Jonathan W. Siegel

Texas A&M University
Department of Mathematics
Blocker Building
College Station, TX 77840

Phone: (909) 646-0941
Email: jwsiegel@tamu.edu
Homepage: https://jwsiegel2510.github.io

EDUCATION

University of California at Los Angeles   2013-2018
Ph.D. in Mathematics   Los Angeles, CA
Advisor: Russel E. Caflish
Thesis: "Accelerated First-Order Optimization with Orthogonality Constraints"

University of California at Santa Cruz   2009-2013
B.Sc. (Honors) in Mathematics   Santa Cruz, CA

ACADEMIC APPOINTMENTS

Assistant Professor   2022-present
Texas A&M University   College Station, TX

Assistant Research Professor   2021-2022
Pennsylvania State University   University Park, PA

Postdoctoral Scholar   2018-2021
Pennsylvania State University   University Park, PA

RESEARCH PAPERS

Journal Articles

1. Sharp Convergence Rates for Matching Pursuit. *To appear in IEEE Transactions on Information Theory*, 2025. With Jason Klusowski
   Preprint available at: https://arxiv.org/abs/2307.07679

2. Convergence and Error Control of Consistent PINNs for Elliptic PDEs. *To appear in IMA Journal of Numerical Analysis*, 2025. With Andrea Bonito, Ronald DeVore, and Geurgana Petrova.
   Preprint available at: https://arxiv.org/abs/2406.09217

3. Efficient Structure-Informed Featurization and Property Prediction of Ordered, Dilute, and Random Atomic Structures. *Computational Materials Science* 247 (2025): 113495. With Adam Krajewski and Zi-Kui Liu.

Preprint available at: https://arxiv.org/abs/2404.02849

4. Weighted variation spaces and approximation by shallow ReLU networks. *Applied and Computational Harmonic Analysis* 74 (2025): 101713. With Ronald DeVore, Robert Nowak and Rahul Parhi.

5. Sharp Lower Bounds on the Manifold Widths of Sobolev and Besov Spaces. *Journal of Complexity* 101884, 2024.

6. Entropy-based convergence rates of greedy algorithms. *Mathematical Models and Methods in Applied Sciences* 34(05):779-802, 2024. With Yuwen Li.

7. Optimal Approximation Rates for Deep ReLU Neural Networks on Sobolev and Besov Spaces. *Journal of Machine Learning Research* 24.357:1-52, 2023.

8. Greedy Training Algorithms for Neural Networks and Applications to PDEs. *Journal of Computational Physics* 484:112084, 2023. With Qingguo Hong, Xianlin Jin, Wenrui Hao, and Jinchao Xu.

9. Extended Regularized Dual Averaging Methods for Stochastic Optimization. *Journal of Computational Mathematics* 41(3):525-541, 2023. With Jinchao Xu.

10. Sharp Bounds on the Approximation Rates, Metric Entropy, and n-widths of Shallow Neural Networks. *Foundations of Computational Mathematics* 1-57, 2022. With Jinchao Xu.

11. Characterization of the Variation Spaces Corresponding to Shallow Neural Networks. *Constructive Approximation* 1-24, 2023. With Jinchao Xu.

12. Uniform Approximation Rates and Metric Entropy of Shallow Neural Networks. *Research in the Mathematical Sciences* 9.3:1-21, 2022. With Limin Ma and Jinchao Xu.

13. Optimal Convergence Rates for the Orthogonal Greedy Algorithm. *IEEE Transactions on Information Theory* 68.5:3354-3361, 2022. With Jinchao Xu.

14. Extensible Structure-Informed Prediction of Formation Energy with Improved Accuracy and Usability employing Neural Networks. *Computational Materials Science* 208:111254, 2021. With Adam Krajewski, Zi-Kui Liu, and Jinchao Xu.

15. High-Order Approximation Rates for Shallow Neural Networks with Cosine and ReLU^k Activation Functions. *Applied and Computational Harmonic Analysis* 58:1-26, 2022. With Jinchao Xu.

16. Approximation Rates for Neural Networks with General Activation Functions. *Neural Networks* 128:313-321, 2020. With Jinchao Xu.

17. Accuracy, Efficiency and Optimization of Signal Fragmentation. *Multiscale Modeling and Simulation* 18(2):737–757, 2020. With Russel Caflisch and Hung Hsu Chou

18. Accelerated Optimization with Orthogonality Constraints. *Journal of Computational Mathematics* 39(2):207–226, 2020.

19. Compact Support of L^1 Penalized Variational Problems. *Communications in Mathematical Sciences* 15(6):1771-1790, 2017. With Omer Tekin.

Conference Papers

1. On the Expressiveness and Spectral Bias of KANs. *Thirteenth International Conference on Learning Representations* 2025. With Yixuan Wang, Ziming Liu, and Thomas Y. Hou.

2. Achieving Acceleration Despite Very Noisy Gradients. *38th Conference on Neural Information Processing Systems* 2024. With Kanan Gupta and Stephan Wojtowytsch.

3. Equivariant Frames and the Impossibility of Continuous Canonicalization. *Forty-first International Conference on Machine Learning* 2024. With Nadav Dym and Hannah Lawrence.

Under Review

- Approximation Rates for Shallow ReLU^k Neural Networks on Sobolev Spaces via the Radon Transform. *Submitted to SIAM Journal on Mathematical Analysis, 2024.* With Tong Mao and Jinchao Xu.
  Preprint available at: https://arxiv.org/abs/2408.10996

- Optimal Approximation of Zonoids and Uniform Approximation by Shallow Neural Networks. *Submitted to Constructive Approximation*, 2023.
  Preprint available at: https://arxiv.org/abs/2307.15285

- Sharp Lower Bounds on Interpolation by Deep ReLU Neural Networks at Irregularly Spaced Data. *Submitted to Journal of Approximation Theory*, 2023.
  Preprint available at: https://arxiv.org/abs/2302.00834

- On the Activation Function Dependence of the Spectral Bias of Neural Networks. *Submitted to Computer Methods in Applied Mechanics and Engineering*, 2024. With Qingguo Hong, Qingyang Tan and Jinchao Xu
  Preprint available at: https://arxiv.org/abs/2208.04924

Preprints

- Training Sparse Neural Networks using Compressed Sensing, 2021. With Jianhong Chen, Pengchuan Zhang and Jinchao Xu.
  Preprint available at: https://arxiv.org/abs/2008.09661

- Accelerated First-Order Methods: Differential Equations and Lyapunov Functions, 2019.
  Preprint available at: https://arxiv.org/abs/1903.05671

GRANTS

NSF DMS-2216799 (PI)   2022
"US Participation at the Twenty-sixth International Domain Decomposition Conference" $15,000

NSF CCF-2205004 (co-PI)   2022-2025
PI: Jia Li
"CIF: Small: Interpretable Machine Learning based on Deep Neural Networks: A Source Coding Perspective" $600,000

SciTech Services (PI)   2024-2025
"Three-Dimensional Compression of Spatial-Spectral Information Using Machine Learning Technique" $75,263

KAUST OFP 2023 (Sub-award)   2024-2025
PI: Jinchao Xu
"Multilevel Training Algorithms for Scientific Computing" $17,090

TEACHING EXPERIENCE

Texas A&M University   Fall 2023, 2024
Instructor   College Station, TX
Math 689 - Principle of Deep Learning (Graduate Course)

Texas A&M University   Spring 2023, 2025
Instructor   College Station, TX
Math 667 - Foundations and Methods of Approximation (Graduate Course)

Texas A&M University   Fall 2022
Instructor   College Station, TX
Math 308H - Honors Differential Equations

Pennsylvania State University   Fall 2021
Instructor   University Park, PA
Math 141 - Integral Calculus

Pennsylvania State University   Spring 2021
Co-Instructor   University Park, PA
Math 555 - Optimization Theory (Graduate Course)

Pennsylvania State University   Fall 2020
Instructor   University Park, PA
Math 140 - Differential Calculus

Pennsylvania State University   Spring 2020

Instructor   University Park, PA
Math 251 - Differential Equations
Math 251H - Honors Differential Equations

Pennsylvania State University   Fall 2019
Instructor   University Park, PA
Math 141 - Integral Calculus

Pennsylvania State University/Peking University   Summer 2019
Co-Instructor   Beijing, China
Math 497 - Introduction to Deep Learning

Pennsylvania State University   Fall 2018
Instructor   University Park, PA
Math 141 - Integral Calculus

University of California, Los Angeles   2014-2017
Teaching Assistant   Los Angeles, CA
Math 32B - Integral Vector Calculus
Math 32A - Differential Vector Calculus
Math 110B - Finite Group Theory

INVITED SEMINAR AND CONFERENCE TALKS

UT Austin   February 20, 2025
Workshop on Mathematical Machine Learning

RWTH Aachen   October 21, 2024
Conference in Honor of Wolfgang Dahmen

Texas A&M University   September 11, 2024
Interdisciplinary Lecture Series: Science and Engineering at the Frontiers

University of Houston   September 6, 2024
Applied Mathematics Seminar

Pennsylvania State University   May 21, 2024
Computation and Applied Mathematics Seminar

Oberwolfach Workshop   April 9, 2024
Mathematics of Entropic AI in the Natural Sciences

Texas A& M University   March 21, 2024
AI, ML, and Health Collaborations Workshop

National Yang Ming Chiao Tung University — November 3, 2023
Webinar on Scientific Machine Learning

Steklov Institute — November 1, 2023
Conference in Honor of Vladimir Temlyakov

Southern Methodist University — October 4, 2023
Math Colloquium

Brigham Young University — September 21, 2023
Applied Math Seminar

Duke University — August 17, 2023
Workshop on Computational and Data Science

Duke University — August 15, 2023
Summer School on Computational and Data Science

Morgan State University — June 22, 2023
CBMS Conference on Deep Learning and Numerical PDEs

Texas A&M University — May 23, 2023
Inaugural CAMDA Conference

University of Texas at El Paso — February 17, 2023
Applied Mathematics Seminar

SUNY Albany — January 23, 2023
Data Science Seminar

Brown University — December 23, 2022
Crunch Seminar on Scientific Computing

Texas A&M University — December 8, 2022
TAMIDS Seminar

University of Oslo — December 1, 2022
Scientific and Machine Learning Seminar

King Abdullah University of Science and Technology (KAUST) — November 22, 2022
Mathematics and Computational Science Seminar

King Abdullah University of Science and Technology (KAUST) — November 15, 2022
Conference on Scientific Computing and Machine Learning

Texas State University   September 30, 2022
SyDATA Symposium

Texas A&M University   August 31, 2022
CAMDA Seminar

Czech Technical University in Prague   July 26, 2022
27th International Conference on Domain Decomposition Methods, Invited Plenary Talk

Princeton University   May 16, 2022
Wilks Seminar

Georgia Institute of Technology   April 4, 2022
Applied and Computational Mathematics (ACM) Seminar

Illinois Institute of Technology   January 21, 2022
Mathematics Department Colloquium

Texas A&M University   December 6, 2021
Mathematics Department Colloquium

University of South Carolina   November 29, 2021
Mathematics Department Colloquium

Rensselaer Polytechnic Institute   October 6, 2021
Mathematics in Imaging, Data and Optimization Seminar

RWTH Aachen   October 4, 2021
Applied Mathematics Group Lunch Seminar

ETH Zurich   June 2, 2021
FoMICS Seminar Talk and Lecture

University of Texas, Austin   May 21, 2021
Applied Mathematics Seminar

University of California, San Diego   May 11, 2021
CCoM Seminar

Purdue University   May 10, 2021
Mathematical Data Science Webinar

University of Notre Dame   April 15, 2021
ACMS Applied Mathematics Seminar

University of California, Irvine   March 15, 2021
Computational Mathematics Seminar

California Institute of Technology   February 17, 2021
CMX (Computational Mathematics) Seminar

Pennsylvania State University   December 15, 2020
CCMA Workshop on Mathematical Machine Learning and Applications

INVITED MINI-SYMPOSIUM TALKS

SIAM Annual Meeting   July 18, 2024
Recent Advances in Optimization for Training Neural Networks

North American High Order Methods Conference at Dartmouth   June 18, 2024
Design and analysis of machine learning algorithms inspired by traditional numerical methods

AMS Sectional Meeting at the UW Milwaukee   April 20, 2024
Recent Advances in Numerical PDE Solvers by Deep Learning

AMS Sectional Meeting at Florida State University   March 23, 2024
Mathematical Advances in Scientific Machine Learning

Foundations of Computational Mathematics Conference   June 19, 2023
Approximation Theory Session

Copper Mountain Conference on Multigrid Methods   April 17, 2023
Artificial intelligence and multilevel methods

SIAM Conference on the Mathematics of Data Science   September 27, 2022
Recent Advances in Machine Learning and Optimization

SIAM Conference on Uncertainty Quantification   April 12, 2022
Recent Advances in Machine Learning and Data-Driven Methods for Physical Sciences and Engineering

AMS Fall Western Sectional Meeting   October 23, 2021
Special Session on Theoretical and Applied perspectives in Machine Learning

SIAM Conference on Analysis of PDEs   March 16, 2021
Mathematics of Machine Learning Methods for PDEs

Kunming, China   August 15, 2019
International Multigrid Conference (IMG)

SERVICE

Students Advised

- Jianhong Chen, Penn State Graduate Student, 2019-2020 (co-advised)

- Xianlin Jin, Peking University Graduate student, 2021-present (co-advised)

- Kanan Gupta, Texas A&M University Graduate Student, 2022-present (co-advised)

- Jiyoung Park, Texas A&M University Graduate Student, 2023-present

- Ali Hamza Abidi Syed, Texas A&M University Graduate Student, 2025-present

Conferences Co-Organized

- CCMA Workshop on Mathematical Machine Learning and Applications, December 14-16, 2020.

Seminars Co-Organized

- Computational and Applied Mathematics (CAM) Colloquium at Penn State, Fall 2020-Fall 2021

Ad-Hoc Reviewer for

- **Journals**: Mathematical Programming, Neural Networks, Numerical Algorithms, Calculus of Variations and Partial Differential Equations, Expert Systems with Applications, IEEE Transactions on Neural Networks and Learning Systems, SIAM Journal on Optimization, SIAM Journal on Numerical Analysis, SIAM Journal on Scientific Computing, SIAM Journal on Mathematics of Data Science, Journal of Machine Learning Research, Analysis and Applications, Annals of Statistics

- **Conferences**: AISTATS, CAMDA Conference Proceedings

- **Funding Agencies**: NSF Panel Member, 2025

AWARDS AND SCHOLARSHIPS

University of California, Los Angeles	2018
• Pacific Journal of Mathematics Dissertation Award	
University of California, Los Angeles	2013-2014
• University of California Regents Fellow	
University of California, Santa Cruz	2012
• Stephen M. Palais Award	
University of California, Santa Cruz	2011
• Putnam Mathematical Competition Honorable Mention	

AFFILIATIONS

American Mathematical Association (AMS)	2021-present
Society of Industrial and Applied Mathematicians (SIAM)	2021-present

Institute of Electrical and Electronics Engineers (IEEE)   2023-present

INDUSTRY EXPERIENCE

Google Intern   June 6, 2016-August 26, 2016
Mountainview, CA
I worked with the Network Architecture team on improving the efficiency of a Monte Carlo network reliability simulation. Specifically, I implemented importance sampling, which reduced the number of samples required by a factor of 3.

Google Intern   June 12, 2017-September 1, 2017
Los Angeles, CA
I worked with the Budgetplanner Team (a division working on advertisement). I built a data processing pipeline that collected and processed data which was scattered across multiple relational databases to create training data for a machine learning model. Then I used TensorFlow to design and test multiple machine learning models on the resulting dataset.

TECHNICAL STRENGTHS

Programming Skills: C/C++, Java, Matlab, Latex, Python