Florian Schäfer

September 8, 2023

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

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

III Honors and Awards

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

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

IV-A.1 Preprints

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

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

Spencer H. Bryngelson, **Florian Schäfer**, Jessie Liu, and Ali Mani, *Fast Macroscopic Forcing Method*, 2023, https://arxiv.org/abs/2306.13625

Nisha Chandramoorthy, **Florian Schäfer**, and Youssef Marzouk, *A score-based operator Newton method for measure transport*, 2023, https://arxiv.org/abs/2305.09792

Yifan Chen, Houman Owhadi, and **Florian Schäfer**, *Sparse Cholesky Factorization for Solving Nonlinear PDEs via Gaussian Processes* , 2023, https://arxiv.org/abs/2304.01294

Jeffrey Ma, Alistair Letcher, **Florian Schäfer**, Yuanyuan Shi, and Anima Anandkumar,

Polymatrix Competitive Gradient Descent , 2021, https://arxiv.org/abs/2111.08565

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-A.2 Published and Accepted Journal Articles

[J1] **Florian Schäfer** and Houman Owhadi, *Sparse recovery of elliptic solvers from matrix-vector products*, 2023, **SIAM Journal on Scientific Computing**

[J2] Matthias Katzfuss and **Florian Schäfer**, *Scalable Bayesian transport maps for high-dimensional non-Gaussian spatial fields*, 2021, **JASA T&M**

[J3] Jiawei Zhao, **Florian Schäfer**, and Anima Anandkumar, *ZerO Initialization: Initializing Residual Networks with only Zeros and Ones*, 2021, **Transactions on Machine Learning Research**

[J4] **Florian Schäfer**, Matthias Katzfuss, and Houman Owhadi, *Sparse Cholesky factorization by Kullback-Leibler minimization*, 2021, **SIAM Journal on Scientific Computing**

[J5] **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**

[J6] Houman Owhadi, Clint Scovel, **Florian Schäfer**, *Statistical Numerical Approximation*, 2019, **Notices of the AMS**

[J7] 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.3 Conference Presentation with Proceedings (Refereed)

[C1] 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**

[C2] **Qi Zeng**, Yash Kothari, Spencer Bryngelson, and **Florian Schäfer**, Competitive Physics Informed Networks, 2022, **ICLR 2023**

[C3] Jing Yu, Clement Gehring, **Florian Schäfer**, and Anima Anandkumar, *Robust Reinforcement Learning: A Constrained Game-theoretic Approach*, **L4DC 2021**

[C4] **Florian Schäfer***, Hongkai Zheng*, and Anima Anandkumar, *Implicit competitive regularization in GANs*, **ICML 2020**

[C5] **Florian Schäfer** and Anima Anandkumar, *Competitive Gradient Descent*, **NeurIPS 2019**

IV-A.4 Other Refereed Material

[W1] Spencer Bryngelson*, **Florian Schäfer***, Jessie Liu, and Ali Mani, *Fast Macroscopic Forcing Method*, **Proceedings of the 2022 Summer Program**

of the Stanford Center for Turbulence Research

[W2] 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"

[W3] 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-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] "Solvers, Models, Learners: Statistical Inspiration for Scientific Computing", Applied Mathematics Seminar, August 2023, Peking University, Beijing, China

[T2] "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

[T3] "ORNL AI Seminar Series," August 2023, Oak Ridge National Laboratory, Oak Ridge, TN

[T4] "Information geometric regularization for the barotropic Euler equation," May 2023, École Polytechnique, Palaiseau, France

[T5] "Competitive Physics Informed Networks" Math 2 Product(M2P), Minisymposium on Neural PDE Solvers, May 2023, Taormina, Italy

[T6] "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

[T7] "Inference, Computation, and Games", Numerical Analysis and Scientific Computing Seminar, October 2022, Courant Institute of Mathematical Sciences, New York City, NY

[T8] "Inference, Computation, and Games", Seminar for mathematics in imaging, data, and optimization, September 2022, Rochester Polytechnic Institute, online

[T9] "An Exponential Speedup in the Rigorous Operator Learning of Elliptic PDEs" SIAM Conference on Uncertainty Quantification, Minisymposium on Advances in Fast and Scalable Bayesian Inference, September 2022, San Diego, CA

[T10] "Inference, Computation, and Games", Applied Mathematics and Computational Science Colloquium, April 2022, UPenn, Philadelphia, PA

[T11] "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

[T12] "Inference, Computation, and Games", Stanford Applied Math Seminar, February 2022, online

[T13] "A probabilistic view on sparse Cholesky factorization", Dagstuhl Seminar on Probabilistic Numerical Methods – From Theory to Implementation, October 2021, online

[T14] "Inference, Computation, and Games", Scientific Computing Seminar, Emory University September 2021, Atlanta, GA

[T15] "Inference, Computation, and Games", Applied and Computational Mathematics Seminar, Georgia Tech, September 2021, Atlanta, GA

[T16] "Cholesky factorization by Kullback-Leibler minimization", Bernoulli-IMS One World Symposium 2020, August 2020, online

[T17] "Cholesky factorization by Kullback-Leibler minimization", 2$^{\text{nd}}$ Symp. on Machine Learning & Dynamical Systems, September 2020, Fields Institute (online)

[T18] "Competitive Optimization", NVIDIA, May 2020, online

[T19] "Competitive Optimization", Montréal Machine Learning and Optimization (internal meeting), August 2020, online

[T20] "Competitive Gradient Descent", Stanford, July 2019, Palo Alto, CA

[T21] "Competitive Gradient Descent", NVIDIA, July 2019, Santa Clara, CA

[T22] "Competitive Gradient Descent", Ford Motor Company, August 2019, Palo Alto, CA

[T23] "A probabilistic view on sparse Cholesky factorization" EnuMath 2019, Minisymposium on randomized algorithms and parametrized PDEs, October 2019, Egmond aan Zee, Netherlands

[T24] "A probabilistic view on sparse Cholesky factorization" Texas A&M University, August 2019, College Station, TX

[T25] "A probabilistic view on sparse Cholesky factorization" SciCADE 2019, Minisymposium on machine learning and multiscale methods, July 2019, Innsbruck, Austria

[T26] "A probabilistic view on sparse Cholesky factorization" Aerospace Computational Design Laboratory Seminar April 2019, MIT, Cambridge, MA

[T27] "Compression, inversion, and approximate PCA of dense kernel matrices at near-linear computational complexity" Research Seminar: "Mathematical Statistics", May 2018, Weierstrass Institute, Berlin, Germany

[T28] "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

[T29] "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.

[T30] "Compression, inversion, and approximate PCA of dense kernel matrices at near-linear computational complexity" "Tea Talk", July 2017 Oxford-Man Institute, Oxford, UK

[T31] "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
Spring 2022	CSE 6740	Computational Data Analysis	24
Fall 2022	CSE 6644	Iterative Methods for Sys. of Eqns.	9
Spring 2023	CSE 6643	Numerical Linear Algebra	136
Fall 2023	CSE 6644	Iterative Methods for Sys. of Eqns.	17

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 Current Undergraduate Students

- Christian Engman, B.S. in CS and Mathematics *2023 – present*
- Shreya Jha, B.S. in CS and Mathematics, *2023 – present*
- Ruijia Cao, B.S. in Computer Science, *2022 – present*
- William Beard, B.S. in Computer Science, *2022 – present*
- Stephen-Huan, B.S. in Computer Science, *2021 – present*

V-B.3 Undergraduate Student Alumni

- 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, *Fall 2022*

V-B.4 Service on Thesis or Dissertation Committees

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

V-C.3 Technical Journal or Conference Referee Activities

- 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 2020, 2021, 2022, 2023
- ICLR 2020, 2021(**"outstanding reviewer"**), 2023
- 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*

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