Jingxuan Fan (She/Her/hers)

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EDUCATION

Harvard University **Cambridge, MA**
Ph.D. Candidate, Program in Neuroscience — Expected May 2026
Dissertation: Sensory Motor Circuit Computation in *Drosophila* Goal-directed Navigation
M.S. in Applied Math — March 2024
Relevant Coursework: Reinforcement Learning, Neural Computation, Advanced Topics in Data Science, Physical Mathematics, TinyML and Efficient Deep Learning, Mathematical & Engineering Principles for Training Foundation Models
Massachusetts Institute of Technology **Cambridge, MA**
B.S. in Brain and Cognitive Science — May 2020
Honors & Awards: Hans Lukas Teuber Award for Outstanding Academics, Walle J.H. Nauta Award for Outstanding Research

SKILL & INTERESTS

Programming skills: Python (PyTorch, Tensorflow, scikit-learn, Pandas, SciPy/NumPy), Matlab, SQL, Linux, Git
Modeling skills: LLM post-training, reinforcement learning, text-to-image diffusion, mechanistic interpretability, systems and computational neuroscience

SELECTED RESEARCH EXPERIENCE

Harvard University ***Cambridge, MA***
PhD Researcher, Dept. of Neurobiology *Expected May 2026*

- **Discovered** heterogeneous locomotion and directional goal related tuning in Drosophila sensory learning center; Demonstrated the emergence of such tuning through differential dopamine-driven plasticity of sensory panorama learning; Showed that such tunings coordinate downstream motor programs through regulating a coupled ring attractor (selected talk at **Janelia Grounding Cognition in Mechanistic Insight Conference**; journal manuscript in prep)
- **Pretrained text-to-image diffusion model** on carefully designed text-image corpora and conducted controlled attention localization, ablation and circuit discovery to understand the attention mechanisms for generating different object properties – color, shape and spatial relationship; **Discovered a general solution** for generating correct object spatial relationships **and demonstrated** how convergence on this solution vary with text encoding and parameter size (**NEMI workshop**, submission to **CVPR 2026**)
- **Developed a simple synthetic dataset** and **benchmarked** a novel and important LLM behavior – information bias along user-assistant axis – across 26 open-source models (base, instruction-tuned, reasoning) and 26 closed-source models (non-reasoning, reasoning); benchmarking result demonstrates how different post-training methods result in different user-assistant bias; **performed RLHF or reasoning trace SFT** on Llama and Qwen family base models and comprehensively demonstrated user-assistant bias evolving over training stages; **finetuned on the synthetic dataset** can showed bidirectionally change in models' user-assistant bias on real-life conversations (**NeurIPS Multi-Turn Interactions 2025,** submission to **ICLR 2026**)
- **Solved** continual learning by weight modifications in SOTA autoregressive (AR) LLMs; comprehensively characterized the **knowledge injection data efficiency** with and without paraphrasing style data augmentation in SOTA AR vs. diffusion language models; Demonstrated that dLLM has big advantage in data efficiency and free of reversal curse; Developed a **novel masked-based training recipe for AR LLMs** that can match the knowledge injection performance and data efficiency of dLLMs (submission to **ICLR 2026**)

Master's Researcher, Dept. of Applied Mathematics *March 2024*

- Developed an **entropy-penalized composition method** for multi-attribute reward models and demonstrated **improved results on reward model benchmarks (AAAI 2026)**
- **Developed** a framework to **generate large-scale synthetic rule pool** and **perform data-aware rule selection** for scoring preference data in the safety domain; Demonstrated **improved results on reward model benchmarks** using preference data scoring with the rule adaptor (**ICML 2025**)
- **Developed an automated method** to generate a large-scale, domain-specific dataset of graduate-level applied mathematics problems; **Benchmarked** leading closed- and open-source LLMs on this dataset and **performed in-depth error analysis**; Developed a framework to improve this domain specific ability through **tool usage** and **finetuning** (**NeurIPS MATH-AI 2024, ICLR 2025**)
- **Developed a novel RL post-training pipeline** – reward model training, benchmarking and policy model training – to improve math domain specific question-answer (QA) performance with only web sourced math text (finemath), bypassing the need for resource-consuming dataset construction; demonstrated math QA performance in downstream tasks matching the training procedure with ground truth answer

Massachusetts Institute of Technology ***Cambridge, MA***
Undergraduate Researcher, Picower Institute *Sept.2017-May 2020*

- Conducted smFISH, IHC, q-PCR and behavioral assays to study the neural circuit for danger signal detection and avoidance during social behaviors and co-authored a paper published in ***Nature***

Undergraduate Researcher, McGovern Institute *Sept.2018-May 2020*

- Designed single-nanometer iron oxide nanoparticles as dopamine-responsive MRI sensors, developed brain-wide delivery methods to assess its distribution and functionality; Co-authored two papers published in ***JACS*** and ***PNAS***

PROFESSIONAL EXPERIENCE

Amazon, Research Intern   *June. 2025-Sept. 2025*
- Created a novel benchmark for evaluating LLMs task performance considering both model capability and personalized preference alignment; in the application case of personalized recommendation, developed a process reward metric to balance both recommendation adoption and evidence faithfulness and leveraged it to perform RL post-training (accepted at **NYRL**)

Harvard AI Safety Student Team, Technical Fellow   *Feb. 2025-May 2025*
Meta, Research Intern   *May 2024-Aug. 2024*
- Developed a novel image-based feature representation tailored to high density sEMG and used customized CV models for gesture decoding and input feature attributions
- Introduced manifold capacity as a theoretical metric for representation quality evaluation and multimodal SSL loss
- Implemented generative models to extract disentangled factors in sEMG for generalization and data augmentation

Axoft, Software Intern   *Sept. 2023-Dec. 2023*
- Developed and maintained in-house software pipelines for fluorescence imaging processing and spike sorting
- Applied statistical and machine learning models for neural decoding from population spiking and LFP data

SELECTED PUBLICATIONS AND TALKS

Xu, P.*, Hahami, E.*, Fan, J.*, Xie, Z., Sompolinsky, H. (2025). Closing the Data-Efficiency Gap Between Autoregressive and Masked Diffusion LLMs. Submission to **ICLR 2026**

Fan, J., Liu, H., Yuan, B. (2025). Measuring and optimizing evidence preference tradeoff in LLM personalized recommendation. **NYRL**

Xu, P.*, Fan, J.*, Xiong, Z., Hahami, E., Overwiening, J., Xie, Z. (2025). User-Assistant Bias in LLMs. **NeurIPS Multi-Turn Interactions 2025,** submission to **ICLR 2026**

Wang, B.*, Fan, J.*, Xu, P.* (2025). Circuit Mechanisms for Spatial Relation Generation in Diffusion Transformers. **New England Mechanistic Interpretability (NEMI) workshop**, submission to **CVPR 2026**

Fan, J., Wilson, R. (2025). Mapping a dynamic sensory panorama onto allocentric direction representations in goal-directed navigation. Selected talk at **Janelia Grounding Cognition in Mechanistic Insight Conference**

Mechanisms for balancing course stabilization and exploration. Talk at **Harvard Department of Neurobiology**.

Li, X., Chen X., Fan, J., Gao, M., Jiang, H. (2025). Entropy-aware Attribute Composition of Multi-head Reward Models (https://arxiv.org/abs/2503.20995). **AAAI 2026**

Li, X.*, Gao, M.*, Fan, J.[†], Zhang, Z.[†], Li, W. (2025). Data-adaptive Safety Rules for Training Reward Models (https://arxiv.org/pdf/2501.15453). **ICLR BiAlign 2025, ICML 2025**

Fan, J., Martinson, S., Wang, E.Y., Hausknecht, K. (2024). HARDMath: A Benchmark Dataset for Challenging Problems in Applied Mathematics (https://arxiv.org/pdf/2410.09988). **NeurIPS 2024 MATH-AI workshop, ICLR 2025**

Kwon, J.-T., Ryu, C., Lee, H., Sheffield, A., Fan, J., Cho, D. H., Bigler, S., Sullivan, H. A., Choe, H. K., Wickersham, I. R., Heiman, M., & Choi, G. B. (2021). An amygdala circuit that suppresses social engagement. **Nature**, 593(7857), 114–118.

Wei, H.*, Wiśniowska, A.*, Fan, J.[†], Harvey, P.[†], Li, Y., Wu, V., Hansen, E. C., Zhang, J., Kaul, M. G., Frey, A. M., Adam, G., Frenkel, A. I., Bawendi, M. G., & Jasanoff, A. (2021). Single-nanometer iron oxide nanoparticles as tissue-permeable MRI contrast agents. **Proceedings of the National Academy of Sciences**, 118(42).

Hsieh V., Okada S., Wei H., García-Álvarez I., Barandov A., Alvarado SR., Ohlendorf R., Fan J., Ortega A., Jasanoff A. (2019). Neurotransmitter-responsive nanosensors for T2-weighted magnetic resonance imaging. **Journal of the American Chemical Society**, 141 (40), 15751-15