CIML Summer Institute 2024
Prompt Engineering

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LLM Prompt Engineering - Agenda

- Introduction to Prompt Engineering
- Prompt Engineering Techniques
- Prompting Examples
- Prompting Hands-on
- API Prompting Demo

What is Prompt Engineering?

- **Large Language Models (LLMs)**
  - Powerful AI tools
  - Need guidance to provide accurate & useful info
- **Prompt Engineering**
  - Definition: The art & science of crafting inputs (prompts) to LLMs to tell them what to do
  - process of designing, refining, and optimizing input prompts to guide LLM toward producing desired outputs
  - Important for both NLP and image generation tasks

Why is Prompt Engineering Important?

- **Good prompt engineering can provide**
  - Enhanced accuracy in results from LLMs
  - Better control over LLM outputs
  - Ability to tailor responses to specific tasks
  - Ways to elicit LLM outputs with different formats/styles
- **Effective prompt engineering**
  - Is essential for leveraging LLMs effectively

Common Uses of LLMs

- **Summarization**
  - Summarize plot of book, movie, etc.
  - Provide main findings of technical paper
- **Text generation**
  - Give definition of term or concept
  - Provide explanation about complex topics
  - Create resume, presentation, letter, etc.
  - Write a poem or story
- **Code generation, debugging, and interpretation**
  - Write code to perform certain function
  - Explain what code error is and how to fix it
  - Provide explanation of code segment

What Makes a Good Prompt?

- **Clarity**
  - What do you want the LLM to do?
  - Provide instructions that clearly specifies what you want (e.g., detailed explanation, concise summary, text generation)
- **Specificity**
  - What do you want included in the response?
  - Provide details about format, style, length, etc.
- **Context**
  - What is some background information related to your question?
  - Provide context to guide response

Prompt Engineering Tips

DOs

- Be specific and clear
- Provide context
- Provide information about tone and intended audience as needed
- Provide output format as needed (length, bullet points, etc.)
- Iterate on prompts
- Can regenerate response or select alternate responses
- Create new chats for new topics

DONT's

- Don't assume output is absolutely correct. Need to verify
- Don't need to have perfect prompt at beginning
- Don't include sensitive or personally identifying information. Don't use info not publicly available. Data goes back to chatbot company.

Prompt Engineering Techniques

Prompt Engineering Techniques

- **Prompt refining**
  - Reformulating and rephrasing
- **Shot prompting**
  - Providing examples in prompt
- **Prompt chaining**
  - Linking multiple prompts for more complex dialog
- **Chain-of-thought prompting**
  - Ask to provide step-by-step reasoning

Prompt Refining

Desc:

Reformulate or rephrase prompt to get desired response

Prompt:

What is llama?

Response:

The word "llama" can refer to two things:

1. A llama is a domesticated South American camelid, widely used as a meat and pack animal by Andean cultures since the pre-Columbian era.They are social animals and live with others as a herd. Their wool is soft and contains only a small amount of lanolin.
2. Llama is also a family of autoregressive large language models released by Meta AI starting in February 2023. The latest version is Llama 3 released in April 2024.These are computer programs that are trained to be informative and comprehensive. I am actually one kind of large language model!

Refined Prompt:

What is llama in the context of AI?

Response:

In the context of AI,Llama refers to a family of large language models (LLMs) created by Meta AI. Released in February 2023, the most recent version is Llama 3, launched in April 2024.

Here's a breakdown of Llama LLMs: …

Prompt Refining

Desc:

Reformulate or rephrase prompt to get desired response

Prompt:

Provide an explanation of quantum computing

Response:

Regular computers use bits, which are zeros or ones, to process information. Quantum computers, on the other hand, use qubits, which can be zeros, ones, or both at the same time. This is because they exploit the strangeness of quantum mechanics, the science that governs the behavior of matter at the atomic and subatomic level.

Here's a bit more detail on how it works:

- Qubits and superposition: …
- Quantum phenomena: …

Overall, quantum computing is a revolutionary technology with the potential to solve problems that are currently beyond our reach. While it's not going to replace your laptop anytime soon, it has the potential to make significant breakthroughs in various fields.

Prompt Refining

Refined Prompt #1:

Provide an explanation of quantum computing, summarized in one paragraph.

Response:

Quantum computing utilizes the strange laws of quantum mechanics to tackle problems that would take regular computers an impractical amount of time. Unlike our computers that use bits (0 or 1), quantum computers use qubits which can be both 0 and 1 at the same time. This lets them explore many solutions simultaneously, making them super-fast for specific tasks like drug discovery or materials science simulations. However, they are still in early stages and complex to build and program.

Refined Prompt #2:

Provide an explanation of quantum computing for a 4th grader, summarized in one paragraph.

Response:

Regular computers use bits, which are like switches that are either on (1) or off (0). Quantum computers are like superpowered computers that use qubits, which can be both on and off at the same time! This lets them solve certain problems super fast, kind of like having a bunch of extra brains working together to find the answer. It's a new technology that's still being explored, but it could one day help us design new medicines, create unbreakable codes, and do other amazing things!

Shot Prompting

- **Description**
  - Providing minimal examples in prompt to guide model towards desired response
- **zero-shot**
  - No examples given
- **one-shot**
  - A single example is given
- **few-shot**
  - A few examples (usually 2-5) are given

Shot Prompting

Zero-shot

Prompt:

Extract the relationship between entities in the following sentence: Bill Gates founded Microsoft in 1975

Response:

Bill Gates is the founder of Microsoft.

Few-shot

Prompt:

Extract the relationship between entities in the following sentence.

Here's an example:

Q: Steve Jobs co-founded Apple.

A: Entity:Steve Jobs; Relation:co-founded; Entity:Apple

Here's another example:

Q: Elon Musk started SpaceX

A: Entity:Elon Musk; Relation:started;Entity:SpaceX

Now extract the relationship between entities in this sentence:
Bill Gates founded of Microsoft in 1975

Response:

Entity: Bill Gates; Relation: founder; Entity: Microsoft

Prompt Chaining

Desc:

Linking multiple prompts for more complex dialog

Prompt 1:

What is climate change?

Response:

Climate change refers to long-term shifts in temperatures and typical weather patterns in a place. Climate change could refer to a particular location or the planet as a whole. Climate change may cause weather patterns to be less predictable. A region might experience lower or higher-than-average temperatures. Climate change may cause more frequent and severe weather events, such as storms, floods, and droughts.

…

Prompt Chaining

Prompt 2:

What are the main drivers?

Response:

The main drivers of climate change are human activities that release greenhouse gases into the atmosphere. Here's a breakdown of the key culprits:

- Burning fossil fuels: This is the biggest contributor, responsible for over 75% of global greenhouse gas emissions …
- Deforestation: Cutting down forests disrupts the natural carbon cycle …
- Agriculture: Livestock farming and agricultural practices like using fertilizers contribute to greenhouse gas emissions, including methane and nitrous oxide.

These activities have significantly increased the concentration of greenhouse gases in the atmosphere, trapping more heat from the sun and causing global warming.

Prompt Chaining

Prompt 3:

What are the effects seen in the last decade

Response:

The last decade (2011-2020) has been particularly alarming for climate change, with a clear acceleration in its effects. Here are some of the key observations:

- Temperature rise: …
- Sea level rise: …
- Extreme weather: …

…

Chain-of-Thought Prompting

Desc:

- Instruct model to provide step-by-step explanation.
- To encourage model to “think out loud” to break a problem down into smaller parts in order to solve problem.

Benefits

- Improved problem solving
- Makes the reasoning process transparent; useful for understanding and verifying the model’s response

Chain-of-Thought Prompting

Prompt:

Is 171 a prime number?

Response:

No, 171 is not a prime number. A prime number has exactly two factors: 1 and itself. In contrast, 171 has several factors, including 1, 3, 9, 19, 57, and 171 itself. Therefore, 171 is classified as a composite number.

Chain-of-Thought Prompting

CoT Prompt:

Is 171 a prime number? Explain the steps you would take to determine the answer.

Response:

No, 171 is not a prime number. A prime number has exactly two factors: 1 and itself. In other words, a prime number is only divisible by 1 and itself.

Here's how you can determine if a number is prime by checking its divisibility by smaller primes:

1. Start with the smallest prime number, 2. If the number is even (divisible by 2), it's not prime. Since 171 is odd, we can move on to the next prime number.
2. Check divisibility by 3. If the number leaves no remainder when divided by 3, it's not prime. In this case, 171 divided by 3 gives a remainder of 0, so we can stop here.

Since 171 is divisible by 3, it is not a prime number. It is a composite number, which means it has more than two factors (1, 3, 9, 19, 57, and 171).

Chain-of-Thought Prompting

Prompt:

I went to the market and bought 10 apples. I gave 2 apples to the neighbor and 2 to the repairman. I then went and bought 5 more apples and ate 1. How many apples do I have left?

Response:

The answer is 11 apples **(X)**

CoT Prompt:

I went to the market and bought 10 apples. I gave 2 apples to the neighbor and 2 to the repairman. I then went and bought 5 more apples and ate 1. How many apples do I have left? Let's think step-by-step.

Response:

First, you started with 10 apples.

You gave away 2 apples to the neighbor and 2 to the repairman, so you had 6 apples left.

Then you bought 5 more apples, so now you had 11 apples.

Finally, you ate 1 apple, so you would be left with 10 apples.

Prompting Examples

Getting Specific Information

Use Cases

Internet search

Examples

What is pearson's correlation coefficient

What is the Linux command to uncompress a tar.gz file?

What is a synonym for ‘synonym’?

What is the longest word in English?

Getting Specific Information

Use Cases

Difficult to get direct answer with Internet search

Examples

In this sentence, "Neither she or I agree with the committee," should that be 'agree' or 'agrees'?

What is another way to say 'this is a misleading way to present this data'?

What is the LaTeX formulation for the following: lr = lr_factor * min(step ** (-0.5), step * warm_up ** (-1.5))?

Translation

Can you translate this from French to English: Je ne parle Francais

Can you translate to English: Toi la nguoi Viet

How do you say this in Japanase: Sorry, I don’t speak Japanese

What does this mean: Hella fit; at first I was triggered and shook, but then looked closer, saw it was popping and legit, in fact it is totally lit!

Summarization

Prompt:

Can you summarize “To Kill a Mockingbird”?

ChatGPT:

"To Kill a Mockingbird" is a classic novel written by Harper Lee, published in 1960. The story is set in the fictional town of Maycomb, Alabama, during the 1930s, and it revolves around the Finch family, particularly the young girl Scout Finch and her older brother Jem. The narrative is primarily a retrospective account by Scout, looking back on her childhood…

Gemini:

To Kill a Mockingbird, narrated by the young Scout Finch, unfolds in the Depression-era Southern town of Maycomb, Alabama. It explores themes of racial injustice, prejudice, and the power of empathy through the lens of childhood innocence.

Content Generation

Prompt:

Generate a lab report for a chemistry class where students conducted the flame tests on various compounds.

CHATGPT:

Title: Flame Tests on Various Compounds

Abstract:
The flame test is a qualitative analysis technique used to identify the presence of certain metal ions based on the characteristic colors emitted when exposed to a flame. In this experiment, flame tests were conducted on various compounds to observe and identify the distinctive flame colors associated with different metal ions.

Objective:
To perform flame tests on a set of unknown compounds and identify the metal ions present based on the observed flame colors.

Materials and Methods:
1. **Compounds:**

GEMINI:

Flame Test Lab Report

Experiment Title: Identification of Elements Using Flame Tests

Date: [Date of Experiment]

Group Members: [List your group members]

Instructor: [Instructor Name]

Abstract:

This experiment aimed to identify various elements present in unknown compounds using the principles of flame tests. By observing the characteristic colors emitted by the excited electrons of metals in the flame, we were able to identify the presence of specific elements in each sample. The observed colors were compared to reference values to confirm the element's identity.

Code Generation

Prompt:

Can you provide Python code to read in a dataframe with Name, Dept, remove missing values, then group by Dept?

Response:

```
import pandas as pd

# Read the DataFrame from a CSV file (replace 'your_data.csv' with your actual file path)
df = pd.read_csv('your_data.csv')

# Remove rows with missing values in any column (including Name and Dept)
df_cleaned = df.dropna()

# Group the DataFrame by the Dept column
grouped_by_dept = df_cleaned.groupby('Dept')

# You can now perform operations on each department group
# For example, print the size (number of rows) of each department
print(grouped_by_dept.size())
```

Code Interpretation

Prompt:

Given the Penguins dataset in Python, what does this line of code do?

```
sub_df = df[(df['flipper_length_mm'] == 9) & (df['bill_length_mm'] < 4)]
```

Response:

This line of code filters the penguins dataframe (df) to create a new dataframe (sub_df) containing only penguins that meet specific criteria based on their flipper and bill measurements.

Here's a breakdown:

- sub_df = df[...]: This assigns the result of the filtering operation within the brackets to a new dataframe named sub_df.
- (df['flipper_length_mm'] == 9): This part filters the dataframe to include only rows where the value in the flipper_length_mm column is exactly equal to 9 millimeters.
- &: The & symbol represents the logical AND operator. It ensures that only penguins meeting both the flipper length and bill length criteria are included in the new dataframe.
- (df['bill_length_mm'] < 4): This part filters the dataframe to include only rows where the value in the bill_length_mm column is strictly less than 4 millimeters.

In summary, this code snippet creates a dataframe sub_df containing penguins with a flipper length of exactly 9 millimeters and a bill length strictly less than 4 millimeters.

Code Debugging

Prompt:

Can you debug this code?

```
import pandas as pd
df = pd.DataFrame({'A': ['1', '2', '3']})
df[‘A’] + 1
```

The error is TypeError: can only concatenate str (not "int") to str

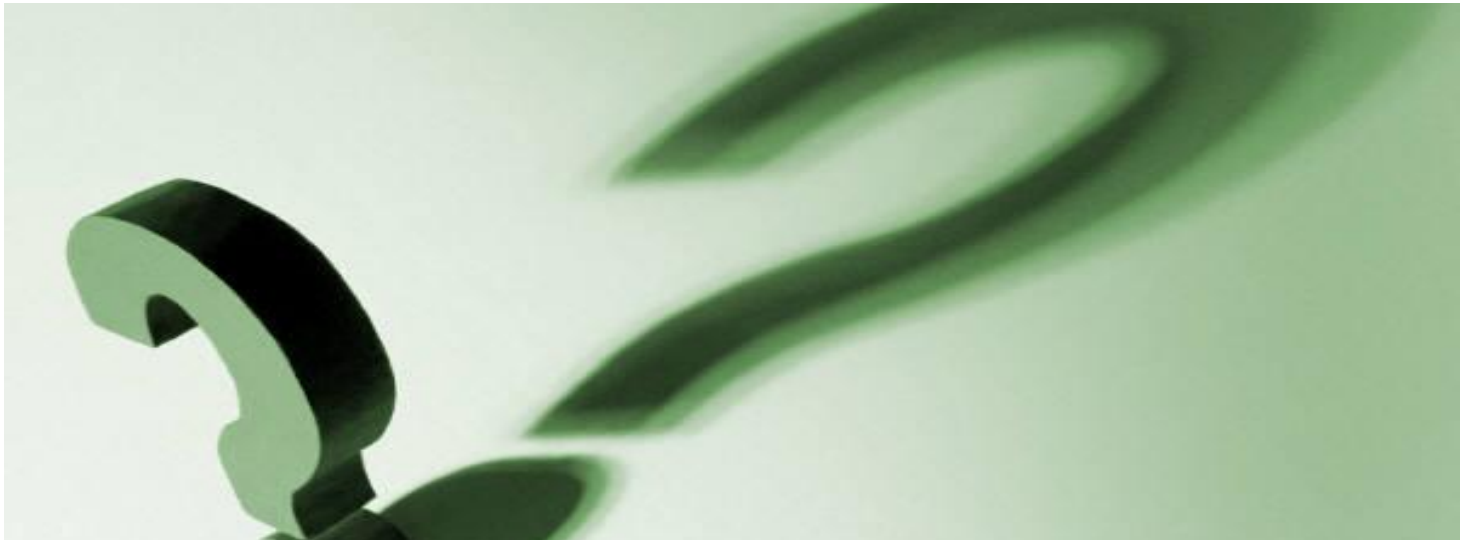
Response:

The error arises because you're trying to perform arithmetic (+) between a string ('1', '2', '3') and an integer (1). In Python, you cannot directly concatenate (join) strings and integers.

To fix this, we need to convert the string elements in column 'A' to numerical data types (integers in this case) before attempting any mathematical operations. Here's the corrected code:

```
import pandas as pd
df = pd.DataFrame({'A': ['1', '2', '3']})
df['A'] = pd.to_numeric(df['A'])
df['A'] = df['A'] + 1
print(df)
```

Questions?



Hands-On & Demo

Prompt Engineering Hands-On

- **Description**
  - Prompt engineering exercises
  - LLMs:
    - ChatGPT: https://chatgpt.com
    - Gemini: https://gemini.google.com

- **Material**
  - Prompt Engineering Hands-On Workbook.pdf
  - Prompt Engineering Hands-On Solution.pdf

API Prompting Demo

- **Description**
  - Access LLM programmatically
  - LLM: GPT-3 and GPT-4 models
  - API: OpenAPI
    - Need to have OpenAPI account
    - Pay-as-you-go or subscription plan
- **Material**
  - openai-api.ipynb
    - API prompting basics
  - openai-api-conversation.ipynb
    - Use chat history to have conversation with model

Prompt Engineering Resources

- https://help.openai.com/en/articles/6654000-best-practices-for-prompt-engineering-with-the-openai-api
- https://arxiv.org/pdf/2201.11903
- https://konfuzio.com/en/python-tutorial-complexity/

OpenAI API Resources

- Create account: https://platform.openai.com/
- Get API key: https://platform.openai.com/api-keys
- Add payment: https://openai.com/api/pricing/
- Documentation: https://platform.openai.com/docs/overview
- Models: https://platform.openai.com/docs/models
- API Reference: https://platform.openai.com/docs/api-reference/fine-tuning

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Questions?