Zhuo (Cecilia) Chen

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Education

Bryn Mawr College — Bryn Mawr, PA
Double major in Computer Science and Mathematics — *expected May 2026*

Research Experience

Hamiltonian Paths in Rectangular Grid Graphs with Triangular Holes — April 2025 – Present
Independent Researcher & Thesis — *Bryn Mawr College, PA*

- Developed a parameterized framework for modeling triangular-hole grid graphs using stacked reversed T-shapes, enabling systematic geometric and parity-based analysis of Hamiltonian path feasibility.
- Proved new necessary conditions and impossibility results by decomposing grids into tractable subgraphs and identifying configurations where triangular holes force global parity violations.
- Designed constructive algorithms that assemble global Hamiltonian paths via 2-rectangle decompositions, forming the basis for a near-full case classification in progress.
- Thesis work extends to path enumeration, grid-cutting strategies, and structural patterns in small-grid Hamiltonian paths, with links to zero-relocation conditions in grid-based storage systems.
- Draft paper [link] and thesis proposal [link] are available.

Robust Scientific Machine Learning — June 2024 – Present
Research Assistant — *University of California, San Diego*

- Evaluated the robustness of scientific neural networks for 4D STEM reconstruction and cloud segmentation by training and testing under controlled noise injections—Gaussian, salt-and-pepper, and bit-flip.
- Found that training CC-ST-AE with 25% noise improved performance on similarly noisy inputs but caused a 35.48% degradation on clean data, revealing limited robustness.
- Benchmarked full-precision and quantized variants (via `brevitas`), analyzing sensitivity to input noise, weight perturbations, activation noise, and bit-width reductions using loss-landscape and sharpness metrics.
- The first stage of this work was presented as a **poster** - ***Evaluating the Robustness of a 4D STEM Autoencoder to Noisy Inputs***, **Z. Chen**, O. Weng, S. Qin, J. Agar, N. Tran and R Kastner, 2024, Fast Machine Learning for Science Conference (FastML 2024) (poster link)

Automated Exceptional Test Oracle Generation — June 2025 – Present
Research Assistant — *Bryn Mawr College*

- Compared TOGA, TOGLL, and EditAS2 on Defects4J—a benchmark of real-world bugs—and found that TOGLL's accuracy on exceptional bugs was 38.88% lower than its accuracy across all bug types.
- Evaluated and engineered prompting strategies for large language models (LLMs) to synthesize oracles that capture subtle exceptional conditions beyond syntactic or prefix-based patterns.
- Integrated Claude and xAI via the Model Context Protocol (MCP) to classify fault types and analyze oracle quality, enabling systematic inspection of LLM reasoning when identifying specific exception types.

Debugging Visualization and Edge-Based Fault Localization — June 2023 – Present
Independent Researcher — *Bryn Mawr College*

- Developed the +Edges extension for Spectrum-Based Fault Localization (SBFL), enhancing eight established techniques by incorporating control-flow graph edge information to better visualize and capture branch behavior.
- Conducted a large-scale evaluation on 262 real faults from Defects4J, demonstrating significant performance improvements across four metrics; for example, Sørensen+Edges improved Mean First Rank by 55.8%.
- This research led to the **paper and presentation** - ***Use of Control Flow Graphs with Edges Consideration for Fault Localization***, **Z. Chen** and C. Murphy, 2025, presented in CAPWIC 2025, paper in submission

Blockchain-Based Framework for EV Charging Scheduling — May 2024 – July 2024
Research Assistant — *Shanghai Jiao Tong University*

- Implemented and evaluated a blockchain-based EV charging scheduler that used geometric distance calculations to assign vehicles to charging stations through smart-contract–driven coordination.
- Tested the scheduling algorithm to assess spatial efficiency and cost tradeoffs under varying demand patterns.
- This work resulted in **paper** - ***A Blockchain-Based Optimized and Secure Scheduling Framework for Charging Service***, X. Lu, Z. Wang, **Z. Chen**, J. Lou, C. Wu, Y. Luo, G. Xue, Y. Ji, W. Zhao and J. Li, 2024, paper in submission (link)

Teaching Experience

CMSC B340 Analysis of Algorithm - Teaching Assistant 25 Fall, 26 Spring
Bryn Mawr College *Bryn Mawr, PA*

CMSC H/B231 Discrete Mathematics - Teaching Assistant 23 Spring, 24 Fall, and 25 Spring
Haverford College & Bryn Mawr College *Haverford/Bryn Mawr, PA*

Discrete Mathematics Tutor 23 Spring
Haverford College *Haverford, PA*

Course Projects

Automated Software Analysis and Test Generation Spring 2025
Software Analysis Course Project for Prof. Elizabeth Dinella *Bryn Mawr College*

- Evaluated EvoSuite and EditAS2 on Defects4J Time bugs, analyzing prefix generation, assertion quality, and bug-detection effectiveness.
- Proposed improvements such as domain-aware exception templates and input-seeding heuristics to increase bug-triggering coverage on semantic/time-dependent bugs.
- Final report is available via [link].

Evolutionary Dynamics of ML Techniques on Spam Filtering Spring 2025
Evolutionary Game Theory Course Project for Prof. Olivia Chu *Bryn Mawr College*

- Analyzed spam filters and adversarial spammer strategies using evolutionary game theory, computing Nash equilibria, ESS, and invasion dynamics.
- Implemented spatial grid simulations to examine propagation of adversarial strategies and attacker–defender co-evolution.
- Final report can be found here [link].

Course Scheduling Optimization Fall 2024
Analysis of Algorithm Course Project for Prof. Dianna Xu *Bryn Mawr College*

- Designed an end-to-end scheduling algorithm for assigning classrooms, timeslots, and student enrollments; analyzed worst-case runtime and verified asymptotic behavior using synthetic datasets.
- Adapted the algorithm to real Registrar data from Bryn Mawr and Haverford, addressing missing instructor data, variable preference lists, and overlapping timeslots.
- Implemented and compared five extensions—greedy, dynamic programming, independent set, popularity–conflict hybrid, and simulated annealing—to improve scheduling quality.
- Final report available [link].

ML Classification for Online Purchase Intention Fall 2024
Machine Learning Course Project for Prof. Adam Poliak *Bryn Mawr College*

- Developed and evaluated supervised learning models (e.g., logistic regression, decision trees, random forests) with full preprocessing and hyperparameter tuning.
- Analyzed model performance using accuracy, confusion matrices, and validation curves to study dataset characteristics and bias–variance tradeoffs.
- Code and report are available on [GitHub].

Related Coursework

Computer Science:
Randomized Algorithms, Computational Geometry, Algorithms for Big Data, Analysis of Algorithms, Software Analysis, Information and Coding Theory, Discrete Mathematics, Computational Linguistics, Data Structures, Machine Learning, Principles of Programming Languages, Computer Systems, Senior Conference

Mathematics:
Abstract Algebra I & II, Real Analysis I, Linear Algebra, Multivariable Calculus, Evolutionary Game Theory