# Lab 1: Generative AI Concepts and Project Ideas

## What is Generative AI?

**Generative AI** is a type of artificial intelligence that can create new and original content, such as text, images, audio, and synthetic data. These models work by learning the underlying patterns and structures from large amounts of training data and then using that knowledge to generate new outputs with similar characteristics.

## 1. Comparison of Generative AI Models

### Four Types of Generative AI Models

1. **Generative Adversarial Networks (GANs)**: GANs consist of two competing neural networks: a **Generator** that creates new data and a **Discriminator** that tries to distinguish between real and fake data. They challenge each other to improve, with the generator getting better at making realistic content and the discriminator getting better at spotting fakes.
   * **Best for**: Creating highly realistic images, videos, and art.
2. **Variational Autoencoders (VAEs)**: VAEs are excellent at learning a compressed representation of input data. They consist of an **encoder** that compresses the data and a **decoder** that reconstructs it. This allows them to generate new data with slight variations.
   * **Best for**: Image generation, data compression, and creating new designs.
3. **Transformer-based Models**: These models (like GPT) use an "attention" mechanism to weigh the importance of different words in a sequence, allowing them to understand context and generate coherent text, code, or music.
   * **Best for**: Text generation, translation, summarization, and code generation.
4. **Diffusion Models**: These models work by adding "noise" to an image until it's unrecognizable and then learning how to reverse the process. By starting with random noise and carefully removing it, they can generate incredibly detailed and high-quality images.
   * **Best for**: High-fidelity image and video generation.

### Open-Source vs. Closed-Source Models

| **Feature** | **Open-Source Models** | **Closed-Source Models** |
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| **Accessibility** | Code is publicly available. Anyone can view, modify, and use them. | Code is proprietary. Access is typically via a paid API. |
| **Customization** | **High**. Users can fine-tune the model on their own datasets. | **Low to None**. Customization is limited to what the provider allows. |
| **Cost** | Free to use, but requires significant computational resources. | Often has a free tier but becomes costly with increased usage. |
| **Transparency** | **High**. Researchers can scrutinize the model's inner workings. | **Low**. The model operates as a "black box." |
| **Support** | Community-driven. The user is responsible for maintenance. | Professional customer support and maintenance handled by the provider. |
| **Examples** | Llama 3, Stable Diffusion, Mistral. | GPT-4, Claude 3, Gemini. |

## 2. Generative AI Graduation Project Ideas

### Idea 1: AI-Powered Historical Learning Platform

* **Concept**: An interactive platform where students can "talk" to historical figures.
* **Generative AI Application**: Use a fine-tuned language model trained on historical documents to generate responses in character.
* **Features**: Chat interface, source viewer, and a GAN-generated avatar for the historical figure.

### Idea 2: Automated Video Game Asset Generator

* **Concept**: A tool for game developers that automatically generates unique game assets from text prompts or sketches.
* **Generative AI Application**: Use diffusion models or GANs trained on a dataset of game assets.
* **Features**: Text-to-image/sketch-to-image generation, style controls, and export options for game engines.

### Idea 3: Personalized Music Composition Assistant

* **Concept**: An AI assistant that helps musicians compose original music based on a melody, chords, or a mood.
* **Generative AI Application**: Utilize a transformer-based model trained on a large corpus of MIDI music files.
* **Features**: Music generation from text/MIDI, genre/instrument selection, and an editor for the output.