

Madelyn Esther Chua Cruz

+1 848-459-0933
mccruz@umich.edu

Education

- 2022 - **University of Michigan, Ann Arbor**, *Ph.D. in Applied and Interdisciplinary Mathematics*
Present with dual M.S. in Bioinformatics,
General Point Average: 4.00, Ph.D. Candidate.
Advisors: Dr. Daniel Forger and Dr. George Mashour
- 2019 - **University of the Philippines - Diliman**, *B.S. Mathematics (Four-Year Program)*,
2022 General Weighted Average: 1.0682 (scale: 1.00 highest, 5.00 lowest), *Summa cum laude*,
Thesis: Mathematical Analysis used in EEGs and Other Extensions.
Advisor: Dr. Carlene Arceo

Skills

- **Programming Languages:** Python, MATLAB, R, Maxima
- **Tools & Frameworks:** PyTorch, TensorFlow, Python-MNE, Pandas, CUDA, Scikit-learn, Jupyter, Matplotlib, Hugging Face, LaTeX, SPM (fMRI), Linux, Git, HPC, Slurm
- **Machine Learning & AI:** Deep Learning, Biological Neural Networks, Parallel Computing

Publications and Preprints

- Ginsberg, A. G., **Cruz, M.** E., Weber, F., Booth, V., & Diniz Behn, C. G. (2024). A predictive propensity measure to enter REM sleep. *Frontiers in Neuroscience*, 18, 1431407.
- Aldous, D. J., **Cruz, M.**, & Feng, S. (2024). Markov chains and mappings of distributions on compact spaces II: Numerics and Conjectures. arXiv preprint arXiv:2403.18153.
- Aldous, D. J., & **Cruz, M.** (2022). A real-world Markov chain arising in recreational volleyball. *Involve, a Journal of Mathematics*, 14(5), 829-852.

Talks

- **Biologically Interpretable Machine Learning Approaches for Analyzing EEG.**
Contributed lecture, 2025 SIAM Annual Meeting, Montreal, Canada (July 2025).
- **Biologically Interpretable Machine Learning Approaches for Analyzing Neural Data.**
Poster, 34th Annual Computational Neuroscience Meeting (CNS*2025), Florence, Italy (July 2025).
- **Biophysical Machine Learning Models for Analyzing Neural Data.**
Poster, Frontiers in NeuroAI – Kempner Institute Symposium, Harvard University (June 2025).
- **A predictive propensity measure to enter REM sleep.**
Lightning Talk, Chicago Area SIAM Student Conference (April 2025)
- **Biophysical Models in EEG.**
Oral presentation, Cognitive Fatigue MURI Meeting, Walter Reed Army Institute of Research (Nov 2023).
- **Mathematical Analysis used in EEGs and Other Extensions.**
Oral presentation, 2022 Mathematical Society of the Philippines Annual Convention (May 2022).

Work and Teaching Experiences

- 2023– **University of Michigan, Ann Arbor**, *Graduate Student Research Assistant*, Perform research
Present under the supervision of Prof. Daniel Forger.

- 2022– **University of Michigan, Ann Arbor**, *Graduate Student Instructor*, Taught 17-22 students
Present Math 115 (Calculus I) during Fall 2022, Winter 2023, and Fall 2023 and 80 students Math 215 (Calculus III) during Fall 2024.
- 2019– **Art of Problem Solving**, *Teaching Assistant and Releaser*, Assisted and graded in classes
2022 to help advanced middle-school and high-school students win mathematics competitions.

Research Experience

- 2023- **Biophysical Models in EEG**, *I am incorporating biophysical models with machine learning algorithms to better classify and understand EEG signals biologically.*
- 2023- **Quantifying the propensity for rapid eye movement sleep in rodents**, *We present a novel method to quantify REM propensity using analysis of statistical features of rodent sleep data.*
- 2023 **Sleep network model with infraslow oscillations with Dr. Victoria Booth**, *We created a sleep network model (REM-NREM-Microarousals) in mice that incorporates infraslow oscillations which are seen in Locus Coeruleus neurons.*
- 2022 **Mathematical Analysis used in EEGs and Other Extensions with Dr. Carlene Arceo**, *I used power spectrum analysis and graph theory to analyze disorders such as Parkinson's disease.*
- 2019 **Assessing the Safety and Risk Factors of the PSHS-MC SHB using the Helbing-Molnar-Farkas-Vicsek Model**, *Simulations on the emergency situations in the Science & Humanities Building of the PSHS-MC incorporating socio-psychological and physical forces were performed.*
- 2017 **Isolation and purification of natural products at the University of the Philippines – Manila Department of Physical Sciences and Mathematics**, *I worked as a Natural Science Research Intern in the laboratory to determine the phytochemicals present in different plant samples.*

Selected Projects

- 2025 **Quantum Sudoku puzzle using Grover's algorithm**, *Created a quantum circuit to search for bitstrings that encode valid Sudoku solutions using Grover's algorithm [Project Repository].*
- 2024 **Leveraging Foundation Models to Derive Multi-Level Representations of Xenium Data to Analyze Idiopathic Pulmonary Fibrosis Stage and Structural Composition**, *Used foundation models to obtain multi-level representations of Xenium data, integrate information from multiple levels, and distinguish between healthy samples and samples with IPF.*
- 2024 **Skin Cancer Detection with 3D Total Body Photos**, *Developed an ensemble AI model to analyze low-quality images and distinguish malignant from benign skin lesions [Project Repository].*
- 2024 **Harmful Brain Activity Classification**, *We classified seizures and other patterns of harmful brain activity in critically ill patients using ensemble models [Project Repository].*

2023 **Nutrition Nuts**, *Using the United States Department of Agriculture (USDA)'s Food and Nutrient Database, we created an algorithm where a user inputs a food item, and the program spits out a few suggestions for side dishes that would make a balanced meal [Project Repository]*.

Leadership and Volunteer Experiences

- 2024 **SIAM Student Chapter Co-Organizer, University of Michigan**, *Organize events for the Applied and Interdisciplinary Mathematics students at the University of Michigan, such as the 2024 and 2025 SIAM Student Mini-Symposium in Applied Mathematics.*
- Present **Student AIM Seminar Co-Organizer, University of Michigan**, *Organize seminars and events for the Applied and Interdisciplinary Mathematics students at the University of Michigan.*
- 2024 **Michigan Medicine Children's Emergency Services**, *Provide and assist patients/families, offer items from comfort cart, sit with/engage child at bedside, among others.*
- 2023 **Michigan Medicine Cardiovascular Center Cardiac Procedures Unit**, *Walk patients to prep area, families to consult rooms and recovery and, support lobby host, among others.*

Awards and Honors

International and Proof-Based Competitions

- 2017 **China Girls Mathematical Olympiad**, *Bronze Medalist*, Chongqing No. 8 High School, China, This is an international mathematics competition for females with a proof-based format.
- 2019 **21st Philippine Mathematical Olympiad**, *National Finalist (Top 20)*, Philippines, The Philippines' most prestigious math competition for secondary students, it selects the country's representatives for the International Mathematical Olympiad, with the Top 20 advancing to the national finals.

Scholarships

- 2025 **University of Michigan, Department of Mathematics, Cameron & John Courtney Scholarship award**, This fund was established in 2004 in honor of Cameron and John Courtney for graduate students studying mathematics..
- 2019- **Department of Science and Technology Merit Scholar**, This merit scholarship is awarded 2022 to undergraduate students with high aptitude in science and mathematics.

Trainings and other Programs Attended

- **Data Parallelism: How to Train Deep Learning Models on Multiple GPUs.** NVIDIA Certification ID: aDIBD9sSTBGHMoztSC6CRw
- **The Erdos Institute Deep Learning Boot Camp (Summer 2024).** 1-month long intensive boot camp for deep learning with a final project on classifying benign and malignant melanomas using 3D-TBP images.
- **The Erdos Institute Data Science Boot Camp (Spring 2023).** 1-month long intensive boot camp for data science and machine learning.
- **Mathematical Olympiad Summer Camp 2019 (MOSC).** This is the summer training and selection venue for the representatives to the International Mathematical Olympiad (IMO) where all Philippine Mathematical Olympiad National Finalists are invited.