Florian Schäfer

September 02, 2024

Title: Assistant Professor, School of Computational Science & Engineering
Institution: Georgia Institute of Technology
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I Degrees

California Institute of Technology (Caltech), Pasadena, CA

Ph.D. in Applied and Computational Mathematics *Summer 2021*

Thesis: "Inference, Computation, and Games"

Advisor: Houman Owhadi

Rheinische Friedrich-Wilhelms Universität, Bonn, Germany

M.S. in Mathematics *fall 2015*

Thesis: "The Time Discrete Exponential Map in the Space of Images"

Advisor: Martin Rumpf

B.S. in Mathematics *fall 2013*

Thesis: "Gibbs-Young Measures"

Advisor: Stefan Müller

II Employment History

Georgia Institute of Technology (Gatech), Atlanta, GA

Assistant Professor *August 2021 – present*

California Institute of Technology (Caltech), Pasadena, CA

Postdoctoral Scholar *July 2021*

Graduate Research and Teaching Assistant *September 2015 – June 2021*

III Honors and Awards

SIGGRAPH 2024 Best Technical Paper Award, *June 2024*

Five awards made that year, out of 840 submissions. For the paper "Lightning-fast Method of Fundamental Solutions," joint with Jiong Chen and Mathieu Desbrun.

W. P. Carey & Co. Prize in Applied Mathematics, *June 2021*

Awarded for "outstanding doctoral dissertations in applied mathematics" at Caltech.

AI4Science/Amazon AWS Fellowship, *November 2017*

$40,000 fellowship awarded to five Caltech graduate students or postdocs.

IV Research and Scholarship

IV-A Publications

α indicates equal contribution. Boldface indicates authorship of FS or of students (co)-advised by FS.

Selected Publications

[S1] **Ruijia Cao** and **Florian Schäfer**, *Information geometric regularization of the barotropic Euler equation*, 2023, https://arxiv.org/pdf/2308.14127

[S2] **Florian Schäfer** and Houman Owhadi, *Sparse recovery of elliptic solvers from matrix-vector products*, 2023, **SIAM Journal on Scientific Computing**

[S3] **Florian Schäfer**, Matthias Katzfuss, and Houman Owhadi, *Sparse Cholesky factorization by Kullback-Leibler minimization*, 2021, **SIAM Journal on Scientific Computing**

[S4] **Florian Schäfer**, T. J. Sullivan, and Houman Owhadi, *Compression, inversion, and approximate PCA of dense kernel matrices at near-linear computational complexity*, 2021, **SIAM Multiscale Modeling and Simulation**

[S5] **Florian Schäfer** and Anima Anandkumar, *Competitive Gradient Descent*, **NeurIPS 2019**

IV-A.1 Published and Accepted Journal Articles

[J1] Jessie Liu, **Florian Schäfer**, Spencer H. Bryngelson, Tamer A. Zaki, and Ali Mani, *Adjoint-based computation of nonlocal eddy viscosity in turbulent channel flow*, 2024, **Physical Review Fluids**

[J2] Yifan Chen, Houman Owhadi, and **Florian Schäfer**, *Sparse Cholesky Factorization for Solving Nonlinear PDEs via Gaussian Processes*, 2024, **Mathematics of Computation**

[J3] Spencer H. Bryngelson$^{\alpha}$, **Florian Schäfer**$^{\alpha}$, Jessie Liu, and Ali Mani, *Fast Macroscopic Forcing Method*, 2023, **Journal of Computational Physics**

[J4] **Florian Schäfer** and Houman Owhadi, *Sparse recovery of elliptic solvers from matrix-vector products*, 2023, **SIAM Journal on Scientific Computing**

[J5] Matthias Katzfuss and **Florian Schäfer**, *Scalable Bayesian transport maps for high-dimensional non-Gaussian spatial fields*, 2023, **JASA T&M**

[J6] Jiawei Zhao, **Florian Schäfer**, and Anima Anandkumar, *ZerO Initialization: Initializing Residual Networks with only Zeros and Ones*, 2022, **Transactions on Machine Learning Research**

[J7] **Florian Schäfer**, Matthias Katzfuss, and Houman Owhadi, *Sparse Cholesky factorization by Kullback-Leibler minimization*, 2021, **SIAM Journal on Scientific Computing**

[J8] **Florian Schäfer**, T. J. Sullivan, and Houman Owhadi, *Compression, inversion, and approximate PCA of dense kernel matrices at near-linear computational complexity*, 2021, **SIAM Multiscale Modeling and Simulation**

[J9] Houman Owhadi, Clint Scovel, **Florian Schäfer**, *Statistical Numerical Approximation*, 2019, **Notices of the AMS**

[J10] Qingfu Zhang, Houman Owhadi, Jun Yao, **Florian Schäfer**, Zhaoqin Huang, and Yang Li, *Multiresolution operator decomposition for flow simulation in fractured porous media*, 2019, **Journal of Computational Physics**

[J11] A.Effland, M. Rumpf, and **F. Schäfer**, *Image extrapolation for the time discrete metamorphosis model - existence and applications*, 2017, **SIAM Journal on Imaging Science**, 11(1), 834–862.

IV-A.2 Conference Presentation with Proceedings (Refereed)

[C1] Jiong Chen, **Florian Schäfer**, and Mathieu Desbrun, *Lightning-fast Method of Fundamental Solutions*, 2024, **SIGGRAPH 2024, best technical paper award**

[C2] Nisha Chandramoorthy, **Florian Schäfer**, and Youssef Marzouk, *Score-operator Newton transport*, 2023, **AISTATS 2024**

[C3] Jian Cao, Myeongjong Kang, Felix Jimenez, Huiyan Sang, **Florian Schäfer**, and Matthias Katzfuss, *Variational sparse inverse Cholesky approximation for latent Gaussian processes via double Kullback-Leibler minimization*, 2023, **ICML 2023**

[C4] **Qi Zeng**, Yash Kothari, Spencer Bryngelson, and **Florian Schäfer**, Competitive Physics Informed Networks, 2022, **ICLR 2023**

[C5] Jing Yu, Clement Gehring, **Florian Schäfer**, and Anima Anandkumar, *Robust Reinforcement Learning: A Constrained Game-theoretic Approach*, **L4DC 2021**

[C6] Jiong Chen, **Florian Schäfer**, Jin Huang, and Mathieu Desbrun, *Multiscale Cholesky preconditioning for ill-conditioned problems*, **SIGGRAPH 2021**

[C7] **Florian Schäfer**$^{\alpha}$, Hongkai Zheng$^{\alpha}$, and Anima Anandkumar, *Implicit competitive regularization in GANs*, **ICML 2020**

[C8] **Florian Schäfer** and Anima Anandkumar, *Competitive Gradient Descent*, **NeurIPS 2019**

IV-A.3 Other Refereed Material

[W1] Jiawei Zhao, Yifei Zhang, Beidi Chen, **Florian Schäfer**, Anima Anandkumar, *Inrank: Incremental low-rank learning*, 2023, **ICML 2023 workshop** on "Efficient Systems for Foundation Models"

[W2] Spencer Bryngelson$^{\alpha}$, **Florian Schäfer**$^{\alpha}$, Jessie Liu, and Ali Mani, *Fast Macroscopic Forcing Method*, **Proceedings of the 2022 Summer Program** of the Stanford Center for Turbulence Research

[W3] Pierre-Luc Bacon, **Florian Schäfer**, Clement Gehring, Animashree Anandkumar, and Emma Brunskill, *A Lagrangian Method for Inverse Problems in Reinforcement Learning*, 2019, **Neurips 2019 workshop** "Optimization Foundations of Reinforcement Learning"

[W4] A.Effland, M. Rumpf, and **F. Schäfer**, *Time discrete extrapolation in a Riemannian space of images*, In Proc. of International Conference on Scale Space and Variational Methods in Computer Vision, volume 10302, pages 473-485. Springer, Cham, 2017. Lecture Notes in Computer Science.

IV-A.4 Preprints

[P1] **Florian Schäfer**, *Möbius inversion and the bootstrap*, 2024, https://www.arxiv.org/abs/2408.05826

[P2] Myeongjong Kang, **Florian Schäfer**, Joseph Guinness, Matthias Katzfuss, *Asymptotic properties of Vecchia approximation for Gaussian processes*, 2024, https://arxiv.org/abs/2401.15813

[P3] **Ruijia Cao** and **Florian Schäfer**, *Information geometric regularization of the barotropic Euler equation*, 2023, https://arxiv.org/pdf/2308.14127

[P4] **Stephen Huan**, Joseph Guinness, Matthias Katzfuss, Houman Owhadi, and **Florian Schäfer**, *Sparse Cholesky factorization by greedy conditional selection*, 2023, https://arxiv.org/abs/2307.11648

[P5] Jeffrey Ma, Alistair Letcher, **Florian Schäfer**, Yuanyuan Shi, and Anima Anandkumar, *Polymatrix Competitive Gradient Descent* , 2021, https://arxiv.org/abs/2111.08565

[P6] **Florian Schäfer**, Anima Anandkumar, Houman Owhadi, *Competitive Mirror Descent*, 2020, **Spotlight talk at ICML 2020 workshop** "Beyond First Order Methods in Machine Learning", https://arxiv.org/abs/2006.10179

IV-B Presentations

IV-B.1 Keynote Addresses and Plenary Lectures

[PL1] "Untangling Computation", Georgia Scientific Computing Symposium, February 2023, Georgia State University, Atlanta, GA

IV-B.2 Seminar and Conference presentations

[T1] "Information geometric regularization of the barotropic Euler equation," Minisymposium on "Discretization Methods Involving Multiple Levels and Scales," SciCADE 2024, July 2024, National University of Singapore

[T2] "An Exponential Speedup in the Rigorous Operator Learning of Elliptic PDEs," Fourth Symposium on Machine Learning and Dynamical Systems, July 2024, Fields Institute, Toronto, Canada

[T3] "Statistical Inference and PDEs: From operator learning to shock capturing," Machine Learning and Dynamical Systems Seminar, Alan Turing Institute (virtual)

[T4] "Models, Solvers, Learners: Statistical Inspiration for Scientific Computing," Scientific Computing Seminar, May 2024, Brown University, Providence, RI

[T5] "An Exponential Speedup in the Rigorous Learning of Elliptic Solution Operators" SIAM Conference on Uncertainty Quantification, Minisymposium on "Efficient Covariance and Operator Estimation, March 2024, Trieste, Italy

[T6] "Games, Information(,) Geometry for learning and solving PDEs" Amazon AI4Science Seminar, March 2024, online,

[T7] "Möbius inversion and the Boostrap" Workshop "Connecting Higher-Order Statistics and Symmetric Tensors", ICERM January 2024, Providence, RI

[T8] "Information geometric regularization of the barotropic Euler equation", Session on Shock Capturing, DG, Higher Order Schemes APS DFD 67th Annual Meeting, November 2023, Washington, DC

[T9] "Solvers, Models, Learners: Toward Statistical Scientific Computing", Optimization in Oslo, November 2023, Simula, virtual

[T10] "Information geometric regularization of the barotropic Euler equation", International Workshop on Recent Developments in Applied Mathematics and its Applications, November 2023, Caltech, Pasadena, CA

[T11] "Information geometric regularization of the barotropic Euler equation", Workshop on Compressible Multiphase Flows, November 2023, Stanford University, Palo Alto, CA

[T12] "Solvers, Models, Learners: Statistical Inspiration for Scientific Computing", Mathematical Institute of Data Science & Center for Imaging Science Seminar, October 2023, Johns Hopkins University, Baltimore, MD

[T13] "Solvers, Models, Learners: Statistical Inspiration for Scientific Computing", Math Machine Learning seminar PMI MiS + UCLA September 2023, Online

[T14] "Solvers, Models, Learners: Statistical Inspiration for Scientific Computing", Applied Mathematics Seminar, August 2023, Peking University, Beijing, China

[T15] "An Exponential Speedup in the Rigorous Operator Learning of Elliptic PDEs" International Congress on Industrial and Applied Mathematics, Minisymposium on Data-Driven Methods in Scientific Machine Learning, August 2023, Tokyo, Japan

[T16] "ORNL AI Seminar Series," August 2023, Oak Ridge National Laboratory, Oak Ridge, TN

[T17] "Information geometric regularization for the barotropic Euler equation," May 2023, École Polytechnique, Palaiseau, France

[T18] "Competitive Physics Informed Networks" Math 2 Product(M2P), Minisymposium on Neural PDE Solvers, May 2023, Taormina, Italy

[T19] "Competitive Gradient Descent Algorithms" SIAM Conference on Computational Science and Engineering, Minisymposium on Acceleration methods for scientific and machine learning applications, February 2023, Amsterdam, Netherlands

[T20] "Inference, Computation, and Games", Numerical Analysis and Scientific Computing Seminar, October 2022, Courant Institute of Mathematical Sciences, New York City, NY

[T21] "Inference, Computation, and Games", Seminar for mathematics in imaging, data, and optimization, September 2022, Rochester Polytechnic In-

stitute, online

[T22] "An Exponential Speedup in the Rigorous Operator Learning of Elliptic PDEs" SIAM Conference on Mathematics of Data Science, Minisymposium on Advances in Fast and Scalable Bayesian Inference, September 2022, San Diego, CA

[T23] "Inference, Computation, and Games", Applied Mathematics and Computational Science Colloquium, April 2022, UPenn, Philadelphia, PA

[T24] "Reconstructing elliptic solvers from polylog(N) matrix-vector products SIAM Conference on Uncertainty Quantification, Minisymposium on operator learning for uncertainty quantification, April 2022, Atlanta, GA

[T25] "Inference, Computation, and Games", Stanford Applied Math Seminar, February 2022, online

[T26] "A probabilistic view on sparse Cholesky factorization", Dagstuhl Seminar on Probabilistic Numerical Methods – From Theory to Implementation, October 2021, online

[T27] "Inference, Computation, and Games", Scientific Computing Seminar, Emory University September 2021, Atlanta, GA

[T28] "Inference, Computation, and Games", Applied and Computational Mathematics Seminar, Georgia Tech, September 2021, Atlanta, GA

[T29] "Cholesky factorization by Kullback-Leibler minimization", Bernoulli-IMS One World Symposium 2020, August 2020, online

[T30] "Cholesky factorization by Kullback-Leibler minimization", 2$^{\text{nd}}$ Symp. on Machine Learning & Dynamical Systems, September 2020, Fields Institute (online)

[T31] "Competitive Optimization", NVIDIA, May 2020, online

[T32] "Competitive Optimization", Montréal Machine Learning and Optimization (internal meeting), August 2020, online

[T33] "Competitive Gradient Descent", Stanford, July 2019, Palo Alto, CA

[T34] "Competitive Gradient Descent", NVIDIA, July 2019, Santa Clara, CA

[T35] "Competitive Gradient Descent", Ford Motor Company, August 2019, Palo Alto, CA

[T36] "A probabilistic view on sparse Cholesky factorization" EnuMath 2019, Minisymposium on randomized algorithms and parametrized PDEs, October 2019, Egmond aan Zee, Netherlands

[T37] "A probabilistic view on sparse Cholesky factorization" Texas A&M University, August 2019, College Station, TX

[T38] "A probabilistic view on sparse Cholesky factorization" SciCADE 2019, Minisymposium on machine learning and multiscale methods, July 2019, Innsbruck, Austria

[T39] "A probabilistic view on sparse Cholesky factorization" Aerospace Computational Design Laboratory Seminar April 2019, MIT, Cambridge, MA

[T40] "Compression, inversion, and approximate PCA of dense kernel matrices at near-linear computational complexity" Research Seminar: "Mathematical Statistics", May 2018, Weierstrass Institute, Berlin, Germany

[T41] "Compression, inversion, and approximate PCA of dense kernel matrices at near-linear computational complexity" SIAM Conference on Uncertainty Quantification, Minisymposium on probabilistic numerical methods for quantification of discretisation error, April 2018, Garden Grove, CA

[T42] "Compression, inversion, and approximate PCA of dense kernel matrices at near-linear computational complexity" Conference: "Multiscale Problems in Materials Science and Biology: Analysis and Computation" January 2018, Tsinghua Sanya International Mathematical Forum, Sanya, China.

[T43] "Compression, inversion, and approximate PCA of dense kernel matrices at near-linear computational complexity" "Tea Talk", July 2017 Oxford-Man Institute, Oxford, UK

[T44] "Compression, inversion, and approximate PCA of dense kernel matrices at near-linear computational complexity" Topical Workshop: "Probabilistic Scientific Computing: Statistical inference approaches to numerical analysis and algorithm design" June 2017, ICERM, Providence, RI

IV-C Grants and Contracts

IV-C.1 As Principal Investigator

- Untangling Computation

  Agency/Company: Office of Naval Research

  Total Dollar Amount: $450K

  Role: Single PI

  Period of Contract: 11/1/2023 – 10/31/2026

  FS Share: 100% ($450K)

- Information Geometric Regularization for Simulation and Optimization of Supersonic Flow

  Agency/Company: Airforce Office of Scientific Research

Total Dollar Amount: $300K

Role: Single PI

Period of Contract: 9/1/2023 – 8/31/2026

FS Share: 100% ($300K)

IV-C.2 Minor Awards, Hardware, and Travel Grants

- Stanford CTR Summer Program, *Summer 2022*
  ($8K, with S. Bryngelson, FS share $4K)
- Linde Institute Research Grant, $10K, *2019*
- Visiting Researcher at The Alan Turing Institute, £6K, *Summer 2017*

V Education

V-A Teaching

V-A.1 Courses at Georgia Tech

Semester, Year	Course Number	Course Title	Class Size
Fall 2024	CSE 6644	Iterative Methods for Sys. of Eqns.	18
Spring 2024	CSE 6643	Numerical Linear Algebra	114
Fall 2023	CSE 6644	Iterative Methods for Sys. of Eqns.	17
Spring 2023	CSE 6643	Numerical Linear Algebra	136
Fall 2022	CSE 6644	Iterative Methods for Sys. of Eqns.	9
Spring 2022	CSE 6740	Computational Data Analysis	24

V-A.2 Workshops and Tutorials

- "An algebraic view on numerical homogenization" *Summer 2019*
  Lecture given as part of the Oberwolfach Seminar:
  "Beyond Numerical Homogenization"

V-B Individual Student Guidance

V-B.1 Ph.D. Students

- Qi Luo, Ph.D. in Comput. Science and Eng., *2022 – 2027 (expected)*
- Brook Eyob, Ph.D. in Machine Learning, *2022 – 2027 (expected)*

V-B.2 B.S. & M.S. Students

- Hongjian Lan, M.Sc. in Comput. Science and Eng., *2023 – present*

– Richard Yu, B.S in Computer Science and Mathematics *2023 – 2024*

– Christian Engman, B.S. in CS and Mathematics *2023 – present*

– Shreya Jha, B.S. in CS and Mathematics, *2023 – present*

PURA Salary Award

– Ruijia Cao, B.S. in Computer Science, *2022 – 2024*

PURA Travel Award

– Stephen Huan, B.S. in Computer Science, *2021 – 2024*

PURA Travel and Salary Awards

– Pranav Narala, B.S. in Computer Science *2023*

– William Beard, B.S. in Computer Science, *2022 – 2023*

– Qi Zeng, B.S. in CS and Mathematics *2021 – 2023*
(co-advised with Spencer Bryngelson),

2023 GT CoC Outstanding Undergraduate Researcher

– Emma Ringe, B.S. in Computer Science, *2022*

V-B.3 Service on Thesis or Dissertation Committees

– Shikhar Shah, Ph.D. in Computational Science and Engineering

Advisor: Edmond Chow

– Noah Lewis, Ph.D. in Computational Science and Engineering

Advisor: Vince Calhoun

Co-Advisor: Sergey Plis

– Conlain Kelly, Ph.D. in Computational Science and Engineering

Advisor: Surya Kalidindi

– Chi-Heng Lin, Ph.D. in Electrical and Computer Engineering

Advisor: Eva Dyer

– Andreas Robertson, Ph.D. in Mechanical Engineering

Advisor: Surya Kalidindi

– Michael Biehler, Ph.D. in Industrial Engineering

Advisor: Jianjun Shi

– Bhuvesh Kumar, Ph.D. in Computer Science

Advisors: Jake Abernethy and Jamie Morgenstern

V-C Professional Contributions

V-C.1 Society Offices, Activities, and Membership

- American Physical Society (SIAM), *2023–present*
  Member
- Society of Industrial and Applied Mathematics (SIAM), *2021–present*
  Member

V-C.2 Organization and Chairmanship of Technical Sessions, Workshops, and Conferences

- Minisymposium on "Statistical approaches to closure modeling in computational mechanics", with Spencer Bryngelson and Ali Mani at IACM MMLDE-CSET 2023 *September 2023*
- Minisymposium on "Advances in Measure Transport for Representing and Comparing Distributions", with Ricardo Baptista and Youssef Marzouk, at SIAM Conference on Uncertainty Quantification *April 2022*

V-C.3 Technical Journal or Conference Referee Activities

- Area Chair at NeurIPS 2024
- Editorial board of reviewers at the Journal of Machine Learning Research
- Transactions on Machine Learning Research
- SIAM Multiscale Modeling and Simulation
- SIAM Journal on Numerical Analysis
- SIAM Journal on Mathematics of Data Science
- SIAM/ASA Journal on Uncertainty Quantification
- NeurIPS 2020, 2021, 2022
- ICML 2021, 2022, 2023
- ICLR 2020, 2021(**"outstanding reviewer"**), 2023, 2024
- Statistics and Computing
- Advances in Computational Mathematics

V-C.4 Proposal Panels and Reviews

- Panel: DOE Express: 2022 Exploratory Research for Extreme-Scale Science *2022*
- Individual Review: AFOSR Young Investigator Program *2022*

– Individual Review: DFG (German Research Foundation) *2024*

V-D Institute Contributions

V-D.1 School of CSE Service

– Seminar Series Committee, *Fall 2022 – present*

– Graduate student admissions committee, *Fall 2022 – present*

– Organization "Short and Sweet Seminar Series" (with S. Bryngelson) *Fall 2022 – present*

– Web committee, *Fall 2021 – 2022*

– Faculty hiring committee, *Fall 2021 – 2022*

V-D.2 Other Institute Service Contributions

– Reviewer for 2023 EECS Rising Stars workshop at GT, *Summer 2023*

– Judge for GT 2023 Spring (UG Research) Symposium, *Spring 2023, 2024*

– Judge for GT Data Science Hackathon, *February 2023*