# Weekly Report

Ferid Beraa Çoruh

Sahil Amin

Cheick Moctar Traore

## 1. Introduction to Generative Models

Generative models represent a class of artificial intelligence systems that learn to understand patterns in data and use this understanding to generate new data instances that resemble the original distribution. These models are designed not just to classify or predict, but to create—from images and audio to text and code.

A generative model learns the underlying structure of a dataset and can produce novel examples from the learned distribution. For example, given thousands of cat images, a generative model can synthesize a new, realistic image of a cat that doesn’t exist in the dataset.

Popular examples include ChatGPT for text, DALL·E for image generation, DeepFakes for video manipulation, and AI music systems that compose melodies based on learned patterns.

These tools offer vast potential but also raise ethical concerns, especially regarding misinformation and authenticity. The future of generative AI includes enhanced tools, stricter regulations, and the possibility of creating complete multimedia experiences.

## 2. Diffusion Models: A Modern Generative Paradigm

Diffusion models are a novel class of generative models that create data by learning to reverse a gradual noising process. They are known for their stability and high fidelity in generating images, audio, and more.

The process involves two stages: a forward diffusion process where noise is progressively added to data, and a reverse process where the model learns to remove the noise step-by-step to reconstruct data from pure noise.

These models often use U-Net architectures with attention mechanisms and are typically trained on large datasets. Applications range from image and audio synthesis to robotics and simulation tasks. They have shown superior results compared to traditional generative approaches like GANs and VAEs.

## 3. Learning from Demonstration (LfD): A Step-by-Step Framework

Learning from Demonstration (LfD) allows agents to learn tasks by observing expert behavior instead of being explicitly programmed. It is particularly useful in robotics where defining reward functions is challenging.

The process includes six main phases: task design, demonstration collection, data processing, learning, execution, and iterative refinement. Demonstrations can be collected through kinesthetic teaching, teleoperation, or vision-based systems.

Models such as behavioral cloning, inverse reinforcement learning, and adversarial imitation are used to learn policies. Recently, latent variable models like VAEs and diffusion-based approaches have also been applied to encode and reproduce expert behaviors.

After training, the agent is deployed in real or simulated environments, and its performance is evaluated and refined through additional demonstrations or synthetic data generation.

## 4. Conclusion

Generative models, diffusion models, and learning from demonstration represent three pillars of modern AI research. Together, they unlock vast potential—from creating lifelike media to teaching robots complex tasks. With continued innovation and responsible design, these technologies are poised to reshape industries and human-computer interaction alike.