Jiayi (Joanna) Li

Contact Information

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Research Profile

I develop mathematical foundations for responsible and trustworthy AI, with a focus on algebraic, geometric, and statistical structures in neural networks and complex learning systems. My work uses tools from numerical algebraic geometry, singular learning theory, and constrained optimization to study identifiability, singularities, optimization landscapes, generalization, phase transitions, and robustness.

Employment

Max Planck Institute, CBG, Dresden, Germany
Section of Mathematics and Artificial Intelligence
Postdoctoral researcher
Mentor: Heather Harrington

Education

University of California, Los Angeles
Ph.D. Statistics, Machine Learning Theory
Thesis: Structure, Symmetry, and Singularity in Learning Systems
Thesis advisor: Guido Montúfar

The University of Hong Kong & **Stony Brook University**
B.S.(Hons) Mathematics, Algebraic Geometry
Thesis advisor: Robert Lazarsfeld

Research Visits

Institute for Pure & Applied Mathematics (IPAM)
Los Angeles, CA, USA
Graduate Fellow, *Long Program: Mathematics of Intelligences*

Simons Institute for the Theory of Computing
Berkeley, CA, USA
Short-Term Visitor, *Modern Paradigms in Generalization*

Institute for Mathematical & Statistical Innovation (IMSI)
Chicago, IL, USA
Graduate Fellow, *Algebraic Statistics and Our Changing World*

Max Planck Institute for Mathematics in the Sciences (MPI MiS)
Leipzig, Germany
Visiting Graduate researcher, *Group: Mathematical Machine Learning*

Preprints

9. Ben Cullen, Sergio Estan-Ruiz, Riya Danait, **Jiayi Li**‡. '*Identifiability in Graphical Discrete Lyapunov Models*", submitted
8. Cecilie Olesen Recke, Sarah Lumpp, Nataliia Kushnerchuk, Janike Oldekop, **Jiayi Li***, Jane Ivy Coons, Elina Robeva. '*Identifiability in Graphical Discrete Lyapunov Models*", submitted

Selected Publications

7. Yulia Alexandr, Miles Bakenhus, Mark Curiel, Sameer K. Deshpande, Elizabeth Gross, Yuqi Gu, Max Hill, Joseph Johnson, Bryson Kagy, Vishesh Karwa, **Jiayi Li***, Hanbaek Lyu, Sonja Petrović, Jose Israel Rodriguez. '*New Directions in Algebraic Statistics: Three Challenges from 2023*", Algebraic Statistics.

6. Kaie Kubjas, **Jiayi Li**†, Maximillian Wiesmann. '*Geometry of Polynomial Neural Networks*", Algebraic Statistics.
5. Shuang Liang, Renata Turkes, **Jiayi Li***, Nina Otter, Guido Montufar. '*Pull-back Geometry of Persistent Homology Encodings*", Transactions on Machine Learning Research (TMLR), 2024.
4. **Jiayi Li**†, Yuantong Li, Xiaowu Dai. '*Discussion: Estimating Means of Bounded Random Variables by Betting" by Waudby-Smith and Ramdas*", Journal of the Royal Statistical Society: Series B (JRSSB), 2023.
3. Dejun Guo, Xu Jin, Dan Shao, **Jiayi Li***, Yang Shen, Huan Tan. '*Image-Based Regulation of Mobile Robots without Pose Measurements*", IEEE Control Systems Letters (L-CSS), vol. 6, pp. 2156-2161, 2022.
2. Guruprasad Raghavan, **Jiayi Li***, Matt Thomson. '*Geometric Algorithms for Predicting Resilience and Recovering Damage in Neural Networks*", preprint.
1. Ziqi Huang, Yang Shen, **Jiayi Li***, Marcel Fey, Christian Brecher. '*A Survey on AI-Driven Digital Twins in Industry 4.0: Smart Manufacturing and Advanced Robotics*", Sensors, 2021.

† primary author, * contributing author, ‡ senior/mentoring author

Invited Talks

21. Machine Learning Seminar, École Normale Supérieure
05/21/2026, Paris, France
"Structure, Symmetry and Singularity in Modern Neural Networks"

20. Conference on Geometry, Topology and Machine Learning
05/18/2026-05/22/2026, Paris, France
"Basin-Selection in Bayesian Learning"

19. Applied CATS Seminar, KTH Royal Institute of Technology
03/03/2026, Stockholm, Sweden
"Grokking as a Phase Transition Between Competing Basins, an SLT Perspective"

18 . Mathematical Foundations of AI, Lie-Størmer Colloquium
12/03/2025-12/04/2025, SIMULA Research Laboratory, Oslo, Norway
"Structure, Symmetry and Singularity in Learning Systems"

17. Math & Machine Learning seminar, Boston College
10/15/2025, online
"Theoretical insights for optimizing rational activations"

16. Applied Algebra and Geometry UK network @ Edinburgh
08/21/2025, Edinburgh, UK
"Geometry of Neural Networks with Algebraic Activations"

15. Algebraic Methods in Optimization, ICCOPT
07/21/2025-07/24/2025, Los Angeles, USA
"Optimizing rational neural networks with trainable parameters"

14. SIAM Conference on Applied Algebraic Geometry
07/07/2025-07/11/2025, Madison, USA
"Geometry of Neural Networks with Algebraic Activations"

13. Mathematics, Ai and Data Science for Material Innovations (MADSMIN), Lancaster University
06/09/2025 - 06/13/2025, Lancaster, UK

"Geometry of Neural Networks with Algebraic Activations"

12. Geometry and Machine Learning (GML2025), Sorbonne Université
05/26/2025 - 05/30/2025, Paris, France
"Geometry of Neural Networks with Algebraic Activations"

11. Workshop on the Statistical Theory of Neural Networks
05/05/2025 - 05/08/2025, Egmond aan Zee, Netherlands
"Geometry of Neural Networks with Algebraic Activations"

10. Numerical (Nonlinear) Algebra in the Real World
02/06/2025, Dresden, Germany
"Taming Non-convexity in Shallow Neural Networks with Algebraic Activations"

9. Joint Mathematics Meetings (JMM) 2025
AMS-ASA-SIAM Special Session on Mathematics of Deep Learning: A High-Dimensional Probability Perspective
01/11/2025, Seattle, WA, USA
"Algebro-geometric Approaches to Optimization and Generalization in Mathematical Machine Learning"

8. Algebraic Geometry and Machine Learning Workshop, SIAM Conference on Mathematics of Data Science
10/25/2024, Atlanta, GA, USA
"Geometry of Polynomial Neural Networks"

7. Numerical Analysis Seminar, Institute of Mathematical Research and Dept. of Mathematics, The University of Hong Kong
04/30/2024, Hong Kong
"Geometry of Polynomial Neural Networks"

6. Special Session: Applications of Algebra and Geometry, American Mathematics Society 2024 Spring Central Sectional Meeting
04/20/2024, Milwaukee, WI, USA
"An Algebraic Approach to Supply Network Formation and Fragility"

5. Dept. of Mathematics and Statistics, University of Mass. Amherst
04/12/2024, Online
"Geometry of Polynomial Neural Networks"

4. Level Set Seminar, Dept. of Mathematics, UCLA
04/08/2024, Los Angeles, CA, USA
"Geometry of Polynomial Neural Networks"

3. Applied Algebra Seminar, Dept. of Maths, University of Wisc. Madison
12/2023, Madison, WI, USA
"Geometry of Polynomial Neural Networks"

2. Deep Learning Theory Seminar, UCLA
09/2023, Los Angeles, CA, USA
"Neural Collapse Beyond Unconstrained Feature Models"

1. SCISS, UCLA
07/2023, Los Angeles, CA, USA

"Mathematical Machine Learning: Theory & Beyond"

Academic and Community Services

Joint Mathematics Meetings (JMM) 2026
1/4/2026 - 1/7/2026, Washington D.C., USA
AMS Special Session on Algebraic Methods in Machine Learning and Optimization
Organizers: Jiayi Li (MPI-CBG, Germany), Heather A. Harrington (University of Oxford, UK; MPI-CBG, Germany), Georgy Scholten (MPI-CBG, Germany)

London Geometry and Machine Learning (LOGML) 2025
7/7/2025 - 7/11/2025, London, UK
Project: Symmetry, degeneracy and effective dimensions of neural networks
Academic mentor: Jiayi Li (MPI-CBG, Germany)

IPAM Research in Industrial Projects for Students (RIPS) 2025
6/23/2025 - 8/22/2025, Los Angeles, CA, USA
Project: Geometry of representation in Large Language Models
Academic mentor: Jiayi Li (MPI-CBG, Germany)
Industrial partner: Microsoft Research

Joint Mathematics Meetings (JMM) 2025
1/8/2025 - 1/11/2025, Seattle, WA, USA
AMS Special Session on Algebraic Methods in Machine Learning and Optimization
Organizers: Jiayi Li (UCLA, USA), Guido Francisco Montufar (MPI MiS, Germany; UCLA, USA), Yulia Alexandr (UCLA, USA), Julia Lindberg (UT Austin, USA)

Association for Computing Machinery (ACM) XRDS Magazine
Editor-in-Chief, 2022 - 2025
Lead Editor, 2021
Feature Editor, 2020

Outreach
Distinguished Women in Statistics and Data Science Workshop Series 1st (Women in Academia, 05/23/2023), 2nd Symposium (Women in Industry, 10/17/2023)
UCLA Society of Women in Statistics (Committee, 2022 - 2024)
UCLA Statistics Club (Mentor, 2022 - 2024)
Rotary Club, Westwood Village, CA (Invited Speaker, 09/07/2023)
UCLA Bruin Professionals, Westwood, CA (Invited Speaker, 05/16/2024)
Dublin High School, Dublin, CA (Invited Speaker, 10/25/2024)

Reviewing
NeurIPS, ICML, ICLR, Algebraic Statistics, SIAM Journal on Applied Algebra and Geometry, Effective Methods in Algebraic Geometry (MEGA).

Contributed Talks

6. Workshop on Real Applied Algebra
03/23/2026-03/25/2026, University of Copenhagen, Denmark
"LLC in transformers: An algebro-geometric lens on generalization in neural networks"

5. Higher-order interactions at the crossroads of geometry and topology
12/10/2025-12/12/2025, Paris, France
"Geometry of Higher-Order Structures in Machine Learning"

4. Matroids, Rigidity, and Algebraic Statistics, ICERM Workshop

03/17/2025, Providence, RI, USA
"Geometric Framework for Optimizing Algebraic Neural Networks"

3. 2024 UC Davis Peter Hall Conference on Statistics in the Age of AI
11/09/2024, Davis, CA, USA
"Optimization in Polynomial Neural Networks: Insights from Algebraic Geometry"

2. Women in Algebraic Statistics Workshop, St John's College, University of Oxford
07/12/2024, Oxford, UK
"Algebraic Structures in Terminal Phase of Neural Network Training"

1. Institute for Mathematical and Statistical Innovation (IMSI)
10/10/2023, Chicago, IL, USA
"Simplex ETF - Algebraic structure arising in the terminal phase of neural network training"

Teaching Experience

Summary: Instructor, Teaching Associate, and Teaching Assistant for 25+ course offerings across statistics, engineering, and machine learning, reaching 1000+ students at UCLA and the University of Oxford.

Courses:

Statistics and Data Science (e.g., STATS 13, ENGR 116)

Engineering Systems (ENGR 200, 202, 203, 205)

Machine Learning (Oxford Machine Learning Summer School)

Master's preparatory programs in statistics and data science

Selected Honors, Awards, and Grants

Dimitris N. Chorafas Foundation Award ($10,000)	2024
Dissertation Year Fellowship, UCLA ($20,000)	2024
Distinguished Teaching Award Nominee, Statistics/MSOL, UCLA	2024
Summer Mentored Research Fellowship, UCLA ($6,000)	2022
ACM Scholarship, Association for Computing Machinery ($2,000)	2020
Cathay Bank Scholarship ($6,000)	2020
Overseas Research Fellowship, HKU ($12,000)	2016
Undergraduate Research Fellowship, HKU ($15,000)	2015
Travel grants for conferences and research programs (*20+ awards; over* $25,000 *total*)	2017–2025

Research Leadership

Organizer, American Mathematical Society Special Sessions on Algebraic Methods in Machine Learning (JMM 2025, 2026)
Academic mentor for interdisciplinary research programs (IPAM, LOGML, 2025, 2026)

Memberships

American Statistical Association (ASA)
Institute of Mathematical Statistics (IMS)
Association for Computing Machinery (ACM)