ATHARV GOEL

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EDUCATION

• IIIT Delhi *2021 - 2025*

B.Tech in Computer Science & Engineering GPA: 8.8/10.0

PUBLICATIONS

[1] **Reliable Active Learning from Unreliable Labels via Neural Collapse Geometry**
Atharv Goel*, Sharat Agarwal*, Saket Anand, Chetan Arora
NeurIPS 2025 Workshop on Reliable ML

[2] **NCAL: Neural Collapse-Guided Active Learning for Robust and Generalizable Representations**
Sharat Agarwal*, **Atharv Goel***, Saket Anand, Chetan Arora
ICASSP 2026 — under review

[3] **Just Add Geometry: Gradient-Free Open-Vocabulary 3D Detection Without Human-in-the-Loop**
Atharv Goel, Mehar Khurana
arXiv 2025

RESEARCH EXPERIENCE

• Infosys Centre for Artificial Intelligence (CAI), IIIT Delhi *Dec 2023 - July 2025*

Undergraduate Thesis | *Thesis PDF* | *Advisor: Prof. Saket Anand* New Delhi, India

- Formulated a novel theoretical connection between Neural Collapse geometry and generalization error by constructing a feature-space analog of weight correlation through collapsed class means.
- Derived Class-Mean Alignment Perturbation (CMAP) metric that selects samples maximizing perturbation to the simplex ETF structure, provably reducing generalization bounds via correlation with KL divergence between posterior and prior over model parameters.
- Achieved state-of-the-art OOD generalization with **20% fewer labels on ImageNet** by selecting structurally impactful samples that improve both discriminability and robustness to covariate shift.
- Demonstrated consistent performance across random initializations, addressing the reproducibility crisis in uncertainty-based active learning.
- Demonstrated that foundation models fail under distribution shift, being systematically outperformed by active learning methods despite their scale.
- Validated approach across OOD detection, long-tail class imbalance, and transfer learning benchmarks on ImageNet and domain-specific datasets.
- **Accepted to NeurIPS 2025 Workshop**; under review at **ICASSP 2026**.

• Datalab, IIIT Delhi *Jan 2025 - Jun 2025*

Research Assistant | *Advisor: Prof. Gautam Shroff* New Delhi, India

- Investigated whether abstract reasoning and compositional task understanding can emerge from diverse interaction in meta-environments with varying objectives.
- Designed curriculum learning and meta-RL training pipelines for open-ended learning; agents mastered individual tasks but struggled to generalize compositional structure across variations.
- Demonstrated that model-free RL lacks mechanisms for compositional generalization, motivating explicit representations (world models, hierarchical abstractions) for open-ended adaptation.

• Wildlife Institute of India *June 2024 - Aug 2024*

Computer Vision Intern New Delhi, India

- **AI for Social Good:** Explored graph-based wildlife re-identification using spectral graph theory and geometric deep learning, building foundations in graph neural networks and geometric reasoning.
- Applied graph registration, neural subgraph matching, and 3D pose-based representations for species recognition across viewpoint variations.

• Theoretical Computer Science Lab, IIIT Delhi *June 2023 - Aug 2023*

Research Intern | *Advisor: Prof. Supratim Shit* New Delhi, India

- Analyzed convergence guarantees for coreset construction in regularized regression under incomplete data.

Industry Experience

- **TBO.COM** *June 2025 - Present*
  Software Engineer Gurugram, India
  - Developed distributed systems for real-time travel inventory management.

Personal Projects

- **Neural Analogical Reasoning for ARC-AGI** *Sep 2024 - Nov 2024*
  Tools: Python, PyTorch, transformers **[Report]**
  - Achieved **41% accuracy** on ARC-AGI challenge (competitive with published methods at the time) through meta-learning and neurosymbolic reasoning.
  - Applied test-time adaptation to fine-tune LLMs on task-specific augmentations via program synthesis.
  - Implemented constrained graph search over LLM outputs to enforce spatial reasoning constraints.
- **OV3D: Open Vocabulary 3D Object Detector Without 3D Supervision** *Mar 2024*
  Tools: Python, PyTorch **[Paper | Code]**
  - Developed zero-shot 3D open-vocabulary detection by lifting 2D foundation model predictions (GroundingDINO, SAM) to 3D using camera geometry and LiDAR.
  - Designed robustness benchmark simulating adverse weather and sensor noise, demonstrating that 2D-to-3D backprojection is fundamentally ill-posed.
  - Matched supervised baselines in clear conditions; failures under distribution shift motivated ground-up 3D reasoning approaches.
- **VXGI: 3D Graphics Rendering Engine** *Oct 2023 - Dec 2023*
  Tools: C++, OpenGL **[Report | Code]**
  - Built real-time global illumination rendering engine from scratch in C++ and OpenGL, implementing voxel cone tracing for indirect lighting.
  - Achieved interactive performance (50-60 FPS) through dynamic voxelization and efficient spatial data structures, demonstrating systems competency in 3D geometric algorithms.
  - Experience with 3D scene representation informs interest in neural scene representations (NeRFs, 3D Gaussian Splatting) for embodied AI.

Teaching Experience

- **Head Teaching Assistant, Computer Vision** *Jan 2025 - May 2025*
  - Led team of 6 TAs for Computer Vision (150+ students), managing course logistics and evaluation. **Received Best TA Award.**
  - Taught tutorials on visual recognition, epipolar & 3D geometry; mentored students on research projects.
  - Taught students how models can game evaluation measures (e.g., mAP) while failing in qualitative visualizations; emphasizing real performance over benchmark metrics

Awards

- **Best Teaching Assistant Award (2025)**: Recognized for outstanding instructional support, based on feedback sent by students and faculty.
- **Dean's List for Academic Excellence (2024–2025)**: Honored for strong academic performance.
- **Distinguished Academic Excellence Award (2025)**: Sole awardee in cohort for earning A+ (exceeding highest standard grade) in three graduate AI courses: *Computer Vision, Meta-Learning, and Explainable AI*.
- **Amazon ML Summer School (2024):** among the top 3% **of 85,000 applicants** for this competitive program.
- **World Cube Association:** Ranked **top 100 in India** among **20+ million** competitive speedcubers.

Graduate Coursework

- **CS:** Computer Vision, Reinforcement Learning, Meta-Learning, Explainable AI, Distributed Systems, Computer Graphics, Statistical Learning Theory
- **Math:** Differential Geometry (audit), Linear Optimization, Abstract Algebra, Game Theory

Technical Skills

- **ML/AI**: PyTorch, OpenCV, OpenGL, NumPy, Scikit-learn, Transformers, fastAI
- **Systems**: CUDA, Linux, Git, GitHub, Docker, AWS, GCP
- **Languages:** Python, C++, C, JavaScript, TypeScript, SQL