Heqin Zhu

Suzhou, Jiangsu, China | Ph.D. candidate @ University of Science and Technology of China | Latest CV
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Google Scholar

Research Interests

My research interests center on AI biology, with focus on fundamental challenges in RNA modeling and design, including: **(1) Structure and function prediction; (2) Multimodal biological foundation model; (3) Drug discovery and RNA design for therapeutics;** (4) Exploration of functional RNA motifs within non-coding genomic regions. Prior to this, I also developed universal models, few-shot and contrastive learning methods for medical image analysis.

- **Computational Biology**: Structure-guided RNA foundation model: structRFM [I8] (Nature, Under Revision); IRES identification [I7]; RNA secondary structure prediction: BPfold [I6] (Nature Communications), NCfold [I9] (ICLR2026).
- **Medical Image Computing**: Domain adaptation: GU2Net [I1, I2] (MICCAI 2021, BMEF), DATR [I4]; Few-shot learning: UOD [I5] (MICCAI 2023), SCP [J3] (MIA); Contrastive learning: IGU-Aug [J4] (TMI).

Educations

Ph.D. **University of Science and Technology of China (USTC)**, Biomedical Engineering — Sept 2023 - Jun 2026 (expected)
- Advisor: Prof. Shaohua Kevin Zhou (Fellow of AIMBE, IAMBE, IEEE, MICCAI, and NAI)
- Co-Advisor: Prof. Peng Xiong

MS **Institute of Computing Technology (ICT), Chinese Academy of Sciences (CAS) & University of Chinese Academy of Sciences (UCAS)**, Computer Applications — Sept 2020 - Jun 2023
- Advisor: Prof. Shaohua Kevin Zhou

BS **University of Science and Technology of China (USTC)**, Computer Science and Technology — Sept 2016 - Jun 2020
- Hua Xia Talent Program in Computer Science and Technology

Awards and Honors

National Scholarship for Doctoral Students, Chinese Ministry of Education — 2025

The Second Prize of the oral talk, The 3rd National Conference on Biomolecular Structure Prediction and Simulation — 2025

Suzhou Industrial Park Scholarship, USTC — 2025

Merit student award, UCAS & ICT — 2023

Graduate Academic Scholarship, UCAS & ICT, USTC — 2020 - 2025

Outstanding Student Award, USTC — 2018 - 2019

Institute of Chemistry Excellence Scholarship, USTC — 2017

Project and Internship

Structure-guided RNA Foundation Model - structRFM Paper | Code (33 stars) — Nature, Under Revision Aug 2025
- First author
- Designed a structure-guided masked language modeling pre-training strategy (SgMLM) that selectively masks input tokens corresponding to canonical base pairs within local structural contexts.
- Achieved state-of-the-art results on fine-tuning downstream tasks: Zero-shot ho-

mology classification, secondary structure prediction, tertiary structure prediction, IRES identification, ncRNA classification, Splice site prediction.

RNA Secondary Structure Prediction Model - BPfold Paper | Code (30 stars) — Nature Communications, Jul 2025

- First author
- Introduced base pair motif energy to improve data coverage and quality for RNA structure prediction.
- Designed multi-modal fusion network BPfold (integrating sequence and energy matrix) to enhance prediction accuracy and generalization.

Tencent, JARVIS Lab, Research Intern — Shenzhen, China, Jul 2021 - Nov 2021

- Developed depth-supervised feature fusion transformer for salient object detection [I3].

USTC Courses Resource GitHub ~16,000 stars, Open-source project — 2019 - Present

- Led and maintained open-source project for curating computer science learning resources.

Academic Activities

- **Academic Reviewer**: MICCAI, TCSVT
- **Volunteer Activities**
  - Medical Augmented Reality Summer School (Suzhou, 2024)
  - Dushu Lake Symposium on Medical Image Computing (Suzhou, 2023)

Teaching Assistant

- Open Practice in Electronic Information (USTC, 2023)
- Biomolecular Structure Modeling (USTC, 2024)

Mentorship

I greatly enjoy partnering with these talented young researchers (including doctoral and master-s candidates I co-advised), and their efforts lead to a series of notable research achievements.

Ao Chang, Ph.D.: Motif-informed RNA language pre-training using Mamba — 2025 - 2026

Haobin Chen, MS: Using LLM and agent to retrieve lncRNA knowledge from literature — 2025 - 2026

Duofan Tu, MS: Building medical agent for diagnosis — 2024 - 2026

Feng Zhang, MS: IRES identification in circlular RNAs — 2024 - 2026

- IRESeek: structure-informed deep learning method for accurate identification of internal ribosome entry sites in circular RNAs

Xiaoqian Zhou, MS: Anatomical landmark detection in medical images — 2022 - 2024

- Hybrid attention network: An efficient approach for anatomy-free landmark detection

Zhen Huang, MS: Anatomical landmark detection in x-ray images — 2021 - 2023

- Pele scores: pelvic x-ray landmark detection with pelvis extraction and enhancement

Invited Talks

Structure-centric AI for RNA modeling, Course on Digital Healthcare Technology and Applications, USTC — Dec 2025

Deep generalizable prediction of RNA secondary structure via base pair motif energy, The 3rd National Conference on Biomolecular Structure Prediction and Simulation — May 2025

Universal one-shot detection of anatomical landmarks, Academic Forum for Graduates, Institute of Computing Technology. Mar 2023

Technical Skills

Deep Learning: PyTorch, LLM, Diffusion Model, Multi-modality Fusion,

Programming & Tools: C++, Python, Git, VIM, Latex, HTML, Office, Matplotlib

References

S. Kevin Zhou, Professor, University of Science and Technology of China skevinzhou@ustc.edu.cn
Peng Xiong, Professor, University of Science and Technology of China xiongxp@ustc.edu.cn
Wanxiang Shen, Professor, Zhejiang University shenwx25@zju.edu.cn

Selected Publications

I=Representative, J=Journal, C=Conference

# denotes co-first author and * denotes co-corresponding author. For full list, please refer to Google Scholar.

Representative Papers

[I9] **Heqin Zhu**#, Ruifeng Li#, Ao Chang, Mingqian Li, Hongyang Chen*, Peng Xiong*, and S. Kevin Zhou*. "Toward Accurate RNA Non-Canonical Structure Prediction: The NC-Bench Benchmark and the NCfold Framework." (ICLR, 2026). [bioRxiv; Code]

[I8] **Heqin Zhu**, Ruifeng Li, Feng Zhang, Fenghe Tang, Tong Ye, Xin Li, Yunjie Gu, Peng Xiong*, and S. Kevin Zhou*. "A fully open structure-guided RNA foundation model for robust structural and functional inference." (Nature, Under Revision). [bioRxiv; Code]

[I7] Feng Zhang#, **Heqin Zhu**#, Jiayin Gao, Jie Hu, Ke Chen, Shaohua Kevin Zhou*, and Peng Xiong*. "IRESeek: structure-informed deep learning method for accurate identification of internal ribosome entry sites in circular RNAs." NAR Genomics and Bioinformatics 7, no. 4 (2025): lqaf210. (NAR Genomics and Bioinformatics). [Paper;Code]

[I6] **Heqin Zhu**, Fenghe Tang, Quan Quan, Ke Chen, Peng Xiong*, and S. Kevin Zhou*. "Deep generalizable prediction of RNA secondary structure via base pair motif energy." Nature Communications 16, (2025): 5856. (Nat. Commun., 2025). [Paper; Code]

[I5] **Heqin Zhu**, Quan Quan, Qingsong Yao, Zaiyi Liu, and S. Kevin Zhou. "Uod: Universal one-shot detection of anatomical landmarks." In International Conference on Medical Image Computing and Computer-Assisted Intervention, pp. 24-34. Cham: Springer Nature Switzerland, 2023. (MICCAI 2023). [Paper; Code]

[I4] **Heqin Zhu**, Qingsong Yao, and S. Kevin Zhou. "Datr: Domain-adaptive transformer for multi-domain landmark detection." arxiv preprint arxiv:2203.06433 (2022). (Preprint). [Paper; Code]

[I3] **Heqin Zhu**, Xu Sun, Yuexiang Li, Kai Ma, S. Kevin Zhou*, and Yefeng Zheng*. "DFTR: Depth-supervised fusion transformer for salient object detection." arxiv preprint arxiv:2203.06429 (2022). (Preprint). [Paper; Code]

[I2] **Heqin Zhu**, Qingsong Yao, Li Xiao, and S. Kevin Zhou. "Learning to Localize Cross-Anatomy Landmarks in X-Ray Images with a Universal Model." BME Frontiers 2022 (2022): 9765095. (BMEF 2022). [Paper; Code]

[I1] **Heqin Zhu**, Qingsong Yao, Li xiao, and S. Kevin Zhou. "You only learn once: Universal anatomical landmark detection." In Medical Image Computing and Computer Assisted Intervention, pp. 85-95. Springer International Publishing, 2021. (MICCAI 2021). [Paper; Code]

Journal Papers

[J4] Quan Quan#, Qingsong Yao#, **Heqin Zhu**, and S. Kevin Zhou. "IGU-Aug: Information-guided unsupervised augmentation and pixel-wise contrastive learning for medical image analysis." IEEE Transactions on Medical Imaging (2024). (TMI 2024).

[J3] Quan Quan#, Qingsong Yao#, **Heqin Zhu**, Qiyuan Wang, and S. Kevin Zhou. "Which images to label for few-shot medical image analysis?." Medical Image Analysis 96 (2024): 103200. (MIA 2024).

[J2] Huang Zhen#, Han Li#, Shitong Shao, **Heqin Zhu**, Huijie Hu, Zhiwei Cheng, Jianji Wang, and S. Kevin Zhou. "PELE scores: pelvic X-ray landmark detection with pelvis extraction and enhancement." International Journal of Computer Assisted Radiology and Surgery 19, no. 5 (2024): 939-950. (IJCARS 2024).

[J1] Pengbo Liu, Hu Han, Yuanqi Du, **Heqin Zhu**, Yinhao Li, Feng Gu et al. "Deep learning to segment pelvic bones: large-scale CT datasets and baseline models." International Journal of Computer Assisted Radiology and Surgery 16 (2021): 749-756. (IJCARS 2021).

Conference Papers

[C4] Fenghe Tang, Chengqi Dong, Wenxin Ma, Zikang Xu, **Heqin Zhu**, Zihang Jiang, Rongsheng Wang, Yuhao Wang, Chenxu Wu, and Shaohua Kevin Zhou. "U-Bench: A Comprehensive Understanding of U-Net through 100-Variant Benchmarking." arXiv preprint arXiv:2510.07041 (2025). (Under review).

[C3] Xinyi Wang, Zikang Xu, **Heqin Zhu**, Qingsong Yao, Yiyong Sun, and S. Kevin Zhou. "SIX-Net: Spatial-Context Information miX-up for Electrode Landmark Detection." In International Conference on Medical Image Computing and Computer-Assisted Intervention, pp. 338-348. Cham: Springer Nature Switzerland, 2024. (MICCAI 2024).

[C2] Fenghe Tang, Ronghao Xu, Qingsong Yao, Xueming Fu, Quan Quan, **Heqin Zhu**, Zaiyi Liu, and S. Kevin Zhou. "Hyspark: Hybrid sparse masking for large scale medical image pre-training." In International Conference on Medical Image Computing and Computer-Assisted Intervention, pp. 330-340. Cham: Springer Nature Switzerland, 2024. (MICCAI 2024).

[C1] Yuanyuan Lyu, Haofu Liao, **Heqin Zhu**, and S. Kevin Zhou. "A 3 DSegNet: anatomy-aware artifact disentanglement and segmentation network for unpaired segmentation, artifact reduction, and modality translation." In International Conference on Information Processing in Medical Imaging, pp. 360-372. Cham: Springer International Publishing, 2021. (IPMI 2021).