

# Jirui Dai

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My interests lie at the intersection of Medical AI and Reinforcement Learning. I focus on (1) building LLM/MLLM/Agent systems for clinical practice that turn 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

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

## 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: Study out-of-distribution generalization in clinical reasoning within digital health settings, testing whether LLMs can transfer compositional reasoning across integrative medicine domains—linking herbal drugs → pharmacology/pathway mechanisms → predicted properties and clinical effects (traditional Chinese medicine ↔ biomedical knowledge).
- 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>

*Research Collaborator with University of Washington & The Gulou Hospital of Traditional Chinese Medicine of Beijing*

Aug. 2025 — Jan. 2026

- Aim: Build a digital-health-ready multimodal dermatology agent that mirrors real-world TCM dermatology workflows, supporting both single-image assessment and longitudinal multi-image reasoning to imitate clinicians’ syndrome differentiation habits—from visual evidence to structured clinical decisions.
- Methodology: Develop a psoriasis-focused vision-language model with two modes: single-image generation for lesion descriptions and pathogenesis cues, and multi-image longitudinal generation for progression summaries, syndrome diagnosis, treatment principles, formula selection, and prescription drafts; apply multi-stage curriculum training with SFT + LoRA for parameter-efficient alignment between dermatology images and structured reasoning outputs; benchmark using RAG-backed Multi-LLMs-as-a-Judge evaluation to reduce evaluator bias and test robustness 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.

### 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/](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: Reproduce and adapt a DeepSeek R1-style training route under partial or unknown settings to enable LLM-based inheritance of multiple renowned traditional Chinese medicine physicians' academic doctrines and clinical decision patterns—distilling lifetime expert insights into switchable, scalable clinical agents for digital health workflows.
- Methodology: Build a structured “master-to-agent” training framework on Qwen2.5-1.5B-Base, curating 3M+ structured samples from textbooks, clinical records, and expert knowledge; propose RAG-SFT by injecting retrieved expert evidence into chain-of-reasoning data using GTE embeddings, improving dialectical reasoning accuracy by 32%; engineer an end-to-end pipeline (CPT → cold-start SFT → GRPO with rejection sampling → RAG-SFT → KTO alignment) and construct a multi-master knowledge base from five renowned physicians to support style switching within one model.
- 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. Soumyya Kar from Carnegie Mellon University*

*Mar. 2024-May 2024*

- Outcome: Delivered a four-method non-IID federated learning benchmark on Fashion-MNIST and authored a first-author paper based on the empirical findings (ranking: FedProx > SCAFFOLD > FedAvg > FedSGD).
- Methodology: Identified a missing baseline-style comparison for federated learning generalization under non-IID client partitions on Fashion-MNIST; 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.
- Final result: Found that FedProx consistently outperformed alternatives across evaluation metrics in simulated non-IID settings, and consolidated the pipeline and results into a publishable study.

### **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: Built 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-strategy search (e.g., learning rate, frozen layers, prompt length); used the validation split for model selection and error analysis; built an ensemble by learning and assigning weights to 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](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 (deduplication, normalization, filtering, structured formatting) to produce a 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 full training and evaluation pipelines, and tracking F1 and loss on dev/test; improved NER via stronger pretrained backbones, attention modifications, 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.

## 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 Journal of the American Academy of Dermatology. 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 Health. Patent pending. (\* equal contribution, Co-first author)

Project Website: [https://njucm-bjucm-tcm-ai.github.io/Med-Shicheng\\_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](https://www.researchgate.net/publication/382753798_Comparative_analysis_of_federated_learning_algorithms_under_non-IID_data)

## 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.