# Chuhan Song

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## Education

**University College London**, BSc in Mathematics *Sept 2023 - May 2026*

- Overall GPA: 85.05/100
- ranked 10th in the second year

## Preprints

- **Fairness in Multi-modal Medical Diagnosis with Demonstration Selection**
  *Under review at CVPR 2026*

## Research Experiences

**Multimodal Learning for Medical Imaging** *June 2025 - Present*

*Research Assistant, Supervisor: Assistant Prof. Yu Tian, University of Central Florida (https://yutianyt.com/)* *Remote*

○ **Project 1: Spatial Transcriptomics and WSI Multimodal Design**

- Aimed to benchmark multimodal Mixture-of-Experts (MoE) models on clinical Whole-Slide Images (WSIs), uncovering WSI-gene relationships to enable cancer gene detection and potential productization.
- Proposed integrating MoE into multimodal learning to enhance cross-modal relationships between WSI patches and spatial transcriptomics, improving Image-to-Gene (I2G) and Gene-to-Image (G2I) performance by 15%.
- Conducted in-depth MoE collapse analysis, identifying causes of expert underutilization and informing strategies to stabilize training and improve cross-modal feature learning.

○ **Project 2: Fairness-Aware In-Context Learning for Medical Image Reasoning**

- Conducted systematic analysis revealing that conventional demonstration selection strategies in multimodal large language models (MLLMs) fail to ensure fairness due to demographic imbalance in selected exemplars.
- Conducted the majority of experimental work, including implementation, validation, and analysis across multiple medical imaging benchmarks.
- Proposed and analyzed limitations of existing approaches, identifying the core issue in medical image reasoning fairness.
- Developed FADS-Interaction and FADS-Adaptive based on FADS, achieving state-of-the-art performance in reducing gender-, race-, and ethnicity-related disparities while maintaining strong accuracy.
- Proposed and validated the hypothesis that dataset size determines FADS effectiveness, providing insights for fairness-aware in-context learning in medical imaging.

**Multimodal Adversarial Defense** *March 2025 - June 2025*

*Research Assistant, Supervisor: Assistant Prof. Minghong Fang, University of Louisville* *Remote*

- Investigated adversarial robustness in multimodal learning systems, focusing on audio modality downstream tasks and exploring both contrastive learning during training and inference-time vulnerabilities.
- Analyzed and implemented attack and defense mechanisms across models such as CLIP, AudioCLIP, ImageBind, CLAP, ViT, ViT-Lens, and NextGPT, emphasizing their architectural principles and inference mechanisms.
- Reproduced and extended a VAE-based generative model, and evaluated diffusion-based frameworks (AudioLDM, Pix2Pix) for robustness under input perturbations.
- Explored self-supervised audio representation learning frameworks (Wav2Vec, HuBERT, EnCodec) and audio-to-audio conversion models (AutoVC, FreeVC)

**Spatiotemporal Climate Network Analysis** *May 2025 - June 2025*

*UCL research project*

- Aimed to study interactions in large-scale climate systems to understand the connectivity and influence of key regions on global climate patterns.
- Analyzed dependencies between spatial grid points using mutual information and Pearson correlation coefficients.
- Explored graph-theoretical metrics such as betweenness centrality to identify key regions and understand their structural roles in the climate network.

## Internship

**Kaizen Finance Solution Limited** *London, UK*

*It provides accounting, financial consulting, management information systems (MIS) optimization, and real estate and mortgage-related financial services.*

**Project: Full-Stack Web Application Development** *November 2024 - Present*

**Web** Developer and Business Intern

- Built a full-stack web application using Vue.js + Vite for the frontend and Spring Boot + JDBC + MySQL (MVC architecture) for the backend, supporting complete CRUD operations using Restful API.
- Implemented global route authentication and session-based authentication with cookies using vue3, enabling secure user sessions and distinguishing between authenticated and unauthenticated users.

- Developed a request-handling framework covering authentication, error handling, and API interaction to ensure robust data flow management.
- Deployed the website to AWS, configuring Nginx as a reverse proxy and Amazon RDS for scalable and reliable database management, ensuring high availability and production-readiness.

## Skills

**Programming Languages:** Python, SQL, HTML, CSS, JavaScript, Java, C++
**Frameworks / Libraries:** PyTorch, Tensorflow, Node.js, Vue.js, Bootstrap, Spring Boot, Maven
**Languages:** English (Fluent), Chinese (Native)