

ALEX MOREHEAD

Machine Learning & Computational Biology Researcher

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"Machine Learning & Computational Biology Researcher with over 4 years of experience developing cutting-edge deep learning algorithms for geometric (e.g., structural biology) data. Track record of bringing new ideas to life and implementing them using AI-standard programming languages/frameworks. Experienced leading research teams, fostering collaborations, and presenting research findings at top conferences."

SKILLS

Python PyTorch PyG PyTorch Lightning W&B Hydra Slurm Git LaTeX Pandas Java

Geometric deep learning Generative modeling Graph neural networks AI4Science CompBio/Chem

EXPERIENCE

Graduate Research Assistant (Supervisor: Dr. Jianlin Cheng)

University of Missouri | Bioinformatics & Machine Learning Lab

 Aug 2020 - Ongoing  Missouri, USA

Awarded two competitive first-year PhD fellowships and an **outstanding PhD** award for EECS graduate studies.

- Research geometric and generative modeling methods for bioinformatics, to date yielding **20+ academic works**.
- Developed two state-of-the-art protein representation learning methods along with the first diffusion model to successfully generate valid large 3D molecules and flow model for blind protein-ligand docking. Published results at top-tier machine learning conferences (ICLR) and scientific venues (ISMB / Bioinformatics, CASP16, & Nature Communications Chemistry).
- Introduced the first deep learning benchmark for **broadly applicable** protein-ligand docking.
- Orchestrated several **large-scale** deep learning HPC experiments and contributed to **open-source code**.

Deep learning Geometric & graph representation learning Generative models Structural bioinformatics

Research Intern (Supervisor: Dr. Jeffrey Ruffolo)

Profluent Bio | AI Research Lab

 May 2023 - Aug 2023  California, USA

- Created **MMDiff**, the first SE(3) diffusion model for joint sequence-structure generation of DNA, RNA, and proteins, which achieved a **9% nucleic acid design success rate**. Presented at NeurIPS 2023 MLSB. **Paper and Code**.

Diffusion models Structure generation Sequence generation Differential geometry Google Cloud

Research Intern (Supervisor: Joshua Meier)

Absci | AI Research Lab

 Jun 2022 - Apr 2023  New York, USA

- Collaboratively attained a **0.1% de novo** antibody binder design success rate using deep learning, a **first-of-its-kind result**. **Paper and Data**.

Protein design Generative AI Data science Model prototyping & benchmarking Kubernetes

Undergraduate Research Assistant

IUPUI | NSF REU on the Data Science of Risk and Human Activity

 Jun 2019 - Aug 2019  Indiana, USA

- Invented and deployed a convolutional neural network pipeline that yielded a **98% F-1 score** for gunshot sound detection.
- **Published** and orally presented one corresponding manuscript at **IEEE Big Data (2019)**. **Paper and Code**.

Artificial intelligence Machine learning Data mining Signal processing Edge computing

MY LIFE PHILOSOPHY

*"The cure to boredom is curiosity.
There is no cure for curiosity." - Dorothy Parker*

ACHIEVEMENTS



LoG Top-10 Reviewer

- Awarded large monetary prize for being a *top-3%* reviewer for the 2023 Learning on Graphs (LoG) conference.



Dean's Engineering Excellence & O'Neill Graduate Fellowships and Top-Ranked EECS PhD Student Award

- Won *two* competitive graduate fellowships for first-year PhD students and an *outstanding EECS PhD student* award.



Region IV Scholarship and Floyd Tesmer/Strayer University Prize in Computer Science and Engineering

- Earned *two* awards for innovative computer science research.



Public outreach

- Research featured in *two* public-facing venues including HPCwire and Marktechpost.

INVITED TALKS

- Geometric Deep Learning and Generative Models For Protein-Ligand Docking, **Computational modeling of molecular structures course @ MU**, Nov 2024, Columbia, Missouri, USA
- RNA-FrameFlow for *de novo* 3D RNA backbone design, **SPIGM @ ICML**, Jul 2024, Vienna, AT
- A Gated Graph Transformer for Protein Complex Structure Quality Assessment, **3DSIG @ ISMB**, Jul 2023, Lyon, FR
- Geometry-Complete Perceptron Networks for 3D Molecular Graphs, **AI2ASE @ AAI**, Feb 2023, Washington D.C., USA
- Neural Diffusion Models: Next-Generation Generative Deep Learning, **Advanced topics in deep learning course @ MU**, Nov 2022, Columbia, Missouri, USA
- Geometric Transformers for Protein Interface Contact Prediction, **Xuefeng Cui Lab @ Shandong University**, May 2022, Remote

REVIEWING

- **Conferences:**
 - Neural Information Processing Systems (NeurIPS), also the AI4Science, AI4D3, GenBio, & MLSB workshops
 - International Conference on Learning Representations (ICLR), also the GEM, AI4NA, and FPI workshops
 - International Conference on Machine Learning (ICML), also the AI4Science, CB, AccMLBio, & SPIGM workshops
 - Also served on the ICML 2024 ML4LMS workshop's organizing committee
 - Learning on Graphs Conference (LoG) of the Proceedings of Machine Learning Research (PMLR)
 - Also served on the LoG 2024-2025 organizing committee
 - ACM Conference on Bioinformatics, Computational Biology, & Health Informatics (ACM BCB)
- **Journals:**
 - Nature Machine Intelligence & Nature Methods
 - Bioinformatics, Briefings in Bioinformatics, BMC Bioinformatics, JCI, and CSB Journal
 - IEEE Transactions on Neural Networks & Learning Systems (TNNLS) & Emerging Topics in Comp. Intelligence (TETCI)

EDUCATION

M.S. & Ph.D. in Machine Learning & Computational Biology

University of Missouri | O'Neill and College of Engineering Dean's Graduate Fellow

📅 Aug 2020 - Ongoing

PhD Topic:

- 📖 Geometric Deep Learning & Generative Modeling of 3D Biomolecules

Collaborations:

- University of Cambridge, Research Labs of Prof. Pietro Lió & Prof. Sir Tom Blundell

Coursework:

- Highest distinction (GPA=4.0/4.0)

B.S. in Computer Science

Missouri Western State University | General Studies and Outstanding Graduate Honors

📅 Aug 2016 - May 2020

- Graduated **top of class** among all 2020 graduates in computer science, mathematics, and physics (GPA=4.0/4.0)

REFERENCES

Dr. Jianlin Cheng

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Dr. Dong Xu

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Dr. Xiaoqin Zou

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PUBLICATIONS

Conference Proceedings

- [1] C. K. Joshi et al., “GRNAd: Geometric deep learning for 3d RNA inverse design,” in *Thirteenth International Conference on Learning Representations (ICLR)*, Selected as an ICLR 2025 *spotlight*, 2025.
- [2] A. Morehead and J. Cheng, “Flowdock: Geometric flow matching for generative protein-ligand docking and affinity prediction,” in *Intelligent Systems for Molecular Biology (ISMB)*, Presented as a CASP16 top-5 method, 2025.
- [3] R. Anand* et al., “Rna-frameflow for de novo 3d rna backbone design,” in *ICML AI4Science & SPIGM Workshops*, presented at SPIGM (*oral*) and AI4Science (*spotlight*), top 20% - 30/159, 2024.
- [4] A. R. Jamasb* et al., “Evaluating representation learning on the protein structure universe,” in *Twelfth International Conference on Learning Representations (ICLR)*, also presented at NeurIPS 2023 MLSB (poster), 2024.
- [5] A. Morehead, N. Giri, J. Liu, and J. Cheng, “Deep learning for protein-ligand docking: Are we there yet?” In *ICML AI4Science Workshop*, presented as a *spotlight*, top 20% - 30/159, 2024.
- [6] X. Chen*, A. Morehead*, J. Liu, and J. Cheng, “A gated graph transformer for protein complex structure quality assessment and its performance in casp15,” in *Intelligent Systems for Molecular Biology (ISMB)*, 2023.
- [7] A. Morehead, A. Bhatnagar, J. A. Ruffolo, and A. Madani, “Towards joint sequence-structure generation of nucleic acid and protein complexes,” in *NeurIPS Machine Learning in Structural Biology (MLSB) Workshop*, 2023.
- [8] A. Morehead, W. Chantapakul, and J. Cheng, “Semi-supervised graph learning meets dimensionality reduction,” in *IEEE International Conference on Machine Learning and Applications*, 2023.
- [9] E. Soltanikazemi, R. S. Roy, F. Quadir, N. Giri, A. Morehead, and J. Cheng, “Drlcomplex: Reconstruction of protein quaternary structures using deep reinforcement learning,” in *International Conference on Intelligent Biology and Medicine*, 2023.
- [10] A. Morehead, C. Chen, and J. Cheng, “Geometric transformers for protein interface contact prediction,” in *Tenth International Conference on Learning Representations (ICLR)*, 2022.
- [11] M. Shoman, A. Aboah, A. Morehead, Y. Duan, A. Daud, and Y. Adu-Gyamfi, “A region-based deep learning approach to automated retail checkout,” in *Proceedings of the IEEE/CVF CVPR Workshops*, 2022.
- [12] M. Gao et al., “High-performance deep learning toolbox for genome-scale prediction of protein structure and function,” in *IEEE/ACM Machine Learning with Graphs in High Performance Computing Environments (MLHPC) Workshop*, 2021.
- [13] A. Morehead, L. Ogden, G. Magee, R. Hosler, B. White, and G. Mohler, “Low cost gunshot detection using deep learning on the raspberry pi,” in *IEEE International Conference on Big Data*, 2019.

Journal Articles

- [14] A. Morehead, J. Liu, P. Neupane, N. Giri, and J. Cheng, “Protein-ligand structure and affinity prediction in casp16 using a geometric deep learning ensemble and flow matching,” *Proteins: Structure, Function, and Bioinformatics*, 2025, Presented as a CASP16 top-5 method.
- [15] A. Morehead and J. Cheng, “Geometry-complete diffusion for 3d molecule generation,” *Nature Communications Chemistry*, 2024, also presented at ICLR 2023 MLDD (poster).
- [16] A. Morehead and J. Cheng, “Geometry-complete perceptron networks for 3d molecular graphs,” *Bioinformatics*, 2024, also presented at AAAI 2023 DLG (poster) and AI2ASE (*oral*).
- [17] C. Chen, X. Chen, A. Morehead, T. Wu, and J. Cheng, “3d-equivariant graph neural networks for protein model quality assessment,” *Bioinformatics*, 2023.
- [18] M. F. Lensink et al., “Impact of alphafold on structure prediction of protein complexes: The casp15-capri experiment,” *Proteins: Structure, Function, and Bioinformatics*, 2023.
- [19] S. Mahmud, A. Morehead, and J. Cheng, “Accurate prediction of protein tertiary structural changes induced by single-site mutations with equivariant graph neural networks,” *bioRxiv*, 2023.
- [20] A. Morehead, C. Chen, A. Sedova, and J. Cheng, “Dips-plus: The enhanced database of interacting protein structures for interface prediction,” *Nature Scientific Data*, 2023.
- [21] A. Morehead and J. Cheng, “Protein structure accuracy estimation using geometry-complete perceptron networks,” *Protein Science*, 2023.
- [22] A. Shanehsazzadeh et al., “Unlocking de novo antibody design with generative artificial intelligence,” *bioRxiv*, 2023, follow-up work presented at NeurIPS 2023 MLSB (poster).
- [23] A. Morehead, X. Chen, T. Wu, J. Liu, and J. Cheng, “Egr: Equivariant graph refinement and assessment of 3d protein complex structures,” *arXiv*, 2022.
- [24] O. Kouckya et al., “Synthetic biology bicistronic designs support gene expression equally well in vitro and in vivo,” *AJUR*, 2020.