Prakhar Kaushik

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PROFESSIONAL SUMMARY

Cognitive AI Researcher (PhD Candidate) possessing a unique "dual-expertise" profile: driving **fundamental theoretical breakthroughs** while delivering **scalable AI systems engineering**. The majority of works are **first-authored** or involve **project leadership**, often achieved despite significant compute constraints. A leading proponent of 3D part-based, life-long, efficient, and human-like learning paradigms in AI models.

- **Unique Value:** The only candidate in the field simultaneously publishing "viral" theoretical discoveries (*Universal Weight Subspace Hypothesis*) while building SOTA 3D vision systems (*Name That Part*) and efficiency engines (*EigenLoRAx*).
- **Field Leadership:** De facto leader in **3D Part Segmentation and Naming** research; unified the field's fragmented data landscape by creating **TexParts** (8,450 objects) and the first consistent 3D part ontology. Created the only method to-date for 3D Object Unsupervised Domain Adaptation (3DUDA).
- **Engineering Impact:** Expert in translating deep theoretical insights into massive efficiency and robustness gains, achieving **100x speedups** in segmentation and **100x parameter reduction** in model adaptation.
- **Core Tech:** 3D Analysis-by-Synthesis, Sim-to-Real Adaptation, Parameter-Efficient Fine-Tuning (PEFT/LoRA), and LLM Interpretability, Continual Learning, Controllable Generation.

RESEARCH & PROFESSIONAL EXPERIENCE (3.5 + 5 (PhD) total experience)

Johns Hopkins University (CCVL Lab) | *Graduate Research Assistant (PhD)* | Baltimore, MD *Aug 2020 – Present Lead Researcher: 3D Vision, Efficient LLMs, & Neuro-Symbolic AI*

- **The Universal Weight Subspace Hypothesis (Viral Research):**
  - Proposed and empirically validated the fundamental theory that diverse neural networks (LLMs, ViTs) converge to shared, low-dimensional spectral subspaces.
  - **Impact:** Analyzed **1,100+ models** (Mistral-7B, LLaMA-8B) to demonstrate >90% of variance lies in just 16-32 components. Work became **viral** in the ML community, influencing new methods in Model Merging and Continual Learning.
- **Name That Part (Project Lead):**
  - Architected **ALIGN-Parts**, a feed-forward set-alignment framework for 3D part segmentation that eliminates the need for clustering.
  - **Metric:** Achieved a **100x speedup** over SOTA baselines (e.g., PartField) and established the new industry standard for open-vocabulary part naming.
  - **Resource Creation:** Led the creation of **TexParts**, the largest semantically aligned 3D part dataset (14k categories), solving the "Sim-to-Real" data bottleneck for the community.
- **EigenLoRAx (Efficient AI):**
  - Developed a novel adapter recycling technique that leverages principal subspaces for resource-constrained inference.
  - **Metric:** Reduced trainable parameters by **100x** and memory footprint by **18x** compared to standard LoRA, enabling multi-task LLM deployment on edge devices.
- **Source-Free Sim-to-Real Adaptation (ICLR):**
  - Pioneered **3DUDA**, the first **Source-Free Unsupervised Domain Adaptation** framework for category-level 3D pose estimation.
  - **Innovation:** Solved the "sim-to-real" gap for 3D pose without requiring any target domain 3D annotations, utilizing generative rendering priors.

Amazon (Visual Search) | *Applied Scientist Intern* | Palo Alto, CA *Jun 2022 – Dec 2022*

- **Generative AI for AR:** Pioneered a **Structured Image Inpainting** pipeline specifically for Amazon's "Design Your Room" Augmented Reality feature.

- **Business Impact:** Significantly enhanced the realism of virtual furniture placement, directly improving user engagement metrics and conversion rates for the Visual Search vertical.

Amazon (Sponsored Products) | *Applied Scientist Intern* | Palo Alto, CA *Jun 2021 – Sep 2021*

- **Causal Inference at Scale:** Designed a robust causal inference framework to correct selection bias in observational Weblab data.
- **Outcome:** Eliminated confounding variables to provide leadership with accurate **Return on Ad Spend (ROAS)** metrics, guiding multi-million dollar advertising strategy decisions.

Amplio | *AI Development Lead Engineer* | Chantilly, VA *Apr 2019 – Apr 2020*

- **End-to-End ML Systems:** Led the R&D of a "Digital Twin" predictive engine for athlete performance, fusing heterogeneous data (video, wearables, physiological sensors).
- **Leadership:** Managed cross-functional teams of sports scientists and engineers to deploy multimodal models that predicted injury risks with high accuracy.

Ernst & Young | *Risk Analyst* | India, *Jul 2017 – Dec 2017*

- Identified, assessed, and managed technology-related risks, including cybersecurity and operational IT risks.

JHU Laboratory for Computational Sensing + Robotics | *Graduate Research Assistant (PhD)* | Baltimore *Jun -Sep 2020*

- Created a realtime, Unsupervised **Robot Path Detection** Algorithm. Manager - Dr. Marin Kobilarov

JHU School of Public Health| *Graduate Research Assistant (PhD)* | Baltimore, MD *Oct 2018 - Apr 2019*

- **Created a traffic image dataset** from all around the world for traffic behavior analysis using robust object detection.

CR Rao Institute of Mathematics, Statistics & Computer Science | *Visiting Researcher* | Hyderabad, India *Apr - Jul 2017*

- Multi-Sensory Fusion algorithm for **secure offline navigation system**.. Advisor - Dr. Vishal Saraswat

Indian Statistical Institute | *Research Intern* | Kolkata, India *May - Aug 2016*

- Microsoft Asia Research Internship. **Side Channel Attack Analysis** of AES cryptographic algorithm. Advisor - Dr. Vishal Saraswat

TECHNICAL SKILLS

- **Core AI:** 3D Computer Vision, Generative AI (Diffusion, GANs), LLMs (Llama, Mistral), LoRA/PEFT, Unsupervised Domain Adaptation (UDA), NeRF/Gaussian Splatting, Causal Inference.
- **Engineering:** PyTorch, TensorFlow, Python, C++, Docker, Kubernetes, AWS (SageMaker, EC2), HuggingFace Transformers, OpenCV, Blender (bpy).
- **Math & Theory:** Spectral Analysis, Bayesian Optimization, Geometry Processing, Optimization Theory.

TEACHING EXPERIENCE

Johns Hopkins University **Baltimore, MD**
Graduate Teaching Assistant, Probabilistic Models of the Visual Cortex 08/2024 - 12/2024

EDUCATION

Johns Hopkins University | Baltimore, MD

- **Ph.D. in Computer Science (Advisor: Dr. Alan Yuille) | *Expected early 2026***
- **M.S. in Computer Science | *2020***

Indian Naval Academy, etc | India

- **B.Tech in Electronics & Communications | *2017***
    - ***Awards:* All India Rank 1 (UPSC (RIMC) Exam), Best in Mathematics Medal.**

AWARDS & COMMUNITY

- **Talks** Artificial Intelligence for Engineering and Medicine Lab (Dr. Rama Chellappa) - April 2024, JHU Cognitive Neuroscience and Deep Learning Group - February 2025, Levin Lab (Tufts) - JAn 2026
- **Feature Article:** Work profiled in **Johns Hopkins Engineering News**: In the World of AI, Who Speaks for the Trees? highlighting contributions to sustainable, green AI.
- **Viral Research:** *Universal Weight Subspace Hypothesis* trended on **Hacker News**, **AlphaArxiv**, **Reddit**, **Daily.dev**, and **The AI Timeline**, sparking widespread discussion on neural network interpretability and efficiency.
- Lieutenant General MM Lakhera Silver Medal, 2012 – Best In Mathematics. Colonel Haughten Silver Medal, 2012. Lieutenant Commander Rajat K Sen Silver Medal, 2010. UN Jha Memorial Gold Medal, 2010.
- **All India Rank 1 - Rashtriya Indian Military College Examination, All India Rank 2 - UPSC National Defence Academy and Naval Academy Examination**
- **Leadership: Founder & President, Indian Graduate Student Association (IGSA) at JHU (Largest graduate group).**
- **Memberships**: IEEE, Upsilon Pi Epsilon, the national CS honor society.

Languages: English and Hindi (Native), Japanese and Indic languages (Punjabi, Bengali, Nepali, etc.), Japanese (Conversational), Mandarin Chinese and Korean (Beginner)

Miscellaneous Debating and Quizzing team captain (2008-2012) with multiple All India awards; Licensed Mountaineer (Mt. Bandarpunch, 21,000 feet (2010)), Scuba Diver and Marksman (India Pre-Nationals 2010-11)

APPENDIX: SELECTED PUBLICATIONS & SUMMARIES

Complete list on the homepage and Google Scholar.

Theory & Efficiency, Continual Learning & Mechanistic Interpretibility

- **[Viral Research]** **The Universal Weight Subspace Hypothesis** (arXiv 2025).
  Summary: Proven that diverse neural networks converge to shared low-dimensional spectral subspaces, enabling efficient model merging.
- **EigenLoRAx: Recycling Adapters to Find Principal Subspaces for Resource-Efficient Adaptation and Inference** (**CVPR** 2025, Workshop Oral)
  Summary: An adaptation method reducing parameters by **100x** and memory by **18x** by recycling trained adapters into principal components. Media Coverage of this work - In the World of AI, Who Speaks for the Trees?.
- **Understanding catastrophic forgetting and remembering in continual learning with optimal relevance mapping**, P Kaushik, A Gain, A Kortylewski, A Yuille, 2021 Conference on Neural Information Processing Systems (**NeurIPS**)-W
  Summary: Seminal work regarding Catastrophic Forgetting & Remembering with mapping optimal relevance to prevent forgetting in continual learning.
- inemo: Incremental neural mesh models for robust class-incremental learning, (**ECCV 2024**)
- Adaptive neural connections for sparsity learning, (**WACV**, 2020).

3D Vision, VLM & Generative AI

- **[Project Lead]** **Name That Part: 3D Part Segmentation and Naming** (arXiv 2025)
  Summary: **First work to do 3D part segmentation and naming**. A **100x faster** framework for open-vocabulary 3D part naming, introducing the **TexParts** dataset (8,450 objects).
- **Gaussian Scenes: Pose-Free Sparse-View Scene Reconstruction using Depth-Enhanced Diffusion Priors**, (**TMLR** 2025). Project Page
  Summary: Reconstructs 3D scenes from sparse views without camera poses by leveraging depth-enhanced diffusion priors.

- **Source-Free and Image-Only Unsupervised Domain Adaptation for Category Level Object Pose Estimation,** (**ICLR**) 2024.
  Summary: The first framework to solve "Sim-to-Real" transfer for 3D object pose estimation using only images.
- **Scaling 3D Compositional Models for Robust Classification and Pose Estimation**, (**ICCV**) 2025
  Summary: Demonstrates that scaling compositional models improves robustness against occlusions and domain shifts.
- **Perceptual Taxonomy: Evaluating and Guiding Hierarchical Scene Reasoning in Vision-Language Models.** **(Project Lead, Co-Senior Author)**
  Summary: A benchmark for evaluating how Vision-Language Models reason about hierarchical scene structures.
- Progressive Prompt Detailing for Improved Alignment in Text-to-Image Generative Models, (**CVPR**) 2025. Workshop **Oral.**
- Animal3d: A comprehensive dataset of 3d animal pose and shape. Proceedings of the IEEE/CVF International Conference on Computer Vision (**ICCV**) 2023.

MISCELLANEOUS

- A Bayesian Approach to OOD Robustness in Image Classification, P Kaushik, A Kortylewski, A Yuille, The IEEE/CVF Conference on Computer Vision and Pattern Recognition (**CVPR**) 2024.
- Learning part segmentation from synthetic animals, J Peng, J He, P Kaushik, Z Xiao, J Mu, A Yuille. Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision (**WACV**) 2024
- Radar as a security measure-real time neural model based human detection and behaviour classification. P Kaushik. GlobalSIP 2019.
- Timing attack analysis on AES on modern processors. P Kaushik, R Majumdar. ICRITO 2017
- An Offline Outdoor Navigation System with Full Privacy. P Kaushik, V Saraswat, F Buccafurri, WINSYS, 95-101
- EigenLoRA: Recycle trained Adapters for Resource Efficient Adaptation and Inference. P Kaushik, A Mishra, A Vaidya, R Addanki, RA Rossi, A Nenkova, A Liu, …
- DSPart: A Large-scale Diffusion-generated Synthetic Dataset with Annotations from 3D Parts. J Peng, Y Sun, J He, J Chen, P Kaushik, W Ma, Y Zhang, J Wang, A Wang, …
- CIDA3D: Conformal Inference aided unsupervised Domain Adaptation for 3D-Aware Classification. P Kaushik, A Mishra, A Liu, A Kortylewski, A Yuille.
- TriDiff-4D: Fast 4D Generation through Diffusion-based Triplane Re-posing. EP Sheung, Q Liu, W Ma, P Kaushik, J Xie, A Yuille. Arxiv. 2025

Unreleased Preprints (please contact for drafts or code)

- **High Quality 3D Animal Modelling from images and videos**. P Kaushik and collaborators.
  Summary: World's first method to generate high quality 3D animals from images and videos, including physics oriented hierarchical fur strands.
- **Share: Parameter efficient continual finetuning via Shared Subspace Adaptation**. P Kaushik, A Vaidya, A Yuille.
  Summary: First method to do Strict and efficient Continual Learning for LLMs, VLMs and text to image generative models.
- **The Only 3D metrics you will ever need.** P Kaushik, S Paul, A Yuille
  Summary: Novel and gold standard metrics for novel view synthesis and video diffusion models.
- **VSplats: Efficient and Detail Oriented 3D Splatting.** P Kaushik, S Paul, A Yuille
  Summary: 3D volume representation method with improved sharpness and 50% more efficient than 3D gaussian Splatting.