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Piyush Arora

Education

- **Imperial College London** — UK
  MSc Computing (Artificial Intelligence and Machine Learning) — *2025 - 2026*
- **Indian Institute of Technology Jodhpur** — India
  Bachelor of Technology Computer Science and Engineering; CGPA: 8.88/10 — *2020 - 2024*
  Highlights:
  - *All India Rank **3316 (IIT-JEE 2020)** among 1.3 million applicants.*
  - *Selected for the prestigious **Mitacs Globalink Research Internship** and completed a funded summer research internship*
  - *Capstone Project: Hybrid Sample Synthesis-Based Debiasing in Limited Data Settings published at **WACV 2024**.*
  - *Coursework: Deep Learning, Advanced Machine Learning, Natural Language Understanding, Data Structures and Algorithms, Operating Systems, Computer Networks; Probability, Statistics, Stochastic Processes, Linear Algebra.*

Publications

- **P. Arora**, N. Singh, A. Subramanyam, and A. Mishra, *When Big Models Train Small Ones: Label-Free Model Parity Alignment for Efficient Visual Question Answering with Small VLMs*: **EMNLP 2025**
- **P. Arora**, and P. Mazumder, *Hybrid Sample Synthesis-Based Debiasing Of Classifier In Limited Data Setting*: **WACV 2024**

Professional Experience

- **MetaFusion** — Noida, India
  AI Research Engineer — *May 2024 - Aug 2025*
  - **Vision–Language Model for Attribute Classification and Captioning**
    - Built a unified vision–language model for surveillance that jointly predicts subject attributes and generates captions, addressing limitations of fixed attribute sets.
    - Generated a large-scale synthetic instruction tuning dataset using Qwen2.5VL-7B captions, removing the need for manual annotations and adapting models to various surveillance data.
    - Designed plug-and-play attribute group embeddings with cross-attention and an attribute-conditioned captioning framework for fine-grained recognition and attribute-consistent captions.
    - Fine-tuned Microsoft Florence-2 Base for deployment under GPU constraints, boosting the F1 score from **84% to 91%** with an inference latency of **less than 1s** per image on RTX 4000 Ada.
    - *Technologies: PyTorch, HuggingFace Transformers, Distributed Data Parallel (DDP), Gradio, Git*
  - **Intelligent Traffic Management System (ITMS)**
    - Built a unified detection system for traffic violations including speeding, license plates, helmet use, triple riding, wrong-way driving, and lane discipline, replacing multiple app-specific models to avoid repeated inference and remove major processing bottlenecks.
    - Trained a universal detection model to handle all violation classes in a single pass, improving overall throughput by over **50 percent** while retaining the option to rely on specialized models when necessary.
    - Delivered production deployments in Gandhinagar and Vizag with automated violation logging, remote diagnostics, and centralized monitoring through a scalable cloud backend.
    - *Technologies: PyTorch, YOLO (Ultralytics), Python, C++, Kubernetes, Git*
  - **Toll Automation System – MSRDC Maharashtra**
    - Designed and deployed an application to automatically detect vehicles at toll plazas, localize license plates, and extract plate numbers via OCR for seamless toll processing.
    - Trained a CLIP-based attribute prediction model on a custom dataset extracted from surveillance footage, enabling prediction of vehicle attributes from the best frame of each tracked vehicle.
    - Integrated dual tracking (based on vehicle and plate) to ensure reliable identification in both day and night conditions, reducing missed detections when plates were not visible.
    - *Technologies: PyTorch, YOLO, CLIP, OpenCV, Kalman Tracking, Python*

Research Projects

- **When Big Models Train Small Ones** — IIT Jodhpur
  Supervisor: Dr. Anand Mishra | VL2G Lab — *Dec 2024 – Mar 2025*
  - Designed the **Model Parity Aligner (MPA)** to enable small VLMs such as SmolVLM-500M, TinyLLaVA-2B, InternVL2-2B / 4B to learn from large VLMs such as Qwen2VL-7B, InternVL2-8B, GPT-4o using unlabeled data, eliminating costly annotations.
  - Developed disparity-aware training to close reasoning gaps between S-VLM and L-VLM, improving performance without supervision.
  - Automated QA pair generation and filtering of disparity samples to guide fine-tuning across OCR, commonsense, and factual tasks.
  - Achieved consistent accuracy gains upto **6%** on four VQA benchmarks (TextVQA, ST-VQA, OKVQA, ChartQA) while maintaining computational efficiency.
  - *Technologies: PyTorch, HuggingFace, Docker, Git*

- **Generative Debiasing via Bias Translation (Under Review)** — IIT Jodhpur
  Supervisor: Dr. Pratik Mazumder — *May 2024 – Mar 2025*
  - Built a generative debiasing framework using StarGAN to synthesize bias-translated image counterparts, removing the need for explicit bias labels or conflicting supervision.
  - Developed an instance-specific refinement strategy to detect and correct bias susceptibility, aligning task-relevant representations across original and synthetic domains.
  - Achieved up to **20% absolute improvement** over prior methods in corrupted CIFAR-10 (worst-group evaluation).
  - *Technologies: PyTorch, Docker, Git*

- **Hybrid Sample Synthesis-Based Debiasing in Limited Data Settings** — IIT Jodhpur
  Supervisor: Dr. Pratik Mazumder — *Dec 2022 – Mar 2023*
  - Developed a hybrid sample synthesis method to mitigate unknown biases in low-data regimes, training ResNet classifiers with improved generalization.
  - Implemented a dual-model framework to generate bias-conflicting samples without explicit bias annotations.
  - Outperformed prior debiasing methods, achieving up to **+10%** accuracy gains on benchmarks (CIFAR-10, Colored MNIST, BFFHQ).
  - *Technologies: PyTorch, OpenCV, Docker, Kubernetes, Git*

Research Internships

- **Interpretability in Imbalanced Problems Through Data Transformation** — Ottawa, Canada
  Supervisor: Dr. Paula Branco | Mitacs GRI 2023 | uOttawa — *May 2023 – Aug 2023*
  - Assessed the impact of SMOTE, sample reweighting, and other feature engineering methods on model interpretability in imbalanced datasets.
  - Automated large-scale evaluation across 30+ datasets with Python pipelines, improving experiment reproducibility and speed.
  - Identified generalizable transformation patterns across continuous, discrete, and categorical features.
  - *Technologies: PyTorch, OpenCV, NumPy, Scikit-learn*

- **Unsupervised Learning for Bleed-Through Removal in Historical Documents** — Remote
  Supervisors: Florian Kordon, Dr.-Ing. Vincent Christlein | FAU — *Jun 2022 – Sep 2022*
  - Built an encoder–decoder model to separate bleed-through artifacts from clean text in degraded historical documents using unsupervised learning.
  - Created a synthetic dataset with CV preprocessing (thresholding, erosion, dilation) to simulate real-world document degradation.
  - Demonstrated feasibility of artifact removal without ground-truth clean samples, highlighting potential for large-scale archival restoration.
  - *Technologies: PyTorch, OpenCV*

- **Mitigating Spurious Correlations via Memory-Guided Triplet Loss** — Remote
  Supervisor: Dr. Roberto Capobianco | Sapienza University of Rome — *Apr 2022 – Aug 2022*
  - Enhanced deep classifiers with a memory bank and cosine-similarity retrieval to detect reliance on spurious shortcuts.
  - Retrieved nearest training samples to visualize bias-driven decisions and highlight spurious feature dependence.
  - Applied memory-guided triplet loss to separate embeddings with shared bias features but distinct content, reducing shortcut learning and improving generalization.
  - *Technologies: PyTorch, Git*

Skills Summary

- **Programming**: Python, C++, SQL, Bash
- **ML & AI Frameworks**: PyTorch, TensorFlow, Hugging Face, Transformers, Scikit-learn, OpenCV
- **Quantitative Skills**: Probability Theory, Statistics, Optimization, Stochastic Processes, Monte Carlo Simulation
- **Tools & Platforms**: Docker, Kubernetes, Git, Linux
- **Other**: Technical Writing, Public Speaking, Leadership, Project Management

Teaching and Co-curricular Activities

- **Teaching Assistant — Dr. Angshuman Paul**:
  - Taught "Principles of Computer Systems" (Layered architecture, CPU design, Memory Hierarchy, MIPS).
  - Conducted labs, prepared assignments, and graded exams for 75+ sophomores.
- **Teaching Assistant — Dr. Mayank Vatsa**:
  - Assisted in "Introduction to Computer Science" (C++, Python, DSA basics).
  - Designed/evaluated assignments and conducted tutorials for 200+ first-year students.
- **Exhibition Team Head — Prometeo 2023**:
  - Led a 10-member team at North India's largest tech festival.
  - Organized Technology Exhibition with 15+ companies/startups showcasing innovations.