

Jacob H. Seidman, PhD

POSTDOCTORAL RESEARCHER · APPLIED MATHEMATICS AND MACHINE LEARNING

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Education

University of Pennsylvania

Philadelphia, PA

PH.D. APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE

2016-2022

- Advisors: Dr. George J. Pappas and Dr. Victor M. Preciado
- Dissertation: Machine Learning in Function Spaces

Harvard University

Boston, MA

A.B. MATHEMATICS

2012-2016

Research Experience

University of Pennsylvania

Philadelphia, PA

POSTDOCTORAL RESEARCHER - PREDICTIVE INTELLIGENCE LAB

Oct. 2022 - Present

CO-ADVISED BY DR. PARIS PERDIKARIS AND DR. GEORGE J. PAPPAS

- **Machine Learning Methods:** Designed and collaborated on several research projects for machine learning techniques on functional data including new architectures for regression problems, dimensionality reduction and generative modeling, and connections with computer vision techniques.
- **Implementation and Applications:** Implemented original architectures in Python and JAX with applications to fluid dynamics, material science, and biomarker prediction.
- **Grant Writing:** Contributed to two successfully funded grant proposals involving the development and application of new machine learning tools to problems in physics and biology.
- **Leadership:** Managed weekly group research meetings by leading discussions, organizing speakers, and mentoring early PhD students to present their work.
- **Communication:** Presented original work at top machine learning conferences and workshops including NeurIPS and ICML.

University of Pennsylvania

Philadelphia, PA

PH.D. RESEARCH

Sep. 2016 - Oct. 2022

- **Optimization:** Gave a new and streamlined convergence proof of a classic operator splitting method and proposed a novel distributed optimization algorithm with convergence proof.
- **Control Theory:** Studied optimal control theory and its connections to the dynamics of machine learning architectures. Gave a convergence proof for an adversarial training algorithm. Programmed experiments validating theoretical results.
- **Operator Learning:** Proposed and proved universality of a novel parameterized family of operators between function spaces with applications to modeling of physical and controlled systems.

Harvard University

Boston, MA

SUMMER RESEARCH

Summer 2015

- **Mathematical Biology:** Studied mathematical population dynamics models for the emergence of multicellularity. Funded by a grant from Harvard College Research Program.

Pennsylvania State University

State College, PA

PENN STATE RESEARCH EXPERIENCE FOR UNDERGRADUATES (REU)

Summer 2014

- **Dynamical Systems:** Participated in summer REU program studying the Livsic theorems for hyperbolic dynamical systems.

Presentations

SELECTED INVITED TALKS

June 2023. *Conditioned Neural Fields: A Unifying Framework for Operator Learning*. ICERM

- Invited to present at topical workshop "Mathematical and Scientific Machine Learning" at the Institute for Computational and Experimental Research in Mathematics (ICERM).

April 2023. *Operator Learning and Low Dimensional Approximations*. University of Southern California

- Invited to give a talk at USACM "Workshop on Establishing Benchmarks for Data-Driven Modeling of Physical Systems".

January 2023. *Linear and Nonlinear Representations in Operator Networks*. SIAM CSE23

- Invited to Amsterdam, NL to speak at minisymposium "Advances in Deep Operator Networks".

Spring 2022. *Supervised Learning in Function Spaces*. Johns Hopkins University

- Co-presented 5 hr. practicum session at the Mathematical Institute for Data Science TRIPODS Winter School and "Workshop on Interplay between Artificial Intelligence and Dynamical Systems". Videos available at https://github.com/PredictiveIntelligenceLab/TRIPODS_Winter_School_2022

Spring 2022. *Supervised Operator Learning*. University of California, Riverside

- Invited to give guest lecture in course "Multiscale Modeling and Machine Learning" on operator learning techniques and nonlinear representations of manifolds of functions.

Organized Minisymposia

June 2023. *Biophysics-informed Machine Learning*. Platform for Advanced Scientific Computing (PASC), Davos, Switzerland

- Co-organizer and co-chair.

Publications

Seidman, Jacob H., Kissas, Georgios, et al. "Variational Autoencoding Neural Operators" International Conference on Machine Learning (2023).

Seidman, Jacob H.*, Kissas, Georgios*, et al. "NOMAD: Nonlinear Manifold Decoders for Operator Learning." Advances in Neural Information Processing Systems. (2022).

Kissas, Georgios*, **Seidman, Jacob H.***, et al. "Learning Operators with Coupled Attention." Journal of Machine Learning Research 23.215 (2022): 1-63. *NeurIPS Spotlight*

Beckers, Thomas, **Seidman, Jacob H.**, et. al. "Gaussian Process Port-Hamiltonian Systems: Bayesian Learning with Physics Prior". Proceedings of the Conference on Decision and Control (CDC). IEEE, (2022).

Seidman, Jacob H., et al. "Robust Deep Learning as Optimal Control: Insights and Convergence Guarantees." Learning for Dynamics and Control. PMLR, (2020).

Seidman, Jacob H., et al. "A Control-theoretic Approach to Analysis and Parameter Selection of Douglas–Rachford Splitting." IEEE Control Systems Letters 4.1 (2019): 199-204.

Seidman, Jacob H., et al. "A Chebyshev-accelerated Primal-dual Method for Distributed Optimization." 2018 IEEE Conference on Decision and Control (CDC). IEEE, (2018).

*authors contributed equally

Awards

2023 **SIAM Travel Grant**, Society for Industrial and Applied Mathematics

2016-2020 **Benjamin Franklin Fellowship**, University of Pennsylvania

Teaching Experience

Fall 2017 **Computer Methods in Mathematical Science**, Grader

Spring 2018 **Ideas in Mathematics**, Teaching Assistant

Academic Service

2023 **Journal of Computational Physics**, Reviewer

2022 **International Conference on Machine Learning**, Reviewer

2021 **IFAC Conference on Analysis and Design of Hybrid Systems**, Reviewer

2021 **IEEE Transactions on Automatic Control**, Reviewer