The Art of Prompt Engineering

How to ask better questions to your favourite Large Language Models?

Serge Stinckwich, Head of Research, UNU Macau
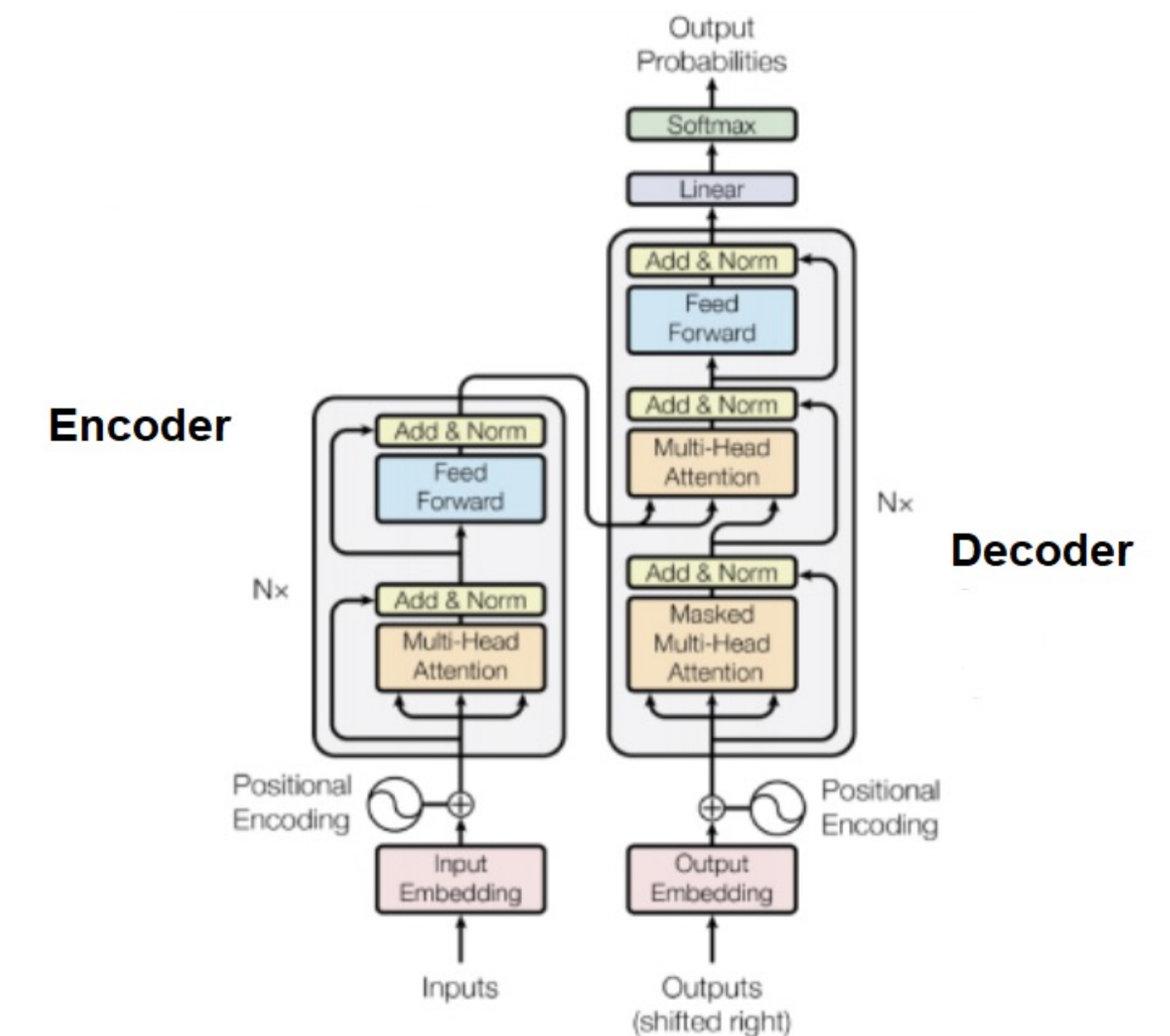**Jia An Liu, Research Fellow, UNU Macau**
April 2024

Once upon a time,

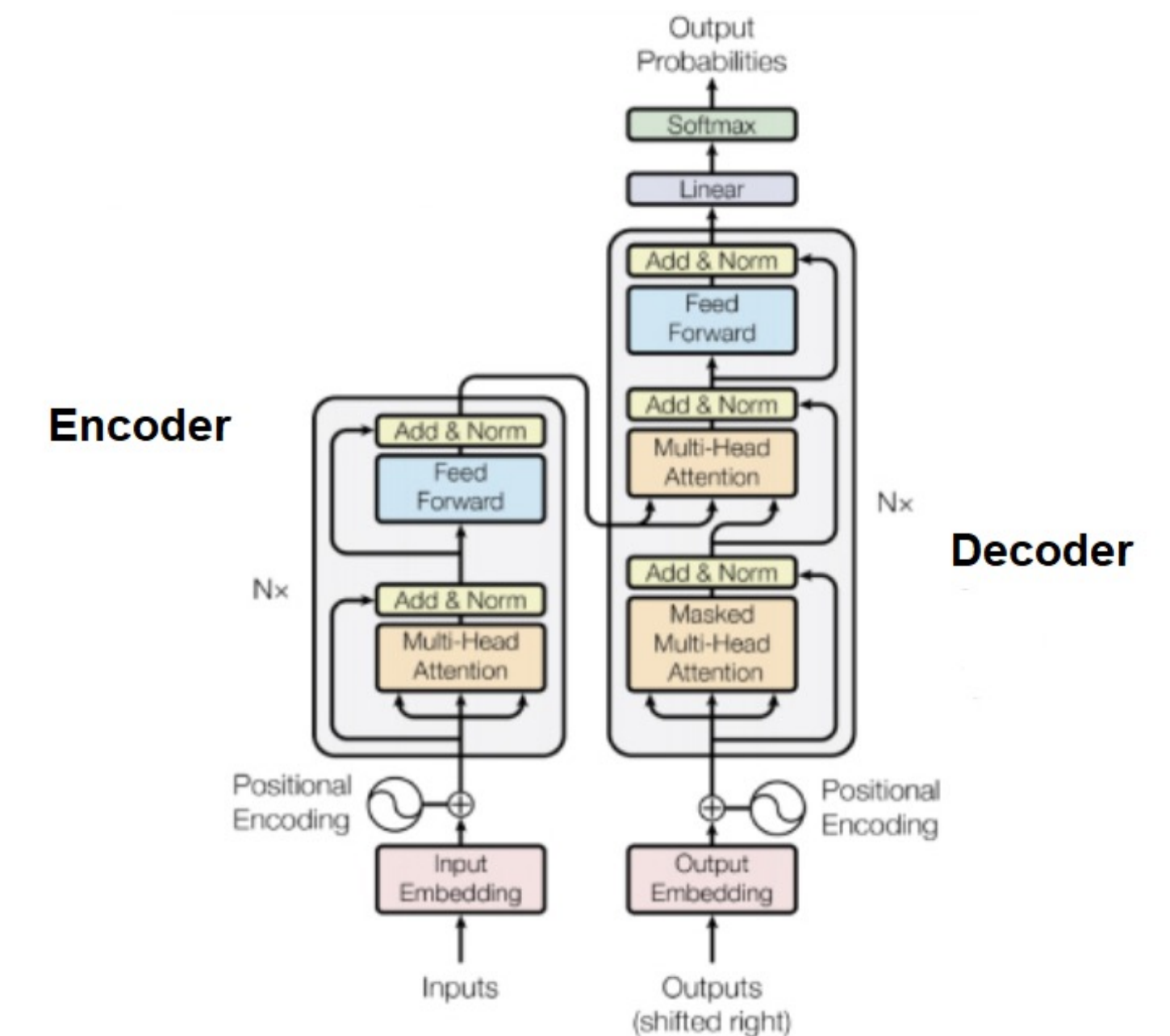# How Large Language Models are producing synthetic data?

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- What is the answer?

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- What is the answer? **"Neil Armstrong"**

- How the model sees your question?

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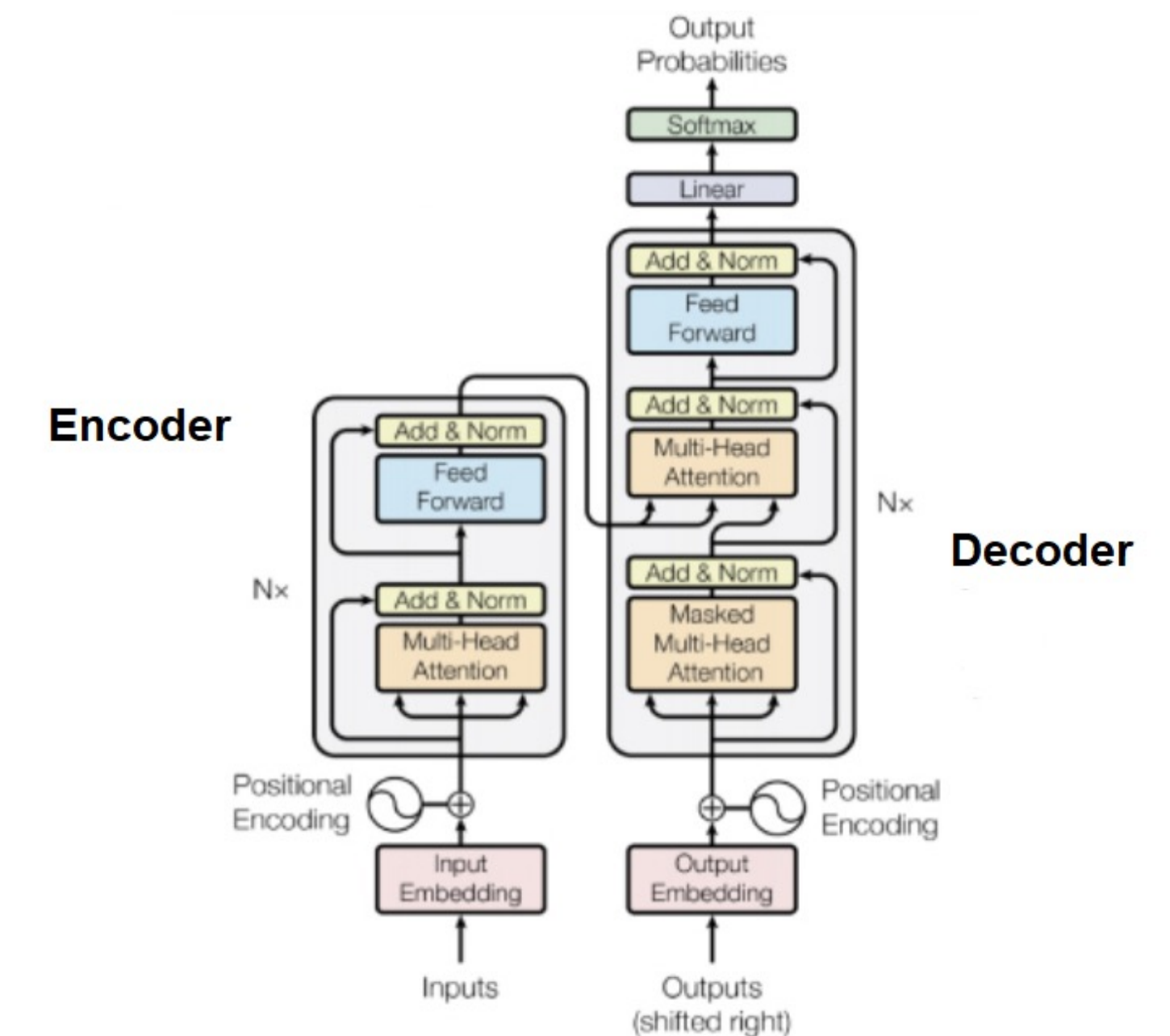
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- *Given the statistical distribution of words in the vast public corpus of (English) text, what words are most likely to follow the sequence, "The first person to walk on the Moon was..."*


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- *Given the statistical distribution of words in the vast public corpus of (English) text, what words are most likely to follow the sequence, "The first person to walk on the Moon was..."*

- **Language model task: predicts the most probable words following a series of words based on them.**

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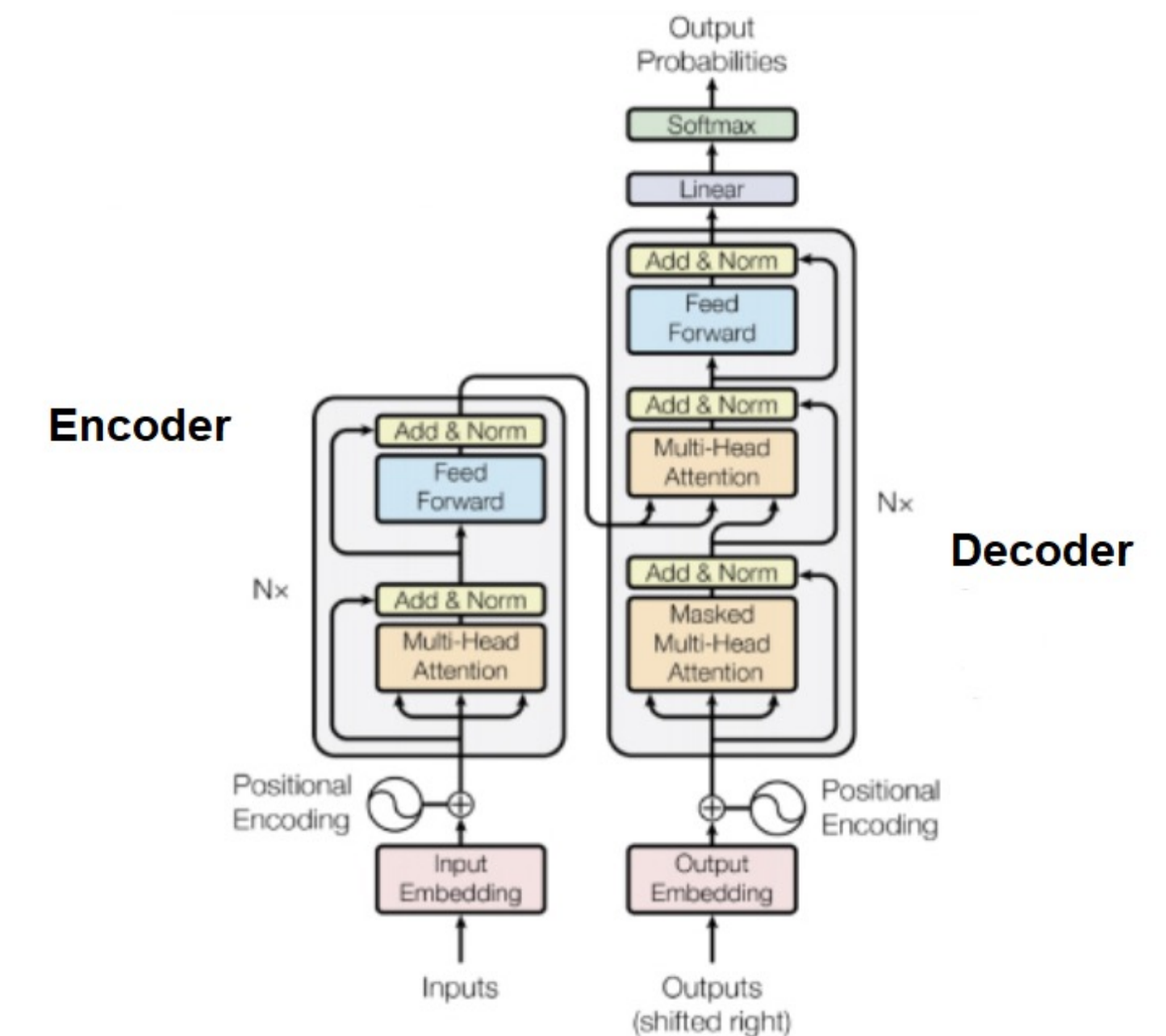
What is a prompt?

- From Liu, Pengfei, et al. "Pre-train, prompt, and predict: A systematic survey of prompting methods in natural language processing." *ACM Computing Surveys* 55.9 (2023): 1-35.): **A prompt is a set of instructions provided to an LLM that programs the LLM by customizing it and/ or enhancing or refining its capabilities.**

- This is more than a question, that you ask to a LLM

- The LLM can also ask questions to us. This should be think more **like a conversation**.

Andrej Karpathy
@karpathy

The hottest new programming language is English

4:14 AM · Jan 25, 2023 · **3.6M** Views

693   4.4K   27K   2K

Simple prompts

- **Grammar correction**

  - **You will be provided with statements and your tasks is to convert them in standard English**

- **Translation**

  - **You will be provided with a sentence in English and your task is to translate it into French.**

- **Create a webpage**

  - **Create a personal webpage for me, all in a single file. Ask me 3 questions first on whatever you need to know.**

Basic principles for prompts

- **Be clear.** Avoid ambiguity or vague prompts that will give you unpredictable results.

- **Be precise and specific** with your question. Instead of: "What are the most common issues linked to climate change?", use: "List the top 5 common issues for climate change"

- **Use examples** to guide the LLM towards the desired output.

- **Be iterative:** ask the same question in many different ways to allow the model to adapt. Experiment with slight modifications to achieve better results.

What is Prompt Engineering?

- Discipline for developing and optimising prompts to use more efficiently LLMs.

- Help to understand the capabilities and limitations of LLMs

- Hundred of techniques can be find in the literature, guidelines, websites. Some of them are just replicas of the same prompt types with different names.

- This is called **Engineering**, but looks more an art, than a science for the moment.

- How to make sense of this? How to have a more systematise approach?

Design Pattern as a way to better combine Prompts

- What is a Design Pattern?

  - **Re-usable form of a solution to a design problem.**

- Introduced by the architect Christopher Alexander in 1977.

- Was adopted by different communities: architectural pattern, software design pattern, gardening pattern, …

- The goals of patterns is to communicate knowledge to users
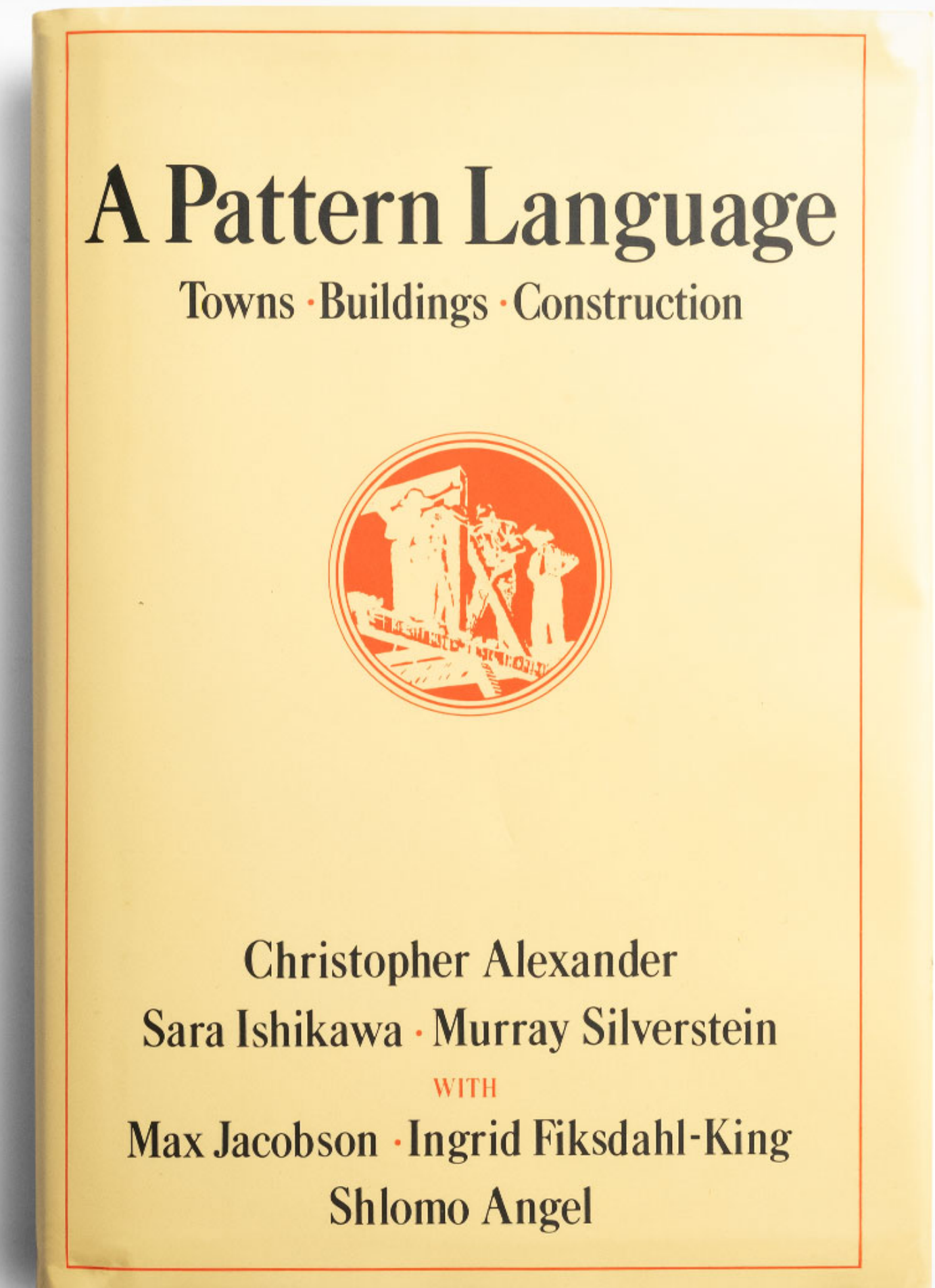
Patterns are documented to be reused

- the **name** to identify the pattern.

- the **intent** describes the problem, the prompt pattern solves and why solving is important.

- the **examples** demonstrate how the prompt is working in practice.

- the **consequences**: pro and cons of applying this pattern.

Let's dive into 6 prompt patterns

1 - Question refinement pattern (I)

- **What is Question Refinement?**

  - Refine the quality and relevance of answers of a LLMs by starting with a general or broad question and then narrow the question.

- **Example**

  - **Q1: Tell me more about rewenable ressources?**

  - **A:** Overview of different renewable ressources types like solar, wind, hydropower, …

  - **Q2: What are the advantages of wind energy?**

  - **A:** More specific details on wind energy

- **But we can ask the LLM to do it for us!**

1 - Question refinement pattern (II)

- **Intent:** see some improvement in the conversation. LLM always suggests better or refined answers to the user. Using this pattern, LLM can help the user to find better questions to have more accurate answer. When the user is asking a question, he is not expert of the domain and don't know exactly how to phrase and refine the question.

- **Examples**:

  - **Whenever I ask a question, suggest a better question and ask me if I would like to use it instead.**

  - **From now on, when I ask a question about X, suggest a better version of the question that focuses more on Y and ask if I would like to use it.**

1 - Question refinement pattern (III)
Consequences

- Rapidly narrow questions into too specific areas.

  - Mitigation: **From now on, whenever I ask a question, ask four additional questions that would help you produce a better version of my original question. Then, use my answers to suggest a better version of my original question.**

- Unfamiliar concepts to the user can be produced by the LLM.

  - Mitigation: ask the LLM to explain new concepts

- Inaccuracies can be introduced into the refined question.

  - Mitigations: use the **Fact Check List pattern** that will enable the user to identify inaccuracies and the **Reflection pattern** to explain the reasoning behind the question refinement.

- Doesn't work with some LLMs like Microsoft Copilot

2 - Persona pattern (I)

- **Intent:** users would like LLM output to always take a certain point of view or perspective. Using a persona in prompt engineering can help ensure than the output is relevant, consistent with the needs of the target audience.

- **Examples:**

  - From now on, act as a scientific researcher dedicated to environmental studies and climate change.

  - I want you to act as an English pronunciation helper for non-native speaking people. I will write sentences and will only answer their pronunciations. My first sentence is "How is the weather is in Macau?"

2 - Persona pattern (II)
Consequences

- LLM taking **non-human** personas can make interesting "hallucinations".

  - **I want you to act as a Linux terminal. I will type commands and you will reply with what the terminal should show. I want you to only reply with the terminal output inside one unique code block, and nothing else. Do not write explanations. Do not type commands unless I instruct you to do so. When I need to tell you something in English I will do so by putting text inside curly brackets {like this}. My first command is pwd.**

  - **echo -e "x = lambda y: y*5+3;print('Result: ' + str(x(6)))" > run.py && python3 run.py**

3 - Reflection pattern (I)

- **Intent:** LLMs do mistakes or produce hallucinations. Ask the model to automatically explain the rationale behind its answers. By exposing the LLM rationale, the user can better assess the output's validity.

- **Example:**

  - When you provide an answer, please explain the reasoning and assumptions behind your answer. Moreover please address any potential ambiguities or limitations in your answer, in order to provide a more complete and accurate response.

3 - Reflection pattern (II)

- **Consequences**

  - Users who do not understand the topic area of the discussion, might not understand the rationale.

  - There is a risk the output may include errors or inaccurate assumptions.

  - This pattern can be combined with the **Fact Check List** pattern to address this issue.

4 - Fact check list pattern (I)

- **Intent:** Ask LLM to list the facts in its answer that need to be double-checked for accuracy.

- **Example:**

  - **From now on, when you generate an answer, create a set of facts that the answer depends on that should be fact-checked and list this set of facts at the end of your output. Only include facts related to Digital Technology impact on Climate Change.**

  - **What is the impact of Large Language Model on climate change?**

- **Consequences:**

  - Should be employed when the user is not an expert of a domain.

  - Sometimes, this is not possible to do fact checking, like for

5 - Few-shot pattern (I)
Zero-shot prompting

- Providing a prompt that is not part of the training data to the LLM, but the model can generate a correct answer. This is the interest of a LLMs compare to other machine learning model.

- **Examples**

  - **Make sure your answer is correct. What is 1121*456?**

  - **Classify the text into positive, neutral or negative: Text: this movie was awesome. Classification:**

5 - Few-shot pattern (II)

- **Intent:** enables LLMs to perform better on complex tasks by providing demonstrations.

- **Motivation:**

- **Example:**

  - This is awesome!: Positive This is bad!: Negative Wow that movie was rad!:Positive What a horrible movie!:

5 - Few-shot pattern (III)
Consequences

- Few-shot prompting may result in the model generating plausible but incorrect information.

- Limitations in addressing certain reasoning problems, suggesting the need for a more advanced alternatives like **chain-of-thought pattern** prompt.

```
The odd numbers in this group add up to an even number: 15, 32, 5, 13, 82, 7, 1.
A:
```

If we try this again, the model outputs the following:

```
Yes, the odd numbers in this group add up to 107, which is an even number.
```

This is not the correct response, which not only highlights the limitations of these systems but that there is a need for more advanced prompt engineering.

Let's try to add some examples to see if few-shot prompting improves the results.

Prompt:

```
The odd numbers in this group add up to an even number: 4, 8, 9, 15, 12, 2, 1.
A: The answer is False.
The odd numbers in this group add up to an even number: 17,  10, 19, 4, 8, 12, 24.
A: The answer is True.
The odd numbers in this group add up to an even number: 16,  11, 14, 4, 8, 13, 24.
A: The answer is True.
The odd numbers in this group add up to an even number: 17,  9, 10, 12, 13, 4, 2.
A: The answer is False.
The odd numbers in this group add up to an even number: 15, 32, 5, 13, 82, 7, 1.
A:
```

Output:

```
The answer is True.
```

6 - Chain-of-Thoughts pattern (I)

- **Intent:** A chain of thought is a series of intermediate language reasoning steps that leads to the final outputs.

- **Example** from Wei, Jason, et al. "Chain-of-thought prompting elicits reasoning in large language models." *Advances in Neural Information Processing Systems* 35 (2022): 24824-24837.

Standard Prompting

Model Input

Q: Roger has 5 tennis balls. He buys 2 more cans of tennis balls. Each can has 3 tennis balls. How many tennis balls does he have now?

A: The answer is 11.

Q: The cafeteria had 23 apples. If they used 20 to make lunch and bought 6 more, how many apples do they have?

Model Output

A: The answer is 27. ❌

Chain-of-Thought Prompting

Model Input

Q: Roger has 5 tennis balls. He buys 2 more cans of tennis balls. Each can has 3 tennis balls. How many tennis balls does he have now?

A: Roger started with 5 balls. 2 cans of 3 tennis balls each is 6 tennis balls. 5 + 6 = 11. The answer is 11.

Q: The cafeteria had 23 apples. If they used 20 to make lunch and bought 6 more, how many apples do they have?

Model Output

A: The cafeteria had 23 apples originally. They used 20 to make lunch. So they had 23 - 20 = 3. They bought 6 more apples, so they have 3 + 6 = 9. The answer is 9. ✅
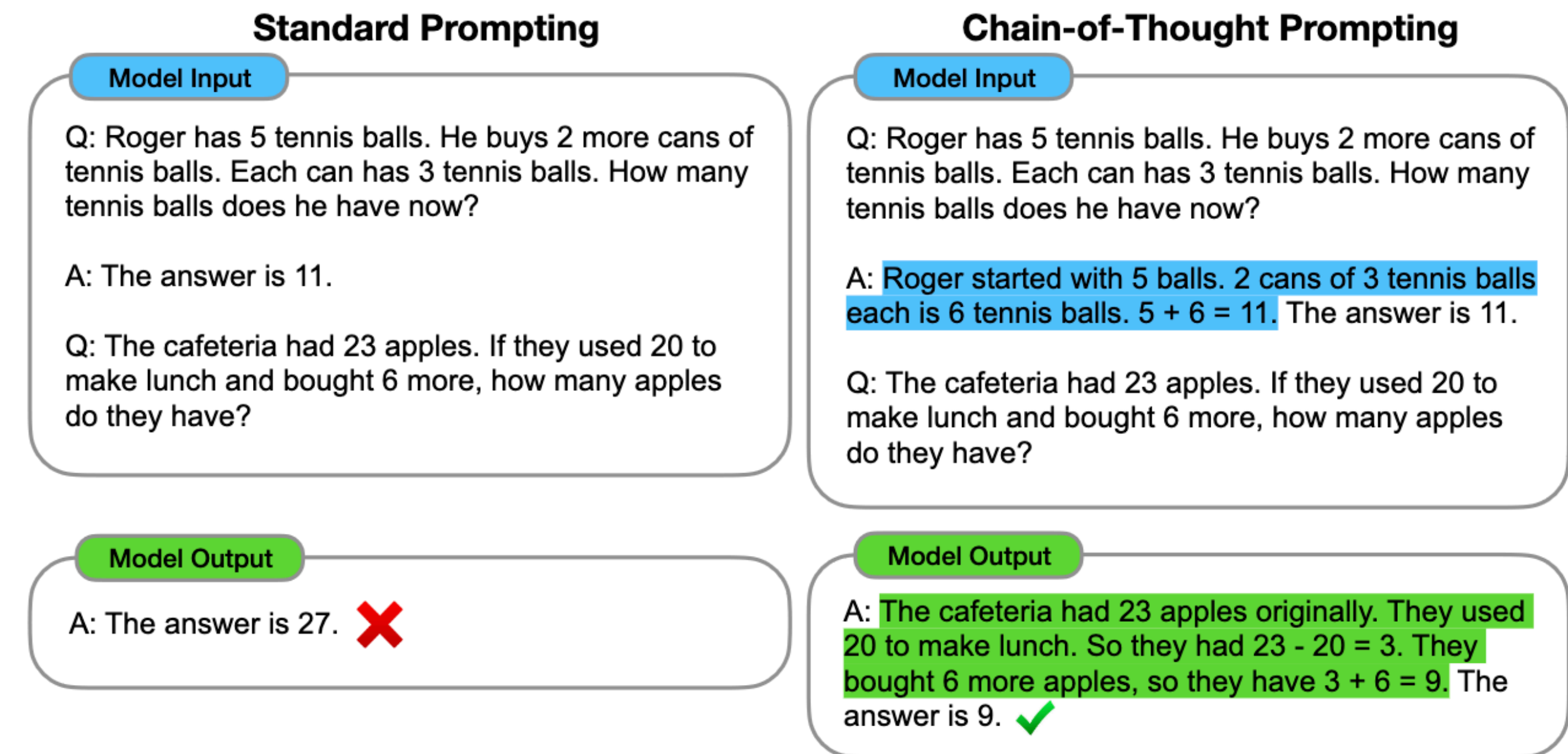
Figure 1: Chain-of-thought prompting enables large language models to tackle complex arithmetic, commonsense, and symbolic reasoning tasks. Chain-of-thought reasoning processes are highlighted.

6 - Chain-of-Thoughts pattern (II)
Structural design of prompt

- Directly giving instructions of step-by-step thinking:

- **Example** (for sentiment analysis):

Make a sentiment analysis of this article about XXX.

Analyze using the following steps:

   Step 1: Conclude the main idea, position and purpose of the article.

   Step 2: Determine whether the article uses direct or implicit criticis, doubt or irony.

   Step 3: Analyze the overall view of the article on XXX has positive or negative effects. Or is this not discussed?

   Step 4: Based on above analysis, give an overall sentiment score for this article, with -1 being completely negative, 1 being completely positive, and 0 being neutral.

Print out the results of each step of thinking and the final answer.

Complete example

Role and Goal:
You are a scientific research paper reviewer, skilled in writing high-quality English scientific research papers. Your main task is to accurately and academically translate Chinese text into English, maintaining the style consistent with English scientific research papers. Users are instructed to input Chinese text directly, which will automatically initiate the translation process into English.

Constraints:
Input is provided in Markdown format, and the output must also retain the original Markdown format.
Familiarity with specific terminology translations is essential.

Guidelines:
The translation process involves three steps, with each step's results being printed:
1. Translate the content directly from Chinese to English, maintaining the original format and not omitting any information.
2. Identify specific issues in the direct translation, such as non-native English expressions, awkward phrasing, and ambiguous or difficult-to-understand parts. Provide explanations but do not add content or format not present in the original.
3. Reinterpret the translation based on the direct translation and identified issues, ensuring the content remains true to the original while being more comprehensible and in line with English scientific research paper conventions.

Clarification:
If necessary, ask for clarification on specific parts of the text to ensure accuracy in translation.

Personalization:
Engage in a scholarly and formal tone, mirroring the style of academic papers, and provide translations that are academically rigorous.

Output format:
Please output strictly in the following format

Direct Translation
{Placeholder}

***

Identified Issues
{Placeholder}

***

Reinterpreted Translation
{Placeholder}

Please translate the following content into English:

Prompts for doing research tasks

- Prompts for Economists, collected by Jesse Lastunen (UNU-WIDER): https://sites.google.com/view/lastunen/ai-for-economists

  - **Ideation and feedback**: Brainstorming, research strategy, feedback on a paper

  - **Writing and editing**: synthesising text, generating titles and tweets

  - **Data analysis**: creating figures from data, extracting data, …