Generative AI course

1. What is Generative AI?
2. Roadmap of Generative AI?
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4. What are the foundational models in Generative AI?
5. What is the future scope of Generative AI?
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7. Why should you learn Generative AI?
8. What are the types of Generative AI compared to other AI types?
9. What are the advantages and disadvantages of Generative AI?

what is Generative AI

Generative AI refers to AI technologies that can create new content, ideas, or data that are coherent and plausible, often resembling human-generated outputs. It has a plethora of practical applications in different domains such as computer vision, natural language processing, and music generation.

Roadmap for Generative AI

1. Foundation in Machine Learning and Deep Learning

- Ensure proficiency in probability, statistics, linear algebra, and calculus.
- Gain hands-on experience with programming languages like Python/R.
- Familiarize yourself with supervised and unsupervised learning algorithms.
- Build machine learning models on tabular datasets.

2. Deep Learning Mastery

- Develop a solid understanding of deep learning architectures such as MLPs, RNNs, LSTMs, GRUs, and CNNs.
- Gain proficiency in at least one deep learning framework like Keras, TensorFlow, PyTorch, or FastAPI.
- Train MLPs on tabular datasets.
- Construct RNNs and CNNs for unstructured data (text and image).

3. Advanced Deep Learning Techniques

- Learn about pretrained models for image data and their types.
- Understand language models and build them using LSTMs/GRUs.
- Explore attention mechanisms and their applications.
- Study autoencoders and GANs architectures and train these models on datasets.

4. Generative Models for NLP:

- Discover Large Language Models (LLMs) like Transformers, BERT, GPT, PaLM, etc.

- Understand how to use LLMs for downstream tasks: finetuning, zero-shot, one-shot, and few-shot learning.
- Learn best practices for training LLMs, including scaling laws and efficient training mechanisms.
- Explore techniques to pre-train LLMs on domain-specific data.
- Implement different techniques to finetune LLMs for downstream tasks.
- Study optimization techniques like Adapters, LoRA, QLoRA, etc., to accelerate finetuning.
- Understand deployment considerations (LLMops) for deploying LLMs in production.
- Explore cutting-edge models like ChatGPT and BARD and understand their training process, including reinforcement learning from human feedback, supervised fine-tuning, and prompt engineering.
- Gain hands-on experience with LLM frameworks like LangChain, AutoGPT, Vector DB etc.

Disadvantages :

1. **Source Ambiguity**: Generative AI may not always attribute content to its original source, leading to ambiguity in authorship and ownership.
2. **Bias Assessment Difficulty**: Assessing bias in original sources can pose challenges, complicating efforts to ensure fairness and accuracy in generated content.
3. **Realism Challenges**: The lifelike quality of generated content can obscure inaccuracies, making it more difficult to distinguish between genuine and

fabricated information.

4. **Tuning Complexity**: Adapting generative AI for new contexts and scenarios can be intricate, requiring nuanced adjustments to ensure optimal performance.
5. **Potential for Oversights**: Despite advancements, there remains a risk that generative AI results may inadvertently perpetuate biases, prejudices, and hateful ideologies, warranting careful scrutiny and mitigation measures .

What are the benefits of generative AI?

- Automating the manual process of writing content.
- Reducing the effort of responding to emails.
- Improving the response to specific technical queries.
- Creating realistic representations of people.
- Summarizing complex information into a coherent narrative.
- Simplifying the process of creating content in a particular style.

What are the concerns surrounding generative AI?

- It can provide inaccurate and misleading information.
- It is more difficult to trust without knowing the source and provenance of information.
- It can promote new kinds of plagiarism that ignore the rights of content creators and artists of original content.
- It might disrupt existing business models built around search engine optimization and advertising.

- It makes it easier to generate fake news.
- It makes it easier to claim that real photographic evidence of a wrongdoing was just an AI-generated fake.
- It could impersonate people for more effective social engineering cyber attacks.

What are some examples of generative AI tools?

- **Text generation tools** include **GPT**, **Jasper**, **AI-Writer**, and **Lex**.
- **Image generation tools** include **DALL-E 2**, **Midjourney**, and **Stable Diffusion**.
- **Music generation tools** include **Amper**, **Dadabots**, and **MuseNet**.
- **Code generation tools** include **CodeStarter**, **Codex**, **GitHub Copilot**, and **Tabnine**.
- **Voice synthesis tools** include **Descript**, **Listnr**, and **Podcast.ai**.
- **AI chip design tool** companies include **Synopsys**, **Cadence**, **Google**, and **Nvidia**.

What are use cases for generative AI?

- Implementing chatbots for customer service and technical support.
- Deploying deepfakes for mimicking people or even specific individuals.

- Improving dubbing for movies and educational content in different languages.
- Writing email responses, dating profiles, resumes and term papers.
- Creating photorealistic art in a particular style.
- Improving product demonstration videos.
- Suggesting new drug compounds to test.
- Designing physical products and buildings.
- Optimizing new chip designs.
- Writing music in a specific style or tone.

Some of the very commonly known LLMs are:

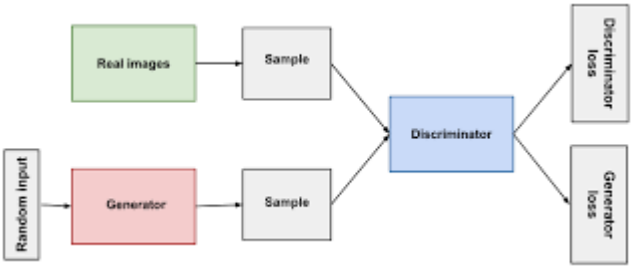
- Open AI's GPT 3, 3.5, and 4
- Google's LaMDA and PaLM
- Hugging Face's BLOOM
- Meta's LLaMA
- NVidia's NeMO LLM

Types of Models for Generative AI ?

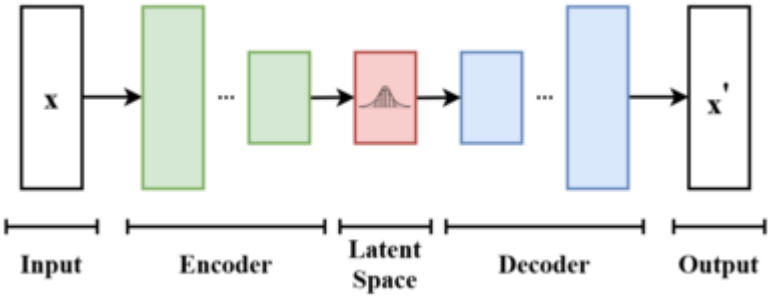
1. **Generative Adversarial Networks (GANs)**: GANs consist of two neural networks, a generator and a discriminator, trained simultaneously in a game-like scenario. The generator tries to create data (e.g., images) that are indistinguishable from real data, while the discriminator tries to

differentiate between real and generated data. This adversarial training process helps improve the quality of generated samples.

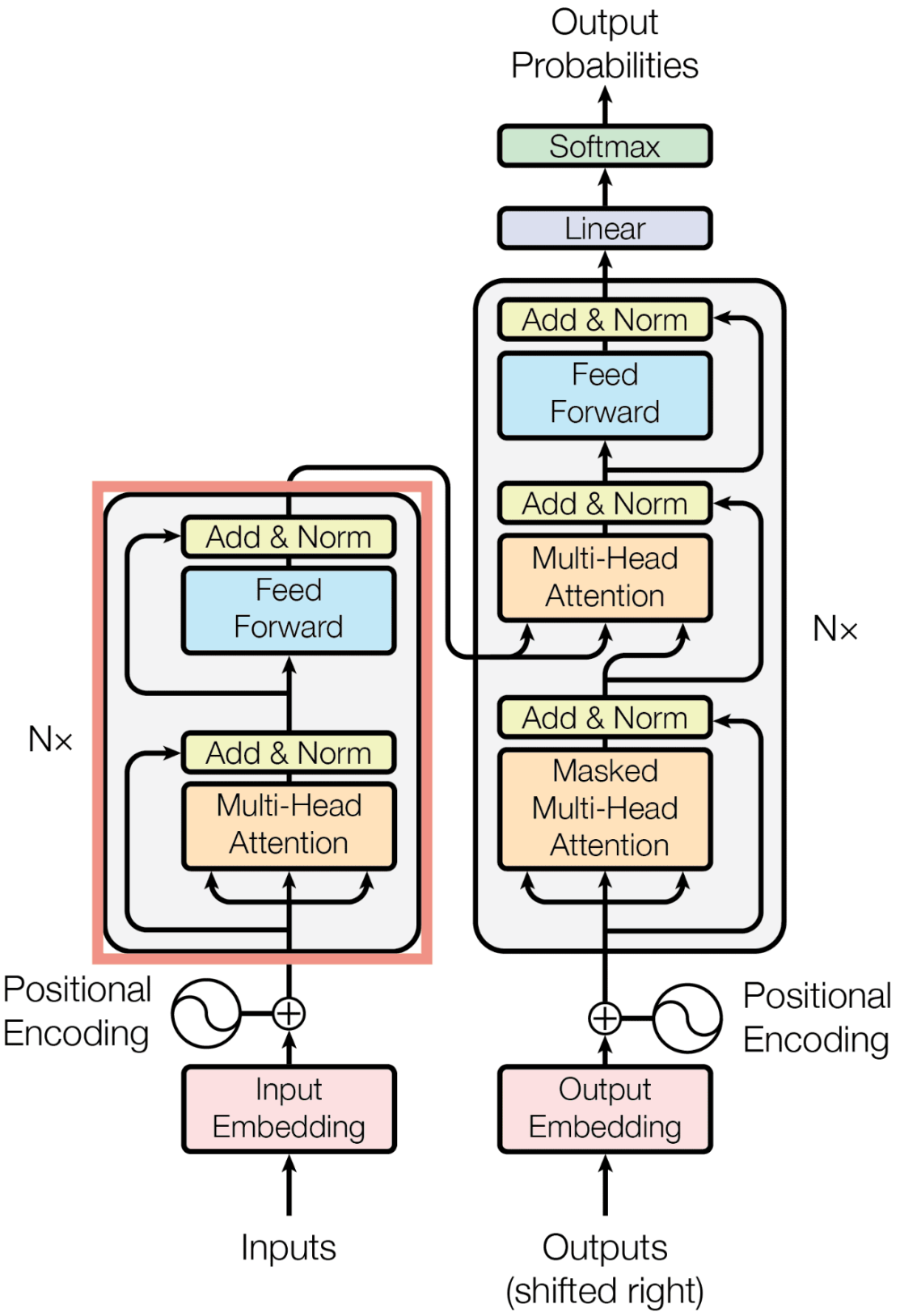
2. https://developers.google.com/machine-learning/gan/loss



1. **Variational Autoencoders (VAEs)**: VAEs are generative models based on the principles of autoencoders. They consist of an encoder network that compresses input data into a latent space representation and a decoder network that reconstructs the original data from the latent space. VAEs are trained to generate new data samples by sampling from the learned latent space distribution.
2.



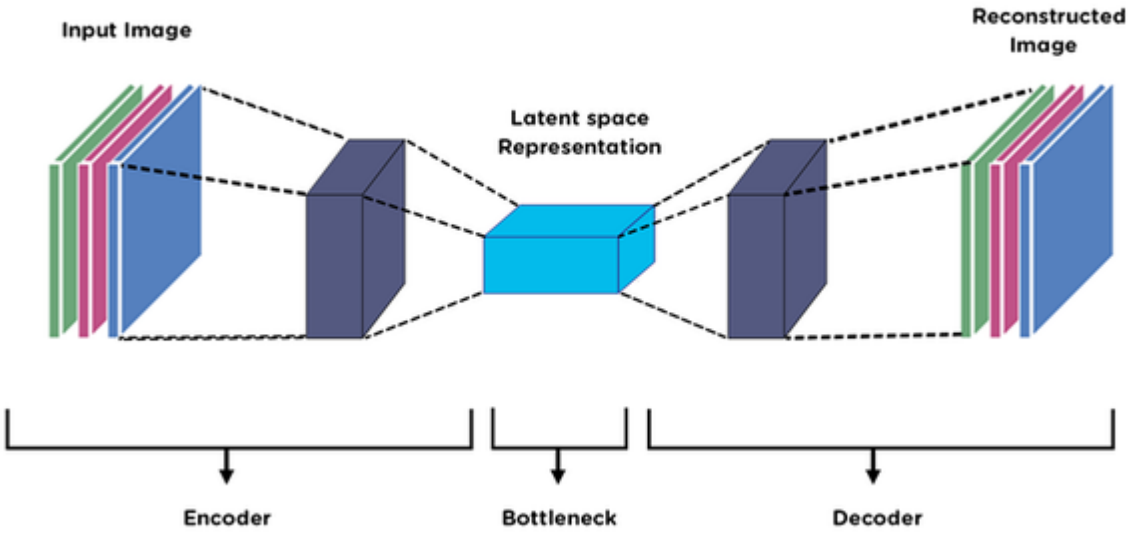
1. **Transformers**: Transformers are a type of deep learning model primarily used in natural language processing (NLP). They are based on a self-attention mechanism that allows the model to weigh the importance of different words in a sequence when processing each word. Transformers have achieved state-of-the-art performance in various NLP tasks and have also been adapted for other tasks beyond NLP, such as image generation and reinforcement learning.
2.



1. **Autoencoders**: Autoencoders are neural networks trained to copy their input to their output. They consist of an encoder network that compresses

the input data into a latent space representation and a decoder network that reconstructs the original input from the latent space representation. Variants like denoising autoencoders, sparse autoencoders, and contractive autoencoders serve different purposes.

2.



Future capabilities of generative AI:

Continued Model Scaling and Efficiency Gains

- **Larger and more parameter-dense models** promise to further expand generative capabilities and general competencies.
- At the same time, **more efficient training techniques** will reduce data and computing needs to improve sustainability.
- Also, **new hardware and software architectures** could be developed to more effectively handle resource intensive workloads.

Steady Improvements in Output Quality and Accuracy

- As this technology advances, its responses may become indistinguishable from, and **possibly superior to human-generated materia**l.
- Improvements will be achieved through **advances in responsible development, model architecture, training techniques, data quality and diversity, and evaluation metrics and tools**.
- Also, **end users and developers contribute to improvements** by providing feedback on responses, labeling data, generating ideas, developing models, and building tools.

Multiple Layered Agent Frameworks:

- **Multiple layered agent frameworks are a complex and hierarchical structure of AI agents** designed to interact and collaborate effectively in a dynamic environment.
- This type of framework allows numerous agents to communicate with one another in order to **solve problems that are too complicated for a single agent to accurately accomplish on its own**.
- In addition, multiple AI agents working together **can dramatically increase the productivity of task completion**.
- For instance, picture a transportation network management system where sensor agents gather real-time data, data processing agents analyze it, routing agents determine optimal paths, coordination agents ensure harmonious cooperation, and supervisory agents oversee the entire operation.

Autonomous AI Agents

- One or more AI agents with **the ability to learn and adapt on their own**, without the need for human intervention.
- This will allow them to **automate tasks and make decisions in real time**.
- For example, an autonomous AI agent could be used to **monitor current events and automatically generate content on flagged topic categories**.

Increased Customization and Specialization :

- Generative AI will become more customizable, allowing for **more parameters to be fine-tuned on custom data**.
- This contextual fine-tuning improves relevance, quality and safety for specific professional use cases while retaining general advantages.
- Which will **serve as springboards for developing specialized systems** tuned on custom datasets for focused tasks, verticals and applications.
- To illustrate, a healthcare company could fine-tune a generative AI model on medical data to generate new drug candidates, predict the effectiveness of different drugs, and design new drug compounds.

Accessibility :

- Generative AI tools will **become more accessible to people with less data and expertise**.
- **Making it easier for businesses of all sizes to use this technology** by lowering barriers to access, enabling broader adoption across languages, domains, geographies and less resourced organizations.
- Specifically, the development of user-friendly apps and AI-as-a-service (ALaaS) platforms will **enable access without having to build and maintain their own infrastructure**.

Text to Everything

- The ability to **generate text, images, audio, videos, and 3D environments from a single platform**.
- This means users will **provide a single text prompt and the model will generate every content format simultaneously**.
- For example, a user could provide a prompt like “A beautiful sunset over a beach” and the model would generate a text description of the sunset, a video of the sunset, and an audio file of the sound of waves crashing on the shore.

Ultra Realistic Talking Avatars :

- Generative AI models will be able to **create videos of talking avatars that are so realistic that they are indistinguishable from real people**.
- These avatars will be **able to lip sync to speech, have natural facial expressions, subtle head movements and even generate their own dialogue**.
- **This will have a wide range of applications**, including virtual assistants, customer service representatives, and even educational characters

Impact of Generative AI on industry and jobs :

Changing Job Roles and Required Skills :

- Though AI won't replace human roles outright, it **will alter the associated required skills**.
- **workers and job requirements will need to transition into more strategic roles**.
- **This may involve upskilling to perform higher-value work** like data analysis, creative direction and strategy.

Automating Tasks to Increase Efficiency

- Conducting process analysis can be used to **identify repetitive and low strategic value tasks that are ideal for AI automation**.
- Task categories such as document review, contract analysis, customer service routines and content generation contain repetitiveness that humans find tedious.

- **free up employees for more impactful and creative responsibilities** better suited to human strengths.

Renewed Focus on Data Governance

- **Generating high-quality outputs relies on extensive training data** that is accurate, comprehensive and aligned to use cases.
- **This places greater emphasis on responsible data governance**, including ethics, integrity, monitoring, security and compliance.
- Where **data collection practices will require more comprehensive auditing** to avoid perpetuating biases.

Tight Integration into Workflows and Software

- To maximize user adoption and impact, AI systems **will integrate seamlessly into existing enterprise software, workflows and processes**.
- This integration will **emphasize on providing a high-quality user experience by actively seeking continuous feedback** to drive enhancements.
- Ultimately, **the main objective of these AI systems is to seamlessly integrate into workflows**, to feel like a natural system component rather than function as isolated tools.

Lower Barriers of Entry

- Generative AI **will make it easier for new competitors to enter the market**.
- As pre-trained models and AI-as-a-service (ALaaS) platforms become more accessible, smaller players will leverage these technologies without massive in-house investments, **somewhat leveling the playing field.**
- As a result, **this will increase market competition** and force existing enterprises to adapt quickly and differentiate themselves.

Enabling New Niche Capabilities

- With the help of generative AI, one can **scan the market for untapped areas to uncover potential niche opportunities**.

- Specifically, **to identify new market opportunities from various sources** by analyzing customer data, social media, demographics, economic trends, etc.
- By feeding all these data points together, **the AI model will be able to identify new customer needs and wants** that are not currently being met by existing products and services.
  • Then
  integrate such findings into the process to generate new ideas for products and services.

Applications Across Industries:

- **Marketing, Advertising, and Entertainment Industry**:
  1. Content Creation: Generative AI powers content creation in various forms like art, music, and literature, allowing artists and musicians to explore innovative creative directions.
  2. Video Game Development: AI-driven systems create game environments, characters, and dialogues, reducing development time and resources.
  3. Scriptwriting: Screenwriters use Generative AI to assist in scriptwriting by generating dialogues, plotlines, and character interactions.
- **Education Sector**:
  1. Personalized Learning: Generative AI adapts educational content to individual student needs by generating tailored assignments, quizzes, and study materials.
  2. Knowledge Base: AI creates exhaustive knowledge bases for students to access information in a conversational style.
  3. Virtual Labs: Generative AI powers virtual laboratories for simulating experiments and scenarios in science and engineering disciplines.
- **Healthcare Industry**:
  1. Medical Image Generation: Generative AI creates synthetic medical images for training models, enhancing diagnostic accuracy, and simulating rare medical conditions.

2. Drug Discovery: Pharmaceutical companies use Generative AI to discover new drug compounds by generating molecular structures.
3. Personalized Medicine: AI analyzes patient data to generate personalized treatment plans, accounting for genetic factors and medical history.

- **Manufacturing Industry**:
  1. Product Design: Generative design creates optimized product designs considering materials, weight, and structural integrity.
  2. Quality Control: AI generates synthetic data for quality control testing, ensuring adherence to quality standards.
  3. Supply Chain Optimization: AI-generated forecasts help make informed decisions about production and distribution.
- **Software & Tech Industry**:
  1. Code Generation: Generative AI assists developers by generating code snippets and templates, speeding up development.
  2. Bug Detection: AI generates synthetic test cases to identify and fix software bugs efficiently.
  3. IT Security: Generative AI models simulate cyberattack scenarios to identify vulnerabilities and enhance cybersecurity measures.

What is prompt engineering

Prompt engineering is the practice of designing inputs for AI tools that will produce optimal output

why we need to learn prompt enginerring ?

Enhanced accuracy and relevance

Improved decision making

Personalized customer experiences

Efficient resource utilization

Ethical considerations and bias mitigation

There are 8 prompt engineering methods:

(1) Zero-Shot Learning, (2) One-Shot Learning, (3) Few-Shot Learning,

(4) Chain-of-Thought Prompting, (5) Iterative Prompting,

(6) Negative Prompting, (7) Hybrid Prompting, and

(8) Prompt Chaining .

1.
Zero-Shot Learning: This involves giving the AI a task without any prior examples. You describe what you want in detail, assuming the AI has no prior knowledge of the task.

. **One-Shot Learning**: You provide one example along with your prompt. This helps the AI understand the context or format you're expecting.

3. **Few-Shot Learning**: This involves providing a few examples (usually 2–5) to help the AI understand the pattern or style of the response you're looking for.

4. **Chain-of-Thought Prompting**: Here, you ask the AI to detail its thought process step-by-step. This is particularly useful for complex reasoning tasks.

5. **Iterative Prompting**: This is a process where you refine your prompt based on the outputs you get, slowly guiding the AI to the desired answer or style of answer.

6. **Negative Prompting**: In this method, you tell the AI what not to do. For instance, you might specify that you don't want a certain type of content in the response.

7. **Hybrid Prompting**: Combining different methods, like few-shot with chain-of-thought, to get more precise or creative outputs.

8. **Prompt Chaining**: Breaking down a complex task into smaller prompts and then chaining the outputs together to form a final response.

Key elements of a prompt :

- **Instruction.** This is the core directive of the prompt. It tells the model what you want it to do. For example, "Summarize the following text" provides a clear action for the model.
- **Context.** Context provides additional information that helps the model understand the broader scenario or background. For instance, "Considering the economic downturn, provide investment advice" gives the model a backdrop against which to frame its response.
- **Input data.** This is the specific information or data you want the model to process. It could be a paragraph, a set of numbers, or even a single word.

- **Output indicator.** Especially useful in role-playing scenarios, this element guides the model on the format or type of response desired. For instance, "In the style of Shakespeare, rewrite the following sentence" gives the model a stylistic direction.

Technical skills for prompt engineering :

- **Understanding of NLP.** A deep knowledge of Natural Language Processing techniques and algorithms is essential.
- **Familiarity with LLMs.** Experience with models like GPT, PaLM2, and other emerging models their underlying architectures.
- **Experimentation and iteration.** Ability to test, refine, and optimize prompts based on model outputs.

Non-technical skills for prompt engineering

- **Communication.** The ability to convey ideas, collaborate with teams, and understand user needs.
- **Subject Matter Expertise.** Depending on the application, domain-specific knowledge can be invaluable.
- **Language Proficiency.** Mastery over language, grammar, and semantics to craft effective prompts.
- **Critical Thinking.** Evaluating model outputs, identifying biases, and ensuring ethical AI practices.
- **Creativity.** Thinking outside the box, experimenting with new prompt styles, and innovating solutions.