Zhuoyang Lyu

MMSc Candidate in Biomedical Informatics · Harvard Medical School
zhuoyang_lyu@hms.harvard.edu · lyurobin914@gmail.com · +1 (510) 304-2758 · Boston, MA
Website · Google Scholar · ORCID 0009-0000-0756-8940

Education

Harvard Medical School, Boston, MA — Sept 2025 – May 2027 (expected)
Master of Medical Sciences in Biomedical Informatics (MMSc-BMI) | GPA: 3.98 / 4.00
Thesis: Multi-modal foundation model for melanoma prognostication (Advisor: Li Zhou)

Brown University, Providence, RI — Sept 2022 – May 2025
Sc.B. in Computer Science, with Honors; A.B. in Applied Mathematics | GPA: 4.00 / 4.00
Honors Thesis: "Predicting Collective Migration in EMT Cells with Graph Neural Networks" (Advisor: Ian Y. Wong)

Purdue University, West Lafayette, IN — Aug 2021 – May 2022
Coursework in Computer Science and Mathematics; transferred to Brown University | GPA: 3.98 / 4.00

Awards & Honors

Magna Cum Laude, Brown University — awarded to approximately the top 20% of the graduating class — 2025
Honors in Computer Science, Brown University — 2025
Undergraduate Teaching and Research Award (UTRA), Brown University — Spring & Summer 2024

Research Interests

Machine learning for biology and medicine, spanning foundation models, AI agents, and multi-modal representation learning. I am drawn to problems where the data is heterogeneous, irregular, or difficult to work with — clinical records, medical images, molecular measurements — and to the question of how models built on such data are evaluated and made dependable.

Publications

Journal Articles and Conference Proceedings

1. Duan, C., Rong, S., Buerer, L., Neil, C. R., Zhong, Y., **Lyu, Z.**, Savatt, J. M., Strande, N. T., & Fairbrother, W. G. "Single antisense oligonucleotides correct diverse splicing mutations in hotspot exons." *Proceedings of the National Academy of Sciences* 122(25), e2425659122 (2025). https://doi.org/10.1073/pnas.2425659122
2. Wang, T., Qu, H., Liu, C., Zheng, T., & **Lyu, Z.** "LLE-STD: traffic sign detection method based on low-light image enhancement and small target detection." *Mathematics* 12(19), 3125 (2024). https://doi.org/10.3390/math12193125
3. Jin, L., Qu, H., Pang, L., Zhang, Z., & **Lyu, Z.** "Identifying stable EEG patterns over time for mental workload recognition using transfer DS-CNN framework." *Biomedical Signal Processing and Control* 89, 105662 (2023). https://doi.org/10.1016/j.bspc.2023.105662
4. Li, Z., Li, Y., Wang, Y., Xie, G., Qu, H., & **Lyu, Z.** "A lightweight model for 3D point cloud object detection." *Applied Sciences* 13(11), 6754 (2023). https://doi.org/10.3390/app13116754
5. **Lyu, Z.** "Histopathological cancer detection: a comparison study of different convolutional neural networks." *Proc. SPIE 12259, 2nd Intl. Conf. on Applied Mathematics, Modelling and Intelligent Computing (CAMMIC)*, 122595V (2022). https://doi.org/10.1117/12.2639368
6. **Lyu, Z.** "Research on subway pedestrian detection algorithm based on big data cleaning technology." *Wireless Communications and Mobile Computing* 2021, 4700204 (2021). https://doi.org/10.1155/2021/4700204

Preprints and Manuscripts Under Review

7. **Lyu, Z.***, Zhang, Y.*, Wang, T.*, & Lan, R.* "Ultrasound vision–language alignment via contrastive learning." *arXiv*:2605.02126 (2026). https://arxiv.org/abs/2605.02126 * Equal contribution.
8. Li, Y., Zhou, H., Blackley, S., Plasek, J. M., **Lyu, Z.**, Zhang, W., You, J., Centi, A., Mishuris, R., Yang, J., & Zhou, L. "Linguistic effects of ambient AI on clinical documentation: a matched pre–post study." *medRxiv* (2026). https://www.medrxiv.org/content/10.64898/2026.02.16.26346370v1

9. Rizvi, S. A., Levine, D., Patel, A., Zhang, S., Wang, E., He, S., Zhang, D., Tang, C., **Lyu, Z.**, et al. (incl. Azizi, S., Perozzi, B., & van Dijk, D.) "Scaling large language models for next-generation single-cell analysis." *bioRxiv* (2025). https://doi.org/10.1101/2025.04.14.648850

10. Rizvi, S. A., Pallikkavaliyaveetil, N., Zhang, D., **Lyu, Z.**, et al. (incl. Karbasi, A., Ying, R., Brbić, M., & van Dijk, D.) "FIMP: Foundation model-informed message passing for graph neural networks." Under review, Transactions on Machine Learning Research. *arXiv*:2210.09475. https://arxiv.org/abs/2210.09475

RESEARCH EXPERIENCE

Agentic AI Clinical Decision Support System for Cognitive Decline Monitoring Sept 2025 – Present

Brigham and Women's Hospital / Harvard Medical School — Advisor: Prof. Li Zhou

- A multi-agent clinical decision support system for early detection of cognitive decline in primary care: it identifies dementia risk-factor information missing from the EHR, interviews the patient to fill those gaps, and returns a provider-ready summary with next-step recommendations.
- Designed and implemented the full system in Python and LangGraph — ReAct tool-calling agents with critic-in-the-loop quality assurance and retrieval-augmented generation over clinical practice guidelines to ground outputs.
- Physicians evaluate across 80 patients: 99.9% F1 on identifying documented risk-factor gaps; next-step suggestions rated 4.7/5 for correctness and completeness. **Co-first-author**; manuscript in final revision.

Multi-Modal Foundation Model for Melanoma Prognostication Feb 2026 – Present

Brigham and Women's Hospital / Harvard Medical School — Advisor: Prof. Li Zhou | MMSc Thesis Project

- A generative foundation model of melanoma patient trajectories, trained jointly on institutional structured EHR data, clinical notes, and clinical genetic testing results.
- Sole developer of the modeling work: designed a custom clinical vocabulary encoding patient history as an event sequence and trained a generative transformer over it. **First-author** manuscript in preparation.

Multi-Modal Foundation Model for ICU Patient Trajectories Jun 2026 – Present

Brigham and Women's Hospital / Harvard Medical School — Advisor: Prof. Li Zhou

- The same trajectory-modeling approach applied to critical care — acute hypoxemic respiratory failure (AHRF) and ARDS — where the event stream is hourly and includes ventilator settings and serial laboratory values alongside notes.
- Sole developer of the modeling work: adapted the event-sequence vocabulary to high-frequency ICU signals and trained the generative transformer on institutional critical-care data. **Co-first-author;** manuscript in preparation.

Cell2Sentence-Scale (C2S-Scale): Single-Cell Foundation Models Jun 2024 – Jul 2025

Yale University — Advisor: Prof. David van Dijk | Undergraduate Research Assistant (remote)

- Contributed to C2S-Scale, a family of large language models adapted to single-cell transcriptomics by representing each cell as a "sentence" of gene names ranked by expression.
- Worked within the post-training group: instruction fine-tuning and reinforcement learning (DPO, PPO, GRPO) to improve the model's biological reasoning over gene expression data.
- Contributed the scRNA-seq publication question-answering benchmark used for instruction tuning and evaluation, assembled from a large corpus of published single-cell studies. **Co-author**; manuscript under review at Nature.

Predicting Collective Migration in EMT Cells with Graph Neural Networks Jun 2024 – May 2025

Brown University — Advisor: Prof. Ian Y. Wong | Senior Honors Thesis; SPRINT/UTRA Summer Fellowship

- Modeled collective migration during epithelial–mesenchymal transition (EMT) as a graph problem: cells cultured on 2D substrates as nodes carrying morphological features and EMT stage, spatial relationships between neighbors as edges.
- Trained graph neural networks to predict each cell's next-frame displacement, testing whether migration is better explained by a cell's own state or by the configuration of the cells around it.
- Preceding summer work in the same system characterized four morphology states and three migration patterns by clustering, distinguishing normal, partial/hybrid, and full EMT states, and trained a multi-head attention model to predict cell turning direction from neighbor interactions; presented as a poster.

Foundation Model-Informed Message Passing (FIMP) for Graph Neural Networks Feb 2024 – Jun 2024
Yale University — Advisor: Prof. David van Dijk | Undergraduate Research Assistant (remote)

- Contributed to FIMP, a framework that injects pretrained foundation-model layer weights into the message-passing step of graph neural networks, letting cross-modal representations flow through graph structure.
- Applied the method to scRNA-seq and spatial transcriptomic data, benchmarking against standard GNNs and domain-specific baselines. **Co-author**; manuscript under review at Transactions on Machine Learning Research (TMLR).

RNA Splicing State Indicator Jan 2024 – May 2025
Brown University — Advisor: Prof. William G. Fairbrother | Undergraduate Research Assistant

- Designed and constructed a multi-exon reference reporter gene as a low-cost assay for characterizing the splicing environment of a cell line, intended as a readout of cell state.
- Mapped splicing patterns from gel electrophoresis results onto reference cell lines, the validation step required before the reporter could be applied. Worked with RNA-seq and scRNA-seq analysis and gene set enrichment analysis (GSEA) throughout.

Automated 3D Detection of Prostate Cancer (PI-CAI Challenge) Sept 2022 – May 2023
Brown University — Advisor: Prof. Chen Sun | Undergraduate Research Assistant

- Benchmarked semantic segmentation and object detection architectures, including nnU-Net and nnDetection, across multiple prostate MRI datasets for the PI-CAI grand challenge.
- Improved detection accuracy over the nnDetection baseline by ensembling predictions across sub-models.

Mental Workload Classification from EEG Signals Jun 2022 – Sept 2023
North China University of Technology — Advisor: Prof. Hongquan Qu | Research Assistant (remote)

- Studied transfer learning for cross-subject generalization in EEG-based mental workload classification, where models trained on one cohort of subjects degrade on another.
- Applied signal decomposition and dimensionality reduction (PCA, ICA, TCA, MSSA, Fourier analysis) and compared SVM, decision tree, k-NN, and CNN classifiers. Co-author on the resulting journal article.

Conference Presentations and Posters

1. Zhang, C., **Lv, Z.**, Lu, Z., Zhang, Y., & Yuan, P. "Deep learning-guided and structure-informed multifunctional AAV capsid design pipeline for manufacturability and redirected tropisms." Poster, American Society of Gene & Cell Therapy (ASGCT) 27th Annual Meeting, Baltimore, MD, May 2024. Published abstract #970 in *Molecular Therapy* 32(4, Suppl. 1), 473. Published under the name variant "Zhuoyang Lv."
2. **Lyu, Z.** "Understanding morphology and motility states in epithelial cells." Poster, Brown University Summer Research Symposium, Providence, RI, August 2024. https://repository.library.brown.edu/studio/item/bdr:ne9eg4pm/

Industry Experience

XiaoYue AI Jun 2026 – Present
Part-time AI Scientist | Clinical decision support startup

- Built a real-time clinical agent that works alongside physicians during patient encounters, providing decision support and ambient documentation of the visit.
- Developed the product's underlying multi-modal imaging model, pretrained on public datasets and fine-tuned on data provided by the collaborating hospital.
- The product is in clinical use by dermatologists at the Second Affiliated Hospital of Henan University of Science and Technology, a tertiary teaching hospital in Henan Province, China. A histopathology extension for the same hospital's pathology department is in preparation for pilot testing.

Edigene Inc. May 2023 – May 2024
Bioinformatics Research Intern

- Built a neural network predicting tissue-specific gene therapy delivery efficacy from the characteristic peptide sequence of an AAV capsid, as part of a deep-learning-guided pipeline for selecting delivery vectors.
- Work contributed to the AAV capsid design pipeline presented at ASGCT 2024 (see Conference Presentations).

TECHNICAL SKILLS

Foundation models	Pretraining and post-training of transformer models; tokenizer and vocabulary design for non-text sequence data; supervised and instruction fine-tuning; reinforcement learning from preferences (DPO, PPO, GRPO); parameter-efficient fine-tuning; multi-modal and vision–language representation learning.
Agentic systems	Agent design and multi-agent orchestration; tool use and function calling; retrieval-augmented generation; persistent cross-agent memory and state management; guardrails and critic-based quality assurance; evaluation and error analysis of agent behavior; LangGraph.
Modeling	Transformers, graph neural networks, convolutional and attention architectures; 3D medical image segmentation and detection (nnU-Net, nnDetection); classical ML (SVM, tree ensembles, k-NN, clustering); dimensionality reduction and signal decomposition (PCA, ICA, Fourier).
Biomedical data	Electronic health records under IRB governance — structured records, clinical notes, genomics, and clinical time series; single-cell and spatial transcriptomics; medical imaging across radiology, dermatology, and pathology.
Systems and delivery	End-to-end development from model training through to a clinical application in production use; full-stack web development (Java/Spring Boot, Vue, MySQL, Redis); implementing architectures and training loops from primitives rather than only from high-level libraries.
Languages and tools	Python, R, C/C++, SQL, Java, MATLAB; PyTorch, HuggingFace (Transformers, TRL, PEFT), TensorFlow/Keras, scikit-learn, NumPy; Git.

Last updated: July 2026