Xiaotong (Kary) Fang

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Summary

PhD researcher in Computational Neuroscience at USC with expertise in machine learning, deep learning, and statistical modeling. Experienced in building end-to-end ML pipelines with Python, PyTorch, and sequence models (HMMs, RNNs), and in fine-tuning large language models (LLM) to simulate psychological disorders for exploring chatbot-assisted clinical diagnostics. Passionate about developing scalable and interpretable AI systems for real-world data challenges.

Research & Technical Projects

Modeling Human Learning under Uncertainty Aug 2023 – Oct 2025

- Engineered and deployed **web-based behavioral tasks** (Bird, Turtle, Sea Lion) using **JavaScript + HTML**, collecting trial-level data from **4,600+ participants** under manipulations of volatility and stochasticity.
- Developed a **binary-native Hidden Markov Model (HMM)** performing **exact inference on binary outcomes**, bridging the misalignment of **Kalman Filter approximations** and enabling mechanisms that link uncertainty processing to **clinical transdiagnostic traits**.
- Implemented and benchmarked **Bayesian models** (HMMs, Kalman Filters, Particle Filters), validated through **large-scale simulations** and cross-task generalization.
- Applied **factor analysis** on survey data (**2,000+ subjects**), uncovering a **double dissociation**: internalizing symptoms ↔ stochasticity misestimation, externalizing ↔ volatility misestimation.
- Built **end-to-end ML pipelines** in Python and MATLAB (data cleaning → model fitting → parameter recovery → simulation → visualization) with **GitHub version control** for reproducibility.
- Published **two manuscripts** (one under review, one in revision) establishing a **normative theory of learning under uncertainty** with implications for psychiatric modeling.

Interpretable Tiny RNNs for Decision-Time Modeling July 2025 – Present

- Developing **compact recurrent neural networks (1–4 units)** to model sequential decision making under uncertainty, producing **phase portrait and attractor dynamics** for interpretable latent computations.
- Integrated **reaction time likelihoods** into the training objective, improving **identifiability** vs. diffusion models and bridge gaps in classical sequential sampling frameworks.
- Benchmarked tiny-RNNs against **HDDM, Kalman Filters, HMMs**, showing improved fit to **binary choice + RT data** while preserving mechanistic interpretability.
- Built modular pipelines in **PyTorch with GPU acceleration**, allowing scaling to multimodal datasets (behavioral + physiological) with reproducibility controls.
- Advances **interpretable deep learning** and **data-efficient sequence modeling** for **time-series AI** (forecasting, recommendation, adaptive systems).
- Provides **minimal mechanistic models** for human / animal studies, enabling **computational comparisons between species**.

Immersive VR Task with Pupillometry Sep 2025 – Present

- Designed a **VR-based reversal-learning paradigm** in **Unity** with integrated **Tobii eye-tracking (120 Hz)**, motion tracking, and physiology recording to probe **phasic vs. tonic responses to uncertainty**.
- Built a **sensor fusion pipeline**: Unity task engine → VR headset interface → Tobii SDK → synchronized multimodal data streams (behavioral, pupillometric, physiological) processed in **Python**.
- Demonstrated **real-time multimodal signal integration** and streaming ML preprocessing, advanc-

ing scalable approaches for **AR/VR-based adaptive user modeling**.
- Testing that **pupil phasic dilations index volatility** and **tonic baseline levels index stochasticity**, offering a **physiological dissociation** of uncertainty sources.
- Foundations for **digital biomarkers** of psychiatric risk using scalable, immersive VR tasks.

AI Clinical Assistant for Therapist Support Sep 2025 – Present

- Designing an **LLM-driven interactive agent** that conducts adaptive psychological intake interviews, administers **decision-making tasks**, and generates **clinician-ready summaries**.
- Engineering a **fusion model** combining **self-report surveys** (∼4k subjects) and **task-based behavioral features** (learning rates, volatility/stochasticity indices) to predict **psychiatric symptom severity**.
- Implementing **conversation state tracking**, **IRT scoring**, and **guardrailed dialogue policies** for safe, evidence-grounded patient interactions.
- Developing a **clinician-facing dashboard** with calibrated risk scores, key patient quotes, and suggested follow-up probes to streamline diagnosis.
- Building a roadmap toward **real-time therapist support**, integrating **ASR + diarization** with live guidance and **safety-critical alerts**.

LLM Psychological Disorder Signature Modeling Sep 2025 – Present

- Designing methods to **fine-tune and steer LLMs** to simulate linguistic **signatures of psychiatric conditions** (e.g., depression, anxiety).
- Developing **representation engineering pipelines** to extract and manipulate activation-space **"disorder vectors"** for **controllable severity adjustment**.
- Implementing **attribute-conditioned fine-tuning** (SteerLM-style) to enable graded, real-valued control of **mental-health dimensions** (e.g., PHQ-9, GAD-7 severity scales).
- Building an **evaluation framework** combining clinician ratings, linguistic markers (LIWC, affect lexicons), and automated metrics to validate **model interpretability and fairness**.
- Exploring applications in **interpretable AI for mental health** and **personalized conversational agents**, while ensuring safety with **guardrails and crisis-response filters**.

Topological Masking for Universal Decoding of Spiking Neural Dynamics Aug-Dec 2022

- Developed a **universal neural decoder** for hippocampal spike data across 59 rats, aligning subjects via **neural masking** and **attention**.
- Designed a **generative embedding framework** producing session-specific masks and attention maps, enabling adaptation while preserving shared dynamics.
- Built a **shared CNN decoder** that improved **cross-subject decoding accuracy to 0.76** vs. 0.65 baseline (**15% lift**); ablations confirmed **attention (+25%)** and masks (+4%) as critical.
- Demonstrated **transfer to unseen subjects**: zero-shot above chance (0.30 vs. 0.25), embedding fine-tuning (0.57), and full fine-tuning (0.79).
- Highlighted implications for **brain-machine interfaces and neural prostheses**, showing transfer learning across individuals as a path for adaptive neurotech.

Clearance Prediction Modeling Mar 2025

- Built an **end-to-end ML pipeline** (EDA, imputation, outlier handling, scaling, feature engineering) on **520k training records** of booking and pricing data with strong seasonality patterns.
- Trained and compared **Random Forest, XGBoost, and LightGBM** under multiple **time-series CV strategies** (rolling, expanding, quarter-end folds) using MAE and RMSE.
- Achieved best performance with **expanding-window CV**:a **15%+ reduction in error** compared to baseline feature sets.
- Applied **feature selection and SHAP-based interpretability** to drop 17 low-importance features, improving generalization and reducing model complexity.

- Proposed **quantile regression extension** to generate confidence intervals, providing more robust predictions for downstream decision-making.

Work Experience

Beijing Topjoy Technology Co. Ltd. – Data Science Intern Beijing, China | May–Sep 2021

- Built a **churn prediction system** on **10M+ user behavior logs**, engineering **temporal engagement features and embeddings** with Python + SQL.
- Benchmarked **XGBoost, LightGBM, and sequence models (RNNs on user sessions)**, achieving **AUC 0.84 vs. 0.71 baseline** (≈18% relative lift) and improving early churn detection.
- **Deployed the best model** as a **batch inference service via REST API on Alibaba Cloud**, enabling product teams to run **weekly churn forecasts at scale**.
- Automated **reporting dashboards** in Python (Matplotlib, Seaborn), cutting reporting latency from **1 day to near real-time**, and delivered actionable retention insights that guided targeted campaigns.

Education

University of Southern California, Dornsife GPA: 3.71/4.0
PhD in Computational Neuroscience | Enrolled Fall 2022, expected graduation May 2027
Coursework: CSCI: Deep Learning and its Applications (Pytorch, LLM), DSCI: Machine Learning (Data Mining), EE: Computing Principles (C++, Bazel), ECE: Probability, EE: Data Analysis & Neurotech Design (Pytorch), PSYC: Decision Neuroscience (Bayesian Modeling)

Emory University, Emory College GPA: 3.75/4.0
BS in Quantitative Statistical Science and Computer Science | 2018 - December 2021

Publications

Fang, Xiaotong and Payam Piray (2025). "Inferring the causes of noise from binary outcomes: A normative theory of learning under uncertainty". In: *Psychological Review*. Under review. URL: https://doi.org/10.31219/osf.io/vuc5g_v1.

Zhang, X., S. Ivanovic, B. Moore, X. Fang, and D. Song (2025). "Topological Masking and Attention for Universal Decoding of Spiking Neural Dynamics". In: *NeurIPS '25*. URL: https://openreview.net/forum?id=A6WQTfLqJ7.

Skills

Programming	Python, R, Java, JavaScript, SQL, Scala, C++, MATLAB; Git/GitHub, Spark
ML & AI	Predictive modeling, generative models, sequence models (HMMs, RNNs, GRU, LSTM), transfer learning, RL, Bayesian inference/optimization; PyTorch, TensorFlow
MLOps	Pandas, NumPy, Scikit-learn, ETL pipelines, preprocessing workflows, reproducible artifacts, MLflow, AWS
Analytics	A/B testing, randomized designs, GLMs/mixed-effects, causal inference, hypothesis testing; CV + simulation-based eval
Community	Teaching Assistant (USC, led two sections); Treasurer, Young Researchers Program (managed funding/logistics)

Last updated: September 19, 2025