

Matthew Kehoe

Data/Research Scientist

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Research Interests

- Applied mathematics and computational science
- Numerical analysis and partial differential equations
- Machine learning and natural language processing
- Acoustics and electromagnetics
- High performance computing
- Calculating zeros of the Riemann zeta function

Education

University of Illinois at Chicago <i>Ph.D. in Applied Mathematics</i> Advisor: Professor David Nicholls Thesis: Joint Analyticity of the Transformed Field and Dirichlet-Neumann Operator in Periodic Media	Chicago, IL 2018–2022
University of Michigan at Dearborn <i>M.S. in Computational Mathematics</i> Advisor: Professor Frank Massey MS Project: Computational methods for the Riemann zeta function	Dearborn, MI 2013–2015
University of Otago <i>Exchange student</i>	Dunedin, New Zealand 2010
Oakland University <i>B.A. in Economics, Minor in Computer Science</i>	Rochester, MI 2006–2010

Employment and Internships

Michigan Tech Research Institute <i>Research Scientist</i>	Ann Arbor, MI August 2022 – Present
University of Illinois at Chicago <i>Graduate Research and Teaching Assistant</i>	Chicago, IL 2018–July 2022
Cold Regions Research and Engineering Laboratory <i>NSF Mathematical Sciences Graduate Internship</i>	Hanover, NH Summer 2020
Argonne National Laboratory <i>NSF Mathematical Sciences Graduate Internship</i>	Lemont, IL Summer 2019
Workforce Software <i>Software Consultant/Programmer</i>	Livonia, MI 2010–2017
Oakland University <i>Web Developer</i>	Rochester, MI 2009–2010
Spec Associates <i>Strategic Research Intern</i>	Detroit, MI 2009–2010

Publications

- 1: M. Kehoe and D. Nicholls, "A Stable High-Order Perturbation of Surfaces/Asymptotic Waveform Evaluation Method for the Numerical Solution of Grating Scattering Problems," *Journal of Scientific Computing* 100 (1), 9 (2024). [Manuscript](#).
- 2: M. Kehoe and D. P. Nicholls, "Joint Geometry/Frequency Analyticity of Fields Scattered by Periodic Layered Media," *SIAM Journal on Mathematical Analysis*, Volume 55, Issue 3, 1737-1765 (2023). [Manuscript](#).

Grants

DoD SBIR Phase II (PI): \$1,250,000

Novel method of estimating moving target spatial dynamics for radar imaging

Ann Arbor, MI

July 2024 – Present

Teaching Experience

University of Illinois at Chicago

Graduate TA: Lead recitation sessions and assisted students with coursework in

Chicago, IL

2018–2021

- Calculus 1 (4 semesters)
- Numerical Analysis (2 semesters)
- Differential Equations (1 semester)
- Mathematical Biology (1 semester)
- Precalculus (1 semester)

My student reviews are listed [here](#).

Mathematical Modeling Experience

Michigan Tech Research Institute

Computational Electromagnetics and Signal Processing

Research

2022–2022

- Developed algorithms to automate the identification of moving ground vehicles using synthetic aperture radar (SAR).
- Corrected geometric distortions and deformations at reflected energy point locations using affine transformations.
- Used the Pycharm IDE to build new programs to identify point locations from scattered energy.

University of Illinois at Chicago

High-Order Perturbation of Surfaces (HOPS)

Thesis

2019–2022

- Investigated the existence and uniqueness of solutions to a system of partial differential equations which model the interaction of linear waves with multilayered media.
- Implemented the HOPS algorithm to produce highly accurate, rapid, and robust numerical schemes.
- Proved joint analyticity of the transformed field with respect to two small physical parameters.
- Developed spectral element methods in the Matlab programming language.

Cold Regions Research and Engineering Laboratory

Mathematics Research Internship

Virtual Summer Internship

2020

- Wrote Fortran code in the Elmer finite element software for multiphysical problems.
- Compared competing models which predict thaw depths, frost heave, and thaw settlement in pavements.
- Collaborated with other researchers at CRREL and improved the accuracy of the thermodynamic model.

Argonne National Laboratory
Mathematics Research Internship

Summer Internship
2019

- Developed a parallel algorithm in C++ to replace existing Matlab code.
- Used the Radon transform and its inverse to test the parallel efficiency and speedup on the Beebop supercomputer at Argonne.
- Collaborated with other scientists at Argonne and presented my results at the summer student symposium.

University of Michigan at Dearborn
Zeros of the Riemann Zeta Function

MS Project
2015

- Wrote Java code to calculate millions of nontrivial zeros of the Riemann zeta function.
- Implemented the Riemann–Siegel formula in combination with the Cauchy–Schlömilch transformation.
- Investigated Lehmer's phenomenon and the distribution of spacing between zeros.

Data Science

Manning
Build a Large Language Model (From Scratch)

Ann Arbor, MI
2024

Coursera
Generative AI for Everyone

Online
2024

Manning
Deep Learning with Python

Ann Arbor, MI
2023-2024

Thinkful
Data Science Bootcamp

Online
2023-2024

DataQuest
Data Science in Python

Online
2023

Coursera
DeepLearning.AI Deep Learning Specialization

Online
2022

Presentations

2024: Tokenization, sequences, and attention masks with Hugging Face. Applied Machine Learning Group.

2024: Transformers and pretrained models with Hugging Face. Applied Machine Learning Group.

2024: Building a NLP Information Retrieval System with Trip Advisor. Ann Arbor Machine Learning Group. [Notebook 1](#), [Notebook 2](#), [Dash App](#).

2024: Scaling-up model training with GPUs and TPUs. Data Science & Machine Learning Collaborative Learning Group.

2024: Generative Adversarial Networks and Unsupervised Learning. Data Science & Machine Learning Collaborative Learning Group.

2024: Neural Style Transfer, Variational Autoencoders, and Supervised Learning. Data Science & Machine Learning Collaborative Learning Group.

2023: Transformers and Natural Language Processing. Data Science & Machine Learning Collaborative Learning Group.

2023: Deep Learning for Timeseries. Data Science & Machine Learning Collaborative Learning Group.

2023: Interpreting what convnets learn. Data Science & Machine Learning Collaborative Learning Group. [Slides](#).

2022: Joint Analyticity of the TFE Method and DNO in Periodic Media, Thesis Defense. [Slides](#).

2022: Wave Scattering in Periodic Media, Graduate Student Colloquium, Graduate student talk. [Slides](#).

2021: Calculating zeros of the Riemann zeta function, UIC Math Club, Graduate student talk. [Slides](#).

2020: The FROST and FROSTb Models, Summary of research performed at summer internship, CRREL. Graduate student talk.

2019: Parallel Iterative Tomographic Reconstruction, LANS Summer Argonne Students Symposium, Argonne National Laboratory. Graduate student talk.

2018-2021: UIC Graduate Analysis and Applied Mathematics Seminar

- Water Waves, Shallow-Water Equations, and Tsunamis (10/20/2021)
- Applications of Pseudo-differential operators (04/08/2021)
- Pseudo-differential operators on \mathbb{R}^n (03/25/2021)
- High-Order Perturbation of Surfaces (HOPS) Method (02/11/2021)
- The Riemann zeta function and Padé approximants (11/07/2018)

2013: Calculating the radiant of the Perseid meteor shower, CUREA Program Physics 2013. Undergraduate student talk. [CUREA Reflections 2013](#).

Workshops and Summer Schools

Argonne National Laboratory <i>Argonne Leadership Computing Facility (ALCF) AI for Science Training Series</i>	Virtual School 2021–2022
Mathematical Sciences Research Institute <i>Graduate Summer School on Mathematics of Big Data: Sketching and Linear Algebra</i>	Virtual School 2021
Mathematical Sciences Research Institute <i>Graduate Summer School on Microlocal Analysis: Theory and Applications</i>	Virtual School 2021
Mathematical Sciences Research Institute <i>Workshop for Recent Developments in Fluid Dynamics</i>	Virtual Workshop 2021
Mathematical Sciences Research Institute <i>Graduate Summer School on Water Waves</i>	Virtual School 2020
Toyota Technological Institute at Chicago <i>Summer School on Machine Learning</i>	Chicago, IL 2018
CUREA Program Physics <i>Summer School on Observational Astronomy</i>	Pasadena, CA 2013

Computer Skills

Tools and Languages: Python, Julia, Matlab, Bash, C++, \LaTeX

Packages: Tensorflow, Keras, PyTorch, Scikit-Learn, NumPy, SciPy, Matplotlib, Chebfun

Quantitative Research: Mathematical Optimization, Mathematical Modeling, SQL

OS: Linux, Windows

Projects: [Data Science](#), [Machine Learning](#), [Computational Electromagnetics](#), [Computational Number Theory](#)

Honors and Awards

2022: Graduate Student Travel Grant (JMM 2022), American Mathematical Society

2021–2022: Victor Twersky Memorial Scholarship, University of Illinois at Chicago

2014–2015: Applied and Computational Mathematics Graduate Scholarship, University of Michigan at Dearborn

2010: Alumni Association Scholarship, Oakland University

2009: Member of Omicron Delta Epsilon (International Honor Society in Economics)

References

David Nicholls

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Gerard Awanou

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University of Illinois at Chicago
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Jerry Bona

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John Steenbergen (Teaching)

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Leadership and Membership

Co-organizer of Ann Arbor AI/ML Meetup Group

Co-organizer of Data Science and Machine Learning Collaborative Learning Meetup Group

American Mathematical Society (AMS)

Society for Industrial and Applied Mathematics (SIAM)