

Kritika Prasai

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Summary

Ph.D. student in Computer Science building AI-driven systems for prediction and decision-making over complex, data-sparse environments. Experience with deep learning, LLMs, foundation models, and scalable data pipelines integrating heterogeneous sources, with applications in early detection and large-scale scientific discovery.

Education

Ph.D. student: Computer Science

University of Missouri, Columbia, MO

Aug 2022 – Present

Advisor: Dr. Henry Wan

- GPA: 4.0/4.0

Bachelor's in Computer Engineering

Tribhuvan University, Nepal

2015 - 2020

- GPA: 3.5/4.0

Experience

Research Assistant

University of Missouri, Columbia, MO

Aug 2022 – Present

- **Multi-Task Protein Binding Prediction:** Developed a multi-task deep learning framework for protein binding prediction leveraging protein language models (ESM-2). Designed a transformer-based gated multi-head cross-attention architecture to model residue-level interactions between viral and host proteins. Jointly optimized classification (binding strength) and regression (binding affinity), achieving improved generalization beyond sequence similarity-based approaches.
- **Epistasis-Aware Modeling for Antigenic Escape:** Developing a graph neural network (GNN)-based modeling framework to capture higher-order protein mutational interactions (epistasis) underlying antigenic evolution in influenza. Formulates residues as graph-structured representations to learn non-additive mutation effects, enabling early identification of immune escape variants and supporting rational vaccine design.
- **Genomic Analysis for Vaccine Effectiveness:** Conducted large-scale viral sequence analyses to quantify polymorphisms and entropy-based diversity, revealing antigenic evolution patterns. Integrated genomic and single-cell RNA-seq data to characterize immune responses and inform **strategic antigenic variation** for improved influenza vaccine breadth and durability.
- **Differential Expression Analysis:** Performed RNA-seq analysis to identify gene expression differences between influenza A and D viruses using GLMs, quasi-likelihood F-tests, and exact tests. Visualized results with volcano plots, gene enrichment, and gene network analysis.

AI Engineer

PSP Corporation, South Asia Liaison Office, Lalitpur, Nepal

Feb 2020 – May 2022

- **Multi-Organ Segmentation:** Developed a two-stage deep learning Bayesian U-Net model for 3D image segmentation of organs including the spleen, liver, kidneys, and kidney cysts. Achieved Dice and Jaccard scores in the range of 92 to 96%, comparable to state-of-the-art models, using real patient data from a Japanese hospital. This model aids doctors in precisely calculating organ volumes and provides an additional layer of verification for diagnoses.
- **Pseudo-Labeling for Cost-Efficient Annotations:** Studied application of Pseudo-Labeling techniques in medical image segmentation. Applied semi-supervised pseudo-labeling techniques to reduce manual annotation effort while maintaining high accuracy in medical image segmentation.
- **Lung Fissure Detection:** Investigated deep learning methods for lung fissure detection to improve lobe segmentation accuracy, using real patient data for model refinement and validation.

Publications

Tang, C.Y., Gao, C., **Prasai, K.**, Li, T., Dash, S., McElroy, J.A., Hang, J., Wan, X.-F. *Prediction models for COVID-19 disease outcomes*. Emerg Microbes Infect. 2024;13(1):2361791. doi: <https://doi.org/10.1080/22221751.2024.2361791> . PMID:38828796; PMCID:PMC11182058.

Prasai, K., Yang, Z., Guan, M., Li, T., Ware, D., Hang, J., Wan, X.-F. *Intrahost HA polymorphisms and culture adaptation shape antigenic profiles of H3N2 influenza viruses*. J Virol. 2026 Jan 7:e0177525. doi: 10.1128/jvi.01775-25 . Epub ahead of print. PMID:41498543; PMCID:PMC12831994.

Wan, X.-F., Guan, M., Balamalaliyage, P., Chen, H., **Prasai, K.**, et al. *Epitope-spanning antigenic variation reprograms immunodominance and broadens immunity in sequential influenza vaccination*. Nature Communications. doi: 10.1038/s41467-026-70202-y

Espada, C., Ye, K., Long, Y., **Prasai, K.**, DeLiberto, T., Heale, J., Wiese, R., Yang, Q., Zhou, M., Streich, S., Tao, Y., Chandler, J. *Species- and variant-specific ACE2 compatibility shapes SARS-CoV-2 spillover potential in North American cervids*. Nature Communications doi: 10.1038/s41467-026-71623-5

Prasai, K., Chandler, J.C., Espada, C., Wiese, R., Long, Y., Streich, S.P., Heale, J., Roberts, N., Tao, Y.J., DeLiberto, T.J., Wan, X.-F. *Interaction-aware multitask deep learning reveals cross-species receptor compatibility landscapes across sarbecoviruses*. Nature Communications biology (under review).

Machine Learning, AI & Computational Skills

- **Machine Learning & Foundation Models:** Deep Learning, Transformers, Representation Learning, Multi-task Learning, Uncertainty Quantification; LLMs (GPT, BERT, LLaMA), Protein LMs (ESM, Prot-BERT), LoRA Fine-tuning
- **Frameworks & Programming:** PyTorch, TensorFlow, Scikit-learn; Python, C/C++, R, JavaScript, Node.js
- **Mathematics & Modeling:** Linear Algebra, Probability, Optimization, Information Theory
- **HPC & Systems:** CUDA, GPU Acceleration, Parallel & Distributed Computing, Apache Spark; large-scale model training, fine-tuning, optimization, and inference on HPC clusters
- **Data, Bioinformatics & Infrastructure:** NumPy, Pandas, Visualization; scRNA-seq, WGS, Multi-omics, Variant Analysis; Docker, Git

Achievements and Accolades

- **2026 Rising Stars in Computational & Data Sciences Workshop:** Selected for a research talk at the Santa Fe Institute workshop recognizing emerging Phd researchers in computational and data sciences.
- **Interdisciplinary Case Competition 2024 Winner:** Organized by the Graduate Professional Council (University of Missouri).
- **Conference Presentations:** American Society of Virology (ASV 2024) – Oral presentation on Ph.D. research focused on differential expression analysis of innate immune responses; Epidemics 2025 – Poster presentation on intrahost polymorphisms and culture adaptation shaping antigenic profiles of H3N2 influenza viruses.

Student Leadership & Service

- **President, Electrical Engineering and Computer Science GSA (2025–2026):** Led graduate engagement initiatives by organizing the Mizzou Tiger Internship Seminar, founding the ShowMe Course Project Showcase, and coordinating a college-wide ARC-AGI hackathon to promote collaboration and professional development.
- **Department Representative, Graduate Professional Council (GPC):** Represented EECS department on the GPC and contributed to the Student Affairs Subcommittee, advocating for graduate student mental health and well-being through campus-wide initiatives.