Pulkit Madaan

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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: 3.93/4.00 — *Aug 2022 – May 2024*
- **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** — *Aug 2023 - Present*
    Advised by: Prof. Anjalie Field
    - 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** — *May 2023 - Present*
    Advised by: Prof. Phillip Koehn
    - 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*
  - **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 — Mumbai, India (Virtual)

- *Associate Machine Learning Scientist - I* — *Jan 2021 - July 2022*
  Research Fellow — *Jul 2020 - Jan 2021*
  - **Pest Management | CoreML [code] ★ 8 on**
    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** — Montreal, Canada
  MITACS Globalink Research Intern — *May 2019 - Aug 2019*
  - **Multilingual Neural Machine Translation for Low-Resource Languages**
    Advised by: Prof. Fatiha Sadat
    * 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 $\mathbb{R}^{n\dagger}$, 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.

Projects

- **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.
  - **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.
  - **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.
  - **Keywords:** *HuggingFace, Transformers, LangChain, PineCone, LLM, Pinecone, GPT4ALL*
- **Emotional Text-to-speech** [webpage] [slides] ★ **311** **46** **on**
  - 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.
  - **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
  - **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.
  - **Keywords:** *PyTorch, ViZDoom, Reinforcement Learning, Deep Q-Learning*
- **Passive v/s Active Induced Emotions**
  - 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.
  - **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)