

# **Generative AI: Introduction and Applications**

## **Module 1: Introduction and Capabilities of Generative AI**

### **Reading 1: Specialization Overview**

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This course is part of multiple programs:

1. Generative AI Fundamentals Specialization
2. IBM Applied AI Professional Certificate
3. Generative AI for Data Scientists Specialization
4. Generative AI for Software Developers Specialization
5. Generative AI for Data Analysts Specialization (Coming Soon)
6. Generative AI for Data Engineers Specialization (Coming Soon)
7. Generative AI for Cybersecurity Professionals Specialization (Coming Soon)
8. Generative AI for Customer Support Professionals Specialization (Coming Soon)
9. Generative AI for Project Managers Specialization (Coming Soon)
10. Generative AI for Product Managers Specialization (Coming Soon)
11. Generative AI for BI Analysts Specialization (Coming Soon)

Feel free to read below to learn more about these programs. Information about programs listed as "Coming Soon" will be added as they are released.

#### **1. Generative AI Fundamentals specialization**

This specialization provides a comprehensive understanding of the fundamental concepts, models, tools, and applications of Generative AI, empowering you to apply and unlock its possibilities.

In this specialization, you will explore the capabilities and applications of generative AI. You will learn about the building blocks and foundation models of generative AI. You will explore generative AI tools and platforms for diverse use cases. Additionally, you will learn about prompt engineering, enabling you to optimize the outcomes produced by generative AI tools. Further, you will gain an understanding of the ethical implications of generative AI in relation to data privacy, security, the workforce, and the environment. Finally, the specialization will help to recognize the potential career implications and opportunities through generative AI.

This specialization is intended for:

- Working professionals who want to enhance their careers by leveraging the power of generative AI
- Technophiles who wish to stay updated with the advancements in AI
- Individuals seeking an introduction to generative AI and a seamless experience through the world of Generative AI
- Managers and executives who want to leverage generative AI in their organizations
- Students who wish to graduate with practical AI skills that will enhance their job-readiness

## Specialization Content

The [Generative AI Fundamentals Specialization](#) comprises five short courses. Each course requires 4-6 hours of learners' engagement time.

- Generative AI: Introduction and Applications
- Generative AI: Prompt Engineering Basics
- Generative AI: Foundation Models and Platforms
- Generative AI: Impact, Considerations, and Ethical Issues
- Generative AI: Business Transformation and Career Growth

## 2. IBM Applied AI Professional Certificate

This professional certificate gives you a firm understanding of AI technology, its applications, and its use cases. You will also explore the capabilities and applications of generative AI. Additionally, you will learn about prompt engineering, enabling you to optimize the outcomes produced by generative AI tools.

You will become familiar with concepts and tools like machine learning, data science, natural language processing, image classification, image processing, IBM Watson AI services, OpenCV, and APIs. Even if you have no programming background, through this Professional Certificate, you will learn practical Python skills to design, build, and deploy AI applications on the web. The courses will also enable you to apply pre-built AI smarts to your products and solutions.

### Certificate Content

The [Applied AI Professional Certificate](#) includes the following courses:

- Introduction to Artificial Intelligence (AI)
- Generative AI: Introduction and Applications
- Generative AI: Prompt Engineering Basics
- Building AI Powered Chatbots Without Programming
- Python for Data Science, AI & Development
- Developing AI Applications with Python and Flask
- Building AI Applications with Watson APIs

## 3. Generative AI for Data Scientists Specialization

This specialization is designed to support individuals to kickstart their journey into applying generative AI in the field of data science. It caters to both current professionals and those aspiring to enter this field, encompassing roles such as data scientists, data analysts, data architects, engineers, and even individuals with a passion for working with data. In this specialization, you will understand the basics of generative AI and its real-world applications, learn about generative AI prompts engineering concepts and approaches, and explore commonly used prompt engineering tools, including IBM Watsonx, Prompt Lab, Spellbook, and Dust. Finally, you will also learn to apply generative AI tools and techniques throughout the data science methodology for data augmentation, data generation, feature engineering, model development, model refinement, visualizations, and insights.

### Specialization Content

The [Generative AI for Data Scientists Specialization](#) includes the following courses:

- Generative AI: Introduction and Applications
- Generative AI: Prompt Engineering Basics
- Generative AI: Elevate your Data Science Career

## 4. Generative AI for Software Developers Specialization

This specialization is designed for anyone interested in leveraging the power of generative AI in software development. This specialization is suitable for both existing and aspiring web developers, mobile app developers, front-end developers, back-end developers, full-stack developers, DevOps professionals, and Site Reliability Engineers (SREs). You will learn the basics of generative AI including its uses, models, and tools for text, code, image, audio, and video generation, and explore various prompt engineering approaches and prompt engineering tools including IBM Watsonx, Prompt Lab, Spellbook, and Dust.

You will also boost your programming skills by learning to leverage generative AI to design, develop, translate, test, document, and launch applications and their code, and gain hands-on experience using generative AI tools and models, such as GitHub Co-pilot, Open AI ChatGPT, and Google Gemini, for various software engineering tasks.

### Specialization Content

The [Generative AI for Software Developers Specialization](#) includes the following courses:

- Generative AI: Introduction and Applications
- Generative AI: Prompt Engineering Basics
- Generative AI: Elevate your Software Development Career

## Reading 2: Course Overview

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Generative artificial intelligence (AI) is all set to transform the future of our society, impacting every facet of our work and daily lives.

This course is your first step toward understanding the capabilities of generative AI powered by different models, including large language models (LLMs). Whether you are an enthusiast, a student, or a professional, this course provides a foundation to use generative AI for diverse use cases.

In this course, you will learn about the fundamentals and evolution of generative AI. You will explore the capabilities of generative AI in different domains, including text, image, audio, video, virtual worlds, code, and data. You will understand the applications of Generative AI across different sectors and industries. You will learn about the capabilities and features of common generative AI models and tools, such as GPT, DALL-E, Stable Diffusion, and Synthesia.

Hands-on labs, included in the course, provide an opportunity to explore the use cases of generative AI through IBM Generative AI Classroom and popular tools like ChatGPT. You will also hear from the practitioners about the capabilities, applications, and tools of Generative AI.

After completing this course, you will be able to:

- Describe generative AI and distinguish it from discriminative AI.
- Describe the capabilities of generative AI and its use cases in the real world.
- Identify the applications of generative AI in different sectors and industries.

- Explore common generative AI models and tools for text, code, image, audio, and video generation.

## Course Content

This course is divided into three modules. It is recommended that you complete one module per week or at a pace that suits you - whether it's a few hours every day or completing the entire course over a weekend or even in one day.

### Week 1 - Module 1: Introduction and Capabilities of Generative AI

In this module, you will learn the fundamentals of generative AI and how it differs from discriminative AI. You will also explore the capabilities of generative AI for generating text, images, code, speech, and video in the real world.

### Week 2 - Module 2: Applications and Tools of Generative AI

In this module, you will learn about the applications and impact of generative AI in different sectors and industries, such as IT and DevOps, entertainment, education, finance, healthcare, and human resources. You will get an insight into how generative AI makes our work lives more efficient and successful.

You will get acquainted with the key capabilities and use cases of some commonly used tools for text, image, code, audio, video, and virtual world generation.

### Week 3 - Module 3: Course Quiz, Project, and Wrap-up

This module includes a graded quiz to test and reinforce your understanding of concepts covered in the course. It also offers a glossary to enhance your comprehension of generative AI-related terms. The module includes an optional project, which provides an opportunity to practice generating text, images, and code through generative AI. Finally, the module guides you about the next steps in your learning journey.

## Learning Resources

The course offers a variety of learning assets: videos, readings, hands-on labs, expert viewpoints, discussion prompts, and quizzes.

The **videos** and **readings** present the instruction, supported by **labs** with hands-on learning experiences.

**"Expert Viewpoints"** videos provide points of view from practitioners in the field to exhibit the real-world application of skills learned in this course.

Interactive learning is encouraged through **discussions** where you can meet and learn from your peers.

The **glossary** provides you with a reference list for all the specialized terms that have been used in the course, along with their definitions.

**Practice quizzes** at the end of each module test your understanding of what you learned, and the final **graded quiz** will assess your conceptual understanding of the course.

## Who should take this course?

This course is for all enthusiasts and practitioners curious about the rapidly developing field of generative AI and its capabilities across domains like text, image, code, audio, and video.

This course is for you if you are:

- An individual seeking an introduction to the field of generative AI.
- A professional who wants to improve your work by leveraging the power of generative AI.
- A manager or executive who wants to explore the use of generative AI in your organization.
- A student who wishes to graduate with practical generative AI skills to enhance your job readiness.

## Recommended Background

This course is relevant for anyone interested in exploring the field of generative AI and requires no specific prerequisites.

The course uses simple, easy-to-understand language to explain the critical concepts of generative AI without relying on technical jargon. The hands-on labs are based on commonly used tools that don't require any programming experience. There is no educational degree required either.

To derive maximum learning from this course, you only require active participation in and completion of the various learning engagements offered across the modules.

# Reading 3: History and Evolution of Generative AI

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## Objectives

After completing this reading, you will be able to:

- Describe the key developments in the field of generative AI in chronological order
- Explain the current scenario of generative AI

## Introduction

Generative artificial intelligence (AI) is a field that focuses on developing algorithms to create new content, such as text, images, music, and code. Generative AI models are trained on substantial datasets of existing content and learn to generate new content similar to the data they were trained on.

## History

The origin of generative AI origins can be traced back to the initial stages of artificial intelligence exploration. In the 1950s, researchers began to explore the use of computers to generate new data, such as text, images, and music. However, the computational power and data resources needed for these systems to flourish were not yet available.

One of the earliest instances of generative AI dates back to 1964 with the creation of the **ELIZA chatbot**. Operating on a rule-based system, ELIZA simulated conversations with users by generating responses based on received text. While not genuinely intelligent, ELIZA showcased the potential of generative AI for human-like communication.

During the 1980s and 1990s, hardware and software capabilities advanced considerably and facilitated the development of advanced generative AI models, including **neural networks**. Neural networks are inspired by the human brain and can learn intricate patterns in data. However, these early neural networks were computationally expensive to train and could only generate small amounts of content.

In the early 2000s, a significant breakthrough occurred in generative AI research with the advent of **deep learning**. Utilizing neural networks with multiple layers, deep learning models could be trained on extensive datasets to discern complex patterns, enabling the generation of new data that closely resembled human-created content. This breakthrough led to the development of innovative generative AI models, including generative adversarial networks (GANs) and variational autoencoders (VAEs).

GANs and VAEs excel at producing high-quality content that is often indistinguishable from content crafted by humans.

**GANs** operate by training two neural networks in opposition: a generator that creates new content and a discriminator that tries to differentiate between real and synthetic content. Eventually, the generator learns to craft content realistic enough to deceive the discriminator.

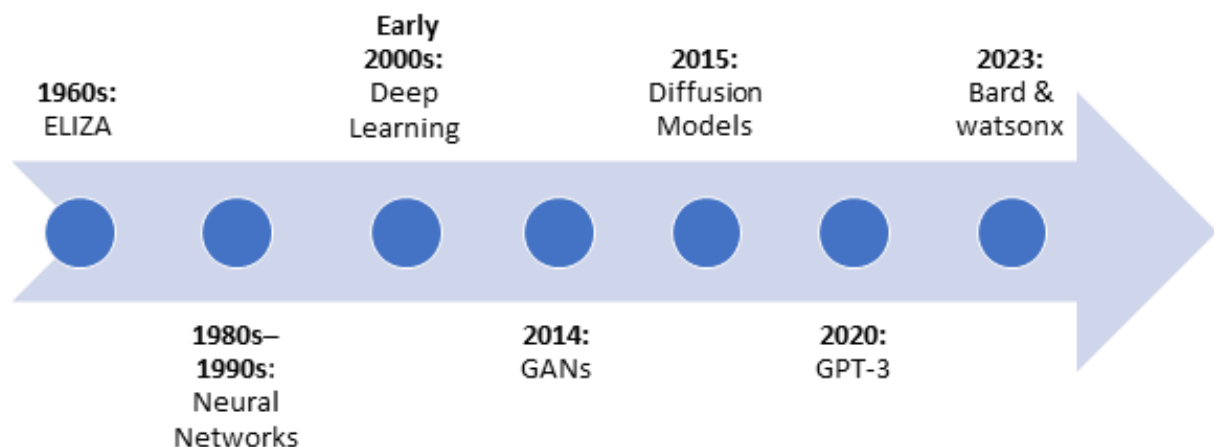
**VAEs** work by learning a latent space of the data they are trained on. The latent space is a representation of the data that captures the most essential features of the data. VAEs can generate new content by sampling from the latent space and decoding the latent code into the original data space.

In recent years, there has been a rapid explosion in the development of new generative AI models. These models can now generate a wide variety of content, including text, images, music, and code. Generative AI is also used in various applications, such as art, design, and healthcare.

One such instance is the development of **diffusion models** in 2015. Diffusion models work by gradually adding noise to a clean image until it is completely unrecognizable. They can then be reversed to gradually remove the noise and generate a new image. Diffusion models have been used to create high-quality images and text.

The next significant development is that of **large language models (LLMs)** like **GPT-3** and **Gemini** in 2020 and 2023, respectively. LLMs are trained on massive datasets of text and code, which allows them to generate realistic text, translate languages, write different kinds of creative content, and answer your questions in an informative way. 2023 was also when **watsonx**, a superior generative AI platform based on the cloud, was introduced by IBM. Watsonx can support multiple LLMs.

Here is a brief **timeline** of some of these milestones in the fascinating journey of generative AI:



### **1960s: ELIZA**

ELIZA, an early chatbot, showcased early attempts at simulating conversation.

### **1980s–1990s: Neural network development**

Researchers started developing more sophisticated generative AI models, including neural networks, capitalizing on advances in hardware and software.

### **Early 2000s: Deep learning**

Deep learning, a breakthrough in AI, gained prominence. Neural networks with multiple layers were employed for training on massive datasets.

### **2014: Generative adversarial networks (GANs)**

Introduced by Ian Goodfellow and his colleagues, GANs presented a revolutionary two-player neural network framework.

### **2015: Diffusion models**

The development of diffusion models brought a novel approach to image generation by gradually adding noise to a clean image.

### **2020: GPT-3**

OpenAI released GPT-3, a state-of-the-art language model, demonstrating impressive natural language understanding and generation capabilities.

### **2023: Gemini and watsonx**

Another large language model, Google's Gemini, and IBM's generative AI system, watsonx are introduced, further advancing the capabilities of generative AI.

These milestones represent an overview of the generative AI journey, capturing vital developments in natural language processing, image generation, and the underlying architectures that have shaped the field over the years.

## Current scenario

Generative AI is still a relatively young field, but it has already significantly impacted the world. Generative AI is being used to create new forms of art and entertainment, develop new medical treatments, and improve businesses' efficiency. As generative AI advances, its potential societal implications are expected to broaden significantly.

Presently, these are some of the specific instances highlighting the current applications of generative AI:

- **Art and entertainment:** Generative AI is being used to create new art forms, such as AI-generated paintings, music, and literature. Generative AI is also being used to develop new video games and other interactive experiences.
- **Medicine:** Generative AI is being used to develop new medical treatments, such as personalized cancer therapies and AI-powered drug discovery. Generative AI is also being used to develop new medical imaging tools and improve diagnosis and treatment accuracy.
- **Business:** Generative AI is being used to improve the efficiency of businesses by automating tasks such as customer service, marketing, and sales. Generative AI is also being used to develop new products and services.

Generative AI holds significant transformative potential across various facets of our lives. Using generative AI responsibly and ethically is essential, but it is also important to be excited about its possibilities.

## Summary

In this reading, you learned about the history of generative AI. You noted the key developments in chronological order. You learned about the contribution of each key development to the field of generative AI. Finally, you learned about the current scenario of generative AI.

## Reading 4: Hands-on-Lab: Generate Text using Generative AI

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In this lab, you will explore the capabilities of generative AI to generate text. You will use IBM's generative AI classroom lab, powered by many language models, to generate the desired output. The generative AI classroom environment allows you to learn and practice working with generative AI models without installing or configuring anything on your machine. It does not require you to create user accounts or sign up, as required when using ChatGPT or other platforms. This is a learning and familiarization tool, not a production tool. This tool lets you write and compare your prompts to generate desired text with real-time chat responses.

Skills Network Labs (SN Labs) is a virtual lab environment used in this course. Upon clicking the "Launch App" button below, your Username and Email will be passed to SN Labs and will be used in



strict accordance with IBM Skills Network Privacy policy, such as for communicating important information to enhance your learning experience.

In case you need to download the lab instructions click [HERE](#) to open in a new tab.

This course uses a third-party app, Hands-on-Lab: Generate Text using Generative AI, to enhance your learning experience. The app will reference basic information like your name, email, and Coursera ID.

## Reading 5: Lesson Summary

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Congratulations! You have completed this lesson.

At this point, you have learned about the fundamentals and evolution of Generative AI. You have identified the capabilities of Generative AI and explored their applications in the real world. You even gained some hands-on experience using Generative AI use cases.

Specifically, you learned that:

- Generative AI models can generate new content based on the data they are trained on.
- While discriminative AI mimics our analytical and predictive skills, Generative AI also mimics our creative skills.
- The creative skills of Generative AI are built on the use of models, such as GANs, VAEs, and transformers.
- Foundation models in Generative AI can be adapted to create specialized models or tools tailored to specific use cases.
- Generative AI models and tools have a broad scope for applications across different domains and industries.
- Generative AI can create coherent and contextually relevant content and generate realistic, high-quality images, synthetic voices, new audio, and dynamic videos.
- Generative AI models can generate and complete code and synthesize new data to augment existing datasets.
- Generative AI models can create highly realistic and complex virtual worlds, including avatars and digital personalities.

## Module 2: Applications and Tools of AI

In this module, you will learn about the applications and impact of generative AI in different sectors and industries, such as IT and DevOps, entertainment, education, finance, healthcare, and human resources. You will get an insight into how generative AI is making our work lives more efficient and successful. Next, you will explore the key capabilities and use cases of some commonly used tools for text, image, code, audio, video, and virtual world generation.

### Learning Objectives

- Identify the applications of generative AI in different sectors and industries.
- Explore common generative AI models and tools for generating text, code, image, audio, and video.
- Demonstrate the application of generative AI tools for text, image, and code generation.

# Reading 1: Economic Potential of Generative AI

## Learning Objectives

After completing this reading, you will be able to:

- Explain the industry impacts of generative AI.
- Reflect on the insights from Gartner and McKinsey on the business value and industry implications of generative AI.

Generative AI strongly impacts businesses and industries across various domains, offering increased productivity and efficiency, an improved customer experience, and opportunities for growth and innovation. Research and advisory firms like Gartner and McKinsey have been tracking the impact of generative AI on business value and its economic potential for industries.

Gartner splits the business opportunities offered by generative AI into three categories:

1. Revenue opportunities by enabling enterprises to create new products and generate new revenue channels.
2. Cost and productivity opportunities by augmenting the workers' ability to draft and edit text, images, and other media. As generative AI becomes more prevalent in the workplace, employees will be distinguished by their ability to conceive, implement, and refine ideas, projects, processes, services, and collaborations in partnership with AI.
3. Risk opportunities through risk mitigation. Generative AI's ability to analyze and offer more insights into data, such as customer transactions and potentially flawed software code, improves the recognition of patterns and the speed at which potential risks to the enterprise can be identified.

Further, Gartner reflects on the industries that are most impacted by generative AI. Generative AI will affect the pharmaceutical, manufacturing, media, architecture, interior design, engineering, automotive, aerospace, defense, medical, electronics, and energy industries by augmenting core processes with AI models. It will impact marketing, design, corporate communications, training, and software engineering by augmenting the supporting processes that span many organizations.

Source: <https://www.gartner.com/en/topics/generative-ai>

A report from McKinsey: The economic potential of generative AI: The next productivity frontier  
McKinsey provides significant insight into the business value, industry impacts, and work and productivity implications achieved through generative AI in a report.

The detailed report from McKinsey is available here: [The economic potential of generative AI: The next productivity frontier](#)

## Summary

In this reading, you learned about the insights from Gartner and McKinsey on the business value and industry impact of generative AI.

## Reading 2: Lesson Summary

At this point, you have learned about some of the applications of Generative AI across domains. You explored some common Generative AI tools for text, image, and code generation. You even had the opportunity to see the generation in action through hands-on lab experiences.

Specifically, you learned that:

- Generative AI has been applied to numerous fields, including IT and DevOps, entertainment, finance, medicine, and human resources.
- In the workplace, the application of Generative AI is changing how we work and making us more efficient and successful in what we do.
- Generative AI has the capability for text generation. Text generation tools can generate different kinds of text, translate languages, and answer questions.
- There are two popular text generation tools: OpenAI's ChatGPT and Google Gemini. ChatGPT is more effective for maintaining conversational flow, and Gemini is a better choice for research.
- Generative AI tools can also produce new images through text or image prompts. These image generation tools can transform images through techniques like image-to-image translation, style transfer, inpainting, or outpainting.
- Some common image generation models include DALL-E, Stable Diffusion, and StyleGAN. In addition, numerous Generative AI tools are available for image generation and transformation.
- Microsoft provides Bing Image Creator for image generation, and Adobe Firefly is a family of Generative AI tools for Adobe's Creative Cloud applications.
- Generative AI tools can generate new code, produce optimized versions of existing code, or convert code from one programming language to another.
- A few prominent code generators are GPT, GitHub Copilot, PolyCoder, and IBM Watson. ChatGPT and Gemini can be valuable tools for basic code generation. However, these tools have limitations based on their training.

## Reading 3: Generative AI: Introduction and Applications

### Glossary

Welcome! This alphabetized glossary contains many of the terms in this course. This comprehensive glossary also includes additional terms not used in course videos. These terms are essential for you to recognize for better comprehension of the concepts covered in the course.

Term	Definition
<b>Data augmentation</b>	A technique commonly used in machine learning and deep learning to increase the diversity and amount of training data.
<b>Deep learning</b>	A subset of machine learning that focuses on training computers to perform tasks by learning from data. It uses artificial neural networks.
<b>Diffusion model</b>	A type of generative model that is popularly used for generating high-quality samples and performing various tasks, including image synthesis. They are trained by gradually adding noise to an image and then learning to remove the noise. This process is called diffusion.
<b>Discriminative AI</b>	A type of artificial intelligence that distinguishes between different classes of data.
<b>Discriminative AI models</b>	Models that identify and classify based on patterns they observe in training data. In general, they are used in prediction and classification tasks.
<b>Foundation models</b>	AI models with broad capabilities that can be adapted to create more specialized models or tools for specific use cases.

Term	Definition
<b>Generative adversarial network (GAN)</b>	A type of generative model that includes two neural networks: generator and discriminator. The generator is trained on vast data sets to create samples like text and images. The discriminator tries to distinguish whether the sample is real or fake.
<b>Generative AI</b>	A type of artificial intelligence that can create new content, such as text, images, audio, and video.
<b>Generative AI models</b>	Models that can understand the context of input content to generate new content. In general, they are used for automated content creation and interactive communication.
<b>Generative pre-trained transformer (GPT)</b>	A series of large language models developed by OpenAI. They are designed to understand language by leveraging a combination of two concepts: training and transformers.
<b>Large language models (LLMs)</b>	A type of deep learning model trained on massive amounts of text data to learn the patterns and structures of language. They can perform language-related tasks, including text generation, translation, summarization, sentiment analysis, and more.
<b>Machine learning</b>	A type of artificial intelligence that focuses on creating algorithms and models that enable computers to learn and make predictions or decisions. It involves designing systems that can learn from training data.
<b>Natural language processing (NLP)</b>	A branch of artificial intelligence that enables computers to understand, manipulate and generate human language (natural language).
<b>Neural networks</b>	Computational models inspired by the structure and functioning of the human brain. They are a fundamental component of deep learning and artificial intelligence.
<b>Prompt</b>	Instructions or questions that are given to a generative AI model to generate new content.
<b>Training data</b>	Data (generally, large datasets that also have examples) used to teach a machine learning model.
<b>Transformers</b>	A deep learning architecture that uses an encoder-decoder mechanism. Transformers can generate coherent and contextually relevant text.
<b>Variational autoencoder (VAE)</b>	A type of generative model that is basically a neural network model designed to learn the efficient representation of input data by encoding it into a smaller space and decoding back to the original space.