Timothy Oh

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Research Interests: computational/theoretical neuroscience, machine learning, artificial intelligence, neuromorphic computing, computational complexity theory

Education

- **University of California, Riverside** Expected June 2026
  Bachelor of Science in Computer Science
- **Relevant Coursework:** CS 228 Deep Learning†, CS 229 Advanced Machine Learning† (taken as CS 190 equivalent under Prof. Greg Ver Steeg), CS 215 Theory of Computation†, PHYS 224 Frontiers of Physics and Astrophysics†, PHYS 156B Quantum Mechanics
- SPS (Society of Physics Students) Officer – Faculty connections lead and event coordinator

† Graduate-level course

Publications

- Li, J., Oh, T., Hoang, J., & Veeramachaneni, V. (2025). *Differential Multimodal Transformers*. arXiv preprint arXiv:2507.15875.
- Oh, T. (2025). *A Design for a Digital Self-Organizing Computer Based on the Predictive Coding Algorithm*. Zenodo. 10.5281/zenodo.17042881.
- Oh, T. (2025). *AI-Driven Charged-Particle Tracking in the ATLAS Detector*. Zenodo. 10.5281/zenodo.15758762. *Project reviewed and discussed with Prof. Barry Barish (Nobel Laureate, Physics 2017).*

Research Experience

.1 Predictive-Coding Neural Computer ("Hinton's Mortal Computer")

Independent project with consultation from Prof. Greg Ver Steeg (May 2025 – Present)

- Developing a predictive-coding ASIC inspired by Geoffrey Hinton's "mortal computer" framework — a self-organizing system that learns by continuously adjusting predictions to minimize energy or surprise.
- Implemented the architecture in SystemVerilog using HardFloat FP32 arithmetic for reproducible, IEEE-compliant operations.
- Designed neuron and layer modules supporting bidirectional (back-vector) signaling, local Hebbian-style updates, and bias plasticity — enabling fully on-chip learning without explicit forward/backward phases.
- Integrated a DPI-C testbench linking Verilator and C++ for floating-point bit-casting, observability hooks, and runtime diagnostics.
- Demonstrated the system's ability to learn a nonlinear function through continuous predictive relaxation, confirming stable self-organization and generalization within fixed-point hardware constraints.

.2 Computational Biophysics and Neuroinflammation

Undergraduate Researcher, Prof. Thomas Kuhlman Lab (Sept 2024 – May 2025)

- Investigated p38-mediated neuroinflammatory signaling in iPSC-derived neuronal cultures, linking chronic kinase activation to neurodegenerative stress responses.
- Performed stem-cell culture, differentiation, and fluorescence microscopy; integrated quantitative image analysis and theoretical modeling of pathway dynamics.

- Explored computational extensions of the Hodgkin–Huxley model to incorporate protein-expression feedback and activity-dependent molecular regulation.

.3 3D Diffusion and AR/VR Systems Research

Collaborations with Profs. Jiasi Chen, Samet Oymak, and Qian Zhang (Aug 2022 – Jun 2023)

- Contributed to real-time 3D model synthesis research, leveraging distillation and quantization to achieve efficient generation on constrained hardware (NVIDIA Jetson).
- Built a large-scale dataset and machine-learning pipeline to analyze AR/VR developer challenges using Stack Overflow data, improving topic-model accuracy and classifier interpretability.

Theoretical and Conceptual Research

- **Biologically Inspired Optimization:** Investigating alternatives to gradient descent inspired by Hinton's Forward-Forward algorithm and synaptic plasticity, emphasizing locally computed learning rules and energy-based formulations.
- **Alternative Models of Computation and Moravec's Paradox:** Exploring computational frameworks beyond the Turing machine to understand why certain perceptual and motor tasks are trivially easy for biological systems yet complex for symbolic machines. Considering predictive-coding and active-matter systems as possible substrates of non-Turing computation.

Technical Skills

Python, C++, C, Java, Verilog/SystemVerilog, PyTorch, TensorFlow, NumPy, OpenCV, Pandas, Matplotlib, Git, Linux, LaTeX

Selected Achievements & Outreach

- Winner, **HackTech 2023 @ Caltech** – *EcoPress:* Sustainability-focused news aggregator summarizing articles and suggesting actionable steps.
- Participant, Longevity Hackathon 2025 @ Caltech; TreeHacks 2024 @ Stanford; AI Berkeley Hackathon 2023 @ UC Berkeley.
- **health{hacks} @ Stanford** (Mar–Aug 2023) – Web development and event logistics team member.
- Author on `Medium/@timothyohoc` – Essays on AI, computation, neuroscience, and science communication.