Patrick Dugan

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Education

University of Pennsylvania Philadelphia, PA

M.S.E. & B.S.E. in Computer Science, B.A. in Mathematics; GPA: 3.99/4.0 *Expected Dec 2027*

- **Coursework:** Theory of ML, Machine Learning, Computer Vision, Big Data Analytics, Randomized Algorithms

Experience

AI Engineering Intern (LLM Agents) May 2026 – Aug 2026

Concurrent EDA *Pittsburgh, PA*

- Pitched and built solo an **LLM agent** that automates FPGA design from C to optimized HDL using agent skills, tool use, and MLIR/LLVM program analysis; prototype chosen for **production**.
- Built a **100+ task evaluation benchmark** and A/B tested prompts, tools, and code transforms; caught a train/test leakage bug and added a system that prunes unreliable transforms over time.
- Vs. an unassisted LLM: **16x fewer tokens**, **30–40%** faster iteration, synthesizable HDL **80%** → **100%**.

Machine Learning Engineer Dec 2025 – Jan 2026

Palm Cosmetics *Remote*

- Built a **computer vision** pipeline that sizes nails from customer hand images; with only ∼100 labeled samples, chose graph-based feature extraction with linear and Gaussian mixture models over deep learning.

Data Science Research Intern May 2025 – Aug 2025

Carnegie Mellon University REUSE *Pittsburgh, PA*

- Built an **LLM (Gemini) scoring pipeline** over GitHub PRs and comments to measure how Rust's roadmaps steer open-source work, replacing keyword matching; found effects the original study missed.

Teaching Assistant, Mathematical Foundations of Computer Science Aug 2024 – Present

University of Pennsylvania *Philadelphia, PA*

- Lead recitations and grade proofs on combinatorics, probability, graph theory, and logic for 150+ students.

Projects & Research

Ambi: Neurosymbolic Policy Loophole Finder | *LLMs, Fuzzy Logic, Python, FastAPI* 2026

- Co-founded startup (CTO). An LLM translates a rulebook into a fuzzy-logic formula; a panel of LLM readers judges 288 real cases, and Shapley attribution pins their disagreement to specific phrases.
- Built an exact solver for fact patterns a policy allows but shouldn't: **360/360 known loopholes found, 0 false positives** on a public EMNLP 2025 benchmark.

Neurosymbolic Logic Gate Networks | *PyTorch, Neurosymbolic AI* 2026

- Extended differentiable logic gate networks by running logic synthesis between gradient steps, plus an exact GF(2) solver that recovers parity where gradient descent stays at chance.
- Models compile to compact circuits and decompile to rule sets with **provable output guarantees**.

C2NN: C-to-Neural-Network Compiler | *LLVM, PyTorch* 2026

- Compiling C programs through LLVM IR into equivalent neural networks, so models can be initialized from existing code.

Sign Patterns of Möbius Functions and Root Bounds | *Combinatorics, Spectral Graph Theory* Preprint, 2026

- Sole author; proved all real roots of chain polynomials of graded posets lie in $[-4, 0]$, and the bound is sharp.

Technical Skills

AI/ML: LLMs, transformers, LLM agents, prompt engineering, RAG, evals, A/B testing, fine-tuning, RL, NLP, computer vision, deep learning, neurosymbolic AI
Languages: Python, C++, C, Java, Haskell, SQL, TypeScript, Bash
Frameworks & Tools: PyTorch, TensorFlow, Hugging Face, scikit-learn, NumPy, pandas, Spark, LLVM, MLIR, Docker, AWS, Git, Linux
Math: Learning theory (PAC, VC dimension), probability, optimization, spectral graph theory, combinatorics