

# 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 *Nature Machine Intelligence*, for which I received the Outstanding CS Senior Thesis Prize.
- Extending my thesis work, my current project, “*OD-VAE<sup>1</sup>: 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 ~ 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 *Nature Machine Intelligence*

Julian Ost\*, Tanushree Banerjee\*, Mario Bijelic, Felix Heide [🔗 Project Page](#) | [Paper](#) | [NMI Submission](#) | [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 *Nature Machine Intelligence*.

#### 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.

<sup>1</sup>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
- **Prof. Karthik Narasimhan**, Associate Professor, Princeton University
- **Prof. Olga Russakovsky**, Associate Professor, Princeton University

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