

# Zhichao Wang

*Curriculum Vitae*

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## RESEARCH INTERESTS

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Foundations of AI and Deep Learning, High-dimensional Probability, High-Dimensional Statistics

## EDUCATION

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**University of California San Diego, USA** *Ph.D. candidate in Mathematics, 2019-present*

Advisors: Prof. Ioana Dumitriu and Prof. Todd Kemp

**Texas A&M University, College Station, USA** *MSc. in Mathematics, 2017-2019*

Advisor: Prof. Michael Anshelevich

**Beihang University, Beijing, China** *BSc. in Mathematics and Applied Mathematics, 2013-2017*

Hua Loo-Keng Honors Class, joint program with the Academy of Mathematics and Systems Science of Chinese Academy of Sciences. Exchange student at Texas A&M University (2016-2017).

## HONORS AND AWARDS

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<i>2023</i>	Scholar Award of NeurIPS 2023, USA
<i>2019</i>	James B. Ax Fellowship, UCSD, USA
<i>2017</i>	Graduate Fellowship in Department of Mathematics, TAMU, USA
<i>2016, 2017</i>	Study Abroad Scholarships, Beihang University, China
<i>2016</i>	Meritorious Winner of MCM/ICM Contest, USA
<i>2015, 2016</i>	Hua Luogeng Scholarships, Academy of Mathematics and Systems Science, Chinese Academy of Sciences
<i>2014, 2015</i>	Huatong Scholarships, Beihang University, China
<i>2014, 2015</i>	Scholarships of Academic Performance, Beihang University, China
<i>2014</i>	First Prize in College Students Physics Contest in Beijing, China

## PUBLICATIONS AND PREPRINTS

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- Nonlinear spiked covariance matrices and signal propagation in deep neural networks.**  
(with Denny Wu and Zhou Fan)  
Submitted.
- Unlocking Exact Recovery in Semi-Supervised Learning: Analysis of Spectral Method and Graph Convolution Network.**  
(with Haixiao Wang)  
Submitted.
- High-Dimensional Asymptotics of Feature Learning in the Early Phase of Neural Network Training.**  
(with Jimmy Ba, Murat A. Erdogdu, Taiji Suzuki, Denny Wu, and Greg Yang)  
In preparation.

4. **Faithful and Efficient Explanations for Neural Networks via Neural Tangent Kernel Surrogate Models.**  
(with Andrew Engel, Natalie S. Frank, Ioana Dumitriu, Sutanay Choudhury, Anand Sarwate, and Tony Chiang)  
*ICLR 2024 Spotlight*, to appear.
5. **Learning in the Presence of Low-dimensional Structure: A Spiked Random Matrix Perspective.**  
(with Jimmy Ba, Murat A. Erdogdu, Taiji Suzuki, and Denny Wu)  
*NeurIPS 2023*, to appear.
6. **Spectral evolution and invariance in linear-width neural networks.**  
(with Andrew Engel, Anand Sarwate, Ioana Dumitriu, and Tony Chiang)  
*NeurIPS 2023*, to appear.
7. **Deformed semicircle law and concentration of nonlinear random matrices for ultra-wide neural networks.**  
(with Yizhe Zhu)  
*Annals of Applied Probability*, to appear.
8. **Overparameterized random feature regression with nearly orthogonal data.**  
(with Yizhe Zhu)  
*In International Conference on Artificial Intelligence and Statistics (AISTATS)*, pp. 8463-8493. PMLR, 2023.
9. **High-dimensional Asymptotics of Feature Learning: How One Gradient Step Improves the Representation.**  
(with Jimmy Ba, Murat A. Erdogdu, Taiji Suzuki, Denny Wu, and Greg Yang)  
*Advances in Neural Information Processing Systems 35 (2022)*: 37932-37946.
10. **Tree convolution for probability distributions with unbounded support.**  
(with Ethan Davis and David Jekel)  
*Latin American Journal of Probability and Mathematical Statistics (ALEA) 18.2 (2021)*, pp. 1585-1623.
11. **Principal components in linear mixed models with general bulk.**  
(with Zhou Fan and Yi Sun)  
*The Annals of Statistics*, 49.3 (2021), pp. 1489-1513.
12. **Spectra of the Conjugate Kernel and Neural Tangent Kernel for linear-width neural networks.**  
(with Zhou Fan)  
*Advances in neural information processing systems 33 (2020)*: 7710-7721. **Oral Presentation**
13. **Higher variations for free Lévy processes.**  
(with Michael Anshelevich)  
*Studia Math.* 252 (2020), pp. 49-81.
14. **Convergence of the Powers of Free Triangular Arrays to Higher Variations of Free Lévy Processes.**  
Master's thesis, Texas A & M University.

## WORK EXPERIENCE

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Research Internship

06/2021- 09/2022

Pacific Northwest National Laboratory, Advisor: Tony Chiang.

Deep learning research and software development.

## Research Internship

07/2016-08/2016

Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Advisor: Prof. Feimin Huang.

## TEACHING EXPERIENCE

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### Teaching Assistant, Department of Mathematics, UCSD

09/2019-present

MATH 3C Pre-Calculus

MATH 10B&C Calculus

MATH 170A Numerical Linear Algebra

MATH 180A Introduction to Probability

MATH 280B&C Graduate Probability Theory

### Teaching Assistant, Department of Mathematics, Texas A&M University

01/2017-07/2019

MATH 308 Differential Equations

MATH 411 Mathematical Probability

MATH 220 Foundation of Mathematics

MATH 467 Modern Geometry

MATH 152&251 Engineering Mathematics

## SELECTED TALKS AND INVITED PRESENTATIONS

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- 11/2023 5th Annual Conference on the Mathematical Theory of Deep Learning (DeepMath).
- 08/2023 IAIFI Summer Workshop at Northeastern University.
- 07/2023 HiLD: High-dimensional Learning Dynamics Workshop, ICML Workshop 2023.
- 05/2023 Summer School on Random Matrix Theory and Its Applications at OSU.
- 04/2023 Southern California Applied Mathematics Symposium (SOCAMS 2023).
- 09/2022 SIAM Conference on Mathematics of Data Science (MDS22).
- 06/2022 RMMC Summer School at University of Wyoming.
- 03/2022 Combinatorics and Probability Seminar at UC Irvine.
- 12/2021 Frontier Probability Days 2021, at Las Vegas.
- 09/2021 Universality and Integrability in Random Matrix Theory and Interacting Particle Systems Workshop, at MSRI (virtual).
- 03/2021 Machine Learning Seminar, at Pacific Northwest National Laboratory (virtual).
- 12/2020 Neural Information Processing Systems (NeurIPS) virtual **oral presentation**.

## MENTORSHIP EXPERIENCE

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### Mentor at the Cohort Program, School of Physical Sciences, UCSD

09/2023-06/2024

Provide first-year undergraduate students in STEM with the essential tools, strategies, and support necessary to excel academically, develop professionally, explore research and internship opportunities, and share experiences of graduate school applications.

### Mentor at Department of Mathematics, UCSD

9/2021-06/2022

### Mentor at Math Department, Beihang University

10/2014-07/2015

## SKILLS

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- Language* Chinese (Native), English (Fluent)
- Software* Python, MATLAB,  $\LaTeX$ , TensorFlow, PyTorch, JAX, C++

## PROFESSIONAL SERVICE

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**Journal Reviewer:** Annals of Statistics, Canadian Journal of Mathematics, Transactions on Machine Learning Research.

**Conference Reviewer:** AISTATS '22, AISTATS '23, NeurIPS '23, ICLR '24, AISTATS '24.

## REFERENCES

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- Prof. Ioana Dumitriu  
Email: idumitriu@ucsd.edu  
Department of Mathematics  
University of California, San Diego (UCSD)  
9500 Gilman Drive 0112  
La Jolla, CA, 92093-0112, USA.
- Prof. Todd Kemp  
Email: tkemp@ucsd.edu  
Department of Mathematics  
University of California, San Diego (UCSD)  
9500 Gilman Drive 0112  
La Jolla, CA, 92093-0112, USA.
- Prof. Zhou Fan  
Email: zhou.fan@yale.edu  
Department of Statistics and Data Science  
Yale University  
24 Hillhouse Avenue  
New Haven, CT, 06511, USA.
- Prof. Murat A. Erdogdu  
Email: erdogdu@cs.toronto.edu  
Department of Statistical Sciences and Department of Computer Science  
University of Toronto  
Vector Institute  
Pratt 286b, 6 King's College Rd.  
Toronto, ON M5S 3H5
- (Teaching) Dr. Frances Hammock  
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