

# Tingran Gao

Department of Statistics  
The University of Chicago  
Chicago, Illinois 60637

(773) 834-1042 (office)  
tingrangao@galton.uchicago.edu  
gaotingran.com

---

## EDUCATION AND TRAINING

**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

Thesis: *Blow-up Analysis of Gauss Curvature Equations*

## PROFESSIONAL APPOINTMENTS

**Department of Statistics (Computational and Applied Mathematics Initiative), The University of Chicago** September 2017 – present

*William H. Kruskal Instructor*

Signal/Image/Geometry Processing, Nonparametric Statistics, Applied and Computational Algebra and Geometry, Optimization, Dynamical Systems, Applied and Computational Harmonic Analysis, Applications in Real Data Science Problems

**Department of Mathematics, Duke University** August 2015 – August 2017

*Visiting Assistant Professor*

Manifold Learning, Topological Data Analysis, Geometry and Topology of High-Dimensional Datasets, Applied Harmonic Analysis, Information Geometry

**Department of Mathematics, Duke University** August 2010 – May 2015

*Graduate Student*

Diffusion Geometry, Riemannian Geometry, Machine Learning, Applied Harmonic Analysis

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

*Research Internship*

The mathematical foundations of Formal Concept Analysis: Ordered Sets, Lattices Theory, Decomposition and Construction of Concept Lattices, Representation Theorems, Distributivity and Modularity

**Department of Mathematical Sciences, Tsinghua University** April 2009 – August 2009

*Undergraduate Independent Studies*

Optimization algorithms for nonlinear complementarity problems

## AWARDS

- AMS-Simons Travel Grant (2018)
- 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)
- National High School Mathematics Olympiad, Zhejiang Division, Second Prize (2005)
- Beijing High School Applied Mathematics Contest, First Prize (2004)

## PUBLICATIONS AND PREPRINTS

- [1] Shahab Asoodeh, **Tingran Gao**, James Evans. "Curvature of Hypergraphs via Multi-Marginal Optimal Transport." *The 57th IEEE Conference on Decision and Control*. eprint: [arXiv:1803.08584](https://arxiv.org/abs/1803.08584). (2018)
- [2] Chandrajit Bajaj, **Tingran Gao**, Zihang He, Qixing Huang, and Zhenxiao Liang. "SMAC: Simultaneous Mapping and Clustering Using Spectral Decompositions." *2018 International Conference on Machine Learning*. (2018)
- [3] **Tingran Gao**, Shahar Z. Kovalsky, Doug M. Boyer, and Ingrid Daubechies, "Gaussian Process Landmarking on Manifolds." *arxiv preprint*. eprint: [arXiv:1802.03479](https://arxiv.org/abs/1802.03479). (2018)
- [4] **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.*, 301:636-658, DOI:[10.1002/ar.23700](https://doi.org/10.1002/ar.23700) (2018)
- [5] **Tingran Gao**, Jacek Brodzki, and Sayan Mukherjee, "The Geometry of Synchronization Problems and Learning Group Actions." *submitted*. eprint: [arXiv:1610.09051](https://arxiv.org/abs/1610.09051). (2016)
- [6] 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)
- [7] 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." *Methods in Ecology and Evolution*, 2017;7:5041-5055. DOI:<https://doi.org/10.1002/ece3.3058> (2017)
- [8] **Tingran Gao**, "The Diffusion Geometry of Fibre Bundles." *under review*. eprint: [arXiv:1602.02330](https://arxiv.org/abs/1602.02330). (2016)
- [9] **Tingran Gao**, "Hypoelliptic Diffusion Maps and Their Applications in Automated Geometric Morphometrics." *PhD thesis, Duke University*. (2015) eprint: <http://hdl.handle.net/10161/9931>
- [10] 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)

## TEACHING EXPERIENCES

<b>STAT 27400/37400: Nonparametric Inference</b> The University of Chicago	Autumn 2018
<b>STAT 25100: Introduction to Mathematical Probability</b> The University of Chicago	Autumn 2018
<b>STAT 25100: Introduction to Mathematical Probability</b> The University of Chicago	Spring 2018
<b>STAT 27400/37400: Nonparametric Inference</b> The University of Chicago	Winter 2018
<b>MATH 181.02: Math Everywhere</b> Duke University	Spring 2016
<b>MATH 212L.12 &amp; 14: Multivariable Calculus</b> Duke University	Fall 2015
<b>MATH 105L.01: Lab Calculus I</b> Duke University	Summer Term II 2014
<b>MATH 122L.13: Introductory Calculus II with Applications</b> Duke University	Fall 2015

## INTERNSHIP

### **Data Science Intern at MarkMonitor, Part of Thomson Reuters**

June 2015 – August 2015

#### *Data Scientist – Machine Learning*

- Prototyped in Python a high-accuracy real-time machine learning system for malicious URL detection based on Random Forest. Implementation involved extensive programming with Spark Streaming and MLlib; final product deployed to Amazon EC2.
- Built a Titan graph database from real web crawler data, and created a Python demo for infringement prediction based on graph inference algorithm Loopy Belief Propagation. The database is highly available through Rexster Graph Server, backed by Cassandra and ElasticSearch.

## RECENT AND UPCOMING INVITED PRESENTATIONS

- *Gaussian Process Landmarking on Manifolds*, The 9th International Conference on Curves and Surfaces, Palais des Congrès, Arcachon, France, June 30, 2018
- *Gaussian Process Landmarking on Manifolds*, Daubechies64: Time, Frequency, and Everything That Follows, Park Molenheide, Houthalen-Helchteren, Belgium, June 27, 2018
- *A Tale of Two Bases: Local-Nonlocal Regularization on Image Patches with Convolution Framelets*, 2018 SIAM Conference on Imaging Science: Minisymposium on “Low Dimensional Structures in Imaging Science”, Bologna, Italy, June 7, 2018
- *The Geometry of Synchronization Problems and Learning Group Actions*, 2018 SIAM Conference on Imaging Science: Minisymposium on “Geometry and Learning in 3D Shape Analysis”, Bologna, Italy, June 6, 2018
- *Synchronization Problems: From Geometry to Learning*, IMA Workshop on “Bridging Statistics and Sheaves”, The Institute for Mathematics and Its Applications, Minneapolis MN, USA, May 21 – May 25, 2018
- *Synchronization Problems: From Geometry to Learning*, Oberwolfach Workshop on “Applied Harmonic Analysis and Data Processing”, Mathematisches Forschungsinstitut Oberwolfach, Oberwolfach, Germany, March 25 – March 31, 2018
- *Manifold Learning on Fibre Bundles*, ENAR 2018 Spring Meeting: IMS Invited Session on “Geometry and Topology in Statistical Inference”, Atlanta GA, March 25 – March 28, 2018
- *Gaussian Process Landmarking on Manifolds*, The 42nd SIAM Southeastern Atlantic Section Conference (SIAM-SEAS 2018): Minisymposium on “Mathematics in Data Analysis and Machine Learning”, Chapel Hill NC, March 10, 2018
- *Manifold Learning on Fibre Bundles*, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Beijing, Dec 7, 2017
- *Manifold Learning on Fibre Bundles*, SING (Signals, Information, and Networks Group) Group Seminar, Harvard University, Boston MA, Nov 28, 2017
- *The Geometry of Synchronization Problems and Learning Group Actions*, 2017 SIAM Conference on Applied Algebra and Geometry, Atlanta GA, August 1, 2017
- *Manifold Learning on Fibre Bundles*, 2017 Meeting of the International Linear Algebra Society, Ames IA, July 27, 2017
- *Diffusion Geometry and Manifold Learning on Fibre Bundles*, 2017 SIAM Annual Meeting, Minisymposium on “Geometry and Computational Challenges in Data Science,” Pittsburgh PA, July 12, 2017
- *Synchronization Problems and Manifold Learning on Fibre Bundles*, Geometry and Topology Seminar, North Carolina State University, Raleigh NC, January 18, 2017
- *The Diffusion Geometry of Shape Spaces*, AMS Sectional Meeting: Special Session on Geometry and Topology in Image and Shape Analysis, North Carolina State University, Raleigh NC, November 13, 2016

- *Synchronization Problems and the Diffusion Geometry of Shape Spaces*, Department of Computer Science, Stanford University, Palo Alto CA, May 2, 2016
- *Synchronization Problems and the Diffusion Geometry of Shape Spaces*, Department of Mathematics, Rensselaer Polytechnic Institute, Troy NY, April 18, 2016
- *Geometry Processing and Visualization in Paleontology*, Visualization Friday Forum, Duke University, Durham NC, March 11, 2016
- *Machine Learning, Fibre Bundles and Biological Morphology*, Shape Analysis and Learning by Geometry and Machine, IPAM, Los Angeles CA, February 11, 2016
- *An Invitation to Geometry Processing*, Graduate/Faculty Seminar, Duke University, Durham NC, September 25, 2015
- *Hypoelliptic Diffusion Maps*, Data Seminar, Duke University, Durham NC, April 16, 2015
- *The Diffusion Geometry of Shape Spaces*, Student Talk at Triangle Area Graduate Mathematics Conference (TAGMaC), North Carolina State University, Raleigh NC, March 21, 2015

### **SELECTED ACTIVITIES**

- *The 9th International Conference on Curves and Surfaces*, Palais des Congrès, Arcachon, France, June 28 – July 4, 2018
- *2018 SIAM Annual Meeting*, Oregon Convention Center, Oregon OR, July 9 – July 13, 2018
- *Dynamics, Topology and Computations 2018*, Mathematical Research and Conference Center in Bełdewo, Poland, June 18 – June 23, 2018
- *2018 SIAM Conference on Imaging Science: Minisymposium on “Geometry and Learning in 3D Shape Analysis”*, Bologna, Italy, June 5 – June 8, 2018
- *IMA Workshop on “Bridging Statistics and Sheaves”*, The Institute for Mathematics and Its Applications, Minneapolis MN, May 21 – May 25, 2018
- *Oberwolfach Workshop on “Applied Harmonic Analysis and Data Processing”*, Mathematisches Forschungsinstitut Oberwolfach, Oberwolfach Germany, March 25 – March 31, 2018
- *ENAR 2018 Spring Meeting: IMS Invited Session on “Geometry and Topology in Statistical Inference”*, Atlanta GA, March 25 – March 28, 2018
- *2017 SIAM Conference on Applied Algebraic Geometry*, Georgia Institute of Technology, Atlanta GA, July 31 – August 4, 2017
- *2017 Joint Statistical Meetings (Invited Poster)*, Baltimore Convention Center, Baltimore MD, July 29 – August 3, 2017
- *2017 Meeting of the International Linear Algebra Society*, Iowa State University, Ames IA, July 24 – July 28, 2017
- *2017 SIAM Annual Meeting and 2017 SIAM Conference on Industrial and Applied Geometry*, David Lawrence Convention Center, Pittsburgh PA, July 10 – July 14, 2017
- *AMS Sectional Meeting: Special Session on “Geometry and Topology in Image and Shape Analysis,”* North Carolina State University, Raleigh NC, November 12 – November 13, 2016
- *Stochastic Numerical Algorithms, Multiscale Modeling and High-Dimensional Data Analytics*, ICERM, Brown University, Providence RI, July 18 – July 22, 2016
- *NSF-CBMS Regional Conference on Topological Data Analysis*, University of Texas at Austin, Austin TX, May 31 – June 4, 2016
- *Topology, Geometry, and Data Analysis Conference*, Ohio State University, Columbus OH, May 16 – May 20, 2016.
- Short-Term Visiting Scholar, Department of Computer Science, Stanford University, Palo Alto CA, May 1 – May 28, 2016

- Summer Graduate Workshop: *Optimal Transport: Geometry and Dynamics*, MSRI, Berkeley CA, August 26 – August 30, 2013
- Short-Term Visiting Graduate Student, Weizmann Institute of Science, Rehovot Israel, July 6 – July 19, 2013
- The 11th Symposium on Geometry Processing, Genova, Italy, July 3 – July 5, 2013
- IMA New Directions Short Course, *Applied Statistics and Machine Learning*, The Institute for Mathematics and Its Applications, Minneapolis MN, June 17 – June 28, 2013
- Short-Term Visiting Graduate Student, Weizmann Institute of Science, Rehovot Israel, May 2 – May 26, 2012
- Second Abel Conference: *A Mathematical Celebration of John Milnor*, IMA, Minneapolis MN, January 30 – February 1, 2012
- Summer Graduate Workshop: *Geometric Measure Theory and Applications*, MSRI, Berkeley CA, July 11 – July 22, 2011
- Workshop on Frontiers in Computational and Applied Mathematics, Tsinghua University, Beijing, China, August 9 – August 10, 2009
- Summer Workshop on Duality Theory and Application, Tsinghua University, Beijing, China, May 23 – May 24, 2009

## **PROFESSIONAL SERVICES**

### **Conference Organizer**

- SIAM Annual Meeting 2018 (SIAM AN18) - Minisymposium on “Numerical Differential Geometry Meets Numerical Algebraic Geometry,” Portland, OR, July 2018 (with Dr. Jose I. Rodriguez)
- SIAM Annual Meeting 2018 (SIAM AN18) - Minisymposium I & II on “Data Science with Tools from Applied Geometry and Algebra,” Portland, OR, July 2018 (with Prof. 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

### **Journal Referee**

- Constructive Approximation
- SIAM Journal on Imaging Sciences
- SIAM Journal on Applied Algebra and Geometry
- Electronic Journal of Statistics
- Communications in Mathematical Sciences
- Frontiers in Applied Mathematics and Statistics
- Annals of Statistics
- IEEE Transactions on Image Processing
- Journal of the American Mathematical Society (JAMS)
- IEEE Signal Processing Letters
- SIAM Journal on Matrix Analysis and Applications
- Journal of the Royal Society Interface

### **Seminar Organizer**

- Applied Mathematics & Analysis Seminar (Duke University)