# Learning From Demonstration

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Github Link: https://github.com/Gitarisd/LearningFromDemonstration.git

# 1. Introduction

The field of artificial intelligence (AI) is rapidly evolving, particularly in how machines learn to interact with their environments. One innovative method is Learning from Demonstration (LfD) — a technique where AI systems learn tasks by observing demonstrations rather than being explicitly programmed or trained via trial and error. This project explores the use of Inverse Reinforcement Learning (IRL) within LfD, supported by generative models for scene creation and transformer-based object detection to simulate decision-making in autonomous systems.

# 2. Problem Definition

Our project addresses the challenge of enabling AI models to learn how to generate their own training data and detect objects in a way that mimics human perception. The goal is to create a system capable of understanding visual environments and making navigation decisions, similar to how a human would observe, interpret, and act based on their surroundings.

# 5. Project Implementation

# 5.1 Environment Setup

- Installed Python libraries: diffusers, transformers, torch, etc.  
- Enabled GPU-based computation for efficient processing.  
- Integrated image generation and object detection capabilities.

# 5.2 Execution Flow

The complete workflow follows a structured pipeline:  
1. Scene Generation (via Stable Diffusion)  
2. Object Detection (via DETR model)  
3. Navigation Decision based on object analysis

# 5.3 Key Modules

- Dependencies Imported: For model loading, image I/O, and GPU operations.  
- GPU Check: Ensures CUDA availability; raises an error if not.  
- Image Generation: Generates and stores visual scenes from user prompts.  
- Object Detection: Uses DETR (Detection Transformer) to annotate objects.  
- Navigation Logic: Interprets object labels to determine safe paths or evasive maneuvers.  
- Display: Presents the final output with annotations.

# 6. Results

The project successfully simulates an autonomous vision system that:  
- Creates realistic scenes from prompts.  
- Detects and labels relevant environmental elements.  
- Makes decisions based on scene understanding (e.g., avoiding cars or pedestrians).  
  
Although effective, the current model's image resolution and generation speed can be further optimized for real-time applications.

# 7. Conclusion

This project showcases how Learning from Demonstration can be enhanced through Inverse Reinforcement Learning and Deep Generative Models. By integrating Stable Diffusion and DETR, we simulate a visual decision-making system that mimics human-like reasoning from demonstrations. Future work includes improving generation quality and real-time detection performance.

# 8.Work Division Table

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| --- | --- | --- |
| **Sahil Amin** | **Cheick Moctar Traore** | **Ferid Beraa Çoruh** |
| Future of LfD | Deep Generative Models in LfD | Introduction to LfD,Created the presentation and Report |
| What is a Generative Model | Diffusion Models | A Guide for LfD, Created the presentation and Report |
| Reverse Diffusion | Diffusion Models (Detailed) | Understanding Generative Models, Created the presentation and Report |
| Markov Chain | Denoise Process, Created the presentation | Started the implementation of the project (1st release, CPU based generative AI), Created the Report |
| - | - | İmproving the project, (2nd release, GPU based generative AI and a primitive way to detect objects) Created the Presentation and Report |
| Summary of LfD | Summary of Deep Generative Models | Finalised the project (3rd release, GPU based Generative AI and object detection and annotation with DETR), Created the Presentation and Report |