

# Matthew Kehoe

Data/Research Scientist

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## Research Interests

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- 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

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

## Employment and Internships

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

## Publications

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- 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](#).

## Teaching Experience

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### University of Illinois at Chicago

Chicago, IL

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

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

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### Michigan Tech Research Institute

Research

Computational Electromagnetics and Signal Processing

2022-Present

- 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

Thesis

High-Order Perturbation of Surfaces (HOPS)

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

Virtual Summer Internship

Mathematics Research 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

Summer Internship

Mathematics Research 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.

- o Collaborated with other scientists at Argonne and presented my results at the summer student symposium.

**University of Michigan at Dearborn**

**MS Project**

*Zeros of the Riemann Zeta Function*

*2015*

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

## Data Science

<b>Manning</b>	<b>Ann Arbor, MI</b>
<i>Build a Large Language Model (From Scratch)</i>	<i>2024</i>
<b>Coursera</b>	<b>Online</b>
<i>Generative AI for Everyone</i>	<i>2024</i>
<b>Manning</b>	<b>Ann Arbor, MI</b>
<i>Deep Learning with Python</i>	<i>2023-2024</i>
<b>Thinkful</b>	<b>Online</b>
<i>Data Science Bootcamp</i>	<i>2023-2024</i>
<b>DataQuest</b>	<b>Online</b>
<i>Data Science in Python</i>	<i>2023</i>
<b>Coursera</b>	<b>Online</b>
<i>DeepLearning.AI Deep Learning Specialization</i>	<i>2022</i>

## Presentations

**2025: Physics-Informed Neural Networks (PINNs) and Scientific Machine Learning.** Ann Arbor Machine Learning Group. [Notebook](#).

**2025: Single-Head and Multi-Head Self-Attention.** Data Science & Machine Learning Collaborative Learning Group.

**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**

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

## **Computer Skills**

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**Tools and Languages:** Python, Julia, Matlab, Bash, C++,  $\text{\LaTeX}$

**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**

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**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

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### **David Nicholls**

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### **Gerard Awanou**

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### **Jerry Bona**

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### **John Steenbergen (Teaching)**

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## Leadership and Membership

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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)