Kelvin Peng

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Education

University of Waterloo Sept 2023 – Present
Bachelor of Mathematics – Major in Combinatorics & Optimization (Expected 2027)

Relevant Coursework:
Number Theory, Quantum Info Processing, Applied Cryptography, Graph Theory, Convex Optimization, Linear Algebra.

Research & Technical Projects

TopoAdamW: TDA-Guided Meta-Optimizer *Python, PyTorch, GUDHI*
github.com/SVAH-X/topoadamw

- Designed **TopoAdamW**, a PyTorch optimizer that incorporates **TDA-derived geometry signals** to probe local loss landscape structure (e.g., sharp vs. flat regions) and adapt the effective learning rate during training.
- Implemented a **GUDHI**-based topological feature extraction pipeline and an optimizer **safety lock** mechanism to keep updates stable while responding to geometry cues.
- Benchmarked against **AdamW** on CIFAR-10 and packaged the method as a reproducible training/evaluation workflow; continuing to study how topology-guided signals correlate with **generalization**.

Geometry Dash World-Model Agent (DreamerV3-style) *RL, JAX*
github.com/SVAH-X/gd_agent

- Implemented a **DreamerV3-style** world-model agent for *Geometry Dash* as a research prototype, learning latent dynamics and planning behavior in a **60Hz** physics-driven environment with tight failure constraints.
- Built a custom **Gymnasium** environment and a **Windows** $\leftrightarrow$ **WSL** bridge to stream observations/state and synchronize **discrete actions** for stable training and evaluation on consumer hardware.
- Developed a high-frequency **recorder/logger** to collect trajectories for offline analysis and reproducible experiments, enabling systematic debugging of perception–action timing and model behavior.

Efficient Large Language Model Fine-Tuning *LLMs, DeepSpeed, RunPod*
Technical Implementation

- Built an efficient fine-tuning pipeline for **Dream-7B** and **GPT-OSS-20B** on mathematical datasets (e.g., OpenWebMath), targeting both single-GPU (16GB) and multi-GPU setups.
- Applied **QLoRA (4-bit)**, gradient checkpointing, and **DeepSpeed** optimizations to maximize throughput while reducing memory footprint.
- Achieved **20% improvement** in math reasoning benchmarks with over **60% VRAM reduction**, enabling cost-effective customization of large models.

Technical Skills

- **Languages:** Python, C/C++, Racket, SQL, Bash, LaTeX
- **AI Frameworks:** PyTorch, JAX, DeepSpeed, HuggingFace, BitsAndBytes
- **Research Tools:** Gudhi (TDA), Ripser, WandB, RunPod/Cloud Computing
- **Mathematics:** Combinatorial Optimization, Graph Theory, TDA, Bayesian Statistics, Cryptography

Awards

Euclid Mathematics Contest 2021 – 2022
School Champion (2x), Honour Roll, **Top 1 in BC Province**.

Canadian Senior Mathematics Contest (CSMC) 2022
School Champion, Honour Roll.