XUANLIN ZHU

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Portfolio: https://myouza.github.io/phd-portfolio/

EDUCATION

College of William and Mary Williamsburg, VA
Bachelor of Science, Double Major in Applied Mathematics & Computer Science *Degree Expected: Dec 2025*

- **GPA:** 3.83/4.0 (Major GPA: 3.93/4.0)
- **Selected Coursework:**
  - *Computational:* Intro to Edge Computing, Operating Systems, Data Mining, Algorithms, Software Development.
  - *Mathematical:* Numerical Analysis I/II, Euclidean Geometry, Graph Theory, Probability, Symmetry.
  - *Interdisciplinary:* Intro to Computer Music, Sociocultural Linguistics, Chinese Literature in English, Chinese Art & Archaeology (Visual Material Culture).

RESEARCH INTERESTS

Computational Media, Algorithmic Narratology, Epistemology of Simulation, Optimal Transport in NLP, Critical Code Studies, Sound Synthesis.

RESEARCH EXPERIENCE

Stability Analysis of Semantic Transport in Computational Poetics *Independent Researcher*
Independent Project Fall 2025 – Present

- Deriving formal stability bounds for **Wasserstein Distance** (Word Mover's Distance) to validate its use in quantitative literary analysis.
- Proved that transport cost is Lipschitz continuous with respect to embedding perturbations, establishing a "safe interpretation zone" for algorithmic criticism.
- Conducted empirical verification using `all-MiniLM` transformer embeddings on poetic corpora, visualizing transport plans to demonstrate geometric preservation of semantic meaning.
- **Output:** Methodological Note (featured in portfolio).

Heuristic Optimization of Legacy Game Algorithms *Undergraduate Researcher*
Independent Project / Faculty Mentored Spring 2025 – Present

- Deconstructed the legendary "Fast Inverse Square Root" algorithm (Quake III Arena) to analyze its bit-level logic.
- Implemented a custom **Differential Evolution (DE)** pipeline to search the 32-bit integer space.
- Discovered a new constant (`0x5f375966`) that minimizes relative error better than the original historical constant, demonstrating the utility of evolutionary computing in analyzing legacy code.
- **Output:** Symposium Talk at **JMM 2026**; Poster at **SIAM NNP 2025**.

TinyLite: Pruned BERT for Edge-Based Spam Detection *Research Assistant*
Advisor: Prof. Sidi Lu Spring 2025 - Present

- Architected a custom Transformer variant by systematically pruning self-attention heads and shrinking hidden dimensions, reducing FLOPs by **81.6%** while maintaining **98%** of baseline F1 score on SMS benchmarks.
- Validated in Federated Learning scenarios to ensure privacy-preserving deployment on consumer hardware.
- **Output:** Draft manuscript available.

Epistemological Foundations of Geometric Models *Research Monograph*
Advisor: Prof. Eric Swartz Fall 2024

- Authored a comparative analysis of Poincaré's Conventionalism versus Kantian Synthetic Apriority using three geometric models.
- Formalized the relationship between "physical laws" (temperature/refraction) and "geometric axioms," arguing that simulation parameters dictate perceived spatial truths—a framework applicable to game engine rhetoric.

Sociolinguistic Perception of Generative AI Writing Styles *Student Researcher (Coursework)*
Advisor: Prof. Leslie Cochrane Fall 2025 – Present

- Pilot study completed (N=18); investigating the correlation between user demographics and the perception of punctuation—specifically the em-dash—as a marker of "AI-generated" text.
- Formulated survey hypotheses based on preliminary participant observation and interviews with writing tutors; applied coursework training in research ethics to design the final survey instrument.
- **Output:** Drafting a quantitative field note on how "Algorithmic Folk Theories" vary across social groups.

CONFERENCE PRESENTATIONS

- **Zhu, X.** (2026, January). *Optimizing the Magic Constant in Fast Inverse Square Root Using Differential Evolution.* Symposium Talk to be presented at the **Joint Mathematics Meetings (JMM)**, Washington, D.C.
- **Zhu, X.** (2025, October). *Optimizing the Magic Constant in Fast Inverse Square Root Using Differential Evolution.* Poster presented at the **Annual Meeting of the SIAM New York, New Jersey and Pennsylvania Section (SIAM NNP)**.

SELECTED TECHNICAL PROJECTS

Songs of Memory (Narrative RPG & Design Research) *Solo Developer & Writer*

- Designed a 30-hour RPG exploring existentialist themes using "Radical Hybridity" aesthetics (combining Western fantasy with Qing Dynasty material culture).
- Authored a 300,000-word branching narrative script and developed the **"Automated Archaeology"** methodology to parse game event logic as textual discourse for hermeneutic analysis.
- **Output:** 39-page Game Design Document (GDD) and internal research build.

Cluster API Provider "Slinky" (CAPS) *Systems Architect*

- Designed a proof-of-concept converged infrastructure to bridge Slurm (HPC) and Kubernetes (Microservices), eliminating resource waste in academic labs.
- Architected a declarative control plane using the **Composite Design Pattern** to treat heterogeneous nodes as a unified resource pool.
- **Impact:** Core logic and architecture subsequently adopted for internal research at **Microsoft Azure**.

Eurorack Synthesizer Module Prototype *Product Engineer & Signal Analyst*

- Designed a cost-optimized Eurorack module to challenge high-markup proprietary synthesizers, integrating consumer hardware (Teensy, Raspberry Pi).
- **Signal Analysis:** Generated reference signals using **PureData (Pd)** and conducted spectral analysis using **SPEAR** to benchmark synthesis quality.
- Engineered custom PCB layouts in AutoCAD to interface Zynthian architecture with analog control voltage (CV).

SKILLS & LANGUAGES

- **Languages:** C/C++, Python (PyTorch, NumPy, SciPy), Java, R, MATLAB.
- **Audio & Creative Coding:** PureData (Pd), SuperCollider, PlugData, SPEAR, Ableton Live, AutoCAD.
- **Tools:** Git, Docker, Kubernetes, LaTeX, Jupyter.
- **Languages:** English (Fluent), Chinese (Native), **Japanese (JLPT N1 - Advanced Fluency)**.