Tingran Gao

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EMPLOYMENT

Radix Trading, LLC 2020 – present
Quantitative Researcher

Committee on Computational and Applied Mathematics, 2017 – 2020
Department of Statistics, The University of Chicago
William H. Kruskal Instructor

Department of Mathematics, Duke University 2015 – 2017
Visiting Assistant Professor

EDUCATION

Duke University 2010 – 2015
Ph.D. in Mathematics, May 2015
Thesis: *Hypoelliptic Diffusion Maps and Their Applications in Automated Geometric Morphometrics*
Thesis Advisor: Ingrid Daubechies

Duke University 2013 – 2015
M.S. in Computer Science, May 2015

Tsinghua University 2006 – 2010
B.S. in Mathematics, July 2010
Dissertation: *Blow-up Analysis of Gauss Curvature Equations*
Dissertation Mentor: Yuxiang Li

VISITING APPOINTMENTS

Institute for Computational and Experimental Research in February 2019 – May 2019
Mathematics (ICERM), Brown University
Long-Term Participant of semester program "Computer Vision"

Institute for Pure and Applied Mathematics (IPAM), University March 2019 – June 2019
of California, Los Angeles
Fellow of Spring 2019 program "Geometry and Learning from Data in 3D and Beyond"

INTERNSHIP

Data Science Intern at MarkMonitor, Part of Thomson Reuters June 2015 – August 2015
Data Scientist – Machine Learning

Institute of Computing Technology, Chinese Academy of Sciences July 2009 – July 2010
Research Intern

SCHOLARSHIPS AND TRAVEL AWARDS

- SIAM Early Career AG19 Travel Award (2019)
- ICIAM Travel Grant (2019, €2,000)
- Duke Arts & Sciences Council Committee on Faculty Research Travel Award (2017)
- SIAM Early Career Travel Award (2017)
- Yongwang Scholarship for Academic Excellence, Tsinghua University (2009)

GRANTS

- NSF CDS&E-MSS DMS-1854831: Collaborative Research: Geometric Harmonic Analysis in Learning and Inference: Theory and Applications (2019–2022, PI, $110,000; transferred to Lek-Heng Lim)
- The University of Chicago Center for Data and Computing (CDAC) Data Science Discovery Fund: Predicting Shifts in Biological Growth Driven by Climate Change: A Geometric Deep Learning Approach (2019–2020, PI, $86,541.87)
- AMS–Simons Travel Grant (2018–2020, $4,000)

PUBLICATIONS

[1] Ethan L. Fulwood, Shan Shan, Julia M. Winchester, **Tingran Gao**, Henry Kirveslahti, Ingrid Daubechies, and Doug M. Boyer, "Reconstructing Dietary Ecology of Extinct Strepsirrhines (Primates, Mammalia) with New Approaches for Characterizing and Analyzing Tooth Shape," *Paleobiology*, 1–20 (2021) DOI: 10.1017/pab.2021.9

[2] Yifeng Fan, **Tingran Gao**, and Zhizhen Zhao, "Representation Theoretic Patterns in Multi-Frequency Class Averaging for Three-Dimensional Cryo-Electron Microscopy," *Information and Inference: A Journal of the IMA*, Volume 10, Issue 3, September 2021, Pages 723–771 (2021) DOI: 10.1093/imaiai/iaab012

[3] Bruce Wang, Timothy Sudijono, Henry Kirveslahti, **Tingran Gao**, Doug M. Boyer, Sayan Mukherjee, and Lorin Crawford, "A Statistical Pipeline for Identifying Physical Features that Differentiate Classes of 3D Shapes," *Annals of Applied Statistics,* Vol. 15, No. 2, 638–661 (2021) DOI: 10.1214/20-AOAS1430

[4] Yunru Liu, **Tingran Gao**, and Haizhao Yang, "SelectNet: Learning to Sample from the Wild for Imbalanced Data Training," *Proceedings of The First Mathematical and Scientific Machine Learning Conference*, PMLR 107:193–206 (2020)

[5] Courtney P. Orsbon, Nicholas J. Gidmark, **Tingran Gao**, and Callum F. Ross, "XROMM and diceCT Reveal a Hydraulic Mechanism of Tongue Base Retraction in Swallowing," *Scientific Reports* 10:8215 (2020) DOI: 10.1038/s41598-020-64935-z

[6] Yuanyuan Feng, **Tingran Gao**, Lei Li, Jian-Guo Liu, and Yulong Lu, "Uniform-in-Time Weak Error Analysis for Stochastic Gradient Descent Algorithms via Diffusion Approximation," *Communications in Mathematical Sciences,* Vol. 18, No. 1, pp. 163–188 (2020)

[7] Yifeng Fan, **Tingran Gao**, and Zhizhen Zhao, "Unsupervised Co-Learning on $\mathcal{G}$-Manifolds Across Irreducible Representations," *Advances in Neural Information Processing Systems* 32, 9041–9053 (2019)

[8] Katie S. Collins, Stewart M. Edie, **Tingran Gao**, Rudiger Bieler, and David Jablonski, "Spatial Filters of Function and Phylogeny Determine Morphological Disparity with Latitude," *PLoS ONE* 14(8): e0221490. (2019) DOI: 10.1371/journal.pone.0221490

[9] **Tingran Gao**, "The Diffusion Geometry of Fibre Bundles: Horizontal Diffusion Maps," *Applied and Computational Harmonic Analysis,* Volume 50, 147–215 (2021) DOI: 10.1016/j.acha.2019.08.001

[10] **Tingran Gao** and Zhizhen Zhao, "Multi-Frequency Phase Synchronization," *Proceedings of the 36th International Conference on Machine Learning*, PMLR 97:2132–2141 (2019)

[11] **Tingran Gao**, Jacek Brodzki, and Sayan Mukherjee, "The Geometry of Synchronization Problems and Learning Group Actions," *Discrete & Computational Geometry* 65, 150–211 (2021) DOI: 10.1007/s00454-019-00100-2

[12] **Tingran Gao**, Shahar Z. Kovalsky, and Ingrid Daubechies, "Gaussian Process Landmarking on Manifolds," *SIAM Journal on Mathematics of Data Science* 1(1), 208–236 (2019)

[13] **Tingran Gao**, Shahar Z. Kovalsky, Doug M. Boyer, and Ingrid Daubechies, "Gaussian Process Landmarking for Three-Dimensional Geometric Morphometrics," *SIAM Journal on Mathematics of Data Science* 1(1), 237–267 (2019)

[14] **Tingran Gao**, Shahab Asoodeh, Yi Huang, and James Evans, "Wasserstein Soft Label Propagation on Hypergraphs: Algorithm and Generalization Error Bounds," *Proceedings of the AAAI Conference on Artificial Intelligence* 33(01), 3630–3637 (2019)

[15] Shahab Asoodeh, **Tingran Gao**, James Evans, "Curvature of Hypergraphs via Multi-Marginal Optimal Transport," *2018 IEEE Conference on Decision and Control (CDC)*, FL, USA, 2018, pp. 1180–1185

[16] **Tingran Gao**, "Synchronization Problems: Geometry Meets Learning," *Mathematisches Forschungsinstitut Oberwolfach Report* 14, 776–778 (2018). DOI: 10.4171/OWR/2018/14

[17] Chandrajit Bajaj, **Tingran Gao**, Zihang He, Qixing Huang, and Zhenxiao Liang, "SMAC: Simultaneous Mapping and Clustering Using Spectral Decompositions," *Proceedings of the 35th International Conference on Machine Learning*, PMLR 80:324–333 (2018)

[18] **Tingran Gao**, Gabriel S. Yapuncich, Ingrid Daubechies, Sayan Mukherjee, and Doug M. Boyer, "Development and Assessment of Fully Automated and Globally Transitive Geometric Morphometric Methods, with Application to a Biological Comparative Dataset with High Interspecific Variation," *The Anatomical Record: Advances in Integrative Anatomy and Evolutionary Biology* 301:636–658 (2018)

[19] Rujie Yin, **Tingran Gao**, Yue M. Lu, and Ingrid Daubechies, "A Tale of Two Bases: Local-Nonlocal Regularization on Image Patches with Convolution Framelets," *SIAM Journal on Imaging Sciences* 10(2), 711–750 (2017)

[20] Natasha S. Vitek, Carly L. Manz, **Tingran Gao**, Jonathan I. Bloch, Suzanne G. Strait, and Doug M. Boyer, "Semi-Supervised Determination of Pseudocryptic Morphotypes Using Observer-Free Characterizations of Anatomical Alignment and Shape," *Ecology and Evolution* 2017;7:5041–5055 (2017)

[21] Liping Zhang, Soon-Yi Wu, and **Tingran Gao**, "Improved Smoothing Newton Methods for Nonlinear Complementarity Problems," *Applied Mathematics and Computation* 215(1), pp.324–332 (2009)

PREPRINTS

[1] **Tingran Gao**, Lek-Heng Lim, and Ke Ye, "Semi-Riemannian Manifold Optimization," *arxiv preprint.* `arXiv:1812.07643.` (2018)

PROFESSIONAL SERVICES

Conference Session Organizer

- SIAM Conference on Imaging Science (SIAM IS20) – Minisymposium on "Machine Learning Meets Imaging Science," Toronto, Ontario, Canada, July 2020 (with Qing Qu and Zhihui Zhu)

- SIAM Conference on Mathematics of Data Science (SIAM MDS20) – Minisymposium on "Geometric Harmonic Analysis and Data Science," Cincinnati, Ohio, May 2020 (with Zhizhen Zhao)

- 2020 AMS Spring Central Sectional Meeting at Purdue University – Special Session on "Theory and Algorithms for Data Science," West Lafayette, IN, April 2020 (with Haizhao Yang)

- 2020 Joint Mathematics Meetings (JMM 2020) – AMS Special Session on "Mathematical Analysis on Data Science," Denver, CO, January 2020 (with Radu Balan, Sinan Gunturk, and Ozgur Yilmaz)

- The 9th International Congress on Industrial and Applied Mathematics (ICIAM 2019) – Minisymposium on "Mathematical Theory and Applications of Deep Learning," Valencia, Spain, July 2019 (with Haizhao Yang)

- SIAM Conference on Applied Algebraic Geometry (SIAM AG19) - Minisymposium on "Numerical Differential Geometry," Bern, Switzerland, July 2019 (with Ke Ye)

- SIAM Annual Meeting 2018 (SIAM AN18) – Minisymposium on "Numerical Differential Geometry Meets Numerical Algebraic Geometry," Portland, OR, July 2018 (with Jose I. Rodriguez)

- SIAM Annual Meeting 2018 (SIAM AN18) – Minisymposium on "Data Science with Tools from Applied Geometry and Algebra," Portland, OR, July 2018 (with Ke Ye)

- The 42nd SIAM Southeastern Atlantic Section Conference (SIAM-SEAS 2018) – Minisymposium on "Manifold Learning in Modern Signal Processing," Chapel Hill, NC, March 2018

- SIAM Annual Meeting 2017 (SIAM AN17) – Minisymposium I & II on "Geometry and Computational Challenges in Data Science," Pittsburgh, PA, July 2017 (with Haizhao Yang)

Journal Referee

Annals of Statistics; BIT Numerical Mathematics; Communications in Mathematical Sciences; Constructive Approximation; Electronic Journal of Statistics (2 times); Foundations of Computational Mathematics (FoCM); Frontiers in Applied Mathematics and Statistics (2 times); IEEE Transactions on Image Processing (2 times); IEEE Transactions on Neural Networks and Learning Systems; IEEE Transactions on Signal Processing; IEEE Signal Processing Letters; Journal of Artificial Intelligence Research; Journal of Machine Learning Research (5 times); Journal of the American Mathematical Society; Journal of the Royal Society Interface; Linear Algebra and its Applications; Machine Learning; Mathematical Programming; Numerical Linear Algebra with Applications; SIAM Journal on Applied Algebra and Geometry (2 times); SIAM Journal on Mathematics of Data Science (2 times); SIAM Journal on Imaging Sciences (2 times); SIAM Journal on Matrix Analysis and Applications (3 times); SIAM Journal on Scientific Computing

Reviewer

Mathematical Reviews/MathSciNet (2019 – present)
JMLR Editorial Board Reviewer (2020 – 2021)

Conference Reviewer

AISTATS (2019, 2020); ICML (2019, 2020, 2021, 2022); NeurIPS (2019, 2020, 2021); AAAI (2020 Program Committee)

Grant Proposal Reviewer

National Science Foundation (review panel, March 2019)

Seminar Moderator

Applied Mathematics & Analysis Seminar, Duke University (2016 – 2017)

Professional Memberships

American Mathematical Society (AMS), Society for Industrial and Applied Mathematics (SIAM)

TEACHING

The University of Chicago (Instructor)

STAT 27400/37400: Nonparametric Inference	Autumn 2019
STAT 25100: Introduction to Mathematical Probability	Autumn 2019
STAT 27400/37400: Nonparametric Inference	Autumn 2018
STAT 25100: Introduction to Mathematical Probability	Autumn 2018
STAT 25100: Introduction to Mathematical Probability	Spring 2018
STAT 27400/37400: Nonparametric Inference	Winter 2018

Duke University (Instructor)

MATH 181.02: Math Everywhere	Spring 2016
MATH 212L.12 & 14: Multivariable Calculus (Two Concurrent Sections)	Fall 2015
MATH 105L.01: Lab Calculus I	Summer Term II 2014
MATH 122L.13: Introductory Calculus II with Applications	Fall 2015

Duke University (Course Assistant)

MATH 181: Math Everywhere	Spring 2014
MATH 181: Math Everywhere	Spring 2013
MATH 41L.09 & 10: Introductory Calculus II with Applications (Two Concurrent Sections)	Fall 2011
MATH 41L.04: Introductory Calculus II with Applications	Fall 2010

TALKS

Seminars
- Numerical Analysis / CCM Seminar, Flatiron Institute – Simons Foundation, New York City NY,

March 4, 2020

- Colloquium, Department of Mathematics, University of Hawai'i at Mānoa, Honolulu HI, February 20, 2020

- Colloquium, Department of Computational and Applied Mathematics, Rice University, Houston TX, February 6, 2020

- Colloquium, Department of Mathematics, University of California, Davis, Davis CA, January 31, 2020

- Colloquium, Department of Mathematics, Massachusetts Institute of Technology, Boston MA, January 29, 2020

- Colloquium, School of Industrial Engineering, Purdue University, West Lafayette IN, January 21, 2020

- Colloquium, Institute of Mathematics, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland, January 14, 2020

- Colloquium, Department of Mathematics, The University of Utah, Salt Lake City UT, January 9 & January 10, 2020

- Colloquium, Department of Computing and Mathematical Sciences, California Institute of Technology, Pasadena CA, January 6, 2020

- Colloquium, Department of Mathematics, Rutgers University – New Brunswick, New Brunswick NJ, December 16, 2019

- Colloquium, Courant Institute of Mathematical Sciences, New York University, New York NY, December 12, 2019

- Colloquium, Department of Mathematics, University of Wisconsin – Madison, Madison WI, December 2, 2019

- Colloquium, Department of Mathematics and Statistics, Washington University in St. Louis, St. Louis MO, November 26, 2019

- Colloquium, Department of Mathematics, The University of Texas at Arlington, Arlington TX, November 20, 2019

- Applied Mathematics & Analysis Seminar, Duke University, Durham NC, September 25, 2019

- Algorithm Seminar, Boston College, Boston MA, September 20, 2019

- Geometry/Topology Seminar, Boston College, Boston MA, September 19, 2019

- Data Science Seminar, Johns Hopkins University, Baltimore MD, September 11, 2019

- Academy of Mathematics & Systems Science, Chinese Academy of Science, Beijing, China, July 3, 2019

- Computational and Applied Mathematics Colloquium, University of Chicago, Chicago IL, May 16, 2019

- Applied Algebra Seminar, University of Wisconsin – Madison, Madison WI, April 26, 2019

- Geometry Seminar, Texas A&M University, College Station TX, March 4, 2019

- SINE Seminar, University of Illinois at Urbana–Champaign (UIUC), Champaign IL, November 19, 2018

- Applied & Computational Mathematics Seminar, National University of Singapore, Singapore, September 18, 2018

- Academy of Mathematics & Systems Science, Chinese Academy of Sciences, Beijing, China, Dec 7, 2017

- Geometry and Topology Seminar, North Carolina State University, Raleigh NC, January 18, 2017

- Mathematical Sciences Colloquium, Rensselaer Polytechnic Institute, Troy NY, April 18, 2016

- Visualization Friday Forum, Duke University, Durham NC, March 11, 2016

- Data Seminar, Duke University, Durham NC, April 16, 2015

Conferences

- 2020 SIAM Conference on Mathematics of Data Science, Cincinnati, Ohio, May 7, 2020

- The 43rd SIAM Southeastern Atlantic Section Conference, Auburn AL, March 14-15, 2020

- 2020 Joint Mathematics Meetings (JMM 2020), Denver CO, January 16, 2020

- *Applied Math Youth Forum*, Beijing International Center for Mathematical Research, Peking University, December 22, 2019

- BIRS-CMO Workshop on *Computational Harmonic Analysis and Data Science*, Casa Matemática Oaxaca, Oaxaca, Mexico, October 28, 2019

- 2019 Joint Statistical Meetings (American Statistical Association), Denver CO, July 28, 2019

- The 9th International Congress on Industrial and Applied Mathematics, Valencia, Spain, July 18, 2019

- 2019 SIAM Conference on Applied Algebra and Geometry, Bern, Switzerland, July 9, 2019

- NUS Workshop on High-Dimensional Learning and Computation in Physics, Singapore, June 22, 2019

- The 36th International Conference on Machine Learning, Long Beach CA, June 13, 2019

- IPAM Geometry and Learning Culminating Workshop, Lake Arrowhead CA, June 11, 2019

- Conference on Geometric Data Analysis, University of Chicago, Chicago IL, May 23, 2019

- IPAM Workshop on *Shape Analysis*, Los Angeles CA, April 19, 2019

- China–Korea International Conference on Matrix Theory with Applications, Shanghai China, December 19, 2018

- Twenty Years' Anniversary of the Academic Talent Program 1998–2018, Beijing, China, July 18, 2018

- The 9th International Conference on Curves and Surfaces, Arcachon, France, June 30, 2018

- Daubechies64: Time, Frequency, and Everything That Follows, Houthalen-Helchteren, Belgium, June 27, 2018

- 2018 SIAM Conference on Imaging Science, Bologna, Italy, June 6 & 7, 2018

- IMA Workshop on *Bridging Statistics and Sheaves*, Minneapolis MN, May 22, 2018

- Oberwolfach Workshop on *Applied Harmonic Analysis and Data Processing*, Mathematisches Forschungsinstitut Oberwolfach, Germany, March 29, 2018

- ENAR 2018 Spring Meeting, Atlanta GA, March 27, 2018

- The 42nd SIAM Southeastern Atlantic Section Conference, Chapel Hill NC, March 10, 2018

- 2017 SIAM Conference on Applied Algebra and Geometry, Atlanta GA, August 1, 2017

- 2017 Meeting of the International Linear Algebra Society, Ames IA, July 27, 2017

- 2017 SIAM Annual Meeting, Pittsburgh PA, July 12, 2017

- AMS Sectional Meeting, North Carolina State University, Raleigh NC, November 13, 2016

- Shape Analysis and Learning by Geometry and Machine, IPAM, Los Angeles CA, February 11, 2016