Paul Jason Mello

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Summary: PhD candidate and deep learning researcher with an MS in AI, studying neural systems through an information theoretic lens, with foundations in classical and contemporary machine learning paradigms. Published contributions in generative modeling including SOTA recommendation systems and neural information processing.

Publications

Information Processing in Diffusion Processes — *Master's Thesis* May 2022 - May 2024
- Established quantifiable bounds on information preservation and processing under extreme noise corruption in diffusion models.
- Identified and characterized fundamental information theoretic biases in diffusion models' class generation, revealing systematic preferences for high entropy data distributions with implications for data preprocessing, model interpretability and model control.

Multi-Resolution Diffusion for Privacy-Sensitive Recommender Systems — *IEEE* May 2023 - Nov 2023
- Developed a SOTA diffusion architecture utilizing noise to preserve the underlying data distribution while respecting user privacy.
- Designed a novel denoising score matching objective to reduce variance in biases in synthetically generated recommendation samples.

Research Experience

IEEE — *Reviewer* Jan 2024 - Present
- Active IEEE access reviewer with a focus in generative models, score based methods, and information theory.

Information Grokking — *Ongoing Research* Dec 2024 - Present
- Currently leveraging grokking to experiment with 4 novel feature manifold reduction techniques aimed at accelerating neural network generalization by optimizing for local rank and intrinsic dimensionality in sample constrained environments.

Perturbation Driven Generalization — *Research* Jan 2025 - May 2025
- Conducted an empirical analysis spanning 3,325 augmentation experiments testing all permutations of augmentation configurations (none, single, paired) consisting of 8 augmentation techniques, 4 neural architectures (CNNs, MLPs, VAEs, VITs), 3 parameter scales (1M, 3M, 9M), and 3 noise intensities (0.1, 0.3, 0.5), establishing comprehensive generalization performance benchmarks.
- Found geometric transformations which preserve semantic content while injecting variance orthogonal to the data manifold consistently outperform noise based perturbations across all architectures, achieving an average generalization improvement of 5.3%.

Diffusion Trajectories Through Data Manifolds — *Research* Aug 2023 - May 2024
- Analyzed diffusion model trajectories through latent space at various timesteps using manifold learning techniques (t-SNE, Isomap, MDS, PCA), revealing forward diffusion processes create curved paths away from the data manifold while reverse diffusion processes exhibit phase, timestep, and noise dependent return trajectories to the data manifold.
- Conducted ablation studies characterizing how different noise distributions and noise injection methods alter diffusion trajectories through the latent manifolds and utilized information theory to measure and control these dynamics.

Education

Computer Science and Engineering — *Doctor of Philosophy* Aug 2024 - Present
College of Engineering
University of Nevada, Reno
Related Coursework: Machine Learning, Deep Learning, Computer Vision

Artificial Intelligence — *Master of Science* Aug 2021 - May 2024
Charles W. Davidson College of Engineering
San José State University, California
Related Coursework: Deep Learning, Autonomous Systems, Data Science

Computer Science — *Bachelor of Science* | **Minors - *Mathematics, Philosophy*** Aug 2016 – May 2021
College of Engineering & Computer Science
California State University, Sacramento
Related Coursework: Machine Learning, Software Engineering

Skills

Technical Skills

- **Languages:** Python, C/C++, R, CUDA, Assembly, Go, SQL, Java, Shell/Bash, LaTeX
- **Frameworks:** PyTorch, TensorFlow, JAX, Keras, tinygrad, Flax, NumPy, Pandas, Polars
- **Infrastructure:** HPC/SLURM, GPU/TPU, Git/GitHub, Distributed Training, AWS, S3