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 — **Chicago, IL**
Ph.D. in Applied Mathematics — *2018–2022*
Advisor: Professor David Nicholls
Thesis: Joint Analyticity of the Transformed Field and Dirichlet-Neumann Operator in Periodic Media

University of Michigan at Dearborn — **Dearborn, MI**
M.S. in Computational Mathematics — *2013–2015*
Advisor: Professor Frank Massey
MS Project: Computational methods for the Riemann zeta function

University of Otago — **Dunedin, New Zealand**
Exchange student — *2010*

Oakland University — **Rochester, MI**
B.A. in Economics, Minor in Computer Science — *2006–2010*

Employment

Elder Research — **Arlington, VA**
Senior Data Scientist — *2025–Present*

Michigan Tech Research Institute — **Ann Arbor, MI**
Research Scientist — *2022–2025*

University of Illinois at Chicago — **Chicago, IL**
Computational Scientist — *2018 – 2022*

Cold Regions Research and Engineering Laboratory — **Hanover, NH**
NSF Mathematical Sciences Graduate Internship — *Summer 2020*

Argonne National Laboratory — **Lemont, IL**
NSF Mathematical Sciences Graduate Internship — *Summer 2019*

Workforce Software — **Livonia, MI**
Software Consultant/Programmer — *2010–2017*

Oakland University — **Rochester, MI**
Web Developer — *2009–2010*

Spec Associates **Detroit, MI**
Strategic Research Intern *2009–2010*

Publications

1: M. Kehoe, "Joint Geometry/Frequency Analyticity of Fields Scattered In Triply Layered Periodic Media", In Progress

2: M. Kehoe and B. Bhan, "The Method of Perturbation in Physics Informed Neural Networks", In Progress

3: 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.

4: 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

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

Michigan Tech Research Institute **Research**
Computational Electromagnetics and Signal Processing *2022–2025*

- 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.
- 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*

- 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

Hugging Face **Online**
Transformers and Natural Language Processing *2024–2025*

Manning **Ann Arbor, MI**
Build a Large Language Model (From Scratch) *2024–2025*

Coursera **Online**
Generative AI for Everyone *2024*

Manning **Ann Arbor, MI**
Deep Learning with Python *2023–2024*

Thinkful **Online**
Data Science Bootcamp *2023–2024*

DataQuest **Online**
Data Science in Python *2023*

Coursera **Online**
DeepLearning.AI Deep Learning Specialization *2022*

Presentations

2025: **The method of perturbation and curriculum learning in Physics-Informed Neural Networks.** Applied Machine Learning Group.

2025: **Fine-tuning LLMs for supervised instruction.** Data Science & Machine Learning Collaborative Learning Group. Notebook.

2025: **Pretraining on Unlabeled Data and Fine-tuning LLMs for text classification.** Data Science & Machine Learning Collaborative Learning Group. Notebook.

2025: **Applications of Machine Learning in Cancer Prediction and Prognosis.** Ann Arbor Machine Learning Group. Notebook.

2025: **Building and fine-tuning a GPT model to produce song lyrics.** Data Science & Machine Learning Collaborative Learning Group. Notebook.

2025: **Sharing models, tokenizers, and the Datasets library in Hugging Face.** Applied Machine Learning Group.

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.

2025: **Career Panel Discussion for Mathematical Scientists.** Joint Mathematics Meeting 2025. AMS Special Session

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

2024: **Transformers and pretrained models in 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: **Climate Change: Modeling Earth Surface Temperatures.** Ann Arbor Machine Learning Group. Notebook.

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. Slides.

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

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 Pertubation 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 — **Virtual School**
Argonne Leadership Computing Facility (ALCF) AI for Science Training Series — *2021–2022*

Mathematical Sciences Research Institute **Virtual School**
Graduate Summer School on Mathematics of Big Data: Sketching and Linear Algebra *2021*

Mathematical Sciences Research Institute **Virtual School**
Graduate Summer School on Microlocal Analysis: Theory and Applications *2021*

Mathematical Sciences Research Institute **Virtual Workshop**
Workshop for Recent Developments in Fluid Dynamics *2021*

Mathematical Sciences Research Institute **Virtual School**
Graduate Summer School on Water Waves *2020*

Toyota Technological Institute at Chicago **Chicago, IL**
Summer School on Machine Learning *2018*

CUREA Program Physics **Pasadena, CA**
Summer School on Observational Astronomy *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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University of Illinois at Chicago
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Jerry Bona
Department of Mathematics
University of Illinois at Chicago
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Gerard Awanou
Department of Mathematics
University of Illinois at Chicago
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John Steenbergen (Teaching)
Department of Mathematics
University of Illinois at Chicago
Chicago, IL 60607
jbergen@uic.edu

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)