Derek Onken

https://derekonken.com/

Philomath, Polymath, BS in Math

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Current Research Interests

I am interested in problems in the interdisciplinary overlap of mathematics, computer science, and statistics. I value using the theory from these fields to develop models for practical applications that mostly fall in the physical and biological realms.

PDE-based Machine Learning

- Applying partial differential equation (PDE) knowledge to neural networks, specifically higher-order time integration schemes and the Discretize-Optimize approach.
- Using PDE-based neural networks to lower false positives in lung cancer diagnosis
- Developing methods to efficiently train high-dimensional continuous normalizing flows
- Solving high-dimensional multi-agent optimal control problems

Education

Ph.D. in Computer Science & Informatics, Emory University 2021
Advisor: Lars Ruthotto
Research: Optimal control approaches for designing neural ordinary differential equations

M.S. in Computer Science, Emory University 2019

B.S. in Mathematics and Computer Science, Honors College, University of Georgia 2015
Minors: Physics and Classical Culture
Honors: Graduated High Honors with Capstone
Advisor: Juan B. Gutierrez
Research: Statistical analysis of natality data and the relationships of sex ratio against gestation length and calendar distribution

Computational Skills

Comfortable in Python, PyTorch, Matlab, SQL, Java
Familiar with Julia, TensorFlow, Keras, `C`, `C++`, R , x86 , MPI

Work Experience

Data Scientist Intern, UnitedHealth Group, R&D 2019, 2020
High Performance Computing Intern, Air Force Research Labs, UES Inc. 2018
Teaching Assistant, Emory University 2016-2018
Tutor, UGA Athletic Department 2016
Undergraduate Researcher, UGA Mathematics Department 2014
Piano Teacher 2013-2014
Summer League Swim Coach 2009, 2010

Leadership & Service

External Reviewer Mathematical Sciences of Machine Learning Conference
External Reviewer Cell *Patterns*
External Reviewer Springer *International Journal of Dynamics and Control*
Member Emory Society for Industrial and Applied Mathematics (SIAM) 2016-2021
Volunteer Atlanta Science Festival 2016-2019
University of Georgia Men's Swimming & Diving Team 2011-2015

- Captain & NCAA Division I Varsity Athlete
- Competed at the SEC championships
- Qualified and competed at the 2016 U.S. Olympic Trials
- NCAA Academic All-American Honorable Mention 2013, 2014, 2015
- Awarded Dick Bestwick Scholar-Athlete Award, UGA Athletic Dept 2015
- Awarded Ramsey Scholarship for Academic and Athletic Excellence 2014-2015
- Awarded Peter O'Sullivan Hardest Worker Award, UGA Men's Swimming 2014, 2015
- Awarded Alex Patterson Scholar-Athlete Award , UGA Men's Swimming 2014
- College Swim Coaches of America Association Scholar All-American Team 2013-2015

Student-Athlete Advisory Committee Team Representative 2014-2015

Honors & Awards

Phi Beta Kappa 2015
UGA Presidential Scholar 2014
UGA Athletic Director's Honor Roll 2012-2015
Southeastern Conference Academic Honor Roll 2012-2015
UGA Dean's List 2012-2015
IBM Thomas J. Watson Memorial Scholarship Recipient 2011-2015
Chartered Property Casualty Underwriter (CPCU) Scholarship Recipient 2011

Publications

D. Onken, L. Nurbekyan, X. Li, S. W. Fung, S. Osher, L. Ruthotto. A Neural Network Approach for High-Dimensional Optimal Control. preprint [Submitted]

D. Onken, L. Ruthotto. Discretize-Optimize vs. Optimize-Discretize for Time-Series Regression and Continuous Normalizing Flows. preprint [In Revision]

D. Onken, L. Nurbekyan, X. Li, S. W. Fung, S. Osher, L. Ruthotto. A Neural Network Approach Applied to Multi-Agent Optimal Control. European Control Conference 2021. paper

D. Onken, S. W. Fung, X. Li, L. Ruthotto. OT-Flow: Fast and Accurate Continuous Normalizing Flows via Optimal Transport. AAAI Conference on Artificial Intelligence, 35(10), 9223-9232. 2021. paper

Y. Vigfusson*, T. Karlsson*, **D. Onken***, *et al.* Cell-Phone Traces Reveal Infection-Associated Behavioral Change. Proceedings of the National Academy of Sciences, Feb 2021, 118 (6) e2005241118; DOI: 10.1073/pnas.2005241118. paper

* denotes co-first authors

Invited Talks

D. Onken. "Efficient and Accurate Discretize-Optimize Approaches for Training Deep Residual Networks" in *SIAM Mathematics of Data Science 2020*, link.

Peer-Reviewed Poster Presentations

D. Onken, S. W. Fung, X. Li, L. Ruthotto. "Normalizing Flows Via Mean Field Games and Hamilton-Jacobi-Bellman Equations" in *SIAM/CAIMS AN2020*, link.

D. Onken, R. Jennings, S. Garth, E. Haber, E. Treister, S. Novikov, L. Ruthotto. "Using PDE-Based Neural Networks for Classifying 3-D LDCT Images for Lung Cancer Detection" in *IPAM Deep Learning for Medical Applications 2020*, link.

Selected Presentations & Posters

Image Classification For Lung Cancer Via Neural Networks Based On Partial Differential Equations, *UnitedHealth Group Intern Presentation*, Aug 2019, talk

PDE-based Neural Networks, *UnitedHealth Group Brown Bag Lecture Series*, Jul 2019, talk

Applying Higher-Order Runge-Kutta Methods To Neural Networks, *Emory Scientific Computing Seminar*, Apr 2019, talk

Applying Higher-Order Runge-Kutta Methods To Neural Networks, *Georgia Scientific Computing Symposium*, Feb 2019, poster

Cell Segmentation via Convolutional Neural Networks, *High Performance Computing and Modernization Program*, Aug 2018, poster and talk

Tracking Behavioral Alterations via Cell Phone Data, *Amazon Graduate Research Symposium*, Oct 2017, poster

Selected Relevant Coursework

Coursework at Emory University:

- Numerical Optimization
- Deep Learning Numerics
- Numerical Analysis II
- Numerical Analysis I
- Data Mining
- Machine Learning
- Biostatistical Methods
- Algorithms
- Systems Programming
- Distributed Processing
- Database Systems
- Computer Security (Hacking)

Graduate-level coursework at the University of Georgia:

- Bivariate Splines
- Complex Analysis
- Automata
- Algorithms
- Software Engineering
- Thermodynamics