

Jirui Dai

Phone: +1 4438355175 & Email: Jdai27@jh.edu

My interests lie at the intersection of Medical AI and Reinforcement Learning, focusing on (1) building LLM/MLLM/Agent systems for clinical practice that transform expert knowledge and real-world medical signals into reliable, usable tools, and (2) using RL for foundation models to expand capabilities beyond alignment toward broader, more robust solution spaces.

EDUCATION

Nanchang Hangkong University(NCHU) Bachelor of Engineer in Software Engineering	Nanchang, China 09/2020–06/2024
Nanjing University of Chinese Medicine (NJUCN) Research Assistant	Nanjing, China 01/2025–07/2025
Johns Hopkins University(JHU) Master of Science in Engineering in Computer Science	Baltimore, America 08/2025–06/2027

RESEARCH EXPERIENCE

PART 1: Medical AI & Clinical Foundation Models

Project One: Reinforcement Learning for Robust Clinical Reasoning Transfer (Traditional Chinese Medicine & Biomedical Pathways)

Assistant Researcher (collaboration) supervised by PhD. Zhi Liu, postdoctoral researcher at Nanjing University of Chinese Medicine & Stanford Visiting Scholar Nov. 2025 — Present

- Developing a GRPO-style on-policy reinforcement learning + on-policy distillation pipeline to test whether LLMs can acquire new compositional reasoning skills that transfer to out of distributions.
- Building chain-of-thought compositional data that unifies Wenbing theory, herbal pharmacology, and biomedical pathway knowledge into a single reasoning space.
- Designing a new benchmarking paradigm (“Medmulti-Agent as a Judge”) to reduce single-judge bias and improve robustness under distribution shift.
- Current status: dataset structuring and evaluation infrastructure in progress.

Project Two: DERM-3R:Multimodal Dermatology Vision-Language Model for Psoriasis (Single-Image & Multi-Image Reasoning)

Research Collaborator with University of Washington & The Gulou Hospital of Traditional Chinese Medicine of Beijing Aug. 2025 — Jan.2026

- Developing a vision-language model for psoriasis that supports both single-image recognition and longitudinal multi-image reasoning.
- Applying supervised fine-tuning(SFT) + LoRA (parameter-efficient adaptation) with a curriculum-style multi-stage training strategy to better align dermatology images with clinical text and structured reasoning outputs.. Single-image: generate lesion description and pathogenesis cues; multi-image: generate progression summary, syndrome diagnosis, treatment principle, formula selection, and prescription draft.
- Benchmarking with RAG-backed (retrieval-augmented, evidence-grounded) Multi-LLMs-as-a-Judge evaluation to reduce evaluator bias under distribution shift on clinical reasoning tasks.
- Final outcome: released the DERM-3R resource-efficient multimodal agent framework and public project page, packaging the model, data pipeline, and evaluation protocol for real-world dermatology workflows.

Project Three: Med-Shicheng:From Master Physicians to Clinical Agents via LLM Inheritance (traditional chinese medicine expertise standardization & scaling)

Research Assistant supervised by PhD. Zhi Liu, a postdoctoral researcher at Nanjing University of Chinese Medicine & Stanford Scholar Dec. 2024 — Nov.2025

- Built a structured training framework for Traditional Chinese Medicine “master-to-agent” inheritance on Qwen2.5-1.5B-Base; curated 3M+ structured medical samples from textbooks, clinical records, and expert knowledge.
- Proposed RAG-SFT (retrieval-augmented fine-tuning): injected retrieved expert evidence into chain-of-reasoning data using GTE embeddings (text retrieval vectors), improving dialectical reasoning accuracy by 32%.
- Engineered an end-to-end training pipeline: CPT (continued pretraining) → Cold-Start SFT (supervised warm-up) → GRPO (RL-style policy optimization with rejection sampling) → RAG-SFT → KTO alignment (preference-style tuning).
- Constructed an expert knowledge base capturing lifetime clinical insights from five renowned Traditional Chinese Medicine physicians and enabled one model to learn and switch among multiple masters’ styles.

- Final outcome: achieved top-tier performance among lightweight models, with overall evaluation trends comparable to strong general LLMs on multi-task clinical reasoning.

Project Four: Training and Evaluation of a Traditional Chinese Medicine and Western Medicine Vertical Domain Model

Researcher supervised by PhD Jiayi Yang, a postdoctoral researcher at Columbia University

Jun.2024–Dec.2024

- Preprocessed the open-source datasets to compile two high-quality datasets of 300,000 entries, each suitable for incremental pre-training and supervised fine-tuning, and manually annotated a third dataset with 10,000 samples for preference alignment
- Trained Llama-3.1-8B-zh using LLaMA-Factory on AutoDL; implemented LoRA-based continued pretraining and SFT, reducing training loss from 14.10 \rightarrow 5.47 (CPT) and 7.27 \rightarrow 3.43 (SFT). Attempted preference alignment with DPO (Direct Preference Optimization) to improve instruction-following and response quality.
- Post-mortem / outcome: the project did not yield a competitive domain model due to limited data scale/quality and base-model data overlap (the selected open corpora had likely been seen during base pretraining), leading to weak measurable gains. The effort provided hands-on experience in dataset quality control, decontamination awareness, and end-to-end training/evaluation workflows for domain adaptation.

PART 2: General ML & NLP Engineering

Project Five: Comparison of Federated Learning Algorithms for Predicting Results Based on the Fashion-MNIST Dataset in Non-IID Data Environments

Research Leader supervised by Prof. Soumya Kar from Carnegie Mellon University

Mar.2024-May 2024

- Compared four FL algorithms (FedAvg, FedSGD, SCAFFOLD, FedProx) under simulated non-IID client data distributions.
- Built an end-to-end experimental pipeline (data partitioning, CNN baseline, evaluation metrics) and ran controlled ablations across methods.
- Implemented and optimized FedProx and SCAFFOLD, and wrote distributed scripts to parallelize runs across multiple machines.
- Key finding: FedProx consistently outperformed others across metrics (FedProx > SCAFFOLD > FedAvg > FedSGD); results formed the basis of a published paper.

Project Six: LMSYS - Chatbot Arena Human Preference Predictions (Kaggle Competition)

Research Leader of a Four-person Team

Jun.2024- Aug.2024

- Split 20% of a competition dataset (user interactions from the ChatBot Arena) as a training validation set
- Trained two LLMs, i.e., gemma-2-9b and llama-3.1-8b, using the optimal configurations determined through adjusting the parameters (learning rate, frozen layers, prompt lengths, etc.)
- Leveraged the validation set to assess the two models' performance
- Utilized ensemble learning techniques to assign weights to the outputs of two models and then combine these outputs through weighted summation
- Achievement: Upon evaluating the logarithmic loss between the predicted probabilities and the actual values, our team achieved a silver medal in the competition.

Internship: ByteDance (TikTok) — NLP Algorithm Intern

Beijing, China Sept. 2024-Dec.2024

- Built and cleaned a TikTok video-comment dataset to 100K samples; implemented preprocessing to ensure a consistent and structured corpus.
- Conducted sentiment analysis (SnowNLP baseline) and summarized related literature; presented findings in team seminars.
- Reproduced and benchmarked two conference NER models: annotated data in BIOES format, implemented training/evaluation, and compared via F1 and loss on dev/test sets.
- Improved NER performance through stronger pretrained backbones, attention tweaks, data augmentation, mixed-precision training, and dropout regularization.

Project Seven: Text-CNN for Social Hot Topic Classification (Undergraduate Thesis)

The 1st Author, Dec.2023- Mar.2024

- Collected and annotated news text from major sources; built a cleaned dataset for supervised topic classification.
- Implemented Text-CNN and tuned architecture (kernel sizes, layer depth) with dropout to reduce overfitting.
- Achieved strong validation/test performance and enabled near real-time topic categorization in experiments.

PUBLICATION

1. Ziwen Chen*; Zhendong Wang*; Chongjing Wang*; ...; Jirui Dai†; Changyong Luo†; Xiameng Gai†; Haibing Lan†; Zhi Liu†; et al. “DERM-3R: A Resource-Efficient Multimodal Agents Framework for Dermatologic Diagnosis and Treatment in Real-World Clinical Settings.”

Under review at npj Digital Health. Patent pending.

(* equal contribution, co-first authors; † co-corresponding authors)

Project Website: <https://github.com/NJUCM-BJUCM-TCM-AI/DERM-3R>

2. Changyong, Luo*; Jirui, Dai*; Zhendong, Wang*; et al. “From Physician Expertise to Clinical Agents: Preserving, Standardizing, and Scaling Physicians’ Medical Expertise with Lightweight LLM.”

Manuscript submitted to Nature Medicine. Patent pending. (* equal contribution, Co-first author)

Project Website: https://njucm-bjucm-tcm-ai.github.io/Med-Shicheng_project_website/

3. Jirui Dai. “Comparative analysis of federated learning algorithms under non-IID data.” Applied and Computational Engineering (2024) DOI: 10.54254/2755-2721/86/20241581

https://www.researchgate.net/publication/382753798_Comparative_analysis_of_federated_learning_algorithms_under_non-IID_data

PROFESSIONAL SKILLS

Standardized Tests: TOEFL:103, GRE:332(verbal:162; quantitative:170; analytical writing:4.5)

Programming Language Skills: C(2 yrs), C++(2 yrs), Java(4 yrs), Python(3 yrs), etc.

Models & Architectures: LLM, VLM, MLLM, Agents, Dense, MoE

Training Frameworks: LLaMA-Factory, OpenRLHF, EasyR1, Hugging Face TRL, VeRL, SLiME, ROLL

Inference Serving: vLLM, SGLang

AWARDS, SCHOLARSHIPS & LEADERSHIP

- Won the Silver Medal in the LMSYS - Chatbot Arena Human Preference Predictions (Top 2%)
Aug.2024
- Obtained the Third Prize in the Lanqiao Cup National Software and Information Technology Professional Talent Competition (Top10%)
May.2022
- Awarded the Third-Class Scholarship at NCHU(Top7%, Three Times)
Mar.2022&2023&2024
- Monitor of Class 15 of 2020 at School of Software, NCHU
Sept.2021-Jun.2024

I enjoy both active collaboration and quiet, deep thinking. Working across medicine and AI, I often serve as the bridge—explaining technical decisions in plain language so clinicians can confidently use and critique the system. I place a strong emphasis on engineering execution: I build quickly, instrument experiments, and validate ideas fast—because shortening the loop from hypothesis to evidence matters more than having endless ideas.