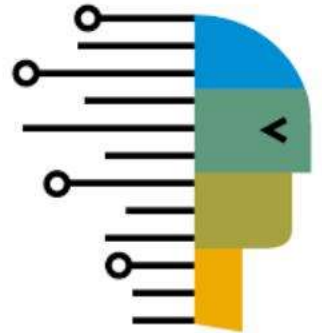# INT426
Generative Artificial Intelligent

Lecture 1

Generative Artificial Intelligence (Generative AI)

Refers to a class of AI models and algorithms that are designed to generate new, often realistic, data samples. These models are capable of creating content such as images, text, audio, and more. **Here are some fundamentals of Generative AI:**

1.Generative Models:

- **Definition:** Generative models are algorithms that learn the underlying patterns and structures of a dataset to generate new, similar data.
- **Types:** Popular generative models include Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), and autoregressive models like Transformers.

i. Variational Autoencoders (VAEs):

- **Working Principle:** VAEs are probabilistic generative models that aim to learn the latent space representation of data. They consist of an encoder and a decoder network.
- **Application:** VAEs are commonly used for generating new data samples, image synthesis, and data compression.

ii. Generative Adversarial Networks (GANs):

- **Working Principle:** GANs consist of a generator and a discriminator network. The generator tries to create realistic data, and the discriminator tries to distinguish between real and generated data.
- **Application:** GANs are widely used for image and video synthesis, style transfer, and creating realistic-looking data.

iii. Autoregressive Models:
- **Working Principle:** Autoregressive models predict the probability distribution of the next element in a sequence given the previous elements.
- **Example:** Transformers, originally designed for natural language processing, are autoregressive models that have been successful in various generative tasks.

iv. Natural Language Processing (NLP) Applications:
- **Text Generation:** Generative models are used to generate human-like text, which can be applied to tasks like language translation, content creation, and chatbot responses.

v. Image Generation:
- **Deep Dream:** Generative models can be used to enhance and modify images in artistic ways, as demonstrated by Google's Deep Dream project.

vi. Conditional Generation:
- **Conditional GANs:** These models allow for the generation of data based on specific conditions or input information, leading to more controlled and targeted generation.

vii. Ethical Considerations:

•**Bias and Fairness:** Generative models can inherit biases from the training data, leading to ethical concerns. Careful consideration and evaluation are necessary to ensure fairness.

ix. Training Challenges:

•**Mode Collapse:** GANs may suffer from mode collapse, where they generate a limited variety of outputs. Techniques like adding diversity-promoting terms can help alleviate this issue.

Generative AI has applications across various domains, from entertainment and art to healthcare and scientific research. As the field continues to evolve, researchers are exploring new architectures and techniques to enhance the capabilities and robustness of generative models.

Applications of Gen AI

❑ **Image Generation and Synthesis:**

❑ **Style Transfer:**

❑ **Text Generation:**

❑ **Voice and Audio Synthesis:**

❑ **Data Augmentation:**

❑ **Video Generation and Editing:**

❑ **Drug Discovery:**

❑ **Anomaly Detection:**

❑ **Medical Image Synthesis:**

❑ **Simulation and Gaming:**

❑ **Interior Design and Fashion:**

❑ **Deepfake Detection:**

❑ **Natural Language Translation:**

❑ **Creativity and Artistic Expression:**
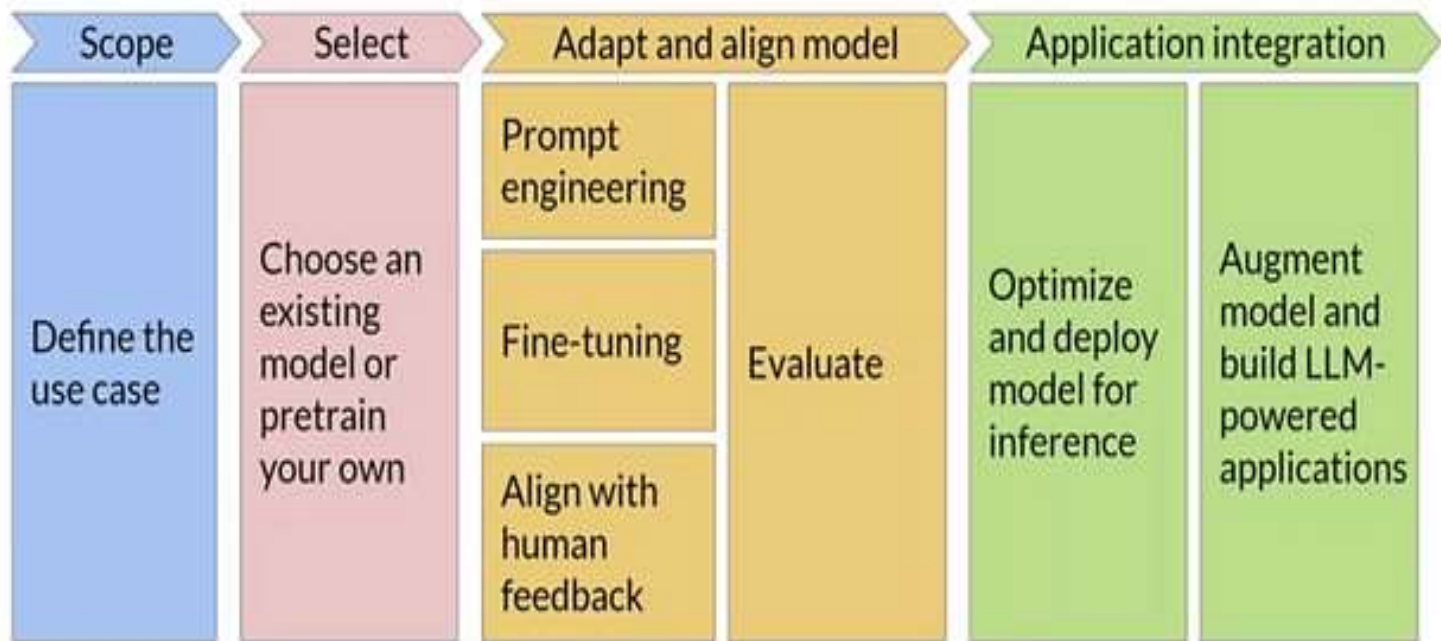
Lifecycle of a Gen AI project

The basic Project lifecycle of a Generative AI deals with 4 core prtinciples

Scope : define the problem statement you want to solve using LLM to determine how it should word

Select : Choose a model or pretrain your — existing one or train from scratch

Adapt and align model : develop and align model to design with Prompts, fine tune and evaluate for best output

Application integration : optimize and deploy models for inference, build LLM powered applications

Scope	Select	Adapt and align model		Application integration	
Define the use case	Choose an existing model or pretrain your own	Prompt engineering / Fine-tuning / Align with human feedback	Evaluate	Optimize and deploy model for inference	Augment model and build LLM-powered applications

Key generative AI applications

While chatbots like ChatGPT and Google Bard have quickly risen in popularity, there are other generative AI use cases that are becoming prominent. Here are some of the most significant applications of generative AI that are being widely implemented today.
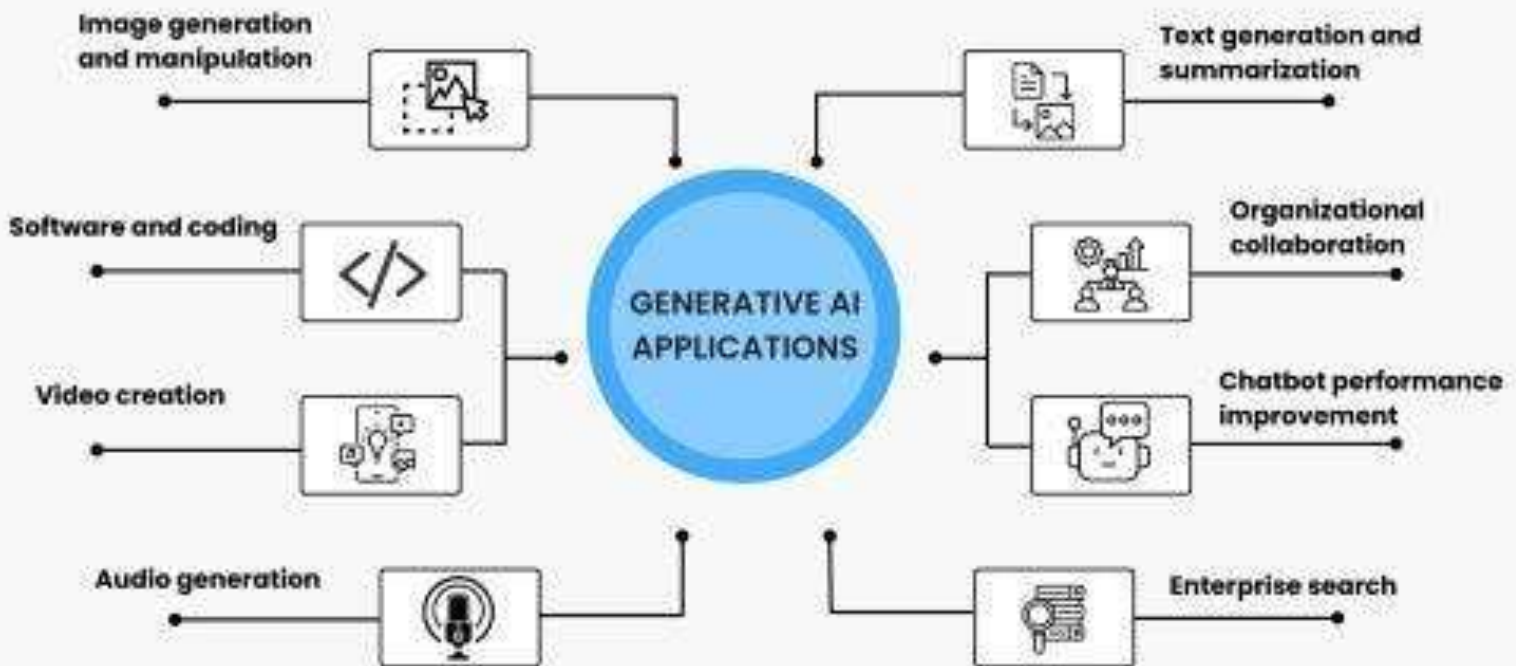
1. Image generation and manipulation

One of the most common use cases of generative AI is image generation, which is typically text-to-image conversion. Here, users can enter a textual prompt describing what type of image they want, and the AI tool will process the input to generate realistic images. When using such generative AI applications, users can specify subjects, styles, settings, locations, or objects to generate the exact images as per their requirements.

Apart from text-to-image AI applications that generate realistic images or 3D models, there are tools that facilitate image enhancement and manipulation, letting users modify existing images. Some of the major functions such tools can perform are:

i. Semantic image-to-image translation - Creating realistic versions of an image based on semantic photos or sketches.

ii. Image completion - Generating missing portions of an image, such as filling in backgrounds with objects, people, or other elements. AI tools with this capability can also fix torn photographs or fill in missing pixels.

iii. Image super-resolution - Enhancing the resolution of images without any pixel-tear or other aspects that can cause loss of detail.

iv. Image manipulation - Altering or modifying existing images. For example, users can transform an external element of an image, like its color, lighting, form, or style, while maintaining its original elements.

2. Software and coding

Here's how applications of generative AI are impacting software and coding:

i. Code generation - One of generative AI's most prominent applications in software development is code generation. This involves training AI models on vast repositories of existing code, allowing them to generate code functions, snippets, or even entire programs based on prompted requirements. Code generation through generative AI applications proves invaluable in accelerating software development by automating repetitive coding tasks, and letting developers focus on problem-solving and higher-level design.

ii. Code completion - Generative AI can also boost coding efficiency by offering intelligent code completion and suggestions. IDEs (integrated development environments) can leverage generative AI models to predict future code lines that developers may write based on the context, expediting the coding process and reducing the possibility of error.

iii. Natural language interfaces for coding - Generative AI also enables natural language interfaces to code, allowing a developer to interact with software systems through human language instead of programming languages. Many organizations implement this through generative AI applications to bridge the gap between domain experts and developers. In turn, this helps to save resources on hiring experts to tackle software systems, by simply letting developers do it.

iv. Automated testing - Generative AI-powered tools can automate test case and scenario generation which is generally quite time-consuming during a software development lifecycle. Such tools analyze code and its probable execution paths to generate comprehensive test suits, thus enhancing code coverage and allowing developers to identify potential bottlenecks early on.

3. Video creation

Generative AI applications also simplify video production through highly flexible and efficient features that generate high-quality video content. Using generative AI models, applications can automate tedious tasks like video compositions, and animations, adding special effects, editing video snippets, etc. Like image generation, generative AI tools for video production can create videos from scratch, which can be used for enhancing video resolution, video manipulation, and completion.

Video generation AI tools can also perform:

i. Video style transfers - AI video tools with this feature can generate new videos that follow the same style as another reference image or video.

ii. Video predictions - AI tools with this capability can predict the next frames in a video, using generative AI models. Such tools understand a video's spatial and temporal elements, producing future sequences based on that data.

4. Audio generation

Another one of the widely implemented generative AI use cases is audio generation, where generative AI is used to expedite the process of creating audio. There are three major use cases under this category, which are:

i. TTS generators - GAN-based TTS (text-to-speech) generators can generate realistic speech audio from a user's textual prompts. TTS AI tools use extensive text and speech data to train machine learning models, which can then be tweaked to create high-quality audio from text. Moreover, such tools are often used in applications like speech-based interfaces, speech-enabled devices, and assistive technologies.

ii. Creating music - Making music has proven to be one of the most common generative AI applications today. Generative AI models can easily produce new music pieces and generate complete audio by learning the styles and patterns of the music a user inputs.

iii. STS conversions - STS (speech-to-speech) conversions involve generative AI creating new speech or voices via existing audio files, which is commonly implemented in audio-related AI applications. STS conversions have become massively popular in the gaming and filming industries, where professionals use AI tools with STS conversion capabilities to seamlessly create voiceovers.

5. Text generation and summarization

ChatGPT is one of the best examples of text-generative AI tools that creates and summarizes textual content from user prompts. Such tools utilize generative AI models and are trained on large data sets to generate updated and authentic content. Listed below are some of the most common use cases of generative AI applications used for text generation and summarization:

i. **Content creation -** Generative AI models are extremely helpful in creating various types of written content, from blogs to marketing posts and social media copies. Plus, generative AI applications like ChatGPT also speed up the writing process by generating ideas, quotes, content outlines, etc.

ii. Language translation - AI developers can also fine-tune generative AI models for translation tasks, where the models can analyze texts in one language and provide accurate translations in another.

iii. Virtual assistants and chatbots - Generative AI powers virtual assistants and chatbots, letting them generate contextually relevant and natural responses in real-time user conversations. Creating chatbots like ChatGPT has become one of the biggest generative AI use cases. Such chatbots enhance user engagement and help businesses offer personalized assistance.

iv. Content aggregation - In addition to text creation, generative AI tools can automatically summarize bulk texts like research papers, news articles, blogs, and lengthy emails to help users get a concise overview of the content. This also includes document summarization that helps businesses streamline document-related tasks using generative AI models. Automatic report generation - In business intelligence and data analysis, generative AI can help summarize complex datasets and generate detailed reports. This simplifies decision-making and allows concerned stakeholders to better understand trends, patterns, and insights.

Business Applications:

Product Design and Innovation:

Generative AI can assist in product design by generating and iterating on design concepts. This is particularly valuable in industries such as automotive and aerospace for creating efficient and novel designs.

Content Creation and Marketing:

Businesses use generative models to automate content creation for marketing purposes. This includes generating social media posts, writing product descriptions, and creating personalized advertising content.

Supply Chain Optimization:

Generative AI helps optimize supply chain processes by forecasting demand, predicting potential disruptions, and suggesting more efficient routes for logistics.

Financial Modeling and Analysis:

In finance, generative models are employed for risk analysis, portfolio optimization, and generating synthetic financial data for testing and simulation purposes.

Customer Service Chatbots:

Generative models power natural language processing in chatbots, providing more human-like and context-aware interactions in customer service applications.

Fraud Detection:

Generative AI aids in detecting anomalies and potential fraud by learning normal patterns in financial transactions and identifying deviations from these patterns.

Human Resources:

HR departments use generative models for tasks such as resume screening, candidate matching, and even drafting initial communication with job applicants.

Personalized Recommendations:

Generative models analyze user behavior and preferences to generate personalized recommendations for products, services, and content, improving user engagement and satisfaction.

Healthcare Diagnostics and Imaging:

In healthcare, generative models contribute to medical image analysis, diagnostics, and even drug discovery. They generate synthetic medical images for training AI models and can assist in predicting disease outcomes.

Societal Impact:

Art and Creativity:

Generative AI has found applications in the creation of art, music, and literature, blurring the lines between human and machine creativity. Artists use these tools to explore new forms of expression.

Accessibility:

Generative models are used to create tools and applications that enhance accessibility for individuals with disabilities. This includes generating alternative text for images and providing voice-controlled interfaces.

Education:

In education, generative models can be used for content creation, automated grading, and even generating personalized learning materials tailored to individual students' needs.

Language Translation:

Generative models, especially language models like GPT, have improved language translation services, making communication across different languages more accessible.

Disaster Response and Planning:

Generative models can assist in predicting and planning for natural disasters by analyzing historical data and simulating potential scenarios, aiding in disaster response and preparedness.

Climate Modeling:

Generative AI is used in climate modeling to simulate and predict climate patterns, contributing to research on climate change and its potential impacts.

Crisis Communication:

In times of crisis, generative models can be used to automate and personalize communication, providing real-time updates and information to the public.

Legal and Compliance:

Generative AI is applied in legal research, contract generation, and compliance analysis, automating tasks and improving the efficiency of legal processes.

What is the different between GPT and Search Engine?

	Chat GPT	Search Engine
Purpose	Language model for generating text and conversation	Tool for finding and accessing information on the web
Function	Generates responses to prompts in natural language	Crawls and indexes web pages to provide search results
Training	Trained on vast amounts of text data	N/A (not applicable)
Input	Text prompts	Text queries
Output	Text responses	List of relevant web pages
Use cases	Chatbots, virtual assistants, content generation	Information retrieval, research, analysis
Limitations	Limited to generating text based on input	Limited to indexing and ranking web pages

What is Responsible AI?

Importance of Responsible AI in Business

Responsible AI holds an important place in the business world as AI becomes more mainstream. Here's how:

Trust Building: Responsible AI helps companies gain the trust of customers and stakeholders. This trust can lead to increased brand loyalty and a better reputation.

Mitigating the Risk: Utilizing Responsible AI reduces legal and reputational damage chances. It helps in avoiding biases and ensures compliance with data privacy laws.

Enhanced Decision-Making: Fair and unbiased insights generated by Responsible AI contribute to better business decisions. This leads to more effective strategies.

Innovation and Sustainability: Responsible AI practices encourage innovation within ethical limits. Companies prioritizing Responsible AI are likely to achieve long-term success.

What is Ethical AI?

Importance of Ethical AI in business

Ethical concern has garnered attention from industry leaders and is becoming increasingly relevant as AI evolves. That's why ethical AI has become important for several reasons:

Public Safety: Ethical AI is crucial for ensuring public safety. For example, self-driving cars require ethical algorithms to make emergency decisions.

Fraud Prevention: Ethical AI safeguards against misuse, as AI can also be weaponized for scams. For instance, AI was used in a $243,000 scam in 2019 by mimicking a CEO's voice.

Eliminating Bias: Addressing unconscious bias in AI is essential. Faulty algorithms can perpetuate harmful gender, racial, and age-related stereotypes.

Prominent Concern: Industry leaders like Bill Gates stressed the need to assess AI risks to avoid future crises.

Key Differences between Responsible AI and Ethical AI

Criteria	Responsible AI	Ethical AI
Goal	Aims to create AI for safe, ethical, and transparent interactions with users.	Aims to create AI that makes morally sound decisions and treats all users fairly.
Scope	Can be applied to various sectors, from healthcare to finance.	Addresses broader societal values like fairness, accountability, and transparency.
Implementation	Involves a multi-disciplinary approach, including legal experts for governance.	Also requires a multi-disciplinary team, but with more focus on ethics and moral awareness
User Experience	Strives for a balanced experience that is both efficient and ethical.	Prioritizes a fair and unbiased experience, potentially at the expense of speed.

THANK YOU