ELINA ROBEVA

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Positions	**University of British Columbia,**	Vancouver, BC
	Assistant Professor	July 2019 - present
	Department of Mathematics	
	Massachusetts Institute of Technology,	Cambridge, MA
	Statistics Instructor and NSF Postdoctoral Fellow	Sept 2016 - Jun 2019
	Department of Mathematics	
Education	**University of California at Berkeley**,	Berkeley, CA
	Mathematics Ph.D.	Sept 2012 - May 2016
	Advisor: Bernd Sturmfels	
	Harvard University,	Cambridge, MA
	Master of Arts in Mathematics	Sept 2011 - June 2012
		GPA 4.00
	Stanford University,	Stanford, CA
	B.S in Mathematics with Honors and Distinctions; Minor: Computer Science	Sept 2007 – June 2011
		GPA 4.00
	Sofia High School of Mathematics,	Sofia, Bulgaria
	Graduated with recognition for outstanding achievements in the area of mathematics	June 2007
	National diploma for outstanding achievements from the Minister of Education of Bulgaria	GPA 6.00/6.00

Awards & Honors	**André-Aisenstadt Prize** 2023	Montreal, QC
	CAIMS/PIMS Early Career Research Award 2022	Kelowna, BC
	UBC/PIMS Mathematical Sciences Young Faculty Award 2020	Vancouver, BC
	SIAM Algebraic Geometry Early Career Prize 2019	Bern, Switzerland
	Bernard Friedman Memorial Prize in Applied Mathematics (thesis award) 2016	Berkeley, CA
	Outstanding Graduate Student Instructor Award (teaching award) 2016	Berkeley, CA
	MIT Rising Stars workshop participant 2015	Cambridge, MA
	Berkeley Fellowship for outstanding doctoral applicants 2012	Berkeley, CA
	Pierce Fellowship for incoming Harvard graduate students 2011	Cambridge, MA
	Honorable Mention for the Morgan Prize for Outstanding Research in Mathematics 2011	Stanford, CA
	Undergraduate Research Award in Mathematics 2011	Stanford, CA
	Dean's Award for Academic Accomplishment 2011	Stanford, CA
	J.E.Wallace Sterling Award for Scholastic Achievement 2011	Stanford, CA
	Honorable Mention – top 75 in the Putnam Mathematical Competition 2010	Stanford, CA
	Highbridge Award for Mathematical Problem Solving 2008, 2009	Stanford, CA
	Silver Medal – International Mathematical Olympiad 2007	Hanoi, Vietnam
	Silver Medal – International Mathematical Olympiad 2006	Ljubljana, Slovenia
	Gold Medal – Balkan Mathematical Olympiad 2007	Rhodes, Greece
	Gold Medal – 2nd Young International Mathematical Convention 2006	Lucknow, India

Research Interests

I develop machine learning and optimization methods for inference in models that depict complex dependencies in data. I address situations in which many commonly made yet unrealistic assumptions do not hold by leveraging the mathematical structure of the model at hand. This leads to machine learning algorithms with rigorous theoretical guarantees that work in more general and realistic settings. My work spans causal inference, graphical models, tensor decomposition, non-parametric density estimation, hidden variable models, and super-resolution imaging. For example, I develop theory and algorithms for:

- ❖ causal inference algorithms for observational data (both temporal and non-temporal) in the presence of hidden variables and causal feedback loops (12, 16, 20, 22, 27, 28, 32);
- ❖ tensor decomposition applied to machine learning problems (6, 7, 8, 9, 14, 21, 24, 26);
- ❖ sparse inverse problems, such as super-resolution imaging (10, 29);
- ❖ high-dimensional, non-parametric density estimation that leverage dependencies between the variables (15, 17, 18, 19, 23, 25, 30, 31).

In addition to traditional tools from analysis, I utilize pure mathematical tools such as algebra, geometry, and combinatorics, which often depict the structure of the models at hand. On the applied side, I have recently started collaborating with climate scientists to infer causal relationships among climate variables from time series data.

Preprints

32. Causal Inference in Directed, Possibly Cyclic, Graphical Models, with Pardis Semnani, *arXiv:2305.06127*

31. Log-concave Density Estimation with Orthogonal Independent Components, with Sharvaj Kubal and Christian Campbell, *submitted.*

30. Log-concave Density Estimation in Undirected Graphical Models, with Kaie Kubjas, Olga Kuznetsova, Pardis Semnani, and Luca Sodomaco, *arXiv:2206.05227*

Publications

29. Multivariate Super-Resolution without Separation, with Bakytzhan Kurmanbek, *to appear in Information and Inference, 2023*

28. Ultra-marginal Feature Importance: Learning from Data with Causal Guarantees, with Joe Janssen and Vincent Guan, *AISTATS 2023*

27. Third-order Moment Varieties for Non-Gaussian Graphical Models, with Carlos Améndola, Mathias Drton, Alex Grosdos, and Roser Homs, *to appear in Information and Inference, 2023*

26. Robust Eigenvectors of Symmetric Tensors, with Tommi Muller and Konstantin Usevich, *SIAM Journal of Matrix Analysis and Applications, 2022*

25. Kernel Density Estimation for Totally Positive Random Vectors, with Ali Zartash, *Algebraic Statistics, 2022*

24. The Set of Orthogonal Tensor Trains, with Pardis Semnani, *Vietnam Journal of Mathematics, Special Issue in Honor of Bernd Sturmfels' 60th Birthday, 2022*

23. Bimonotone Subdivisions of Point Configurations in the Plane, with Melinda Sun, *Algebraic Statistics,* 12:2 (2021) pp.125-138

22. Learning Linear Non-Gaussian Graphical Models with Multidirected Edges, with Yiheng Liu and Huanqing Wang, *Journal of Causal Inference,* 9:1 (2021) pp. 250-263

21. Orthogonal Decomposition of Tensor Trains, with Karim Halaseh and Tommi Muller, *Linear and Multilinear Algebra, 2021*

20. Multi-trek Separation in Linear Structural Equation Models, with Jean-Baptiste Seby, *SIAM Journal on Applied Algebra and Geometry,* 5:2 (2021) pp. 278-303

19. Optimal Rates for Estimation of Two-Dimensional Totally Positive Distributions, with Jan-Christian Hüter, Cheng Mao, and Philippe Rigollet, *Electronic Journal of Statistics*, 14:2 (2020) pp. 2600-2652

18. Estimation of Monge Matrices, with Jan-Christian Hüter, Cheng Mao, and Philippe Rigollet, *Bernoulli,* 26:4 (2020) pp. 3051-3080

17. Maximum Likelihood Estimation of Totally Positive and Log-concave Densities, with B. Sturmfels, Ngoc Tran, and C. Uhler, *Scandinavian Journal of Statistics,* 48:3 (2020) 817-844

16. Nested Covariance Determinants and Restricted Trek Separation in Gaussian Graphical Models, with M. Drton and L. Weihs, *Bernoulli* 26:4 (2020) pp. 2503-2540

15. Geometry of Log-Concave Density Estimation, with B. Sturmfels and C. Uhler*, Discrete and Computational Geometry* 61 (2019) pp.136-160

14. Duality of Graphical Models and Tensor Networks, with A. Seigal*, Information and Inference: A Journal of the IMA,* 8:2 (2019) pp. 273-288

13. Positive Semidefinite Rank and Nested Spectrahedra, with Kaie Kubjas and Richard Robinson, *Linear and Multilinear Algebra, (2017/10/4), pp.1-23*

12. Determinantal Generalizations of Instrumental Variables, with L. Weihs, B. Robinson, E. Dufrense, J. Kenkel, K. Kubjas, R. McGee II, N. Nguyen, and M. Drton, *Journal of Causal Inference*, **6:1** (2017) ISSN (Online) 2193-3685, https://doi.org/10.1515/jci-2017-0009

11. The Degree of SO(n), with Madeline Brandt, DJ Bruce, Taylor Brysiewicz, and Robert Krone, *Combinatorial Algebraic Geometry, Fields Institute Communications,* **80***, Springer, New York, 2017. Editors: Gregory Smith and Bernd Sturmfels*

10. Super-Resolution without Separation, with Geoffrey Schiebinger and Benjamin Recht: *Information and Inference: A Journal of the IMA, iax006, https://doi.org/10.1093/imaiai/iax006*

9. Singular Vectors of Orthogonally Decomposable Tensors, with Anna Seigal, *Linear and Multilinear Algebra,* 65:12 (2017), pp. 2457-2471

8. Orthogonal and Unitary Tensor Decomposition from an Algebraic Perspective, with Ada Boralevi, Jan Draisma and Emil Horobet, *Israel Journal of Mathematics,* 222:1 (2017), pp 223–260

7. Decomposing Tensors into Frames, with Luke Oeding and Bernd Sturmfels: *Advances in Applied Mathematics,* 73 (2016), pp. 125-153

6. Orthogonal Decomposition of Symmetric Tensors: *SIAM Journal on Matrix Analysis and Applications, 37 (2016), pp. 86-102*

5. Fixed Points of the EM Algorithm and Nonnegative Rank Boundaries, with Kaie Kubjas and Bernd Sturmfels: *Annals of Statistics,* 43:1 (2015), pp. 422-461

4. Robust Toric Ideals, with Adam Boocher: *Journal of Symbolic Computation*, 68 (2015), pp. 254-264

3. A Tropical Proof of the Brill-Noether Theorem, with Philip Cools, Jan Darisma and Sam Payne: *Advances in Mathematics* 230 (2012), pp. 759-776

2. Artificial Intelligence for Bidding Hex, with Sam Payne: *Games of No Chance,* edited by Richard Nowakowski. Mathematical Sciences Research Institute Publications, 63. Cambridge University Press, Cambridge (2015), pp. 207-214

1. An Extensive Survey of Graceful Trees, Undergraduate Honors Thesis, Stanford University 2011

Work Experience	**Google, Inc.** *Software Engineering Intern in Research* Worked on identifying users' online behavior and grouping together different online tasks.	Mountain View, CA May 2013 – Aug 2013
	Facebook, Inc. *Software Engineering Intern* Developed new ways of analyzing incoming data in order to surface fake accounts.	Palo Alto, CA June 2010 – Sept 2010

Invited Talks	*Learning Linear Non-Gaussian Causal Models via Algebraic Constraints,* When Causality Meets Statistics	Paris, France Apr, 2023
	Robust Eigenvectors of Symmetric Tensors, Joint Mathematics Meetings	Boston, MA Jan, 2023
	Linear Non-Gaussian Causal Models, Joint Mathematics Meetings	Boston, MA Jan, 2023
	Structured Log-Concave Density Estimation, Joint Mathematics Meetings	Boston, MA Jan, 2023
	Structured Log-Concave Density Estimation, Oberwolfach Mathematical Institute	Oberwolfach,Germany Dec, 2022
	Log-Concave Graphical Models, KTH Royal Institute of Technology	Online Seminar Sep, 2022
	Log-Concave Graphical Models, Combinatorial, Computational, and Applied Algebraic Geometry	Seattle, WA June, 2022
	Orthogonal and Incoherent Tensor Decompositions, CAIMS Annual Meeting Award Talk	Kelowna, BC June, 2022
	Log-Concave Graphical Models, Algebraic Statistics Conference	Honolulu, HI May, 2022
	Log-Concave Graphical Models, Algebra, Combinatorics, and Geometry Seminar, SFSU	Online Seminar Nov, 2021
	Orthogonal and Incoherent Tensor Decompositions, University of Idaho Mathematics Colloquium	Online Colloquium Nov, 2021
	Hidden Variables in Linear Causal Models, AMS Fall Western Sectional Meeting	Online Conference Oct, 2021
	Log-Concave Graphical Models, SIAM Conference on Applied Algebra and Geometry	Online Conference Aug, 2021
	Orthogonal and Incoherent Tensor Decompositions, International Conference on Large Scale Computation	Online Conference Jun, 2021
	Orthogonal and Incoherent Tensor Decomposition, SIAM Conference on Applied Linear Algebra	Online Conference May, 2021
	Orthogonal Tensor Decomposition, First Annual Meeting of Young Bulgarian Mathematicians	Online Conference May, 2021
	Learning Totally Positive Densities, High-dimensional Covariance Matrices, Networks and Inequalities	Online Workshop May, 2021
	Orthogonal and Incoherent Tensor Decomposition, Codes and Expansions Seminar	Online Seminar May, 2021
	Hidden Variables in Non-Gaussian Linear Causal Models, IPAM Workshop on Tensor Algorithms	Online Workshop May, 2021

Density Estimation under Total Positivity and Conditional Independence, UBC/PIMS Colloquium	Vancouver, BC Apr, 2021
Hidden Variables in Linear Causal Models, Number Theory and Algebraic Geometry Seminar, Simon Fraser	Online Seminar Apr, 2021
Estimating Totally Positive Densities, SIAM Conference on Computational Science and Engineering	Online Conference Mar, 2021
Hidden Variables in Linear Causal Models, Algebra in Statistics and Computation Seminar, UW Madison	Online Seminar Feb, 2021
Orthogonal Decomposition of Tensor Trains, Working Geometry Seminar, Texas A&M	Online Seminar Feb, 2021
Orthogonal Decomposition of Tensor Trains, Nonlinear Algebra Seminar Online	Online Seminar Nov, 2020
Hidden Variables in Linear Causal Models, UBC IAM Colloquium	Online Colloquium Nov, 2020
Orthogonal Tensor Decomposition, St Andrews University Pure Mathematics Colloquium	Online Colloquium Oct, 2020
Duality between Graphical Models and Tensor Networks, Joint Statistical Meetings 2020	Online Workshop Aug, 2020
Superresolution Imaging and Total Positivity, Algebraic Statistics 2020	Online Workshop Jun, 2020
Statistical Estimation under Total Positivity, Boise State Mathematics Colloquium	Boise, ID Mar, 2020
Nonparametric Density Estimation of Totally Positive Distributions, MIFODS Workshop, MIT	Cambridge, MA Jan, 2020
Orthogonal Tensor Decomposition, Seminar on Alg. Geom., Simon Fraser University	Vancouver, BC Oct, 2019
Duality of Graphical Models and Tensor Networks, AI and Tensor Factorizations Workshop	Santa Fe, NM Sep, 2019
Orthogonal Tensor Decomposition, SIAM AG Conference, Early Career Prize Lecture	Bern, Switzerland Jul, 2019
Nested Covariance Determinants in Gaussian Graphical Models, SIAM AG Conference	Bern, Switzerland Jul, 2019
Maximum Likelihood Estimation under Total Positivity, Northeastern Pick My Brain Seminar	Boston, MA Mar, 2019
Statistical Estimation under Algebraic Constraints, UW Madison Machine Learning Seminar	Madison, WI Mar, 2019
Statistical Estimation under Algebraic Constraints, UNC Statistics and Optimization Colloquium	Chapel Hill, NC Feb, 2019
Algebraic Structure in Hidden Variable Models, Duke Statistics Colloquium	Durham, NC Feb, 2019
Statistical Estimation under Algebraic Constraints, Stanford Statistics Colloquium	Stanford, CA Jan, 2019
Statistical Estimation under Algebraic Constraints, UBC Mathematics Colloquium	Vancouver, BC Jan, 2019
Maximum Likelihood Estimation under Total Positivity, UBC Mathematics of Information Seminar	Vancouver, BC Jan, 2019
Statistical Estimation under Algebraic Constraints, UC Irvine Mathematics	Irvine, CA Jan, 2019
Statistical Estimation under Algebraic Constraints, Caltech CMS Frontiers	Pasadena, CA Jan 2019
Maximum Likelihood Estimation under Total Positivity, U of Utah Stochastics Seminar	Salt Lake City, UT Dec, 2018
Orthogonal Tensor Decomposition, U of Utah Mathematics Colloquium	Salt Lake City, UT Dec, 2018
Maximum Likelihood Estimation under Total Positivity, WORDS Workshop, Fuqua School of Business	Durham, NC Dec, 2018
Orthogonal Tensor Decomposition, Duke Applied Math Seminar	Durham, NC Nov, 2018
Maximum Likelihood Estimation under Total Positivity, CU Boulder Applied Math Seminar	Boulder, CO Nov, 2018
Graphical Models from the Perspective of Algebra and Geometry, ICERM Nonlinear Algebra Bootcamp	Providence, RI Sep, 2018
Maximum Likelihood Estimation under Total Positivity, SIAM Annual meeting minisymposium	Portland, OR July, 2018
Maximum Likelihood Estimation under Total Positivity, Brandeis University	Waltham, MA Mar, 2018
Maximum Likelihood Estimation under Total Positivity, UMass Amherst	Amherst, MA Feb, 2018
Maximum Likelihood Estimation under Total Positivity, Applied Math Seminar at Johns Hopkins University	Baltimore, MD Feb, 2018

Maximum Likelihood Estimation under Total Positivity, Applied Math Seminar at Duke	Durham, NC	Jan, 2018
Maximum Likelihood Estimation under Total Positivity, CAM Seminar at University of Chicago	Chicago, IL	Jan, 2018
Maximum Likelihood Estimation under Total Positivity, Microsoft Research	Redmond, WA	Nov, 2017
Maximum Likelihood Estimation under Total Positivity, CMO Oaxaca, Beyond Convexity workshop	Oaxaca, Mexico	Oct, 2017
Decomposing Tensors into Frames, SIAM-AG	Atlanta, GA	Aug, 2017
Orthogonal Tensor Decomposition, CBMS workshop on Tensors	Auburn, AL	Jul, 2017
Geometry of Log-Concave Density Estimation, Oberwolfach MFO Algebraic Statistics Meeting	Oberwolfach,Germany	Apr, 2017
Geometry of Log-Concave Density Estimation, Joint Math Meetings	Atlanta, GA	Jan, 2017
Superresolution without Separation, MIT LIDS Seminar	Cambridge, MA	Sep, 2016
The Geometry of Positive Semidefinite Rank, AMS Special Session	Salt Lake City, UT	Apr, 2016
Orthogonal Tensor Decomposition, ETH Zürich	Zürich, Switzerland	Nov, 2015
Superresolution without Separation, SIAM AG 2015	Daejeon, South Korea	Aug, 2015
Orthogonal Tensor Decomposition, SIAM AG 2015	Daejeon, South Korea	Aug, 2015
The Geometry of Positive Semidefinite Rank, SIAM AG 2015	Daejeon, South Korea	Aug, 2015
The Geometry of Positive Semidefinite Rank, GOAL workshop	Berkeley, CA	May 2015
Super-Resolution Imaging and Tchebychev Systems, Seminar in Computational Algebraic Geometry	Berkeley, CA	Mar 2015
Orthogonal Tensor Decomposition, Tensors in Computer Science and Geometry	Berkeley, CA	Nov 2014
Orthogonal Tensor Decomposition, Computational Algebraic Geometry Seminar	Berkeley, CA	Oct 2014
Orthogonal Tensor Decomposition, Benjamin Recht's Group Meeting	Berkeley, CA	Oct 2014
Robust Toric Ideals, Western Fall Sectional AMS Meeting	San Francisco, CA	Oct 2014
Orthogonal Tensor Decomposition, Western Fall Sectional AMS Meeting	San Francisco, CA	Oct 2014
Orthogonal Tensor Decomposition, AMS Meeting Eau-Claire	Eau-Claire, WI	Sep 2014
Orthogonally Decomposable Tensors, Workshop on the Method of Moments and Spectral Learning, ICML 2014	Beijing, China	Jun 2014
Orthogonally Decomposable Tensors, Optimization and Algebraic Geometry	Daejeon, South Korea	Jun 2014
Fixed Points of the EM Algorithm and Nonnegative Rank Boundaries, Computer Science Seminar, U Washington	Seattle, WA	May, 2014
Fixed Points of the EM Algorithm and Nonnegative Rank Boundaries, Applications of Real Algebraic Geometry	Helsinki, Finland	Mar 2014
A Tropical Proof of the Brill-Noether Theorem, Joint Mathematical Meeting	Boston, MA	Jan 2012
How to win in Bidding Hex. Stanford Undergraduate Math Organization speaker series	Stanford, CA	May 2011

Teaching Experience	**Instructor and course design** *UBC Math 605D Graphical Models and Causal Inference*	Vancouver, BC Spring, 2022
	Instructor and course design *UBC Math 605D Tensor Decompositions and Their Applications; a graduate student topics course*	Vancouver, BC Fall, 2020, 2022
	Instructor *UBC Math 307 Applied Linear Algebra; Math 303 Introduction to Stochastic Processes; Math 302 Introduction to Probability; Math 223 Honors Linear Algebra*	Vancouver, BC 2019-2023

Instructor

Cambridge, MA

MIT IDS.136 / 6.244 Graphical Models: A Combinatorial, Algebraic and Geometric Perspective

Spring, 2019

Co-taught together with Caroline Uhler

Instructor and course design

Cambridge, MA

MIT IDS.S21 / 6.248 Graphical Models: A Combinatorial, Algebraic and Geometric Perspective

Spring, 2016

Developed and co-taught a new class together with Caroline Uhler

Teaching Assistant

Cambridge, MA

MIT 18.03 Introduction to Differential Equations

Fall 2016

Graduate Student Instructor

Berkeley, CA

Math 10B Methods of Mathematics: Calculus, Statistics, and Combinatorics

Spring 2015

Teaching discussion for two sections of 25 students each. Course instructor: Bernd Sturmfels.

Math Circle Lecturer

2012 - 2021

Semesterly lectures to advanced math high-school students at UC Berkeley and UBC

Center for Teaching and Learning – Stanford University

Stanford, CA

Appointment Tutor for Academic Years 2008-2011

Apr 2008 – June 2011

Meeting students in individual appointments and helping them in Mathematics and Computer Science.

Stanford Math Department

Stanford, CA

Grader

Jan 2008 – June 2011

Grading homework for various mathematics classes: Math 42, 51H, 52H, 108, 121.

Advanced Math Group in High School

Sofia, Bulgaria

Group leader

Sept 2006 – May 2007

Organized and taught a series of lectures in advanced mathematics to prepare younger students for Mathematical Olympiads. A few of them participated successfully at the IMO.

Academic Service	**IMSI Semester Long Program Organizer** *Algebraic Statistics in Our Changing World*	Chicago, IL Sep - Dec, 2023
	BIRS Oaxaca Workshop Organizer *Computations and Data in Algebraic Statistics*	Oaxaca, Mexico May, 2023
	IPAM Semester Long Program Organizer *Tensor Methods and Emerging Applications to the Physical and Data Sciences*	Los Angeles, CA Mar - Jun, 2021

Minisymposium Organization

- ❏ **SIAM AG Meeting:** *Theory and Methods for Tensor Decomposition*,

Bern, Switzerland
Jul 2019

- ❏ **SIAM AG Meeting:** *Graphical Models*

Bern, Switzerland
Jul 2019

- ❏ **Joint Statistical Meetings:** *Algebraic Methods in Statistics*

Vancouver, BC
Jul 2018

- ❏ **SIAM Annual Meeting:** *Theoretical Challenges in Tensor Decomposition*

Portland, OR
Jul 2018

Seminar Organization

- ❏ **Algebraic Statistics Online Seminar:** A worldwide virtual seminar series

Online seminar
2020 – 2021

- ❏ **MIT Seminar on Applied Algebra and Geometry:** organizer and founder

Cambridge, MA
2017 – 2018

Students and Postdocs

Graduate Students

- ❏ **Pardis Semnani (UBC)**
- ❏ **Bakytzhan Kurmanbek (UBC)**
- ❏ **Reza Sadoughian (UBC)**
- ❏ **Mateusz Faltyn (UBC)**
- ❏ **Bakytzhan Kurmanbek (UBC)**
- ❏ **Damara Gagnier (UBC)**
- ❏ **Jean-Baptiste Seby (MIT)**

Undergraduate Students

- ❏ **Joshua Boyd (UBC)**
- ❏ **Young Lin (UBC)**

- **Chrisian Campbell (UBC)**
- **Niko Nikov (UBC)**
- **Alex Dong (UBC)**
- **Jaipratap Grewal (UToronto)**
- **Tommi Muller (UBC)**
- **Karim Halaseh (UBC)**
- **Yiheng Liu (UBC)**
- **Huanqing Wang (UBC)**
- **Ali Zartash (MIT)**
- **Melinda Sun (MIT)**

Postdocs
- **Marina Garrote-López (UBC)**