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:** 3.86/4.0 (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).

Automated Derivation of Approximate Arithmetic Constants *Undergraduate Researcher*
Independent Project / Faculty Mentored Spring 2025 – Present

- Characterized the error landscape of the "Fast Inverse Square Root" algorithm, identifying a globally funnel-shaped basin with locally rough structure (the "fractal floor") that defeats gradient methods.
- Derived a closed-form **Chebyshev-optimal baseline** providing a format-blind analytical starting point for any IEEE-like floating-point format.
- Implemented **Differential Evolution (DE)** to discover hardware-aware corrections; identified a $\Delta R \approx$ 25,400 offset compensating for bit-shift truncation bias invisible to real-number analysis.
- Achieved **24% reduction** in worst-case error over the analytical baseline; validated on FP16 (exact global optimum with 18× fewer evaluations than brute force).
- Proposed the "Constant Compiler" paradigm: compute analytical baseline, warm-start DE, generate hardware-optimal constants in <1 second for agile hardware design.
- **Output:** Symposium Talk at **JMM 2026**; Poster at **SIAM NNP 2025**; Working manuscript.

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 Linearization Constant in Fast Inverse Square Root Using Differential Evolution.* Symposium Talk presented at the **Joint Mathematics Meetings (JMM)**, AMS Special Session on Applied Mathematics for Digital Twins, 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)**.