

Jirui Dai

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Research Interest Summary: I work at the intersection of Medical AI and RL, focusing on building reliable clinical LLM/MLLM systems and using reinforcement learning to improve reasoning, robustness, and generalization in medical settings.

WORK EXPERIENCE

Nanjing University of Chinese Medicine (NJUCN) Assistant Researcher	Nanjing, China 08/2025–Present
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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, USA 08/2025–06/2027

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 *Medical Image Analysis*. 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.**”

Under review at *npj Digital 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

RESEARCH EXPERIENCE

Research Track A: Digital Health & Clinical Decision Support — Foundation Models, Multimodal Agents, and Structured Reasoning

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

Assistant Researcher collaboration with PhD. Zhi Liu from Nanjing University of Chinese Medicine

Nov. 2025 — Present

- Aim: Designed an on-policy RL pipeline to study out-of-distribution clinical reasoning transfer across TCM and biomedical domains.
- Methodology: Develop a GRPO-style on-policy RL and on-policy distillation training pipeline; build chain-of-thought compositional supervision that unifies Wenbing theory, herbal pharmacology, and biomedical pathways into a shared reasoning space; design a multi-judge evaluation protocol (“MedMulti-Agent as a Judge”) to reduce single-judge bias and stress-test robustness under distribution shift.
- Current status: dataset structuring and evaluation infrastructure in progress.

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

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

- Aim: Developed a digital-health-ready multimodal dermatology agent that reflects real-world TCM dermatology workflows, supporting both single-image assessment and longitudinal multi-image reasoning which emulates clinicians' syndrome differentiation processes—translating visual evidence to structured clinical decisions.
- Methodology: Built a psoriasis vision-language model for single-image analysis and longitudinal multi-image clinical reasoning; employed SFT + LoRA for efficient alignment and evaluated it via RAG-assisted multi-LLM judges to improve robustness and reduce bias.
- 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.

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

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

Research Assistant supervised by PhD. Zhi Liu from Nanjing University of Chinese Medicine

Dec. 2024 — Nov. 2025

- Aim: Adapt a DeepSeek-R1-style training paradigm to distill the doctrines and decision patterns of renowned TCM physicians' into scalable, switchable clinical LLM agents for digital health applications.
- Methodology: Constructed a “master-to-agent” framework on Qwen2.5-1.5B leveraging 3M+ structured samples from textbooks and clinical records; proposed RAG-SFT with GTE-based evidence injection, improving dialectical reasoning accuracy by 32%; implemented an end-to-end pipeline (CPT → SFT → GRPO → RAG-SFT → KTO) to built multi-physician knowledge base enabling style switching.
- Final outcome: Achieved top-tier performance among lightweight models, with overall evaluation trends comparable to strong general LLMs on multi-task clinical reasoning.

Research Track B: Distributed ML & Language Systems — Training, Evaluation, and Preference Modeling

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

Github Repo: <https://github.com/jiruidai/Distributed-Machine-Learning>

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

Mar. 2024-May 2024

- Aim: Established a baseline-style comparison of federated learning methods under non-IID client partitions to clarify generalization behavior in heterogeneous settings.
- **Outcome:** Delivered a four-method non-IID federated learning benchmark on Fashion-MNIST and authored a first-author paper based on the empirical findings, with a consistent performance ranking of **FedProx > SCAFFOLD > FedAvg > FedSGD**. Results showed that FedProx reliably outperformed alternatives across metrics in simulated non-IID settings, and the full pipeline and findings were consolidated into a publishable study.
- Methodology: built an end-to-end experimental pipeline including non-IID data partitioning, a CNN backbone, standardized evaluation metrics, and controlled ablations; implemented and tuned FedProx and SCAFFOLD, and engineered distributed parallel scripts to scale runs across multiple machines for reproducible comparisons.

LMSYS - Chatbot Arena Human Preference Predictions (Kaggle Competition)

Github Repo: <https://github.com/jiruidai/LMSYS>

Research Team Leader

Jun. 2024- Aug. 2024

- Outcome: Won a Kaggle Silver Medal, ranking 53/1802 teams (Top 2%) on the LMSYS Chatbot Arena human preference prediction task (log loss metric).
- Methodology: Established a robust offline evaluation setup by holding out 20% of the competition interaction data as a validation split; fine-tuned Gemma-2-9B and Llama-3.1-8B through systematic hyperparameter and training strategies (e.g., learning rate, frozen layers, prompt length); used the validation split for model selection and error analysis; Constructed an ensemble by learning weights over each model's predicted probabilities and combining them via weighted summation to reduce log loss.

- Final result: The two-model ensemble consistently outperformed single-model baselines on the held-out split and generalized to the leaderboard, delivering a top-2% finish.

TikTok Comment Mining for Sentiment and Named Entity Recognition: Dataset, Benchmarks, and Model Improvements

Github Repo: https://github.com/jiruidai/Bytedance-Work_in_NLP

ByteDance (TikTok) NLP Algorithm Intern

Beijing, China Sept. 2024-Dec.2024

- Outcome: Built a 100K+ anti-scraping-resilient TikTok comment dataset and delivered a benchmark suite by reproducing and comparing 10+ sentiment analysis baselines, enabling reproducible internal evaluation.
- Methodology: Designed a robust data acquisition and cleaning workflow including deduplication, normalization, filtering, structured formatting to produce a high-quality and consistent dataset; implemented and evaluated a sentiment analysis baseline (SnowNLP) and surveyed related literature, presenting results in team seminars; reproduced and benchmarked two conference-grade NER models by creating BIOES annotations, building end-to-end training and evaluation pipelines, and tracking F1 and loss on test sets; improved NER via stronger pretrained backbones, attention enhancement, data augmentation, mixed-precision training, and dropout regularization.
- Final result: Established an end-to-end, research-oriented NLP workflow—from data collection to reproducible evaluation—and achieved measurable NER improvements over reproduced baselines, providing reliable empirical evidence for model iteration.

Text-CNN for Social Hot Topic Classification

Undergraduate Thesis

Dec.2023- Mar.2024

- Outcome: Completed my undergraduate thesis by building an end-to-end news topic classification system, from data collection to evaluation.
- Methodology: Collected and annotated news text from major sources; cleaned and structured a supervised dataset; implemented and tuned a Text-CNN classifier (kernel sizes, depth, dropout) to reduce overfitting and improve generalization.
- Final result: Achieved strong validation and test performance and demonstrated near real-time topic categorization in experiments.

PROFESSIONAL SKILLS

Languages	Chinese (Native), English (Professional)
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
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

REFERENCE TO CONTACT

- PhD. Zhi Liu (Email: zhiliu@njucm.edu.cn)

Postdoctoral Researcher, Nanjing University of Chinese Medicine

- PhD. Jiaxi Yang (Email: jy2710@tc.columbia.edu)

Associate Researcher, Chinese Zhijiang National Institute

- Dr. Changyong Luo (Email: bdf01344@bucm.edu.cn)

Attending Physician, Dongfang Hospital, Beijing University of Chinese Medicine

- Dr. Zhendong Wang (Email: wangzd@bucm.edu.cn)

Resident Physician, Gulou Hospital of Traditional Chinese Medicine

Values & Working Approach

I enjoy both active collaboration and quiet, deep thinking. Working across medicine and AI, I often serve as a 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.