Lucia Minah Yang

Contact Information

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Research Interests

Geophysical Fluid Dynamics, Computational Mathematics, Machine Learning, Numerical Methods, Data Assimilation

Education

University of Colorado Boulder — Boulder, Colorado USA
Department of Applied Mathematics

- PhD Applied Mathematics, May 2021
- GPA: 3.930/4.000
- Advisor: Ian Grooms

University of Colorado Boulder — Boulder, Colorado USA

M.S. Applied Mathematics, December 2018

Amherst College — Amherst, Massachusetts USA

B.A. Mathematics and Music, May 2015

Academic Honors, Awards and Scholarships

SIAM Science Policy Fellow	**2022-2023**
NASA Wave-induced Atmospheric Variability Enterprise (WAVE) Fellowship	**2022**
SIAM Financial Mathematics Student Programming Challenge 4th Place	**2021**
MIT Graph Challenge 2020 Honorable Mention	**2020**
Lawrence Livermore National Lab Computation Scholar	**2019,2020**
Best Poster Award APPM 30th Anniversary/Recruitment Poster Session	**2019**
Achievement Rewards for College Scientist (ARCS) Scholar	**2018-2021**
The Forris Jewett Moore/Amherst Memorial Fellowship, Amherst College	**2016-2019**
Summer Student Poster Symposium Winner, Lawrence Livermore National Laboratory	**2018**
National Science Foundation Mathematical Sciences Graduate Internship	**2018**
Academic Fellowship, University of Colorado Applied Mathematics Department	**2016**
Cum Laude in Mathematics and Music, Amherst College	**2015**
Gregory S. Call Student Research Fund, Amherst College	**2014**
Actuary Foundation of America's program Project Math Minds Winner	**2010**

Research Topics

Spectral Filtering Methods for Spherical Grids **August 2022 - present**
Develop and implement fast algorithms for computing spectral filters on Gaussian and icosahdral spherical grids. Produce subgrid-scale data products from high resolution GCM simulations for use in data-driven parameterizations of atmospheric gravity waves. Working with Dr. Laura Köhler (Max-Planck-Institute für Meteorologie)

Data-driven Approaches to Parameterizations of Gravity Waves **June 2021 - present**
Develop machine learning and other data-driven approaches to learning gravity wave parameterizations for use in general circulation models, with a special emphasis on mitigating difficulties of learning from datasets with long-tailed distributions. Working with Dr. Ed Gerber (NYU)

Constructed Analogs with Variational Autoencoders **September 2020 - present**
Develop machine learning based data assimilation methodology for high-dimensional geophysical applications. Working with Dr. Ian Grooms (CU Boulder)

Wave Turbulence and Resonant Triad Time-stepping Methods **June 2019 - May 2020**
Develop, test, and analyze implicit/explicit and exponential integrators for wave-turbulence and doubly- diffusive turbulent type problems. Worked with Dr. Ian Grooms and Dr. Keith Julien (CU Boulder).

Variable Precision Computing **May 2018 - July 2020**
Researched viability of using half-precision implementation of QR factorization, specifically as a subroutine for iterative eigensolvers to be used in spectral clustering methods. Tested feasibility in graph ranking problems solved with iterative methods. Conducted rounding error analysis of Householder QR factorization methods and the power method.

Worked with Dr. Alyson Fox and Dr. Geoffrey Sanders (LLNL).

One-pass Randomized SVD **September 2019 - present**
Improve existing one-pass randomized SVD algorithm, and compare against other similar algorithms. Working with Dr. Stephen Becker (CU Boulder).

Madden Julien Oscillation (MJO) Modeling Project **August 2016 - May 2019**
Formulated a 2-layer shallow water model with moist precipitation over equatorial domain of Earth. Coded from scratch explicit and IMEX PDE solvers. Worked with Dr. Ian Grooms (CU Boulder).

Publications

Yang, L. Minah, and Edwin P. Gerber "Overcoming set imbalance in data driven parameterization: A case study of gravity wave momentum transport." *Under preparatin for submission to Journal of Advances in Modeling Earth Systems*

Grooms, Ian, Camille Renaud, Zofia Stanley and L. Minah Yang. "Analog Ensemble Data Assimilation in the Quasigeostrophic Coupled Model." *Under review August 2022: Quarterly Journal of the Royal Meteorological Society*

Yang, Lucia Minah, and Ian Grooms. "Machine Learning Techniques to Construct Patched Analog Ensembles for Data Assimilation." Journal of Computational Physics, Volume 443 (2021): 110532.

Yang, L. Minah, Ian Grooms, and Keith A. Julien. "The fidelity of exponential and IMEX integrators for wave turbulence: Introduction of a new near-minimax integrating factor scheme." Journal of Computational Physics 434 (2021): 109992.

Yang, L. Minah, and Alyson Fox. "Analysis of floating-point round-off error in linear algebra routines for graph clustering." 2020 IEEE High Performance Extreme Computing Conference (HPEC). IEEE, 2020.

Yang, L. Minah, Fox, Alyson, and Sanders, Geoffrey " Rounding error analysis of mixed precision block Householder QR algorithms." SIAM Journal on Scientific Computing 43.3 (2021): A1723-A1753.

Invited Presentations

"Overcoming set imbalance in data driven parameterization: A case study of gravity wave momentum transport." **Goal-oriented and Context-aware Scientific Machine Learning Minisymposium, SIAM Computational Science and Engineering Conference (CSE)**, Amsterdam, Netherlands. ***Future date: February 2023.*

"Sampling Strategies for Training Machine Learning Emulators of Gravity Wave Momentum Transport." **Machine Learning for Climate and Weather Application, Institute for Mathematical and Statistical Innovation**, Chicago, IL. October 2022.

"Sampling Strategies for Training Machine Learning emulators of Gravity wave parameterization." **Wave-induced Atmospheric Variability Enterprise**, Boulder, CO. April 2022.

"Machine Learning Techniques to Construct Patched Analog Ensembles for Data Assimilation." **Atmosphere Ocean Science Colloquium, Courant Institute of Mathematical Sciences, New York University.** October 2021

"Simulated Half-Precision Implementation of Blocked QR Factorization and Graph Clustering Applications." **Variable Precision Minisymposium, SIAM CSE**, Spokane, WA. February 2019.

Contributed Presentations

"Sampling Strategies for Learning from Long-tail Distributed Datasets: Neural Network Emulators for Gravity Wave Parameterizations" [poster] **SPARC General Assembly** October 2022.

"Sampling Strategies for Training Machine Learning Emulators of Gravity Wave Parameterizations" [poster] **23rd Conference on Atmospheric and Oceanic Fluid Dynamics, AMS** July 2022.

"Sampling strategies for data-driven parameterization of gravity wave momentum transport" [oral] **European Geophysical Union General Assembly** May 2022.

"Neural network emulators for gravity wave parameterizations"[oral] **SPARC Gravity Wave Symposium** March 2022

"Machine Learning Techniques to Construct Patched Analog Ensembles for Data Assimilation." [oral] **2021 International Symposium on Data Assimilation- Online: Machine Learning for Data Assimilation.** December 2021

"Using machine learning techniques to generate analog ensembles for data assimilation." [oral] **EGU General Assembly Conference Abstracts.** April 2021.

"Analysis of Floating-Point Round-Off Error in Linear Algebra Routines for Graph Clustering." [oral] **2020 IEEE High Performance Extreme Computing Conference.** September 2020

"The Fidelity of Exponential and IMEX Integrators for Wave Turbulence." [poster] **SIAM Annual Meeting**. July 2020.

"Time Integration of Wave Turbulence Problems." [oral] **Geophysical and Astrophysical Fluid Dynamics Seminar, CU Boulder**. March 2020.

Meeting and Session Organizer

American Geophysical Union (AGU) Fall Meeting Dec 12-17, 2022 Nonlinear Geophysics: Data-Driven Subgrid-Scale Parameterizations for Earth System Modeling

Teaching Experience

University of Colorado Boulder Boulder, CO USA

Grader **January 2019 - May 2019**

Graded homework and provided office hours for a **graduate-level course**: APPM 5480 Methods of Applied Math: Asymptotics.

Teaching Assistant **August 2016 - May 2019**

Lead weekly recitation sections and workgroup sections for undergraduates in Calculus I, II, III, and Differential Equations. In addition, held 3 weekly office hours, created rubrics for homework grading, and prepared for midterm and final exam review sessions.

Computer Lab Instructor **August 2018 - December 2018**

Taught introductory course in Mathematica (APPM 2450) to supplement the Calculus III curriculum. Writing homework assignments and in-class Mathematica notebooks to structure the curriculum of APPM 2450.

Lead Teaching Assistant **May 2017 - May 2018**
Co-led weekly course for new graduate students to facilitate their introduction into teaching assistantship work. Planned several weekly activities for students, including forming multiple panels (faculty, industry, instructors, National labs) to introduce career options available for applied math graduates.

Amherst College Amherst, MA USA

Graduate Associate **August 2015 - May 2016**
Taught Musicianship/ Ear Training classes that supplemented music theory classes (Introduction to Music Theory, Counterpoint and Harmony, 20th century Analysis).

Peer Tutor/Teaching Assistant, Mathematics and Physics Depts **August 2012 - May 2015**
Tutored undergraduate students in Linear Algebra and Calculus courses at the recommendation of the Mathematics department, and led weekly help sessions for introductory physics courses.

Leadership Roles

New York University New York, NY USA
Co-lead of Machine Learning Action Group of VESRI **August 2021 - present**
Organize monthly discussion topics including literature review in machine learning, new topics in machine learning, and advances of scientific applications of machine learning.

University of Colorado Boulder, CO USA
Vice President, Graduate Student Chapter of SIAM **August 2019 - present**
Organize monthly student talks and plan student activities.

Treasurer, Association for Women in Mathematics (AWM) **August 2020 - present**
Secure funding for main chapter activities: AWM colloquium speaker, study sessions, community lunches, recruitment events.

Study Session Coordinator, AWM **August 2018 - May 2020**
Organize study sessions near midterm and final exam times specifically geared towards women in engineering. Responsibilities includes securing funding opportunities and allocating the successful funds towards paying (mostly) women graduate students who would facilitate these exam study groups for undergraduate-level courses.

Professional Experience

Amherst College Amherst, MA USA
Assistant Director of Amherst College Choral Society **August 2015 - May 2016**
Aided in directing 4 distinct choral groups (Women's Chorus, Glee Club, Concert Choir, Madrigal Singers) that comprise the Amherst College Choral Society (∼100 members). Duties included conducting, coaching, and accompanying.

Organist, Northampton, MA USA **August 2015 - July 2016**
Created and performed weekly programs for 1-hour long services that included a 10-minute solo prelude at the beginning, 3 hymns, and a 5-minute closing music.

Computer Skills

- Languages: Julia, Matlab, Python, R, C
- Applications: Matlab, Microsoft Office, LaTeX, Adobe Creative Suite