TANUSHREE BANERJEE

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RESEARCH INTERESTS

I work on **explainable 3D perception methods via inverse generation**. I am excited about how leveraging priors learned in 2D generative models for 3D spatial reasoning can offer a novel perspective on predictive computer vision, enabling interpretable alternatives to black-box feed-forward network-based approaches and paving the way toward a unified framework for perception.

EDUCATION

Princeton University, Princeton, NJ   *August 2020 - May 2024*
Bachelor of Science in Engineering (BSE), Computer Science.
Graduated *magna cum laude*. Received certificates in Statistics & Machine Learning, Optimization & Quantitative Decision Science.

RESEARCH EXPERIENCE

Princeton Computational Imaging Lab | Department of Computer Science, Princeton University   *June 2023 - Present*
Research Assistant: Inverse Generation for Explainable Computer Vision   Advisor: Prof. Felix Heide

- I conducted my senior thesis [3] in the lab on explainable 3D perception via inverse rendering, resulting in an arXiv preprint [1] currently under review at a peer-reviewed journal. I received the Outstanding CS Senior Thesis Prize for my thesis work.
- Extending my thesis work, my current project, *"OD-VAE[1]: Unlocking Analysis-by-Synthesis for Explainable 3D Object Detection"* by Tanushree Banerjee*, Julian Ost*, Maolin Mao, Mario Bijelic, and Felix Heide, proposes a novel method for tackling 3D object detection using an analysis-by-synthesis paradigm to leverage strong learned priors in a Variational Auto-Encoder (VAE). * denotes equal contribution.

Princeton NLP Group | Department of Computer Science, Princeton University   *May 2022 - June 2023*
Research Assistant: Human-in-the-Loop Machine Learning, LLM Self-Refinement   Advisor: Prof. Karthik Narasimhan

- I investigated human-in-the-loop methods and LLM self-correction capabilities to improve LLMs' performance on nuanced tasks like lie detection. My work resulted in an arXiv preprint [2].

Princeton Visual AI Lab | Department of Computer Science, Princeton University   *May 2021 - May 2023*
Lab Assistant: Bias in Computer Vision, Video Action Recognition   Advisor: Prof. Olga Russakovsky

- I conducted my junior and sophomore independent work in the lab, where I investigated hallucination in vision-language models [4] and bias in unbalanced image classification datasets [5].
- Worked on processing $\sim$ 20 TB of police body cam videos for a novel application-focused video action recognition dataset.

PUBLICATIONS AND INDEPENDENT WORK

ArXiv Preprints   ** denotes equal contribution.*

1. **Inverse Neural Rendering for Explainable Multi-Object Tracking**   *Under Review at a Peer-Reviewed Journal*
   Julian Ost*, Tanushree Banerjee*, *Mario Bijelic, Felix Heide*   ✎ Project Page | Paper | arXiv:2404.12359

   We recast 3D multi-object tracking from RGB cameras as an *Inverse Rendering* problem. Our method is not just an alternate take on tracking; it enables examining generated objects and reasoning about failure cases. A version of this paper titled *"Towards Generalizable and Interpretable Vision with Inverse Neural Rendering"* is under review at a peer reviewed journal.

2. **LLMs are Superior Feedback Providers:**   ✎ Paper | arXiv:2408.13915
   Bootstrapping Reasoning for Lie Detection with Self-Generated Feedback
   Tanushree Banerjee*, Richard Zhu, Runzhe Yang, Karthik Narasimhan*

   We investigated a bootstrapping framework that leverages LLM-generated feedback to detect deception in diplomacy games. Our approach achieved a 39% improvement over the zero-shot baseline in lying F1 without any training.

Undergraduate Thesis

3. **Inverse Neural Rendering for Explainable 3D Perception**   *Princeton University, 2024*
   Tanushree Banerjee. *Advisor: Prof. Felix Heide*   ✎ Thesis Report

   This thesis explores unlocking explainable 3D perception via Inverse Neural Rendering. *Part I* proposes and evaluates a novel take on 3D multi-object tracking, while *Part II* proposes recasting 3D object detection as an inverse generation problem.

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[1]Object Detection-Variational Auto-Encoder

Independent Work Reports

4. **Reducing Object Hallucination in Visual Question Answering** *Princeton University, Spring 2023*
Tanushree Banerjee. *Advisor: Prof. Olga Russakovsky* ☍ Report

This paper proposes several approaches to identify questions not related to an image to prevent object hallucination in VQA models. The best approach achieved an improvement of 40% over the random baseline.

5. **Bias in Skin Lesion Classification** *Princeton University, Spring 2022*
Tanushree Banerjee. *Advisor: Prof. Olga Russakovsky* ☍ Report

This paper analyzes the bias in a model against underrepresented skin tones in the training data set on skin lesion classification.

SELECTED AWARDS AND ACHIEVEMENTS

- **Outstanding Computer Science Senior Thesis Prize** for my senior thesis, *Inverse Neural Rendering for Explainable 3D Perception*, advised by Prof. Felix Heide. One of 6 in 216 in the graduating class of the CS Dept. to receive the award (2024).

- **FitzRandolph Gate Award** for *Inverse Neural Rendering for Explainable Tracking* at Princeton Research Day (2024).

- Nominated for the **CRA Outstanding Undergraduate Research Award** by the CS Department at Princeton for my research contributions to the paper *Bootstrapping Reasoning for Lie Detection with Self-Generated Feedback*, advised by Prof. Karthik Narasimhan (2023).

TEACHING AND ACADEMIC SERVICE

Undergraduate Course Assistant: Independent Work Seminar *Spring 2024*
I held office hours for students in the seminar on *AI for Engineering and Physics* taught by Prof. Ryan Adams, helping them debug their code and advising them on their independent work projects for the semester.

Princeton AI4ALL Research Instructor *Summer 2022*
Taught AI technology and policy to 11th-grade students from underrepresented groups. Led NLP workshops and developed coding tutorials and lectures in preparation for an NLP-based capstone project. I also organized guest lectures given by Princeton faculty.

CSML Undergraduate Student Ambassador *Fall 2023 - Spring 2024*
Participated in CSML faculty recruitment interviews and helped organize CSML student social events.

SELECTED COURSE PROJECTS

- **[Re] METRA: Scalable Unsupervised RL with Metric-Aware Abstraction** *Reinforcement Learning, Spring 2024*
Tanushree Banerjee*, Tao Zhong*, Tyler Benson*. Advisors: Prof. Benjamin Eysenbach, Prof. Mengdi Wang ☍ Report

In this reproduction study, we validate the claims of Park et al., 2024, who propose a novel unsupervised RL objective that learns diverse, useful behaviors and a compact latent space that can zero-shot solve various downstream tasks.

- **Counterfactual Analysis for Spoken Dialogue Summarization** *Fundamentals of Deep Learning, Fall 2023*
Tanushree Banerjee*, Kiyosu Maeda*. Advisor: Prof. Sanjeev Arora ☍ Report

We investigate the effect of errors in speaker diarization and speech recognition on an LLM's summarization performance via counterfactual analysis, *i.e.* automatically injecting speaker diarization or speech recognition errors into spoken dialogue.

- **Towards Efficient Frame Sampling Strategies for Video Action Recognition** *Computer Vision, Spring 2023*
Tanushree Banerjee*, Ameya Vaidya*, Brian Lou*. Advisor: Prof. Olga Russakovsky ☍ Report

We propose and evaluate two dataset and model-agnostic frame sampling strategies for computationally efficient video action recognition: one based on the norm of the optical flow of frames and the other based on the number of objects in frames.

- **What Makes In-Context Learning Work On Generative QA Tasks?** *Understanding Large Language Models, Fall 2022*
Tanushree Banerjee*, Simon Park*, Beiqi Zou*. Advisor: Prof. Danqi Chen ☍ Report

We empirically analyze what aspects of the in-context demonstrations contribute to improvements in downstream task performance, extending the work of Min et al., 2022 to multiple choice and classification tasks.

- **[Re] Double-Hard Debias: Tailoring Word Embeddings for Gender Bias Mitigation** *NLP, Spring 2022*
Tanushree Banerjee*, Jessica Ereyi*, Kevin Castro*. Advisors: Prof. Danqi Chen, Prof. Karthik Narasimhan ☍ Report

We reproduce the results of Wang et al., 2020 to reduce the gender bias present in pre-trained word embeddings and evaluate generalization to non-English languages by evaluating their method on Spanish GloVe word embeddings.

OTHER WORK EXPERIENCE

Software Engineering Intern | Nautilus Software Technologies *December 2020 - January 2021*
Recreated the classic code-breaking game *Mastermind* in chat-bot format on Facebook Messenger using JavaScript. Collaborated in a team to present the project's progress to other student interns. Advised by Prof. Chee Wei Tan.

REFERENCES

- **Prof. Felix Heide**, Assistant Professor, Princeton University fheide@cs.princeton.edu
- **Prof. Karthik Narasimhan**, Associate Professor, Princeton University karthikn@cs.princeton.edu
- **Prof. Olga Russakovsky**, Associate Professor, Princeton University olgarus@cs.princeton.edu