AXEL G. R. TURNQUIST, Ph.D.

PERSONAL INFORMATION

email agt6@njit.edu

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RESEARCH INTERESTS

Optimal Transport, Numerical Analysis, Differential Geometry, Analysis, PDE on Manifolds, Diffeomorphic Mappings, Mean-Field Games, Machine Learning

EDUCATION

2016-2022 New Jersey Institute of Technology

Ph.D. in Mathematical Sciences

GPA: 4.0 (out of 4.0) · Advisor: Brittany D. Hamfeldt, Thesis: *Numerical Methods for Optimal Transport and Optimal Information Transport on the Sphere*

2008-2012 University of Washington

Bachelor of Science, Physics

GPA: 3.9 (out of 4.0), *Magna Cum Laude* · Minor in Mathematics

ACADEMIC EMPLOYMENT

Aug. 2022- Postdoctoral Researcher

Department of Mathematics, University of Texas at Austin, Texas, United States

GRANTS

2018-2021 NSF GRFP: 1849508

National Science Foundation Graduate Research Fellowship Program
September 4, 2018-August 9, 2021
$ 138,000

AWARDS & HONORS

2022 Student Speaker for New Jersey Institute of Technology Doctoral Hooding Ceremony

2021 J. Opt. Soc. Am. A Editor's Pick

For manuscript "Convergent numerical method for the reflector antenna problem via optimal transport on the sphere"

2021 CMS President's Award

Canadian Mathematical Society Summer Meeting 2021, $ 100 CAD

2019 NJIT CSLA Outstanding Graduate Student

New Jersey Institute of Technology College of Science and Liberal Arts

2016, 2017 Provost Doctoral Assistantship

New Jersey Institute of Technology Department of Mathematical Sciences

2008 Honors Achievement Award

University of Washington Honors Department. One year tuition free.

PUBLICATIONS

In Prep.

Hamfeldt, B. F., Turnquist, A. G. R. *Higher-Order Numerical Methods for the Optimal Transport Problem on the Sphere*

Hamfeldt, B. F., Turnquist, A. G. R. *Convergence Rates for Monotone Finite-Difference Schemes for the Optimal Transport Problem on Manifolds and the Second-Boundary Value Problem*

Preprints

Hamfeldt, B. F., Turnquist, A. G. R. *On the Reduction in Accuracy of Finite Difference Schemes on Manifolds without Boundary* April 4, 2022, https://arxiv.org/abs/2204.01892, Submitted to IMA Journal of Numerical Analysis

Turnquist, A. G. R. *Adaptive Mesh Methods on Compact Manifolds via Optimal Transport and Optimal Information Transport* November 28, 2021, https://arxiv.org/abs/2111.14276, Submitted to Journal of Computational Physics

In Print

Hamfeldt, B. F., Turnquist, A. G. R. *A Convergence Framework for Optimal Transport on the Sphere* Numerische Mathematik (2022), https://doi.org/10.1007/s00211-022-01292-1

Brittany Froese Hamfeldt and Axel G. R. Turnquist, *Convergent numerical method for the reflector antenna problem via optimal transport on the sphere* J. Opt. Soc. Am. A 38, 1704-1713 (2021), **Selected for Editor's Pick**

Brittany Froese Hamfeldt and Axel G. R. Turnquist *A convergent finite-difference method for optimal transport on the sphere* Journal of Computational Physics, Volume 445, 15 November 2021, 110621

Turnquist A. G. R., Rotstein H. G. (2018) *Quadratization: From Conductance-Based Models to Caricature Models with Parabolic Nonlinearities* In: Jaeger D., Jung R. (eds) Encyclopedia of Computational Neuroscience. Springer, New York, NY

THESES

Numerical Methods for Optimal Transport and Optimal Information Transport on the Sphere, Ph.D. Thesis, New Jersey Institute of Technology, 2022.

TALKS AND POSTER PRESENTATIONS

Talks

Convergent Numerical Schemes for Optimal Transport with Applications on the Sphere and Beyond - Schrödinger Problem and Mean-field PDE Systems: Computational and Theoretical Advances, November 15-19, 2021, Aix Marseille University, Marseille, France

Optical Inverse Problems and Optimal Transport - Entropic Regularization of Optimal Transport and Applications (Online), Jun. 21, 2021, Banff International Research Station, Banff, Alberta, Canada

Optimal Transport on the Sphere - Canadian Mathematical Society Summer Meeting StudC Research Session - Optimal Transport and Applications (Online) - Jun. 11, 2021, University of Ottawa, Ottawa, Ontario, Canada

Gradient Flow on a Statistical Manifold IPAM High Dimensional Hamilton-Jacobi PDEs 2020 (Online), University of California Los Angeles, Los Angeles, California, United States, March 19, 2020

Towards Convergent Finite-Difference Schemes for the Monge-Ampère PDE on the Sphere Invited Talk. Recent Developments in Numerical Methods for PDEs: Joint Mathematics Meeting January 2020, Denver Convention Center, Denver, Colorado, United States

Courant Optimal Transport Discussion Group - New York University, New York, United States

- *Numerical Methods for Kantorovich and Viscosity Solutions of the Monge-Ampère PDE*, April 24, 2019
- *Monge-Ampère PDE and Generalized Solutions*, April 10, 2019
- *Kantorovich and Monge Problems: Existence, Uniqueness, and Duality Gap*, March 13, 2019

Poster Presentations

Smooth Mesh Redistribution on Manifolds Using PDE Techniques - Graduate Student Association 3-Minute Research Presentation, New Jersey Institute of Technology - Mar. 31, 2022, Newark, New Jersey, United States

Optimal Transport on the Sphere - Canadian Mathematical Society Summer Meeting Poster Session - Optimal Transport and Applications (Online) - Jun. 10, 2021, Ottawa, Ontario, Canada - **Won CMS President's Award for Poster Presentation**

Optimal Transport on the Sphere - Dana Knox Student Research Showcase (Online) - Apr. 21, 2021, New Jersey Institute of Technology, Newark, New Jersey, United States

Solution Guarantees for the Reflector Antenna Inverse Problem - Graduate Student Association 3-Minute Research Presentation (Online), New Jersey Institute of Technology - Apr. 13, 2021, Newark, New Jersey, United States

A Convergence Framework for the Monge-Ampère PDE on the Sphere - IMA Workshop on Optimal Control, Optimal Transport, and Data Science (Online), Nov. 10, 2020, University of Minnesota, Minnesota, United States

Effects of Input Amplitude and Global Coupling on Network Synchrony and Entrainment Dana Knox Student Research Showcase - April 19, 2017, New Jersey Institute of Technology, Newark, New Jersey, United States

EVENTS HOSTED

Optimization & Machine Learning Talks

Hosted NJIT Department of Mathematical Sciences Optimization & Machine Learning Talks, Spring 2022. Also delivered talks on the following topics:

- *On the Change of Variables Formula and the Geometry of Diffeomorphic Density Matching* Feb. 24, 2022
- *WGAN works because it fails* Jan. 20, 2022

Hosted NJIT Department of Mathematical Sciences Optimization & Machine Learning Talks, Autumn 2021. Also delivered talks on the following topics:

- *Image Sharpening* Sep. 23, 2021
- *Computing the Distance Between Probability Measures: Wasserstein vs. Fisher-Rao* Sep. 2, 2021

Hosted NJIT Department of Mathematical Sciences Machine Learning Talks, Spring 2021. Also delivered talks on the following topics:

- *Solving High-Dimensional Parabolic PDE Using Deep Learning* Mar. 4, 2021
- *Deep Residual Networks: Optimal Control Point of View* Feb. 4, 2021

Founded & Hosted NJIT Department of Mathematical Sciences Machine Learning Talks, Autumn 2020. Also delivered talks on the following topics:

- *PAC Learning Framework* Dec. 4, 2020
- *Sampling Theory* Nov., 20, 2020
- *Matrix Completion & Sparse Recovery* Oct. 30, 2020
- *"Effective" Dimension in High-Dimensional Problems* Oct. 16, 2020
- *Information Geometry & Learning* Oct. 2, 2020
- *Why does stochastic gradient work so well?* Sep. 25, 2020

Mental Health Talks

Founded & Hosted NJIT Department of Mathematical Sciences Mental Health Talks, Spring 2020. Also delivered first talk in this series:

- *Mental Health I* May. 18, 2020

PROFESSIONAL DEVELOPMENT

May 2022 IMSI Decision Making and Uncertainty: Applied Optimal Transport (Online)

IMSI, University of Chicago, United States

Nov. 2021 Schrödinger Problem and Mean-field PDE Systems: Computational and Theoretical Advances

Aix Marseille University, Marseille, France

Oct.-Dec. 2021 IMSI Distributed Solutions to Complex Societal Problems: (1) Introduction to Distributed Solutions and (2) Mathematical Advances in Mean-Field Games (Online)

IMSI, University of Chicago, United States

Jul. 2021 Fifth Conference on Geometric Science of Information in Paris

Sorbonne University, Paris, France

Jun. 2021 Entropic Regularization of Optimal Transport and Applications (Online)

Banff International Research Station, Banff, Alberta, Canada

Jun. 2021 Canadian Mathematical Society Summer Meeting - Optimal Transport and Applications (Online)

University of Ottawa, Ottawa, Ontario, Canada

Apr. 2021 East Coast Optimization Meeting 2021 (Online)

George Mason University, Fairfax, Virginia, United States

Nov. 2020 IMA Workshop on Optimal Control, Optimal Transport, and Data Science (Online)

University of Minnesota, Minneapolis, Minnesota, United States

Mar.-Jun. 2020 **IPAM High-Dimensional Hamilton-Jacobi PDEs (In Person/Online)**

IPAM, University of California Los Angeles, Los Angeles, California, United States

Jan. 2020 **Joint Mathematics Meeting**

Denver Convention Center, Denver, Colorado, United States

Jun. 2017 **Mathematical Problems in the Industry**

New Jersey Institute of Technology, Newark, New Jersey, United States

OTHER WORK EXPERIENCE

2016-2018 **Teaching Assistant at NJIT**

· MATH 111 - Calculus 1 - Fall 2016
· MATH 450 - Methods of Applied Math (Honors Undergraduate) - Fall 2017
· MATH 110 - University Mathematics B II (Precalculus) - Spring 2018

January 2016 - May 2016 **Mandarin Chinese-English Interpreter**

Accurate Communication, New York, New York, USA

May 2013 - July 2015 **English Teacher**

Meten English, Suzhou, Jiangsu, China, 25 in-class hours/week

PROFESSIONAL AFFILIATIONS

· Society of Industrial and Applied Mathematics (SIAM)

· SIAM SIAG on Optimization

· SIAM SIAG on Analysis of Partial Differential Equations

· Canadian Mathematical Society (CMS)

SKILLS AND CERTIFICATIONS

Certifications, Exams, & Skills

HSK (Mandarin Chinese) Level 6, November 2014

TESOL Certification, Beijing, PRC, May 2013

Proficient in Matlab, some experience in Python and C++

Languages

English · Native Speaker
Mandarin · Advanced
Spanish · Advanced
Japanese · Intermediate
Cantonese · Intermediate
French · Intermediate
Arabic · Beginning

Interests	Reading, travel, languages, guitar, bass, drums, tabla

REFERENCES

Doctoral Advisor	Brittany D. Hamfeldt, Associate Professor, Department of Mathematical Sciences, New Jersey Institute of Technology, brittany.d.froese@njit.edu
Dissertation Committee	Cyrill B. Muratov, Professor, Department of Mathematical Sciences, New Jersey Institute of Technology, cyrill.b.muratov@njit.edu
Dissertation Committee	Yassine Boubendir, Professor, Department of Mathematical Sciences, New Jersey Institute of Technology, yassine.boubendir@njit.edu
Dissertation Committee	David G. Shirokoff, Associate Professor, Department of Mathematical Sciences, New Jersey Institute of Technology, david.g.shirokoff@njit.edu
Dissertation Committee	Rongjie Lai, Associate Professor, Department of Mathematics, Rensselaer Polytechnic Institute, lair@rpi.edu
Teaching Reference	Shahriar Afkhami, Professor, Department of Mathematical Sciences, New Jersey Institute of Technology, shahriar.afkhami@njit.edu

June 1, 2022