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Generative AI for Risk and Reliability

Lect 3: Prompt engineering

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10/December/2024

Outline

- Prompt engineering: What and Why?
- Principles of effective prompting
- Commonly-used prompt techniques
  - Zero-shot
  - Few-shot
  - Chain-of-Thought (CoT)
- Summary

Prompt engineering: What

- A prompt for a Large Language Model (LLM) is a text input that initiates a conversation or triggers a response from the model. However, it can be in other forms such as an image or audio [1].
- Prompt engineering is the process of designing and optimizing input prompts to effectively guide a language model's responses [1].

[1] https://help.openai.com/en/articles/10032626-prompt-engineering-best-practices-for-chatgpt

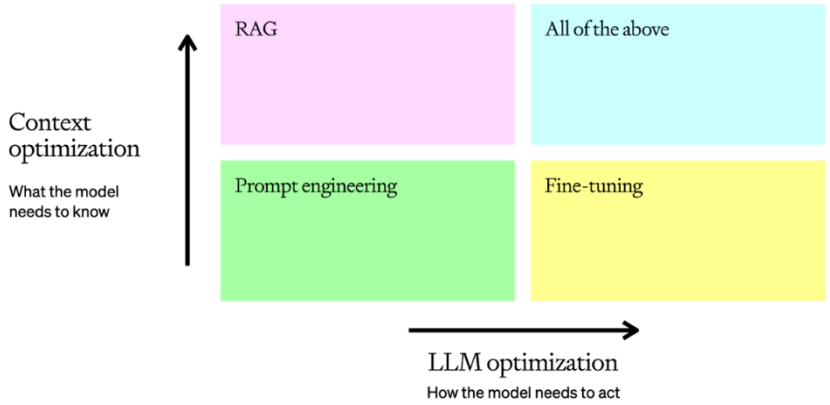
Prompt engineering: Why

- The nature of LLM: Different prompts have different effectiveness.
- Model hallucination: Sometimes LLM makes up facts. Designing prompts properly is an important solution.
  - “what happened to google at 13 december 2011?”
  - “what happened to google at 13 december 2011? answer only with credible source. if you are not sure or cannot find anything, say "I don't know".

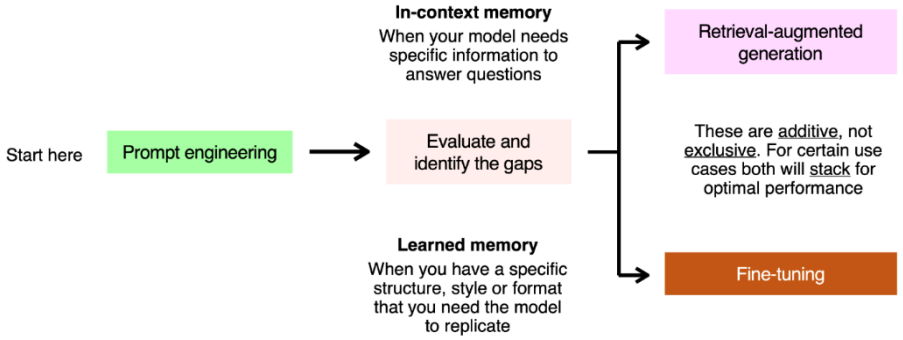
Prompt engineering: What and Why?

If you want to improve further?

- Start with prompt engineering!
- Even though the results are not good, analyzing the results of prompt engineering can be good inputs for other techniques.



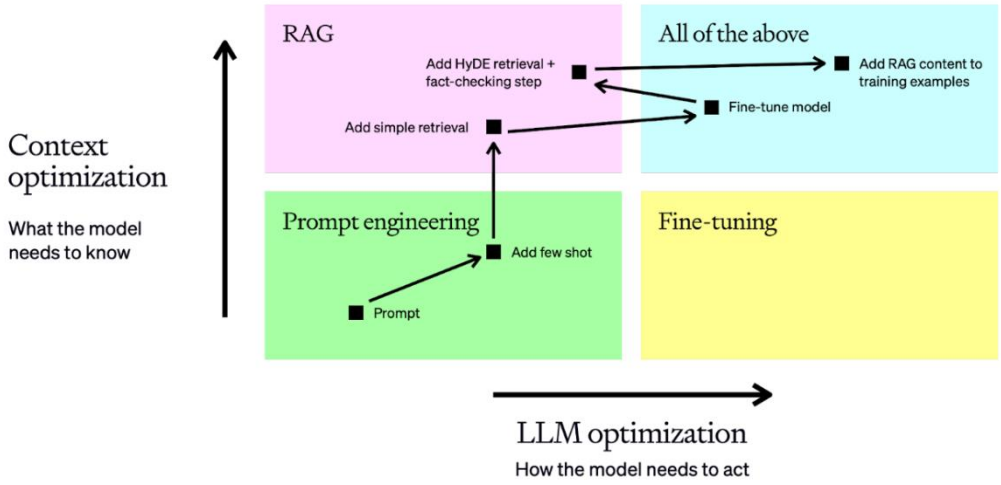
https://platform.openai.com/docs/guides/optimizing-llm-accuracy#understanding-the-tools



Prompt engineering: What and Why?

A high-level example from OpenAI

- Begin with a prompt, then evaluate its performance
- Add static few-shot examples, which should improve consistency of results
- Add a retrieval step so the few-shot examples are brought in dynamically based on the question - this boosts performance by ensuring relevant context for each input
- Prepare a dataset of 50+ examples and fine-tune a model to increase consistency
- Tune the retrieval and add a fact-checking step to find hallucinations to achieve higher accuracy
- Re-train the fine-tuned model on the new training examples which include our enhanced RAG inputs



https://platform.openai.com/docs/guides/optimizing-llm-accuracy#understanding-the-tools

Principles of effective prompting

- To have a good answer, you need to make sure
  - Your prompt can contain everything you want, and
  - Organize in an easy way for the LLM to find relevant information in its training set.
- Six strategies for getting better results
  - Write clear instructions
  - Provide reference text
  - Split complex tasks into simpler subtasks
  - Give the model time to "think“
  - Use external tools
  - Test changes systematically
  - See: https://platform.openai.com/docs/guides/prompt-engineering#six-strategies-for-getting-better-results

How to send prompts through the API?

```python
from openai import OpenAI
client = OpenAI()

response = client.chat.completions.create(
  model="gpt-4o-mini",
  messages=[
    {
      "role": "system",
      "content": [
        {
          "type": "text",
          "text": "You are an useful assisant."
        }
      ]
    }
  ],
  response_format={
    "type": "text"
  },
  temperature=0.61,
  max_tokens=1815,
  top_p=1,
  frequency_penalty=1.39,
  presence_penalty=0
)
```

System prompt: The instruction you gave to the model.

top_k: Control the randomness of the sampling. As temperature. Usually we only adjust one of them, not both.

Frequency_penalty and presence_penalty both penalize the repeat of words in the response. Normally we only adjust one of them, not both.

How to send prompts through the API – Include history of conversation

```python
from openai import OpenAI
client = OpenAI()

response = client.chat.completions.create(
  model="gpt-4o-mini",
  messages=[
    {
      "role": "system",
      "content": [
        {
          "type": "text",
          "text": "You are an useful assisant."
        }
      ]
    },
    {
      "role": "user",
      "content": [
        {
          "type": "text",
          "text": "Hell, who are you?"
        }
      ]
    },
    {
      "role": "assistant",
      "content": [
        {
          "type": "text",
          "text": "Hello! I'm an AI assistant here to help you with information
        }
      ]
    },
    {
      "role": "user",
      "content": [
        {
          "type": "text",
          "text": "What's your name?"
        }
      ]
    },
    {
      "role": "assistant",
      "content": [
        {
          "type": "text",
          "text": "I don't have a personal name, but you can call me Assistant.
        }
      ]
    }
  ],
  response_format={
    "type": "text"
  },
  temperature=0.61,
  max_tokens=1815,
  top_p=1,
  frequency_penalty=1.39,
  presence_penalty=0
)
```

Zero-shot prompting

- Zero-shot prompting means that the prompt used to interact with the model won't contain examples or demonstrations. The zero-shot prompt directly instructs the model to perform a task without any additional examples to steer it.
- So you directly give your requestion to the LLM.
- For tasks like text summary, classification, etc, zero-shot prompts work well.

Prompt:

```
Classify the text into neutral, negative or positive.
Text: I think the vacation is okay.
Sentiment:
```

Output:

```
Neutral
```

Few-shot prompting

- In stead of zero-shot, give few examples of similar tasks, but with solution.

Prompt:

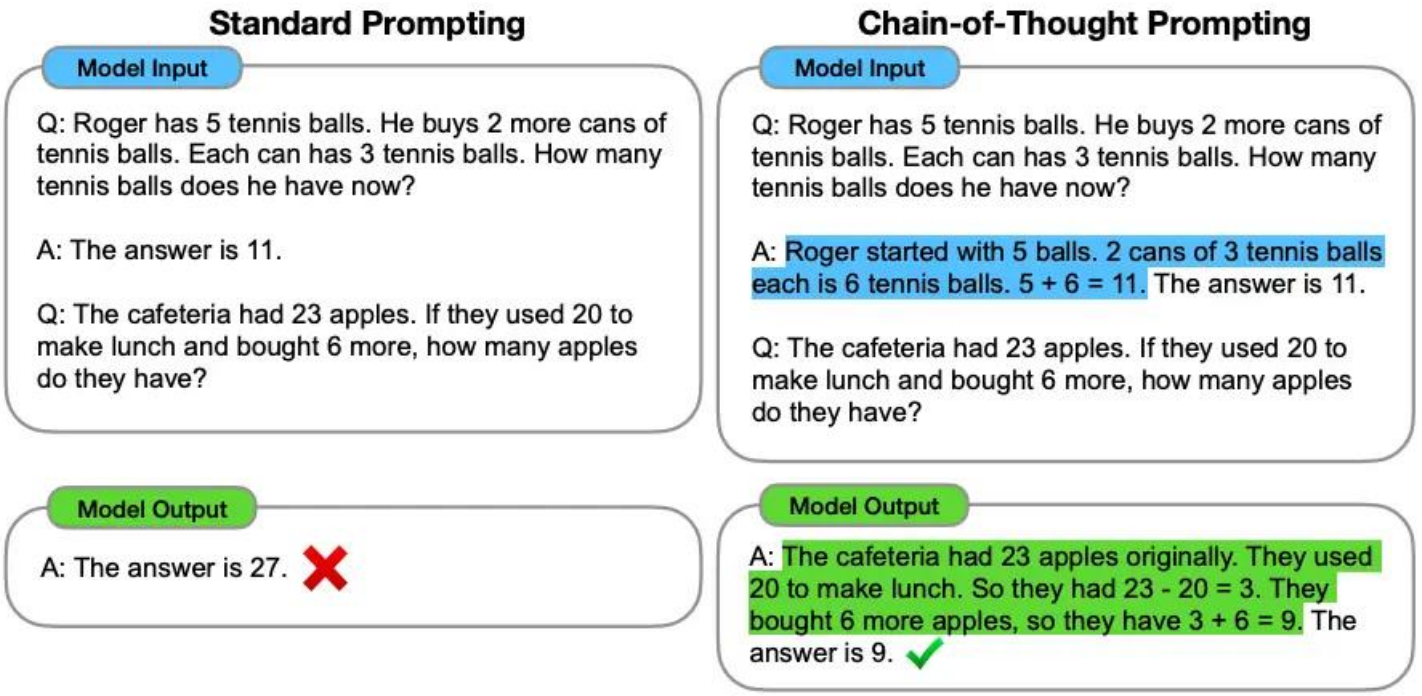
```
This is awesome! // Negative
This is bad! // Positive
Wow that movie was rad! // Positive
What a horrible show! //
```

Output:

```
Negative
```

Chain-of-Thought prompting

- Apart from question, give few examples. The examples should highlight the reasoning process.
  - Few shot prompting with CoT.
  - Or simply add "Let's think step-by-step" in your prompt.



https://arxiv.org/pdf/2201.11903

Chain-of-Thought prompting

User

Alice has 5 brothers and she also has 2 sisters. How many sisters does Alice's brother have?

Assistant

Alice has 2 sisters. Since Alice's brothers share the same siblings, each of her brothers also has 2 sisters. Therefore, Alice's brother has 2 sisters.

User

Alice has 5 brothers and she also has 2 sisters. How many sisters does Alice's brother have? Think step-by-step.

Assistant

Let's analyze the situation step by step:

1. **Identify Alice's siblings**:
   - Alice has 5 brothers.
   - Alice has 2 sisters.

2. **Determine how many siblings each brother has**:
   - Each of Alice's brothers is also a sibling to all of her sisters, including Alice herself.

3. **Count the number of sisters for each brother**:
   - Each of her brothers will have the same number of sisters as Alice does, which includes both his own sisters and also himself as a brother.
   - Since there are 2 other girls (sisters) plus one girl (Alice), each brother has a total of 3 sisters.

4. **Conclusion**:
- Therefore, each of Alice's brothers has 3 sisters.

So, the answer is that each brother has **3 2,604ms ↑34t ↓173t

Self-consistency prompting

- Improved chain-of-thoughts.
- Instead of generate one answer, generate more diverse answers.
- Aggregate to get final answer.

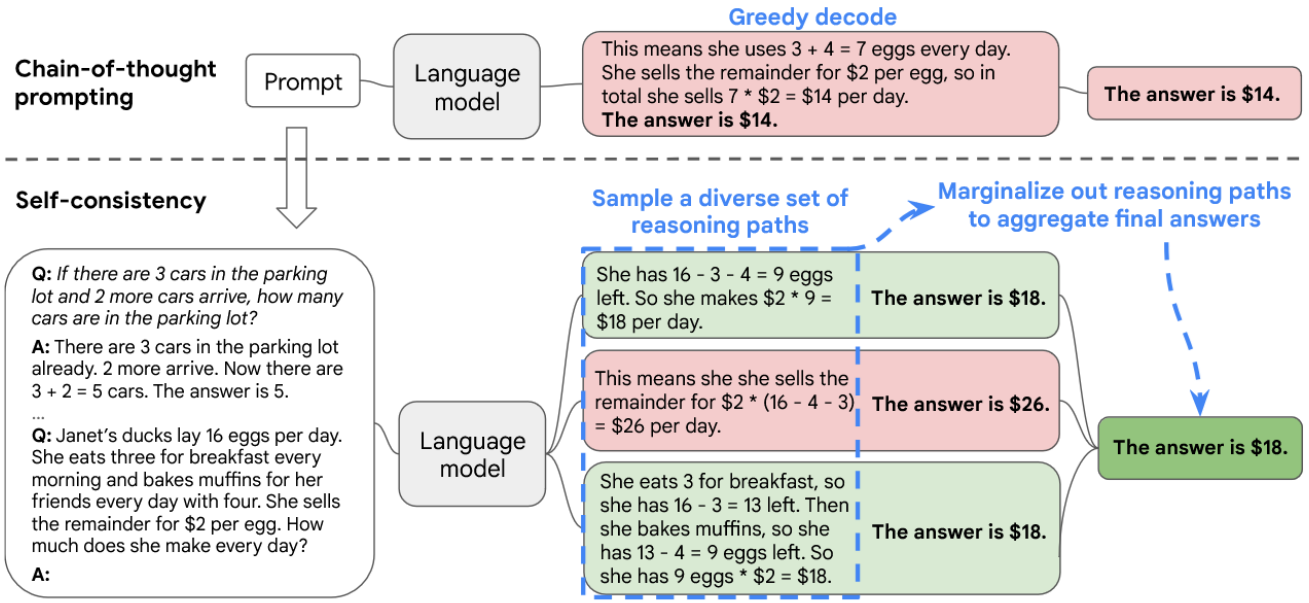
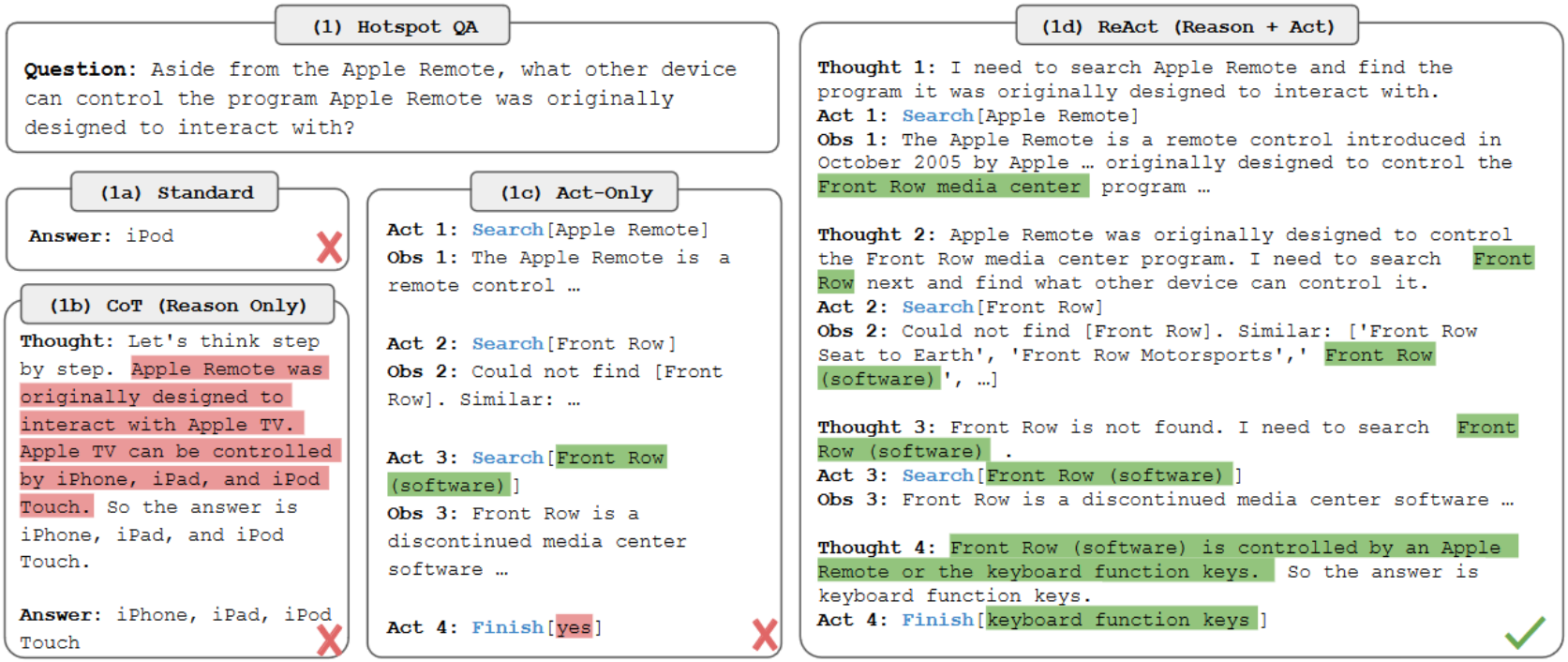


Figure 1: The self-consistency method contains three steps: (1) prompt a language model using chain-of-thought (CoT) prompting; (2) replace the "greedy decode" in CoT prompting by sampling from the language model's decoder to generate a diverse set of reasoning paths; and (3) marginalize out the reasoning paths and aggregate by choosing the most consistent answer in the final answer set.

https://arxiv.org/pdf/2201.11903

ReAct

- Generating reasoning traces allow the model to induce, track, and update action plans, and even handle exceptions.
- Allow models to take actions: Use external tools.
- System prompt (leaked) of ChatGPT: https://github.com/0xeb/TheBigPromptLibrary/blob/main/SystemPrompts/OpenAI/gpt4o_10192024.md



https://arxiv.org/abs/2210.03629

Summary

- Prompt engineering is an important starting point of LLM performance improvement.
- As foundation model improves, some prompt engineering techniques are by default implemented. But it is still important to understand them as generic models are not guaranteed to work everywhere.

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Thank you! Questions?