

Lab Practical: Prompt Engineering Techniques in Generative AI

Date: 03-02-2026

Subject: Generative AI

Title: Study and Application of Advanced Prompt Engineering Patterns

1. Aim of the Experiment

To understand and apply different **prompt engineering techniques** such as Persona Prompt, Root Prompt, Cognitive Verifier Pattern, Question Refinement Pattern, Chain of Thought, RGC framework, and various prompting strategies (Zero-shot, One-shot, Few-shot) for improving the quality, accuracy, and reliability of responses generated by AI models.

2. Objective

- To design structured prompts for effective AI interaction
 - To compare different prompting techniques
 - To analyze how reasoning quality improves using Chain of Thought
 - To understand role-based and context-based prompting
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3. Use of Persona Prompt (Text)

Definition

A Persona Prompt assigns a **specific role, expertise, tone, and behavior** to the AI model to control its responses.

Prompt Example

You are a senior Artificial Intelligence professor with more than 15 years of experience.

Explain the concept of Machine Learning to undergraduate engineering students.

Use simple language, step-by-step explanation, and real-world examples.

Avoid complex mathematics.

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Persona Prompt Output:
Welcome, students, to today's lecture on Generative AI. Today, we're going to dive into the exciting world of Prompt Engineering. I'm sure many of you have heard of AI models like LLaMA or Da Vinci, but do you know how to harness their full potential? Let's explore the art of crafting effective prompts for AI models.

**What is Prompt Engineering?**
Prompt Engineering is the process of crafting carefully designed input prompts to elicit specific, accurate, and relevant responses from AI models. It's like writing a recipe for the AI to follow, ensuring it produces the desired outcome.

**Why is Prompt Engineering important?**
In the past, AI models were limited by their lack of understanding of the context and nuances of human language. However, with the advancement of language models, we can now fine-tune them to produce high-quality results. Prompt Engineering allows us to overcome these limitations.

1. **Improve accuracy:** By providing clear and specific prompts, we can reduce the likelihood of AI models producing incorrect or irrelevant responses.
2. **Increase efficiency:** Well-crafted prompts can help AI models focus on the most critical aspects of a task, reducing the amount of processing time required.
3. **Enhance creativity:** By pushing the boundaries of what's possible with language models, Prompt Engineering can unlock new forms of creative expression.

**Real-life examples:**
Let's consider a few examples to illustrate the power of Prompt Engineering:
1. **Recipe generation:** Imagine you want to create a recipe for a vegan, gluten-free cake. A poorly designed prompt might be: "Create a cake recipe." However, a well-crafted prompt would be: "Create a vegan, gluten-free cake recipe using [specific ingredients]."
2. **Content creation:** Suppose you want to generate a blog post about sustainable fashion. A vague prompt might be: "Write a blog post about sustainable fashion." A more effective prompt would be: "Write a 500-word blog post on sustainable fashion trends and their impact on the environment."
3. **Chatbot development:** Picture a chatbot designed to help customers with their queries. A poorly designed prompt might be: "Answer any question." A more effective prompt would be: "Answer customer questions about product returns, exchanges, and refunds." 

**Best practices for Prompt Engineering:**
To get the most out of Prompt Engineering, keep the following tips in mind:
1. **Be specific:** Clearly define what you want the AI model to produce.
2. **Use context:** Provide relevant information about the task or topic.
3. **Use action verbs:** Verbs like "create," "write," or "generate" help guide the AI model.
4. **Provide constraints:** Specify any limitations or requirements, such as word count or tone.
5. **Test and refine:** Iterate on your prompts to achieve the desired results.

**Conclusion:**
Prompt Engineering is a powerful tool for unlocking the full potential of Generative AI. By crafting carefully designed prompts, we can elicit accurate, relevant, and high-quality responses from AI models. Remember to be specific, use context, and provide clear instructions. For your homework, I want you to experiment with Prompt Engineering using a language model of your choice. Design a prompt for a recipe, a blog post, or a chatbot, and see how well the AI model responds. Don't hesitate to reach out if you have any questions or need further guidance.

Now, let's discuss some of the challenges associated with Prompt Engineering...

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Observation

The AI generates responses aligned with the defined role and audience.

4. Use of Root Prompt (Text)

Definition

A Root Prompt acts as a **base instruction** that governs the AI's behavior throughout the interaction.

Prompt Example

You are an academic AI assistant designed for university-level coursework.

Provide accurate, structured, and formal responses.

Explain concepts step by step and refine unclear questions before answering.

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Root Prompt Output:
I'd be happy to explain Prompt Engineering in a clear and simple way.

**What is Prompt Engineering?**
Prompt Engineering is a process used to create high-quality input (prompts) for Generative AI models like language models, image generators, or music composers. The goal is to design and craft prompts that elicit the desired output from the AI model.

**Why is Prompt Engineering important?**
Generative AI models can produce a wide range of outputs, but the quality and relevance of the output depend heavily on the prompt. A well-crafted prompt can help the AI model generate accurate, relevant, and useful results. On the other hand, a poorly crafted prompt can lead to inaccurate or irrelevant results.

**Key Concepts in Prompt Engineering:**
1. **Natural Language Understanding (NLU):** NLU is the ability of the AI model to understand the meaning of the input prompt. A good prompt should be clear, concise, and free of ambiguity.
2. **Prompt Design:** This involves designing the prompt to elicit the desired output. This includes choosing the right words, phrases, and sentence structure to convey the intended meaning.
3. **Context:** Context is essential in prompt engineering. The AI model needs to understand the context in which the prompt is being used to generate the output.
4. **Bias and Fairness:** AI models can perpetuate biases present in the training data. A well-designed prompt should aim to minimize bias and ensure fairness in the output.

**Step-by-Step Process for Prompt Engineering:**
1. **Define the Goal:** Clearly define what you want the AI model to generate.
2. **Identify the Context:** Determine the context in which the AI model will be used to generate the output.
3. **Craft the Prompt:** Use simple and clear language to craft the prompt. Avoid ambiguity and jargon.
4. **Test and Refine:** Test the prompt with the AI model and refine it as needed to achieve the desired output.
5. **Evaluate and Improve:** Continuously evaluate the output and improve the prompt to ensure it meets the desired goals.

**Examples of Prompt Engineering:**
1. **Generating a Product Description:** "Write a short product description for a new smartphone, highlighting its features and benefits."
2. **Creating a Recipe:** "Generate a simple recipe for a vegan stir-fry using tofu, vegetables, and a variety of spices."
3. **Writing a Short Story:** "Write a short story about a character who discovers a hidden world within their own reflection." 

By following these steps and key concepts, you can effectively design and craft high-quality prompts for Generative AI models, leading to better outputs and more accurate results.

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Observation

Ensures consistency, clarity, and academic tone in responses.

5. Exercise 3 – Cognitive Verifier Pattern (Python Coding)

Aim : To implement the **Cognitive Verifier Pattern**, where the system verifies its own answer before finalizing it.

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Cognitive Verifier Output:  
**What is Prompt Engineering?  
Prompt engineering is the process of designing and optimizing text prompts to elicit specific, high-quality, and relevant responses from language models, such as chatbots, virtual assistants, and other AI systems. It involves understanding the goal of prompt engineering is to craft prompts that are clear, concise, and well-structured, allowing language models to accurately interpret the user's intent and provide relevant responses. This requires a deep understanding of the language model's limitations and the user's needs.  
Some key aspects of prompt engineering include:  
1. **Understanding the language model's limitations**: Knowing what the language model can and cannot do, and how to work within its capabilities.  
2. **Capturing user intent**: Identifying the user's goals and intentions, and crafting prompts that accurately capture their needs.  
3. **Optimizing prompt structure**: Using techniques such as natural language processing (NLP) and linguistics to design prompts that are clear and easy to understand.  
4. **Refining and iterating**: Continuously refining and testing prompts to achieve the desired outcome.  
**Verification and Missing Information**  
My response has been verified through various sources, including academic papers, research articles, and industry reports. However, there may be additional aspects of prompt engineering that are not mentioned here, such as:  
- **Bias and fairness**: The potential for prompts to introduce biases or perpetuate harm, and strategies for mitigating these issues.  
- **Multimodal prompts**: The use of non-textual inputs, such as images or audio, to inform language model responses.  
- **Explainability and transparency**: Techniques for providing insight into the decision-making process of language models, and the role of prompt engineering in this effort.  
Overall, prompt engineering is a rapidly evolving field, and this response provides a foundation for understanding its core principles and practices.
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Inference

The system verifies its reasoning before confirming the final result, demonstrating the Cognitive Verifier Pattern.

6. Exercise 4 – Question Refinement Pattern (Python Coding)

Aim

To implement the **Question Refinement Pattern**, where an unclear question is refined before answering.

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Question Refinement Output:  
Here's a refined version of the question:  
"Can you explain the definition and concept of Artificial Intelligence (AI), including its key characteristics and how it differs from human intelligence?"  
This refined question is clearer because it:  
1. Specifies the term being asked about (Artificial Intelligence)  
2. Asks for a definition and concept, implying a desire for a comprehensive explanation  
3. Includes specific aspects of AI to focus the response (key characteristics and differences from human intelligence)
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Inference

Refining the question improves clarity and quality of the final response.

7. Provide New Information and Ask Questions Pattern (Text)

Prompt Example

Explain Neural Networks in a beginner-friendly manner.

Include definition, components, and a simple example.

After the explanation, ask three follow-up questions to test understanding.

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Provide New Info & Ask Questions Output:
**What is Machine Learning?**
Machine Learning (ML) is a subset of Artificial Intelligence (AI) that enables computers to learn from data without being explicitly programmed. It involves training algorithms on large datasets, allowing them to identify patterns, relationships, and make predictions or decisions based on that learning. There are three primary types of ML:
1. **Supervised Learning**: In this type, the algorithm is trained on labeled data, where the correct output is already known. The algorithm learns to map inputs to outputs based on this labeled data.
2. **Unsupervised Learning**: Here, the algorithm is trained on unlabeled data, and it must find patterns or relationships on its own.
3. **Reinforcement Learning**: In this type, the algorithm learns through interactions with an environment, receiving rewards or penalties for its actions.
**New Related Information:**
Some exciting developments in the field of ML include:
1. **Explainable AI (XAI)**: This is a growing area of research focused on developing techniques to explain the decisions made by ML models. As ML models become increasingly complex, it's essential to understand how they arrive at their conclusions.
2. **Transfer Learning**: This technique allows ML models to leverage pre-trained models and fine-tune them for specific tasks. This approach has led to significant improvements in image recognition, language translation, and other applications.
3. **Quantum Machine Learning**: Researchers are exploring how quantum computing can be used to speed up ML computations. Quantum ML has the potential to solve complex problems that are currently intractable with classical computers.
**Follow-up Questions:**
1. Can you explain the concept of "overfitting" in ML and how to avoid it?
2. What are some real-world applications of Reinforcement Learning, and how has it been used in industries such as robotics and gaming?

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Purpose

Encourages interactive learning and deeper understanding.

8. Practice Chain of Thought Prompting (Text)

Definition : Chain of Thought prompting forces the AI to **reason step by step** before answering.

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Chain of Thought Output:
Here's a step-by-step explanation of how AI detects spam emails:

**Step 1: Data Collection and Preprocessing**
* AI systems collect a large dataset of emails, both legitimate and spam.
* The dataset is preprocessed to remove any unnecessary data, such as formatting and attachments.
* The data is then cleaned and normalized to ensure consistency across all emails.

**Step 2: Feature Extraction**
* AI algorithms extract relevant features from the email data, such as:
    + Language and grammar patterns
    + Keyword frequencies and co-occurrences
    + Sender and recipient information
    + URL patterns and links
    + Attachment types and sizes
    + Email headers and metadata
* These features are used to create a numerical representation of each email.

**Step 3: Model Training**
* A machine learning model is trained on the preprocessed data using supervised learning techniques, such as:
    + Logistic regression
    + Decision trees
    + Random forests
    + Support vector machines (SVMs)
    + Neural networks
* The model learns to recognize patterns in the data that are indicative of spam emails.

**Step 4: Model Evaluation**
* The trained model is evaluated on a test dataset to assess its performance.
* Metrics such as accuracy, precision, recall, and F1-score are used to evaluate the model's performance.

**Step 5: Real-time Classification**
* When a new email arrives, the AI system extracts the relevant features from the email.
* The trained model is used to classify the email as either legitimate or spam based on the extracted features.

**Step 6: Feature Update and Adaptation**
* The AI system continuously updates the model by retraining it on new data and adapting to emerging spam patterns.
* This ensures that the model remains effective in detecting new types of spam emails.

**Step 7: Feedback Loop**
* The AI system collects feedback from users, such as marking emails as spam or legitimate.
* This feedback is used to update the model and improve its performance over time.

**Step 8: Integration with Email Clients**

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Prompt Example

Solve the given problem step by step.

Explain each reasoning stage clearly.

Do not skip intermediate steps.

Summarize the final answer.

Benefit

Improves logical reasoning and accuracy.

9. Tabular Comparison of Prompting Techniques

Tabular Format Output:		
Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) Comparison Table		
Term **Definition** **Key Characteristics** **Examples**		
- - - -		
Artificial Intelligence (AI) The broader field of creating intelligent machines that can perform tasks that typically require human intelligence. Wide range of applications, rule-based systems, decision-making, problem-solving Virtual assistants, expert systems		
Machine Learning (ML) A subset of AI that involves training algorithms to learn from data and improve their performance on a task. Algorithmic learning, data-driven decision-making, predictive modeling Image classification, speech recognition, recommender systems		
Deep Learning (DL) A type of ML that uses neural networks with multiple layers to learn complex patterns in data. Neural networks, hierarchical feature learning, large datasets, parallel processing Image recognition, natural language processing, speech recognition		
Relationship between AI, ML, and DL:		
- - -		
* AI is the parent field that encompasses both ML and DL.		
* ML is a subset of AI that uses algorithms to learn from data.		
* DL is a type of ML that uses neural networks to learn from data.		
Key differences:		
- - -		
* **Scope:** AI is a broader field that includes rule-based systems, whereas ML is a specific technique that involves algorithmic learning. DL is a type of ML that is particularly suited for complex data.		
* **Approach:** AI often relies on rule-based systems, whereas ML uses data-driven decision-making. DL uses neural networks to learn from data.		
* **Complexity:** DL is generally more complex and computationally intensive than ML and AI, requiring large datasets and powerful hardware.		
When to use each:		
- - -		
* Use AI for tasks that require rule-based systems, decision-making, or problem-solving.		
* Use ML for tasks that require algorithmic learning, predictive modeling, or data-driven decision-making.		
* Use DL for tasks that require complex pattern recognition, hierarchical feature learning, or large datasets.		

10. Fill in the Blanks

Fill in the Blank Output:

Artificial Intelligence is the ability of machines to mimic human intelligence.

However, a more literal and often-used phrase is:

Artificial Intelligence is the ability of machines to perform tasks that would typically require human intelligence.

11. RGC Framework (Role – Goal – Context)

Example Prompt

Role: You are a data scientist.

Goal: Explain overfitting and underfitting.

Context: Audience is first-year engineering students with basic programming knowledge.

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RGC Prompt Output:  
Welcome to the world of AI! I'm excited to introduce you to the concept of prompt engineering. Don't worry if you're new to AI; I  
**What is AI?**  
Before we dive into prompt engineering, let's quickly cover the basics. Artificial Intelligence (AI) refers to the development of  
* Recognizing images and speech  
* Understanding natural language  
* Making decisions  
* Learning from data  
  
**What is a Prompt?**  
In AI, a prompt is a piece of text that you provide to a machine learning model to elicit a response. Think of it like asking a question.  
**What is Prompt Engineering?**  
Prompt engineering is the process of designing and crafting effective prompts to elicit specific, accurate, and relevant responses.  
Imagine you're trying to get a recipe for your favorite dish from a chatbot. You could give it a generic prompt like "Give me a recip...  
  
**Key Principles of Prompt Engineering**  
Here are some essential principles to keep in mind when designing effective prompts:  
1. **Specificity**: Clearly define what you're asking the AI model to do.  
2. **Context**: Provide relevant information to help the model understand the context.  
3. **Clarity**: Use simple, concise language to avoid confusion.  
4. **Relevance**: Ensure the prompt is relevant to the task at hand.  
5. **Avoid Ambiguity**: Steer clear of prompts that could be interpreted in multiple ways.  
  
**Why is Prompt Engineering Important?**  
Prompt engineering is crucial because it directly impacts the quality and accuracy of AI responses. A well-designed prompt can:  
* Improve the accuracy of AI responses  
* Increase the relevance of the response  
* Reduce the need for post-processing and editing  
* Enhance the overall user experience  
  
**Conclusion**
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12. Zero-Shot Prompting

Definition

The model is given **no examples**, only a task.

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Zero-Shot Output:  
**Natural Language Processing (NLP)**  
Natural Language Processing (NLP) is a subfield of artificial intelligence (AI) that deals with the interaction between computers and humans.  
  
**Goals of NLP**  
The primary goals of NLP are to:  
1. **Text Analysis**: Analyze and understand the meaning of text, including sentiment, intent, and entities.  
2. **Text Generation**: Generate human-like text, such as responses to user queries or summaries of text.  
3. **Language Translation**: Translate text from one language to another.  
4. **Speech Recognition**: Recognize spoken language and transcribe it into text.  
5. **Dialogue Systems**: Develop systems that can engage in conversation with humans.  
  
**Key NLP Techniques**  
Some key techniques used in NLP include:  
1. **Tokenization**: Breaking down text into individual words or tokens.  
2. **Part-of-Speech (POS) Tagging**: Identifying the grammatical category of each word (e.g., noun, verb, adjective).  
3. **Named Entity Recognition (NER)**: Identifying named entities, such as people, places, and organizations.  
4. **Dependency Parsing**: Analyzing the grammatical structure of sentences.  
5. **Machine Learning**: Using algorithms to learn patterns and relationships in language data.  
  
**Applications of NLP**  
NLP has many applications in various industries, including:  
1. **Virtual Assistants**: Siri, Alexa, and Google Assistant use NLP to understand voice commands.  
2. **Chatbots**: Chatbots use NLP to respond to user queries and provide customer support.  
3. **Sentiment Analysis**: Analyzing customer feedback and sentiment in social media and reviews.  
4. **Language Translation**: Google Translate and other translation services use NLP to translate text and speech.  
5. **Text Summarization**: Summarizing long documents and articles to extract key points.  
  
**Challenges in NLP**  
Despite the progress made in NLP, there are still many challenges to overcome, including:  
1. **Ambiguity**: Words and phrases can have multiple meanings.  
2. **Context**: Understanding the context in which language is used.  
3. **Idioms and Colloquialisms**: Dealing with idiomatic expressions and colloquial language.  
4. **Sarcasm and Irony**: Identifying sarcasm and irony in language.
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Example

Explain the concept of blockchain technology with its applications.

13. One-Shot Prompting

Example

Example:

Question: What is Artificial Intelligence?

Answer: Artificial Intelligence refers to machines that simulate human intelligence.

Now answer:

What is Machine Learning?

One-Shot Output:
Machine Learning is the subset of Artificial Intelligence (AI) that enables systems to learn from data, identify patterns, and make predictions or decisions without being explicitly programmed.
In other words, Machine Learning is a type of AI that allows machines to improve their performance on a task over time based on the data they receive. This process involves training a model using historical data, which enables the model to learn from the data and make accurate predictions on new data.
Machine Learning can be categorized into three main types:
1. Supervised Learning: This type of learning involves training a model on labeled data, where the correct output is already known. The model learns to map inputs to outputs based on the labeled data.
2. Unsupervised Learning: This type of learning involves training a model on unlabeled data, where the correct output is not known. The model learns to identify patterns and relationships in the data.
3. Reinforcement Learning: This type of learning involves training a model to take actions in an environment and receive rewards or penalties based on the outcome. The model learns to make decisions that maximize the reward.
Machine Learning is widely used in various applications such as image recognition, natural language processing, speech recognition, and predictive analytics. Its ability to improve performance over time makes it a powerful tool for solving complex problems in various industries.

14. Few-Shot Prompting

Example

Input: Dog

Output: Mammal

Few-Shot Output:
Machines that use multiple layers to analyze and interpret data.
This refers to a type of machine learning where the goal is to develop models that can learn complex patterns in data by representing it in multiple layers. These layers allow the model to extract more abstract and meaningful features from the input data, leading to improved performance.

15. Result

All prompt engineering techniques were successfully studied and implemented.

Cognitive Verifier and Question Refinement patterns were implemented using Python, while other techniques were analyzed theoretically.

16. Conclusion

This lab practical demonstrates that structured prompt engineering significantly improves the quality, reliability, and reasoning capability of Generative AI systems. Combining text-based prompts with executable Python logic provides a strong foundation for real-world AI applications.