# Derek Onken

*Philomath, Polymath, BS in Math*

https://derekonken.com/
derek@derekonken.com

## 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
– Developing methods to efficiently train high-dimensional continuous normalizing flows
– Solving high-dimensional multi-agent optimal control problems

### Machine Learning for Pharmaceutical Applications

– Developing and deploying machine learning tools for use in clinical trials
– Leveraging neural networks to increase pharmaceutical product manufacturing yield
– Applying machine learning for accelerating drug development

## EDUCATION

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

**M.S. in Computer Science**, Emory University

**B.S. in Mathematics and Computer Science**, Honors College, University of Georgia
*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   JULIÄ, TENSORFLOW, KERAS, C, C++, R , x86 , MPI

## WORK EXPERIENCE

| | |
|---|---:|
| **Research Scientist**, Eli Lilly, Advanced Analytics and Data Science | 2021-present |
| **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**, University of Georgia Athletic Department | 2016 |
| **Undergraduate Researcher**, University of Georgia Mathematics Department | 2014 |
| **Piano Teacher** | 2013-2014 |
| **Summer League Swim Coach** | 2009, 2010 |

## Preprints

**D. Onken**, L. Ruthotto
Discretize-Optimize vs. Optimize-Discretize for Time-Series Regression and Continuous Normalizing Flows
arXiv:2005.13420, 2020
| code | videos |

## Publications

**D. Onken**, L. Nurbekyan, X. Li, S. W. Fung, S. Osher, L. Ruthotto
A Neural Network Approach for High-Dimensional Optimal Control
IEEE Transactions on Control Systems Technology, June 2022
| code | videos | doi |

**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 (ECC), 1036–1041, 2021
| code | videos | doi |

**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
| code | url |

Y. Vigfusson*, T. Karlsson*, **D. Onken**\*, *et al.*
Cell-Phone Traces Reveal Infection-Associated Behavioral Change
Proceedings of the National Academy of Sciences (PNAS), Feb 2021, 118 (6) e2005241118
| code | doi |

* denotes co-first authors

## Invited Talks

A Neural Network Approach for Real-Time High-Dimensional Optimal Control, *Applied Mathematics and Statistics Colloquium, Colorado School of Mines*, Oct 2021
| slides |

A Neural Network Approach for High-Dimensional Optimal Control, *Optimal Transport and Mean Field Games Seminar, University of South Carolina*, Mar 2021
| slides |

A Neural Network Approach for High-Dimensional Optimal Control, *Applied Mathematics Seminar, UCLA*, Mar 2021
| slides |

A Neural Network Approach for High-Dimensional Optimal Control, *Virtual Informal Systems Seminar (VISS) at Centre for Intelligent Machines (CIM) at McGill and the Groupe d'études et de Recherche en Analyse des Décisions (GERAD)*, Feb 2021
| slides | recording |

Efficient and Accurate Discretize-Optimize Approaches for Training Deep Residual Networks, *SIAM Mathematics of Data Science*, Jun 2020
| slides |

## 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

Training Neural Networks in Amazon Web Services, *Lilly Technical Seminar Series*, Jun 2022
| presentation |

Deep Learning Primer: The Truth Behind the Buzzword, *Lilly Technical Seminar Series*, Mar 2022
| presentation |

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

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

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

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

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

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

## Leadership & Service

**External Reviewer** for several entities, including:
  – Mathematical Sciences of Machine Learning Conference
  – Cell *Patterns*
  – Springer *International Journal of Dynamics and Control*
  – IEEE *Transactions on Neural Networks and Learning Systems*

**Mentor** Polygence                                                                 2021-2022
**Member** Emory Society for Industrial and Applied Mathematics (SIAM)                2016-2022
**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 Southeastern Conference 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, 2014, 2015

**Student-Athlete Advisory Committee** Team Representative                          2014-2015

## Honors & Awards

Eli Lilly Chief Information & Digital Officer Award (Manufacturing)                    2021
Eli Lilly Top 100 Innovator Award (Immunology)                                        2021
Eli Lilly Innovator Award (Immunology)                                                2021
Phi Beta Kappa                                                                        2015
University of Georgia Presidential Scholar                                            2014
University of Georgia Athletic Director's Honor Roll                             2012-2015
Southeastern Conference Academic Honor Roll                                      2012-2015
University of Georgia Dean's List                                                2012-2015
IBM Thomas J. Watson Memorial Scholarship Recipient                             2011-2015
Chartered Property Casualty Underwriter (CPCU) Scholarship Recipient                  2011

## 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