Hayden Prairie

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Education

- **University of Texas at Austin** *August 2021 - Present*
  Bachelor of Science in Electrical and Computer Engineering Austin, Texas
  Concentration in Data Science and Information Processing
  - GPA: 3.7/4.0

Research Experience

- **University of Texas at Austin REU** *May 2024 - July 2024*
  Research Assistant UT Austin
  - Self-designed a proposal that was funded researching an extension of Mamba and selective state space models to multi-dimensional data (e.g., images and videos) with Dr. Sujay Sanghavi
  - Derived a sparse representation for classical control theory Fornasini-Marchesini SSMs with a substructure that could be decomposed into two sequential parallel scans
  - Architected a custom GPU Kernel in CUDA and Triton, which realized the theoretical benefits of the sparsification by minimizing global memory accesses, reducing the overall latency and memory usage of vision SSMs
  - Designed and constructed a PyTorch library for distributed training and evaluation of Mamba-based vision models on SLURM systems
  - Presented findings at UT REU Symposium

- **Machine Learning Lab** *November 2023 - Present*
  Research Assistant UT Austin
  - **Upweighting Easy Samples to Mitigate Catastrophic Forgetting** *(November 2024 - February 2025)*
    * Explored a method to mitigate the effects of catastrophic forgetting in ***data-oblivious*** settings, by re-weighting samples inversely with a pre-trained models loss
    * Developed a distributed training library for fine-tuning and evaluating 1-3B language models using PyTorch and HuggingFace Transformers and Datasets
  - **Distilling Fine-Grained Knowledge in Text-to-Image Retrievers** *(January 2024 - June 2024)*
    * Explored a method to self-distill coarse-grained embeddings into fine-grained patch/token-wise understanding for text-to-image CLIP style retrievers by using a ColBERT style loss objective
    * Collaborated with Dr. Sujay Sanghavi to develop a distributed training library for distilling and evaluating fine-grained CLIP models using PyTorch and Open CLIP
  - **Investigating LLMs Embedding Space for Zero-Shot Retrieval** *(February 2024 - May 2024)*
    * Investigated the usage of LLM's attention embedding spaces to perform zero-shot reranking for retrieval augmented language models
    * Designed and developed a library using PyTorch and HuggingFace Transformers and Datasets which automatically generates vector databases to evaluate the embedding spaces of LLMs
  - **Generating Synthetic Data through Posterior Sampling** *(November 2023 - February 2024)*
    * Led a project studying a method to use posterior sampling and other inverse methods in latent diffusion models to generate synthetic data for object-detection computer vision tasks with Dr. Alex Dimakis
    * Substantially improved the downstream accuracy of YOLO style object detection models in data-constrained environments ($\sim$ 8%) and slightly improved in environments with an abundance of data ($\sim$1.5-2%)
    * Conceived and created a library to parallelize the creation of synthetic data using PyTorch and HuggingFace Diffusers and Transformers

- **Laboratory of Computer Architecture** *April 2023 - December 2023*
  Research Assistant UT Austin
  - Evaluated and implemented binary neural network topologies for human activity recognition (HAR) using TensorFlow/Keras and Larq to research the trade-off between inference efficiency/performance in heavily quantized networks with Dr. Lizy John
  - Presented findings at the Semiconductor Research Corporation (SRC) TECHCON 2023

Work Experience

- **Codent, LLC** *May 2021 - August 2022, June 2023 - August 2023*
  Intern - Technical Editor Austin, Texas
  - Edited academic and industry research papers and presentations (e.g., ACM, IEEE)

- **Liberal Arts and Science Academy (LASA)** *February 2022 - May 2022*
  AP Physics C Tutor Austin, Texas
  - Tutored AP Physics 1 & 2, AP Physics C Mechanics, and AP Physics C Electricity/Magnetism
  - Led bi-weekly study sessions to prepare students for the AP physics exams

Projects

- **UT Austin Senior Design Project** *September 2024 - Present*
  Tools: PyTorch, CUDA, NVRTC
  - Conceived and leading a team developing an open-source extension to ThunderKittens (TK) through a frontend API that uplifts kernel launching, configuration, and benchmarking into Python
  - Actively designing extensions to current TK CUDA tile primitives for more complex abstractions
  - Planning a functional expansion of the library that enables researchers and engineers to easily extend and program complex deep-learning operations

- **Bi-Mamba2: A GPU Kernel for Bi-Directional State Space Models** *August 2024*
  Tools: Triton, PyTorch [GitHub]
  - Personally designed, implemented, and published an open-source GPU Kernel in Triton for efficient bi-directional computation of state space models by fusing forward and backward scans to reduce memory access overhead
  - Currently the fastest implementation of bi-directionality for Mamba2, reducing memory (2x reduction) and latency (3x-4x faster) over other PyTorch implementations

Papers and Posters

[1] Sunny Sanyal, Hayden Prairie, Rudrajit Das, Ali Kavis, Sujay Sanghavi, *Upweighting Easy Sample in Fine-tuning Mitigates Forgetting; Under Review at ICML; Feb 2025; Vancouver, Canada*.

[2] Hayden Prairie, *MambaX: Extending SSMs Recurrence to Multidimensional; UT REU Symposium; July 2024; Austin, TX*.

[3] Hayden Prairie, *Efficient Binarized CNNs for Human Activity Recognition; Semiconductor Research Corporation (SRC) TECHON 2023; Sept. 2023; Austin, TX*.

Skills

- **Programming Languages:** Python, C, C++, Java, CUDA, Triton, Bash
- **Libraries:** PyTorch, HuggingFace (i.e., Transformers, Diffusers, Accelerate, Datasets), ThunderKittens
- **DevOps:** Git, GitHub, SLURM
- **Platforms:** Linux

Volunteer Experience

- **Backstage Volunteer** *August 2023, August 2024*
  Hot Chips Conference Stanford
  - Supported academic and industry presenters and assisted in setup/management of a micro-architecture conference

Organizations

- **Texas Engineers for World Health (TEWH)** *2021-2022*
  - Organization focused on making affordable and mass-producible devices to help underdeveloped communities
- **Engineers for a Sustainable World (ESW)** *2021-2022*
  - Engineering organization that teaches sustainable engineering practices and helps connect students with environmentally friendly and sustainably-based companies and research

Professional Memberships

- **IEEE**
- **ACM**