Ankur Mali

Assistant Professor

I am an Assistant Professor in the Computer Science and Engineering Department at the University of South Florida, where I direct the Trustworthy Knowledge-Driven AI (TKAI) Lab. My research focuses on advancing machine learning with a strong emphasis on deep learning theory and practice. Specifically, I work on developing interpretable and verifiable deep learning models rooted in semantic understanding and formal language theory, tensor and memory-augmented models, and knowledge graphs. Additionally, I explore continual/lifelong learning frameworks inspired by predictive coding and design efficient edge computing models that leverage data and model compression to optimize performance.

Employment

Aug 2022 - Current **Assistant Professor**, *Tenure-Track*, Department of Computer Science and Engineering, University of South Florida.
FL, USA

Education

07/2022 **The Pennsylvania State University**, *State College, United States*, PHD, Informatics.
Dr. Clyde Lee Giles

07/2013 **University of Pune**, *Pune, India*, BS, Computer Engineering.
Dr. Sudeep Thepade

Publications

Peer Reviewed Articles

2024 Pengliang Yu, Ankur Mali, Thejasvi Velaga, Alex Bi, Jiayi Yu, Chris Marone, Parisa Shokouhi, and Derek Elsworth. Crustal permeability generated through microearthquakes is constrained by seismic moment. *Nature communications*, volume 15, page 2057. Nature Publishing Group UK London, 2024.

2024 Hitesh Vaidya, Travis Desell, Ankur Mali, and Alexander Ororbia. Neuro-mimetic task-free unsupervised online learning with continual self-organizing maps. *arXiv preprint arXiv:2402.12465*, 2024.

2024 John Stogin, Ankur Mali, and C Lee Giles. A provably stable neural network turing machine with finite precision and time. *Information Sciences*, volume 658, page 120034. Elsevier, 2024.

2024 Aakash Sen Sharma, Niladri Sarkar, Vikram Chundawat, Ankur A Mali, and Murari Mandal. Unlearning or concealment? a critical analysis and evaluation metrics for unlearning in diffusion models. *arXiv preprint arXiv:2409.05668*, 2024.

2024 Alexander Ororbia, Ankur Mali, Adam Kohan, Beren Millidge, and Tommaso Salvatori. A review of neuroscience-inspired machine learning. *arXiv preprint arXiv:2403.18929*, 2024.

2024 Ankur Mali, Tommaso Salvatori, and Alexander Ororbia. Tight stability, convergence, and robustness bounds for predictive coding networks. *arXiv preprint arXiv:2410.04708*, 2024.

2024 Alfredo Fernandez and Ankur Mali. Stable and robust deep learning by hyperbolic tangent exponential linear unit (telu). *arXiv preprint arXiv:2402.02790*, 2024.

2024 Neisarg Dave, Daniel Kifer, Lee Giles, and Ankur Mali. Precision, stability, and generalization: A comprehensive assessment of rnns learnability capability for classifying counter and dyck languages. *arXiv preprint arXiv:2410.03118*, 2024.

2024 Neisarg Dave, Daniel Kifer, C. Lee Giles, and Ankur Mali. Stability analysis of various symbolic rule extraction methods from recurrent neural network. In *ICLR 2024 Workshop on Bridging the Gap Between Practice and Theory in Deep Learning*, 2024.

2024 Neisarg Dave, Daniel Kifer, C Lee Giles, and Ankur Mali. Investigating symbolic capabilities of large language models. *IJCAI 2024 Workshop on Logical Foundations of Neuro-Symbolic AI*, 2024.

2024 Shrabon Das and Ankur Mali. Exploring learnability in memory-augmented recurrent neural networks: Precision, stability, and empirical insights. *arXiv preprint arXiv:2410.03154*, 2024.

2024 Romit Chatterjee, Vikram Chundawat, Ayush Tarun, Ankur Mali, and Murari Mandal. A unified framework for continual learning and machine unlearning. *arXiv preprint arXiv:2408.11374*, 2024.

2023 Parisa Shokouhi, Prabhav Borate, Jacques Riviere, Ankur Mali, and Dan Kifer. Physics-guided machine learning for laboratory earthquake prediction. In *EGU General Assembly Conference Abstracts*, pages EGU–15437, 2023.

2023 Tommaso Salvatori, Ankur Mali, Christopher L Buckley, Thomas Lukasiewicz, Rajesh PN Rao, Karl Friston, and Alexander Ororbia. Brain-inspired computational intelligence via predictive coding. *arXiv preprint arXiv:2308.07870*, 2023.

2023 Alexander G Ororbia, Ankur Mali, Daniel Kifer, and C Lee Giles. Backpropagation-free deep learning with recursive local representation alignment. In *Proceedings of the AAAI Conference on Artificial Intelligence*, volume 37, pages 9327–9335, 2023.

2023 Alexander Ororbia and Ankur Mali. The predictive forward-forward algorithm. *arXiv preprint arXiv:2301.01452*, 2023.

2023 Alexander Ororbia and Ankur Mali. Active predictive coding: Brain-inspired reinforcement learning for sparse reward robotic control problems. In *2023 IEEE International Conference on Robotics and Automation (ICRA)*, pages 3015–3021. IEEE, 2023.

2023 Ankur Mali, Alexander Ororbia, Daniel Kifer, and Lee Giles. On the computational complexity and formal hierarchy of second order recurrent neural networks. *arXiv preprint arXiv:2309.14691*, 2023.

2023 Prabhav Borate, Jacques Rivière, Chris Marone, Ankur Mali, Daniel Kifer, and Parisa Shokouhi. Using a physics-informed neural network and fault zone acoustic monitoring to predict lab earthquakes. *Nature communications*, volume 14, page 3693. Nature Publishing Group UK London, 2023.

2023 Alex Bi, Thejasvi Velaga, Jiayi Yu, Pengliang Yu, Ankur Mali, Parisa Shokouhi, Derek Elsworth, and Chris Marone. Machine learning to connect permeability evolution to microearthquakes in hydraulic stimulations for enhanced geothermal systems. *AGU23*. AGU, 2023.

2022 Timothy Zee, Alexander G. Ororbia, Ankur Mali, and Ifeoma Nwogu. A robust backpropagation-free framework for images, 2022.

2022 Alexander G Ororbia and Ankur Mali. Backprop-free reinforcement learning with active neural generative coding. In *Proceedings of the AAAI Conference on Artificial Intelligence*, volume 36, pages 29–37, 2022.

2022 Alexander Ororbia and Ankur Mali. Convolutional neural generative coding: Scaling predictive coding to natural images. *arXiv preprint arXiv:2211.12047*, 2022.

2022 Khai-Nguyen Nguyen, Zixin Tang, Ankur Mali, and Alex Kelly. Like a bilingual baby: The advantage of visually grounding a bilingual language model. *arXiv preprint arXiv:2210.05487*, 2022.

2022 Ankur Arjun Mali. *Theoretically deriving computational limits of Artificial Neural Networks with bounded precision and time*. PhD thesis, Pennsylvania State University, 2022.

2022 Ankur Mali, Alexander Ororbia, Daniel Kifer, and Lee Giles. Neural jpeg: End-to-end image compression leveraging a standard jpeg encoder-decoder. *arXiv preprint arXiv:2201.11795*, 2022.

2022 Ankur Mali, Alexander Ororbia, Daniel Kifer, and Lee Giles. An empirical analysis of recurrent learning algorithms in neural lossy image compression systems. *arXiv preprint arXiv:2201.11782*, 2022.

2022 Prabhav Borate, Jacques Riviere, Chris Marone, Ankur Mali, Daniel Kifer, and Parisa Shokouhi. A physics-informed machine learning (piml) model for lab earthquake prediction using time-lapse active source ultrasonic data. In *AGU Fall Meeting Abstracts*, volume 2022, pages S55A–08, 2022.

2021 Shivansh Rao, Vikas Kumar, Daniel Kifer, C Lee Giles, and Ankur Mali. Omnilayout: Room layout reconstruction from indoor spherical panoramas. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, pages 3706–3715, 2021.

2021 Ankur Mali, Alexander Ororbia, Daniel Kifer, and Lee Giles. Recognizing long grammatical sequences using recurrent networks augmented with an external differentiable stack. In *International Conference on Grammatical Inference*, pages 130–153. PMLR, 2021.

2021 Ankur Mali, Alexander Ororbia, Daniel Kifer, and Lee Giles. Recognizing and verifying mathematical equations using multiplicative differential neural units. In *AAAI 2021*, 2021.

2021 Mali Ankur, Ororbia Alexander, Kifer Daniel, and Giles Lee. Investigating backpropagation alternatives when learning to dynamically count with recurrent neural networks. In *Proceedings of the Fifteenth International Conference on Grammatical Inference,*, volume 153, pages 154–175, 2021.

2020 Ankur Mali, Alexander G Ororbia, and C Lee Giles. The sibling neural estimator: Improving iterative image decoding with gradient communication. In *2020 Data Compression Conference (DCC)*, pages 23–32. IEEE, 2020.

2019 Alexander G Ororbia, Ankur Mali, Jian Wu, Scott O'Connell, William Dreese, David Miller, and C Lee Giles. Learned neural iterative decoding for lossy image compression systems. In *2019 Data Compression Conference (DCC)*, pages 3–12. IEEE, 2019.

2019 Alexander Ororbia, Ankur Mali, Daniel Kifer, and C Lee Giles. Lifelong neural predictive coding: Sparsity yields less forgetting when learning cumulatively. *arXiv preprint arXiv:1905.10696*, 2019.

2019 Ankur Mali, Alexander Ororbia, and C. Lee Giles. The neural state pushdown automata. *arXiv preprint arXiv:1909.05233*. http://arxiv.org/abs/1909.05233, 2019.

2018 Alexander G Ororbia, Ankur Mali, Daniel Kifer, and C Lee Giles. Conducting credit assignment by aligning local representations. *arXiv preprint arXiv:1803.01834*, 2018.

2018 Alexander G Ororbia, Ankur Mali, Matthew A Kelly, and David Reitter. Like a baby: Visually situated neural language acquisition. *arXiv preprint arXiv:1805.11546*, 2018.

2018 Alexander Ororbia, Ankur Mali, C Lee Giles, and Daniel Kifer. Continual learning of recurrent neural networks by locally aligning distributed representations. *IEEE TNNLS*, 2018.

2018 Dan Kifer C. Lee Giles Alexander G. Ororbia Anand Gopalakrishnan, Ankur Mali. A neural temporal model for human motion prediction. 2018.

2018 Ankur Mali Alexander Gabriel Ororbia. Biologically motivated algorithms for propagating local target representations. In *https://ojs.aaai.org//index.php/AAAI/article/view/4389*, 2018.

2014 Krishnasagar Page Dr Sudeep Thepade, Ankur A Mali. Content based video retrieval using thepade's ternary block truncation coding and thepade's sorted ternary block truncation coding with various color spaces. *International Journal of Emerging Technologies in Computational and Applied Sciences, (IJETCAS)*, pages 462–466. https://pdfs.semanticscholar.org/99cc/b8fea8f776287e7f1b4c94db8bfc3c2f8631.pdf, 2014.

2013 Sudeep D Thepade, Krishnasagar Subhedarpage, Ankur A Mali, and Tushar S Vaidya. Performance augmentation of video retrieval using even-odd videos with multilevel block truncation coding. *International Journal of Computer Applications*, volume 64, pages 17–20. Foundation of Computer Science, 244 5 th Avenue,# 1526, New York, NY 10001 . . . , 2013.

2013 Krishnasagar Page Tushar Vaidya Dr.Sudeep Thepade, Ankur Mali. Color content based video retrieval using block truncation coding with different color spaces. *International Journal of Computer Applications*, volume 64, pages 35–38, 2013.

2013 Dr Sudeep Ankur A Mali, Thepade. Performance rise in content based video retrieval using multi-level thepade's sorted ternary block truncation coding with intermediate block videos and even-odd videos. In *International Conference on Advances in Computing, Communications and Informatics (ICACCI), 2013*, pages 962–966. IEEE Xplorer, 2013.

Alexander G Ororbia, Ankur Mali, C Lee Giles, and Daniel Kifer. Lifelong neural predictive coding: Learning cumulatively online without forgetting (supplementary material).

Ankur Mali, Alexander Ororbia, Daniel Kifer, and Lee Giles. On the tensor representation and algebraic homomorphism of the neural state turing machine. *https://arxiv.org/pdf/2309.14690v1.pdf*. https://arxiv.org/pdf/2309.14690v1.pdf.

Previous Employment

May 2020–Nov 2020 **Research Intern** , *Nvidia Research*, Santa Clara, USA.

Worked on bio-inspired continual learning.

May 2017–August 2017 **Cognitive Analytics and Machine Learning Engineer** , *Verisk Analytics*, New Jersey, USA.

Improved OCR detection results by 12% features from a very deep VGG19 convolution neural network (CNN) and a recurrent neural network with attention. Integrated the attention mechanism to improve recognition results by 7.9%.

Mar 2014– Jun 2016 **Algorithm Engineer, Team Lead**, *Curiologic Technologies*, Pune, IN.

Improved previous face recognition API performance by 32.6% with lowest error rate at 3.46%. Improved multiple face recognition and detection API performance by 16.79%. Developed script to preprocess image data and create one hot encodings to classify data with a CNN architecture.

Professional Activities, Service and Awards

Area-Chair Selected to host 3 sessions in AAAI-23

Program Committee: NeurIPS 2021 - present, ACL 2020 - Present, AAAI 2020-Present, ICLR 2021-Present, CVPR 2020 - Present, ICCV 2021 - Present, ICML 2021 - Present, EMNLP 2021-Presengt, AL4SG 2021 2021 (journal)

Reviewer: IEEE TNNLS, IEEE PAMI, Frontiers in computational neuroscience, Nature Scientific Report

SubReviewer: WWW 2019, Neural Computation 2019, Machine learning journal (MLJ) 2020 (special issue on grammatical inference), ECML 2020, IEEE TNNLS 2021, Frontiers in Psychology (Journal) 2021 , Nature Communications.

Hackathon-Judge Invited Judge at Hackabull-23 organized by USF, compromising of students from 9 universities

STEM-Judge Invited Judge at Hillsborough county elementary school STEM event

Student Travel Grant : Federated Logic Conference 2018, University of Oxford, UK.

Travel Grant: ICRA 2016 (Top 4 finalist in HRATC 16), Sweden.

Nvidia GPU Grant: Team successfully received Nvidia GPU Grant for ICRA 2016.

Postdoctoral Scholarship IVADO Postdoctoral Scholarship, Canada (Declined)

Postdoctoral Scholarship Artificial Intelligence in Medicine Program, at Harvard Medical School (Declined)

Invited Talks

Invited Talk-2023 Presented theoretical model proving the stability of Neural Networks in Michigan State University, Dr. Parisa kordjamshidi group

Invited Talk-2023 Presented new predictive forward forward novel algorithm to train Neural Networks in *AI+X* at University of South Florida, FL

Invited Talk-2022 Presented theoretical model proving stability of Neural Networks in a special group on formal language and Machine learning *Computer Science Seminar*

Invited Talk-2022 Presented theoretical model proving stability of Neural Networks in *Computer Science Seminar* at Rochester Institute of Technology, NY

Invited Talk-2022 Presented theoretical model proving stability of Neural Networks in *AI+X* at University of South Florida, FL

Invited informal Talk-2022 Co-presented with Dr. Lee Giles on recurrent network, memory, formal language at *DARPA SafeDocs group*

Invited Talk-2021 Co-presented with Dr. Lee Giles on recurrent network, memory, formal language at *International Conference on grammatical inference 2021*

Invited Talk-2020 Invited to give talk on continual and bio-inspired learning at Nvidia Research Journal club

Invited Talk-2020 Invited to give talk on Memory networks and automata for course IST597 (Introduction to Deep Learning) taught at The Pennsylvania State University

Invited Talk Invited to give talk on Bioinspired Deep Learning and continual learning for course IST597 (Introduction to Deep Learning) taught at The Pennsylvania State University

Invited Talk: Invited to give talk on content-based video retrieval (CBVR) using Matlab at PCCOE(University of Pune), 2014.

Conference Talks

IJCAI 2024 Symbolic Learnability of LLMs

ICGI 2021 Presented accepted work on differentiable stack and its performance on formal grammars

ICGI 2021 Presented accepted work on investigating alternative of backprop through time and its effect on RNNs used in recognizing formal languages

AAAI 2021 Presented accepted work on tensor recurrent recursive RNN designed to solve neuro-symbolic AI in-particular mathematical reasoning.

DCC 2021 Presented accepted work on investigation effects of various learning algorithm on image compression system and proposed methods to achieve better compression.

DCC 2020 Presented accepted work on hybrid neural decoder designed to achieve better compression with newly introduced sibling RNNs. Our model achieved better compression with minimal computation footprints