Fall 2019, Math 372, Elementary Probability and Statistics  
Spring 2019, Math 242, Calculus II  
Spring 2019, Math 321, Introduction to Advanced Mathematics.
- 2014–2018 **Assistant Professor**, *San José State University*,  
Courses Taught:  
Fall 2014, Math 285-01, Networks  
Spring 2015, Math 31, Calculus II  
Fall 2015, Math 142, Combinatorics  
Spring 2016, Math 129A, Linear Algebra  
Fall 2016, Math 142, Combinatorics  
Spring 2016, Math 128B, Modern Algebra II  
Fall 2017, Math 108, Introduction to Abstract Mathematics and Proofs  
Fall 2017, Math 129A, Linear Algebra  
Spring 2018, Math 108, Introduction to Abstract Mathematics and Proofs .
- 2009–2011 **Graduate Teaching Assistant**, *University of Illinois at Chicago*.  
Discussion leader for Intermediate Algebra and Calculus I; Grader and Tutor for Applied Linear Algebra.
- 2008–2009 **Graduate Teaching Assistant**, *San Francisco State University*.  
Instructor for Beginning Algebra and Intermediate Algebra; Discussion leader for Calculus I, II; Grader for Calculus III.

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## Professional Development, Teaching

- 2017 **Active Learning Certificate**, *SJSU eCampus and Center for Faculty Development*.

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## Teaching Awards

- 2018 **MAA Golden Section Alder Award**.  
Teaching award for junior faculty.
- 2010 **MSCS Graduate Student Teaching Award**, University of Illinois at Chicago.  
Departmental award for excellent teaching by a teaching assistant

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## Talks and Presentations (since Fall 2018)

- Apr 2022 **Computational algebraic geometry for evolutionary biology**, *Topics in Algebra, Topology, Etc., Research Seminar*, Boise State, Boise, ID, Virtual.
- Mar 2022 **Maximum likelihood thresholds for Gaussian graphical models**, *53rd Southeastern Combinatorics conference, Special Session on Matroids and Rigidity Theory*, Florida Atlantic University, Boca Raton, FL.
- Dec 2021 **Learning phylogenetic networks using invariants**, *Information, Network & Topological Data Analysis Workshop*, POSTECH, Pohang, South Korea, Virtual.



- Oct 2021 **Learning phylogenetic networks using invariants**, *Geometry & Learning from Data Workshop*, BIRS, Banff, Virtual.
- Aug 2021 **Machine learning with phylogenetic network invariants**, *SIAM Conference on Applied Algebraic Geometry, Minisymposium on Algebraic Geometry and Machine Learning*, Virtual.
- Mar 2021 **Mixed volumes of steady-state systems**, *Applied Combinatorics, Algebra, Topology & Statistics*, KTH, Stockholm, Sweden, Virtual.
- Mar 2021 **Mixed volumes of chemical reaction networks**, *Graduate Colloquium*, University of Minnesota Duluth, Virtual.
- Feb 2021 **When do two networks have the same steady-state ideal?**, *Nonlinear Algebra Seminar Online*, MPI MIS, Leipzig, Germany, Virtual.
- Jan 2021 **Mixed volumes of steady-state systems**, *Joint Mathematical Meetings, AMS Special Session on Numerical Methods for Solving Polynomial Systems*, Virtual.
- Oct 2020 **The maximum likelihood threshold of a graph**, *Virtual seminar on algebraic matroids, rigidity theory, distance geometry, and geometric constraint systems*, Virtual.
- Sept 2020 **Phylogenetic network varieties**, *Zoom Algebraic Geometry Marathon*, Virtual.
- Sept 2020 **Polynomial systems of graphical models**, *ICERM Workshop on Monodromy and Galois groups in enumerative geometry and applications*, Virtual.
- Sept 2019 **Mixed volumes of steady-state systems**, *AMS Fall Central Sectional Meeting, Special Session on Applications of Algebra and Geometry*, University of Wisconsin, Madison, WI.
- July 2019 **Mixed volumes of steady-state systems**, *2019 Annual Meeting of the Society for Mathematical Biology, Minisymposium on Algebraic Tools for the Analysis of Biochemical Reaction Networks*, Université de Montréal, Montreal, Canada.
- July 2019 **Algebra and statistical learning for inferring phylogenetic networks**, *2017 SIAM Conference on Applied Algebraic Geometry, Minisymposium on Graphical Models*, University of Bern, Bern, Switzerland.
- April 2019 **Distinguishing and inferring phylogenetic networks**, *AWM Research Symposium, Special Session on New Developments in Algebraic Biology*, Rice University, Houston, TX.
- March 2019 **Dimensions of group-based phylogenetic mixtures**, *AMS Spring Central and Western Joint Sectional Meeting, Special Session on Combinatorial and Experimental Methods in Mathematical Phylogeny*, UH Mānoa, Honolulu, HI.
- Feb 2019 **Algebraic Systems Biology**, *2019 MAA Golden Section Meeting*, American Institute of Mathematics, San Jose, CA.
- November 2018 **Distinguishing and inferring phylogenetic networks**, *Applied Algebra Day*, MIT, Cambridge, Massachusetts.
- September 2018 **Algebraic Biology with Macaulay2**, *Workshop on Core Computational Methods in Nonlinear Algebra*, ICERM, Providence, Rhode Island.

## Additional Service to Profession

### Editorial Activities

- 2022–2023 **Guest Editor**, *Algebraic Statistics*, Special Issue: Hawai'i 2022.
- 2021– current **Associate Editor**, *La Mathematica*.

### Committees

- 2018–current **MAA Golden Section Teaching Award Committee**, *Chair of committee since 2021*.
- 2022–2023 **2023 SIAG/AG Early Career Prize Selection Committee**.
- 2021 **Judging Panel for the Graduate Women in Science Hawai'i (GWISH) Research and Travel Grant**.

## Review activities

**Referee**, *Journal of Symbolic Computation*; *International Journal of Approximate Reasoning*; *Bernoulli*; *Statistics and Probability Letters*; *Foundations of Computational Mathematics*; *Bulletin of Mathematical Biology*; *SIAM Journal on Discrete Mathematics*; *Journal of Algebra*; *Journal of Algebraic Statistics*; *Discrete and Computational Geometry*; *Journal of Pure and Applied Algebra*; *SIAM Journal on Applied Algebra and Geometry*; *AMS Notices*; *AIMS Numerical Algebra, Control and Optimization*; *Advances in Applied Mathematics*.

**Panelist and ad hoc reviewer**, *National Science Foundation*.

**Proposal reviewer**, *Banff International Research Station*.

## Articles

**2019 AWM Research Symposium**, with Mary Flagg, *Association for Women in Mathematics Newsletter*, July/August 2019.

**PB&J (An article about motherhood in mathematics)**, *Journal of Humanistic Mathematics*, Volume 8 Issue 2 (2018).

**Discussing the Proof of the Global Attractor Conjecture**, with Matthew Johnston and Nicolette Meshkat, *SIAM News*, July/August 2016.

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## Service to the University

2022–current

**General Education Foundations Board.**

2022–current

**ITS Cyberinfrastructure Faculty Advisory Committee.**