RESEARCH INTERESTS

ML for social good & impact via responsible, safe, trustworthy, and ethical ML solutions that improve downstream critical decision-making. Also interested in building end-to-end solutions for measurable impact.

EDUCATION

Johns Hopkins University

Baltimore, MD

Masters of Science in Engineering, Computer Science; CGPA: 3.95/4.00

Aug 2022 - May 2024

Email: pmadaan2@jhu.edu

Website: madaanpulkit.github.io

Indraprastha Institute of Information Technology, Delhi

New Delhi, India

B. Tech., Computer Science & Applied Mathematics; CGPA: 9.23/10.00

Aug 2016 - Aug 2020

- Department Gold Medal (awarded for best academic performance) [link][cert]
- Thesis: Deep Mean Shift Clustering. [link]

Publications

- White, J., Madaan, P., Shenoy, N., Agnihotri, A., Sharma, M., & Doshi, J. (2022). A Case for Rejection in Low Resource ML Deployment. ArXiv preprint arXiv:2208.06359. [Poster in *Challenges in Deploying and Monitoring ML Systems Workshop at NeurIPS 2022*] [poster] [preprint]
- Madaan, P., & Sadat, F. (2020, May). Multilingual Neural Machine Translation Involving Indian Languages. In the 5th Workshop on Indian Language Data: Resources and Evaluation (pp. 29-32) at LREC 2020. [link]

EXPERIENCE

Johns Hopkins University

Baltimore, MD

Graduate Research Assistant

• Natural Language Text Data Anonymization Advised by: Prof. Anjalie Field Aug 2023 - Present

- * Developing end-to-end sensitive data detection and anonymization model for long-form unstructured natural language data by modeling it as a translation task.
- * Building the mechanism geared toward long-form documents found as medical notes, courtroom proceedings, and child welfare data. Using a Longformer model to fit all the tokens in the context window instead of chunking.
- * Measuring performance with a suite of metrics covering detection, anonymization, and utility.
- * Keywords: Privacy, Anonymization, Natural Language Text

• Language Agnostic Sentence Representations sans Parallel Data *Advised by: Prof. Phillip Koehn

 $May\ 2023$ - Present

- * Developing a model capable of producing sentence representation agnostic of the language without parallel data.
- * The approach models Transformers as AutoEncoders and uses only unpaired data from multiple languages to build representations agnostic of the source language.
- * Such representations would have the potential to be used in any downstream Natural Language Task without language being the barrier to access.
- * Keywords: Representation Learning, Sentence Vectors, Monolingual Data, Low Parallel Resource
- o Domain Adaptative Malarial Slide Analysis

Nov 2022 - Aug 2023

Advised by: Dr. Ben Haeffele & Matthew Ippolito, M.D., Ph.D.

- * Implemented Mean-Teacher and Gradient Reversal Domain Adaptation methods for Malarial Image Slide Analysis improving performance on new unseen domains.
- * Used Contrastive Predictive Coding for cell detection along with Maximal Coding Rate Reduction Loss to improve model performance on noisy labels.
- * Keywords: Domain Adaptation, Object Detection, Convolutional Sparse Coding, Noisy Labels, Healthcare

Wadhwani Institute for Artificial Intelligence

• Associate Machine Learning Scientist - I Research Fellow Mumbai, India (Virtual) Jan 2021 - July 2022 Jul 2020 - Jan 2021

∘ Pest Management | CoreML [code] \bigstar 8 on \bigcirc

Managers: Dr. Jerome White & Jigar Doshi

- * Developed a flexible & generic Object Detection codebase with rejection, visualization & deployment capabilities, on top of PyTorch Lightning, Hydra, & NNI.
- * Reduced the Mean Absolute Error from 4 to 2 for the existing object detection system, with the addition of new architectures, compression algorithms & a rejection framework to build trust incorporating on-ground feedback.
- * Solution reached thousands of small landholder farmers in three of the highest cotton-producing states of India
- * Solution won the Global Change Award 2022 [article].
- * **Keywords:** Object Detection, Open Source, Model Pruning, Framework Building, Core ML, Rejection System, Trustworthy, Deep Learning, Model Deployment, Social Good

Université du Québec à Montréal MITACS Globalink Research Intern

Montreal, Canada May 2019 - Aug 2019

- Multilingual Neural Machine Translation for Low-Resource Languages

 *Advised by: Prof. Fatiha Sadat
 - \ast Developed neural multilingual translation model for low-resource languages.
 - * Solution in the top 3 in half of the translation tasks in LoResMT SharedTask at MT Summit 2019
 - * Improved the BLEU score by 15 points from the baseline.
 - * Keywords: Neural Machine Translation, Low Resource, Transformers

Academic Service

- Course Assistant Computation Finance: Conducted office hours, and graded assignments.
- Course Assistant Statistical Analysis: Conducted office hours, and graded assignments.
- Program Committee RANLP 2023: Reviewed papers submitted in DravidianLangTech 2023 Workshop at RANLP 2023.
- Reviewer ACM TALLIP 2022: Reviewed papers submitted in ACM TALLIP 2022.
- Reviewer DravidianLangTech-ACL 2022: Reviewed papers submitted in DravidianLangTech-ACL 2022
 Workshop.
- Course Assistant Gateway Computing Python: Conducted office hours, labs and in-class help sessions, and graded assignments.

AWARDS

- Part of Wadhwani AI team that won the HUL, Google, and MyGov India's AI for Agriculture Hackathon. The winning prize was a grant of 1 Million INR.
- Mitacs Globalink Research Internship 2019: One of few selected students for a fully funded research opportunity at Université du Québec à Montréal.
- Best Academic Performance in Major [cert]
- Dean's Academic Excellence Award for 2 consecutive years: 2017-18, 2018-19 [cert]

SKILLS

- Masters Courses: Machine Learning System Design, AI Ethics, Computer Vision, Network Security, Machine Translation, Machine Learning, Causal Inference
- Bachelors Courses: Deep Learning[†], Machine Learning, Speech Recognition [†], Affective Computing[†], Reinforcement Learning[†], Linear Algebra, Probability and Statistics, Real Analysis, ODEs & PDEs, Calculus in ℝ^{n†}, Scientific Computing, Numerical PDEs[†], Differential Geometry, Linear Optimisation ([†]Graduate level courses)
- Tools & Technologies: Python, Java, C++, PyTorch, HuggingFace, GPT4ALL, LangChain, Pinecone, Jupyter, Git, Torchtext, Streamlit, Numpy, scikit-learn, PyTorch Lightning, Detectron2, Docker, Hydra, NNI.

• SageRef: Single Image Reflection Removal [code] [report]

- Modeled a denoising autoencoder to remove image reflection from mirror reflection-plagued images with only a single image.
- Used a UNet model with synthetic data from the SIR2 Benchmark.
- o **Keywords:** PyTorch Lightning, TorchVision, TorchMetrics

• Benoit: Better English Noisy Audio Transcripts [code] [slides]

- Developed a grammar-correcting ASR model for non-native English speaker audio.
- Created synthetic dataset by back-translating English sentences from a low-resource language and passing them to Microsoft SAPI5 TTS to create a proxy for non-native English audio.
- Used a GRU-based seq2seq denoising autoencoder on top of a pre-trained Wav2Vec 2.0 (frozen) for grammatically correct ASR.
- o Keywords: PyTorch, TorchAudio, TorchText, Colab

• LLM Chatbots [code]

- Built a chatbot with LangChain prompt templates, HuggingFace google-flan-t5-xl model on vectorized Anime database indexed in Pinecone.
- Built a chatbot with mistral-7b-instruct from GPT4ALL that replies with shell commands that can achieve the task asked by the user in the prompt and runs inside a shell can can execute those commands if accepted by the user.
- o Keywords: HuggingFace, Transformers, LangChain, PineCone, LLM, Pinecone, GPT4ALL

• Emotional Text-to-speech [webpage] [slides] ★ 311 ₺ 46 on •

- o Developed over Tacotron for emotional speech synthesis for English.
- ∘ Explored fine-tuning approaches for pre-trained models to synthesize emotional speech using ~15 mins. of audio.
- o **Keywords:** Deep Learning, Speech Synthesis, Tacotron

• Flow Based Generative Models: GLOW [code] [slides]

- Explored Conditional GLOW in different generation and conversion tasks as a replacement for Vocoders and GANs
- o **Keywords:** PyTorch, Colab, Flow Models

• Doom Playing DeepRL Agent [code][slides]

- Trained an agent using Deep Recurrent Q-Learning to play Doom: An FPS game having partially observable 3D states.
- Recreated a simple case from the Arnold framework with a Deep Recurrent Q-Network.
- Added the capability to self-learn as the agent plays against self to train itself.
- o Keywords: PyTorch, ViZDoom, Reinforcement Learning, Deep Q-Learning

• Passive v/s Active Induced Emotions

- o Comprehensive Analysis on widely used affective features.
- Analyzed featured importance in predicting affective state in an active v/s passive visuals study.
- Collected gameplay videos for active visuals and Bollywood movie trailers for passive.
- Collected affective scores for the curated dataset.
- o **Keywords:** PyTorch, Librosa, Scikit-learn

Co-curricular Activities

- Part of the organizing Committee, ACSS'18 (Workshop on AI for Computational Social Systems)
- Research Volunteer with Global Village Foundation. Helped conduct surveys in rural areas and analyzed data on the impact of government policies and schemes.
- Served as the Event Head, RoboWars, ESYA'17 (Technical Fest)