Kai (Karol) Yan

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EDUCATION

Tongji University **Shanghai, China**
B.S. in Engineering Mechanics GPA:86.99 Expected in July 2026
University of California, Berkeley (UC Berkeley) **CA, USA**
Visiting Student GPA:3.7/4.0 Jan. 2025- May 2025
Main courses: Reinforcement Learning in Neuroscience, Cognitive Decision Model, Electronic Engineering.

RESEARCH INTEREST

My research interest mainly focus on the **Neural-inspired Algorithm&Hardware**, including **Algorithms inspired by Brain mechanisms**, **self-evolving Embodied Agent** and their applications on **Neuromorphic Devices** (**In-memory Computing Architecture** and **Edge Computing Wearable Devices**) .

PUBLICATION

1. (Under Review) **Kai Yan**, Yanbing Jia, Huaguang Gu*, Complex dynamics related seizure in network composed of excitatory and inhibitory neurons modulated by inhibitory autapse, *Nonlinear Dynamics*
2. (In preparation for CVPR 2026) **Kai Yan**, Kaicheng Yu* Reinforcement Learning Enhanced Cognitive Self-Corrected Agent for Autonomous Driving.

RESEARCH EXPERIENCE

Neuromorphic Computing Co-design System based on Ferroelectricity 2D Ga_2O_3 **Hangzhou, China**
Research Assistant | Prof. Wei Kong at Westlake University Sep. 2025-Present

- Fabricated ferroelectric β-Ga2O3 thin films under instruction by using a PAMBE system, and activated their switchable polarization by depositing metallic stressor layers. Validating its high performance including >90% homogeneity, a low 0.8V switching voltage, and a decay factor of 0.039.Developed a Verilog-A behavioral model from empirical device data to enable accurate, large-scale simulations of neuromorphic circuits .
- Designed a 1T1R memristor crossbar array that effectively mitigates sneak path currents. Validated the design's functionality by achieving a high recognition accuracy on an MNIST simulation task.

Self-Evolving Agentic Close-loop Framework **Hangzhou, China**
Research Assistant | Prof. Kaicheng Yu at Westlake University July. 2025-October. 2025

- Architected a novel self-evolving agent framework where a LM-based “Product Manager” agent guides diffusion models to iteratively generate corrective synthetic E2E model training data for failure cases based on updating structural ground truth in direction of reverse gradient descent.
- Generalized the E2E model+Diffusion model Framework to tasks such as Autonomous Driving using UniAD+OpenSora on Nuscenes benchmark and OVD using YOLOWorld+Gligen on COCO benchmark.
- Achieved a 62.5% performance improvement on targeted failure cases after 3 self-correction loops of full-parameter model fine-tuning on mix of original and synthetic data on NVIDIA H800 clusters.

EEG Pattern Recognition and Classification by Class-specific RNN **CA, USA**
Research Assistant | Prof. Lexin Li at UC Berkeley Feb. 2025-July.2025

- Designed a Class-specific RNN, which can assign next-step predicting RNNs for multiple EEG seizure types in dataset and compare their predicting MSE to classify samples. By comparing the Class-specific RNN with Vanilla RNN baseline on simulation EEG dataset and TUH EEG dataset, validated that Class-specific RNN achieved accuracy around 100% while Vanilla RNN only achieved around 28%.
- Mathematically proved that each predictor learned unique hidden dynamics by utilizing statistic methods such as PCA and t-SNE their t-SNE similarity to be larger than 1.4.
- Planning to apply the classification method to EEG-Language Recovery, which can align the tokens with specific EEG patterns, and thus recover the semantic meaning of sentences from EEG data.

Gain-Shift RSNN with Neural Inspired Feedback Control **CA, USA**

Research Assistant | Prof. Kristofer Bouchard at UC Berkeley Jan.2025-July.2025

- Set up a standard platform codebase with in 2 weeks to run function approximation experiments and analyze results autonomously. Analyze more than 10 models hierarchically with ablation study.
- Inspired by FORCE algorithm, designed a Gain&Shift modulated Recurrent SNN with snnTorch package. Extended SNN type to both Spike-rate SNN and Membrane-potential SNN. Realized different parameter initialization strategies to learn the properties under various situation. Applied STDP & Hebbian Learning Rules to modulate the output weight to simulate biological-plausible behavior.
- Replacing standard stochastic gradient descent (SGD) with a linear-quadratic regulator (LQR) as a controller for parameter training; Imposing Dale's law on the network architecture and implemented this approach in both conventional RNNs trained with SGD and in the gain/shift-based Recurrent SNNs.

The Complex Dynamics of Seizure Modulated By Inhibitory Autapses **Shanghai, China**

Research Assistant | Prof. Huaguang Gu at Tongji University Apr. 2023-Dec. 2024

- Developed a fast-spiking synchronous neural network in C++ with featuring excitatory and inhibitory neurons with inhibitory autapses. Utilized grid parameter searching to fine the key parameter range for epileptiform pattern, including gamma oscillations and interictal spike-wave complexes.
- Utilized OriginLab and MATLAB to plot figures to display the attractors on the parameter planes. Applied the Kuromoto-R1 index and firing rate to quantify the seizure extent of networks. Reduced the network synchronism from 0.99 to 0.2 and the Firing rate from 1 to 0 by autapses' modulation.
- Established evidence for dual-regime autaptic modulation according to bifurcation theory, identified the (g_{syn}, β) parameter plane boundaries through the simulation data, and demonstrated how autapses paradoxically increase firing through delayed negative feedback phase locking.

PROJECT

Realization of Logic-operating Circuits based on Ion-Fluidic Memristor **Shenzhen, China**

Research Assistant | Prof. Alessandro Siria at ENS Paris & TsingHua X Institute Aug. 2024-Sept. 2024

- Performed circuit simulation using Multisim to design NAND gates and conducting patch clamp experiments to validate ion-fluidic memristor behavior within nanoscale fluidic tubes, and adjusted the solution concentration to optimize the memristor's On/Off ratio to meet the performance requirements.
- Designed lithographic mask layouts with L-Edit and integrated fluidic memristors on silicon wafers and PDMS substrates, and validated the nanoscale ion-fluidic memristor effect.
- Conducted COMSOL simulations to reveal nonlinear ion migration dynamics governed by Poisson–Nernst–Planck (PNP), and demonstrated that surface charge density modulation (σ = -0.02 to +0.05 C/m²) significantly influences ion migration barriers.

SNN-RL E2E Autonomous Driving System Based on Neuromorphic Computing **Shanghai, China**

Team Leader | Prof. Peng Yi at Tongji University Mar. 2024-Apr. 2025

- Performed an in-depth review of 30+ papers spanning neuromorphic computing, spiking neural networks (SNNs), and event-based sensing, and reproduced key methodologies from a *Nature* publication on reducing event camera latency via Linux-based virtual environment
- Developed a STCNN-SNN-Transformer algorithm to address the energy-accuracy-latency trilemma, where low-frequent ST-CNN can extract spatiotemporal features from RGB inputs and event-driven dual-path SNN can achieve 12ms dynamic detection at 0.8mJ/inference
- Constructed comprehensive simulation environments in UE 4 and Microsoft AirSim, covering 50+ edge cases (adverse weather, sensor failures), and optimized SNN layers for compatibility with Synsense Tech's Xylo neuromorphic chip.

SKILLS

Programming: C/C++, Python, MySQL, MATLAB, PyTorch, MPI, Docker, Bash, Git, Pandas, TensorFlow
Software: OriginLab, Markdown & LaTeX, Zotero, Verilog-A, L-edit, Multisim