

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

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

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/

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. Soumya 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

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/

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

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.