

RANA SHAHROZ

Nashville, TN

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Education

Vanderbilt University

August 2020 – May 2024

Bachelor of Science in Computer Science (Honors) and Mathematics. GPA : 3.974/4.00.

Nashville, TN

Selected Publications / Preprints

1. **PRANC: Pseudo RAndom Networks for Compacting deep models.** Parsa Nooralinejad, Ali Abbasi, Rana Muhammad Shahroz Khan*, Soroush Abbasi Koohpayegani*, Kossar Pourahmadi*, Soheil Kolouri, Hamed Pirsiavash
International Conference on Computer Vision (ICCV) 2023.
2. **Linear Optimal Partial Transport Embedding.** Yikun Bai, Ivan Medri, Rocio Diaz Martin, Rana Muhammad Shahroz Khan, Soheil Kolouri
International Conference on Machine Learning (ICML) 2023.

Selected Awards/Achievements

ACM ICPC Regionals 2022

March 2023

Qualified to the regionals and achieved a rank of 19th in the whole region.

International Mathematical Contest in Modelling (MCM)

May 2023

Received a Silver Medal among 6000+ submissions.

IMC Prosperity Trading Challenge

March 2023

Gained a rating of top 1% among 1500+ teams around the world.

Top 50 Mathematician

August 2019

Qualified for the top 50 (ranked 11th out of 500,000) and attended the IMO training camp.

Dean's List

F20, S21, F21, S22, F22, S23

Made it to Dean's List for all my semesters at Vanderbilt.

Vanderbilt University's Appellate Review Board (ARB)

Appointed to University's Appellate Review Board by the Dean and handle Appellate process at Vanderbilt University.

Selected Experience

Lawrence Livermore National Laboratory

May 2023 - August 2023

Research Engineer Intern

Livermore, CA

- Collaborated with researchers in the Machine Intelligence Group, working alongside Dr. Jay Thiagarajan, Dr. Shusen Liu, and Dr. Rushil Anirudh, to contribute to the field of uncertainty quantification in deep neural networks and forecasting models.
- Developed a PyTorch-based library for uncertainty quantification in deep neural networks, leveraging surrogate models such as Gaussian processes and neural networks. Implemented the library using Python, Botorch, and other relevant tools.
- Created a user-friendly GUI using Gradio to facilitate the utilization of the library, particularly for individuals with limited optimization knowledge. Additionally, provided an API for advanced users to customize and extend the library for specific cases.
- Implemented training routines and optimized black box functions using the Bayesian optimization framework. Integrated design patterns and CI/CD pipelines to ensure the robustness and maintainability of the library.

Google Research

September 2022 - January 2023

CS Research Fellow

- Selected to join competitive 12 week research program by Google called Computer Science Research Mentorship Program (CSRMP) 2022B cohort.
- Meeting a mentor in Google Research 1 on 1 for consultations regarding how to approach different research problems, design experiments to prove or disprove results and invited to virtual talks by leading experts in AI at Google Research.

Institute for Software Integrated Systems

June 2022 - September 2022

Software Engineering Intern

Nashville, TN

- Led the integration of heterogeneous simulations for large-scale system evaluation, developing a seamless integration framework that enabled different simulations to interact and provide comprehensive insights into system behavior funded by NIST.
- Established a robust CI/CD pipeline using GitLab, Jenkins, and Kubernetes for continuous integration and deployment of the CPSWT. Implemented automated tests with JUnit, CPPUnit, and Python (Selenium) for reliable and functional system performance. Utilized Docker for containerization and Gradle for build automation.
- Utilized a diverse range of programming languages (Java, C++, Python, WebGME) to create a heterogeneous federation of time-synchronized federates and simulations. Developed interfaces and communication protocols to facilitate seamless data exchange and coordination, contributing to a cohesive and unified simulation environment.

Machine Intelligence and Neural Technologies Lab

March 2022 - Present

Undergraduate Research Assistant

Nashville, TN

- Advised by Dr. Soheil Kolouri, for conducting research on topics involving Computer Vision and Generative Modeling, while working with GPU Clusters and high performance computing.
- Developed a novel algorithm for compressing images using implicit neural representation, achieving high Peak Signal-to-Noise Ratio (PSNR) scores using Python. The work resulted in a publication currently under review.
- Implemented Sliced Optimal Transport algorithms for shape registration experiments, optimizing the algorithm through parallel computation on GPUs using C++ and CUDA. Acknowledged in a CVPR 2023 paper by Bai et al. titled "Sliced Optimal Partial Transport."

Vanderbilt Undergraduate Research Journal

January 2022 - January 2023

Head Reviewer, Computer Science Department

Nashville, TN

- Responsible for reviewing more than 500 submissions to the Vanderbilt Undergraduate Research Journal for the Computer Science Department, and providing useful feedback on the submitted research papers.

Institute for Software Integrated Systems

November 2021 - February 2022

Software Engineering Intern

Nashville, TN

- Developed and launched an auto grader service for CS 5260, a graduate class in Artificial Intelligence, that allows for an accessible interface for submitting an assignment and receiving the grades back.
- Utilized Jenkins to support continuous integration and deployed the application on AWS using Amazon Elastic Compute Cloud for 24/7 service.

Artificial Intelligence and Visual Analogical Systems Lab

April 2021 – March 2022

Vanderbilt University School of Engineering Research Fellow

Nashville, TN

- Researched deep learning architectures that can extract latent features in images even with background noise, under Dr. Maithilee Kunda and worked with Google Colab, Python, Pytorch and Tensorflow to implement different papers.
- Collaborated with lab to develop architectures from an intersection of Convolutional Neural Networks(CNN), Recurrent Neural Networks(RNN), Generative Adversarial Networks(GANs) and Reinforcement Learning(RL) to solve the problem.

Selected Research Projects/Class Thesis.

Representation Learning on the Hypersphere with Spherical Sliced-Wasserstein Alignment | *Thesis*

- Delved into the world of contrastive representation learning, building on the work of Wang et al., which demonstrated the importance of feature alignment and uniformity. I aimed to enhance the technique by replacing the traditional Euclidean distance with a distribution-wise alternative, inspired by Bonet et al.'s work on the Sliced Spherical Wasserstein(SSW) distance.
- Tested the hypothesis centered on the idea that replacing instance-wise distances with distribution-wise distances (i.e., SSW) could yield better results in Semi-Supervised Learning (SSL) with data augmentation. To validate this hypothesis, I conducted extensive experiments on standard vision datasets such as CIFAR-10 and STL-10.

Combinatorial Optimizaion : Network Flows | *Combinatorics Thesis*

Advisor : Dr. Li Ying

- *Explored Network Flow Algorithms* : Examined key network flow algorithms like Ford-Fulkerson, Edmonds-Karp, and Push-Relabel, showcasing their practical applications.
- *Minimum Cut Analysis* : Conducted an in-depth analysis of minimum cuts in networks, highlighting their real-world relevance and presenting algorithms for their determination.
- *Complexity and Approximation* : Explored computational complexity, NP-hardness, and approximation algorithms, making complex optimization problems more accessible for practical solutions.

Implicit Neural Representation as Compression Algorithm | *Python, Pytorch*

Advisor : Dr. Soheil Kolouri

- Worked on representing images as neural networks using Fourier Mapping and Sine Activation and implementing novel algorithms to compress such models.

- Implemented a Bi-Level Optimization algorithm for learning weight activations that allow for best PSNR scores.
- Resulted in [1], a publication at ICCV 2023.

Sliced Optimal Transport | *Python, C, C++, CUDA, Pytorch, Open3D*

Advisor : Dr. Soheil Kolouri

- Worked on implementing Sliced Optimal Transport Algorithms for Shape Registration Experiments.
- Optimized the algorithm by rewriting it completely in C and CUDA kernels for parallel computation on GPUs.
- Used the variation of algorithm for shape registration application of Point Clouds and compared with SOTA ICP and Optimal Transport based methods.
- Acknowledged in the paper "Sliced Optimal Partial Transport" (CVPR 2023) by Yikun Bai et al.

Diffusion Models in Image Synthesis | *Python, Pytorch*

Advisor : Dr. Daniel Moyer

- Working studying different diffusion model techniques for Image Synthesis like using Stochastic Differential Equations in SDEdit and RePaint.
- Comparing the works already done in this field all the while building up on a novel technique to improve Image Synthesis using Diffusion Models.
- Implemented both methods to get a better understanding of the mechanisms of DDPM (Denoising Diffusion Probabilistic Models), and compare their resampling approaches

Contrastive Clustering | *Python, Pytorch*

Advisor : Dr. Soheil Kolouri

- Studied representation learning on the hypersphere for better Contrastive Image Clustering Algorithms
- Worked on developing a better understanding of Alignment and Uniformity Losses for better representation learning on hyperspheres.

Gated Behaviour of Dropout in Continual Learning | *Python, Pytorch*

Advisor : Dr. Soheil Kolouri

- Studying and exploiting the gated mechanism of dropout to improve the effects from catastrophic forgetting.
- Implemented papers in dropout from scratch and understood its behaviour by performing a suite of tests from computer vision and continual learning.

Noisy Point Cloud Registration via Optimal Partial Transport | *Python, Pytorch*

Advisor : Dr. Soheil Kolouri

- Working on developing a robust parametric non-rigid registration framework using the OPT framework.
- To reduce complexity, we are also trying to rigorously prove a sliced version of the OPT algorithm.

Selected Technical Projects

MuseAI | *Python, Pytorch, Firebase, Google Cloud, Flask, HuggingFace*

VandyHacks IX Winner

- Developed the backend for MuseAI project that won the VandyHacks hackathon competing against more than 400 teams and rated highly positive by more than 60 users during live demo.
- Utilized Firebase for authentication mechanisms and to store 10GB+ worth of media data and user profiles, thereby alleviating back-end workload and decrease the latency of media retrieval algorithms by 40%.
- Used diffusion models and Mubert API to create a REST API that would allow a user to generate images and music given a prompt with variable captions and sizes/duration. Added support for multilingual prompts.
- The REST API would implement the functionality needed by the frontend, generate images/music given prompt, save the generated images/music in Firebase and return the ID to frontend.

Image Classification Library | *Python, Pytorch, Libtorch, JAX*

2022

- Implemented various different Image Classifications Architectures (about 30) in Pytorch and Python to allow rapid comparisons for researchers in Computer Vision. This Project is under progress. Also converting some of the code to C++ and Libtorch.

Technical Skills

Languages: C++, C, Python, C# Go, Racket, Prolog, JavaScript, SQL

Technologies/Frameworks: Pytorch, Tensorflow 2.0, JAX, Open3D, ROS, Node.js, CUDA, Unity, GitHub, Git, Hugging Face, Docker.

Teaching/Teaching Assistant

CS 2201 - Program Design and Data Structures: Fall 2021, Spring 2022

CS - 3251 - Intermediate Software Design: Fall 2022, Spring 2023, Fall 2023

MATH 2410 - Methods of Linear Algebra: Fall 2023

Selected Relevant Coursework

Computer Science : Deep Generative Modeling (PhD Level), Geometric Deep Learning (PhD Level), Extended Mathematical Programming (PhD Level), Foundations of Machine Learning, Image Processing, Virtual Reality, Artificial Intelligence, Computer Graphics (online), Operating Systems, Algorithms of Robotics, Algorithms, Programming Languages, Intermediate Software Design, Digital Systems and Design, Data Structures, Discrete Structures.

Mathematics : Non Linear Optimization, Combinatorics, Graph Theory, Advanced Linear Algebra, Real Analysis, Ordinary Differential Equations, Probability and Statistics, Linear Algebra, Multivariable Calculus.

Academic Services

Workshop Reviewer

- NeurIPS 2022 : NeurReps Workshop. (Symmetry and Geometry in Neural Representations)
- TinyICLR 2023