Madelyn Esther Chua Cruz

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

Education

2022 - Present **University of Michigan, Ann Arbor**, *Ph.D. in Applied and Interdisciplinary Mathematics and Scientific Computing with dual M.S. in Bioinformatics*,
General Point Average: 4.00, Ph.D. Candidate.
Advisors: Dr. Daniel Forger and Dr. George Mashour

2019 - 2022 **University of the Philippines - Diliman**, *B.S. Mathematics (Four-Year Program)*,
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, Hugging Face, LaTeX, SPM (fMRI), Linux, Git, HPC, Slurm
  Machine Learning & AI: Deep Learning, Biological Neural Networks

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, Allston, MA (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).
- **Investigation of Sophie Germain Primes and its Infinitude**.
  Poster, Philippine Society of Youth Science Clubs 1st STEM EXPO (2018).

Work and Teaching Experiences

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

2022– Present **University of Michigan, Ann Arbor**, *Graduate Student Instructor*, Taught 17-22 students Math 115 (Calculus I) during Fall 2022, Winter 2023, and Fall 2023 and 80 students Math 215 (Calculus III) during Fall 2024.

2019– 2022 **Art of Problem Solving**, *Teaching Assistant and Releaser*, Assisted and graded in classes to help advanced middle-school and high-school students win mathematics competitions.

2019– 2021 **University of the Philippines Mathematics Majors' Circle**, *Academic Committee Member*, Holds competitions for high school students and mathematics tutorials for undergraduate students.

2019–2020 **Newton Study Center**, *Tutor*, Tutor for Grades 4 to 12 in mathematics and science subject.

Research Experience

2023-Present **Biophysical Models in EEG**, *I am incorporating biophysical models with machine learning algorithms to better classify and understand EEG signals biologically*.

2023-Present **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 Coereleus neurons*.

2023 **Sleep-wake network model with Dr. Victoria Booth**, *We created a sleep-wake network model (REM-NREM-Wake) that replicates the baseline behavior of mice*.

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, including gene-level, cell-level, domain-level, and slide-level representations of data, 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 **Mission Brain Hackathon: MMVTec**, *Developed a personalized physiotherapy program for low- and middle-income communities by generating tailored rehabilitation videos using real-time wearable data and machine learning.*

2024 **BR41N.IO Hackathon: Locked-in Patient Data Analysis**, *Designed and implemented a preprocessing and classification pipeline for EEG datasets to analyze neural signals from locked-in patients.*

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 -Present **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.*

2024 -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 -Present **Make-a-Wish Michigan**, *Meet with the wish child and their family to help them discover their heartfelt wishes.*

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.

Other National Awards and Competitions

2015-2019 **Department of Science and Technology Youth Excellence in Science Awardee**, Philippines, This award is given to students who obtained a medal from international mathematics and science competitions during the previous year.

2018 **Philippine Society of Youth Science Clubs 1st STEM EXPO**, *Best in Research Category - Mathematics*, Philippines, Students showcase their knowledge and skills in the different fields of science, technology, and innovation by presenting their research projects.

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- 2022 **University of the Philippines University Scholar**, This is an honorary scholarship given to students with a general point average of at least 1.40 (scale: 1.00 highest, 5.00 lowest) every semester.

2019- 2022 **Department of Science and Technology Merit Scholar**, This merit scholarship is awarded 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: aDlBD9sSTBGHMoztSC6CRw
- **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.