Chain-of-thought Prompting

Large Language Models (LLMs)

Learning goals

- illustrate chain-of-thought and point out the benefits it brings to LLMs
- illustrate tree-of-thought and point out the benefits it brings to LLMs

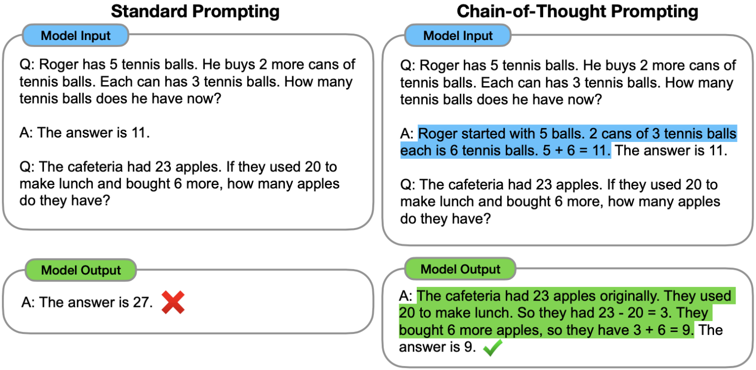
CHAIN-OF-THOUGH MOTIVATION

How to boost the reasoning capabilities of LLMs? ▸ Wei et al., 2021

- Training or tuning with formal languages works well
  - Still, templates & labeled data are costly to create
- Few-shot learning via prompting works for most tasks
  - Still, it works poorly on tasks that require reasoning
- Chain of thought (COT) prompting
  - Prompts in the form <input, *chain of thought*, output>
  - COT: series of intermediate steps that lead to a final output

CHAIN-OF-THOUGHT PROMPTING PARADIGM

CoT enables LLMs to tackle complex arithmetic, commonsense, and symbolic reasoning tasks.



Source: Wei et al., 2022

BENEFITS OF CHAIN-OF-THOUGHT

- Decompose multi-step problems and thus allocate more compute to problems requiring more reasoning steps
- By describing the reasoning, interpretability is increased. It provides the possibility to observe where reasoning went wrong
- It is closer to how humans solve tasks using language
- By designing a prompt, existing large language models are able to perform chain-of-thought reasoning.

EXAMPLES (1)

Examples of $\langle$input, chain of thought, output$\rangle$ triples for arithmetic, commonsense, and symbolic reasoning

StrategyQA

Q: Yes or no: Would a pear sink in water?

A: The density of a pear is about 0.6 g/cm^3, which is less than water. Thus, a pear would float. So the answer is no.

Date Understanding

Q: The concert was scheduled to be on 06/01/1943, but was delayed by one day to today. What is the date 10 days ago in MM/DD/YYYY?

A: One day after 06/01/1943 is 06/02/1943, so today is 06/02/1943. 10 days before today is 05/23/1943. So the answer is 05/23/1943.

Sports Understanding

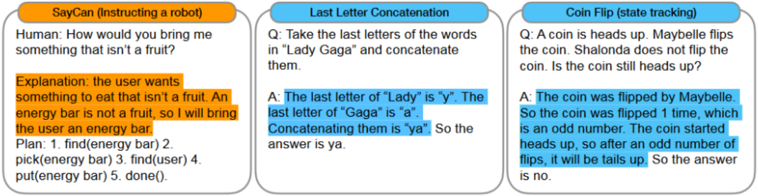
Q: Is the following sentence plausible? "Joao Moutinho caught the screen pass in the NFC championship."

A: Joao Moutinho is a soccer player. The NFC championship is part of American football, not soccer. So the answer is no.

Source: Wei et al., 2022

EXAMPLES (2)

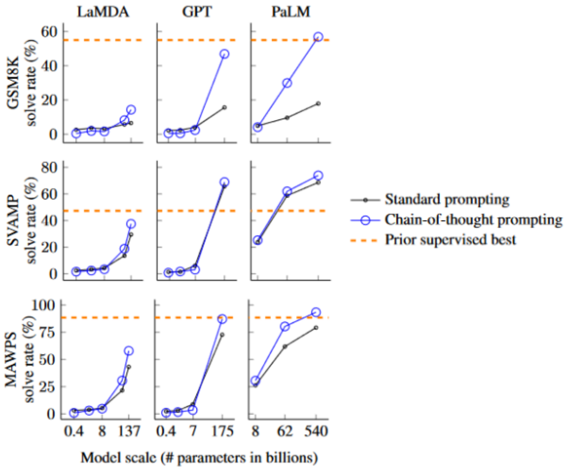
Examples of ⟨input, chain of thought, output⟩ triples for arithmetic, commonsense, and symbolic reasoning



▸ Source: Wei et al., 2022

PERFORMANCE (1)

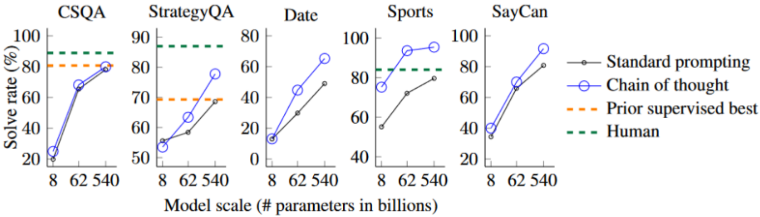
CoT prompting enables LLMs to solve challenging arithmetics.



Source: Wei et al., 2022

PERFORMANCE (2)

CoT prompting improves commonsense reasoning abilities of LLMs.



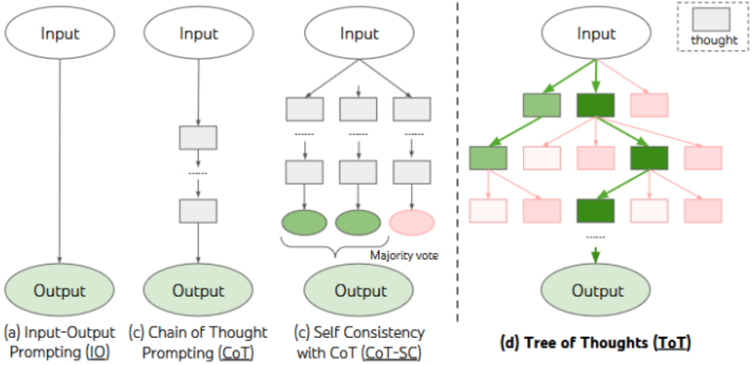
▸ Source: Wei et al., 2022

TREE-OF-THOUGHT: MOTIVATION

- The token-level and left-to-right decisions of the autoregressive mechanism pose a limitation for:
    - Tasks where initial decisions play a pivotal role
    - Tasks requiring exploration or strategic lookahead
- Potential strategy to solve those:
    - Maintain and explore diverse alternatives instead of just picking one
    - Evaluates current status and looks ahead or backtrack to make global decisions

TREE-OF-THOUGHT: PROMPTING PARADIGM

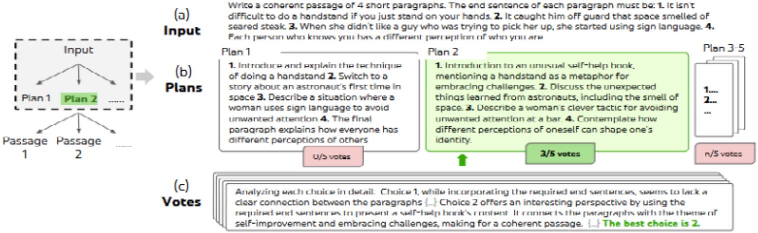
Schematic illustrating various approaches to problem solving with LLMs. Each rectangle box represents a *thought*, a coherent language sequence serving as an intermediate step toward problem solving.



▸ Yao et al., 2023

TREE-OF-THOUGHT FOR CREATIVE WRITING

A step of deliberate search in a randomly picked Creative Writing task. Given the input, the LM samples five different plans, and then votes five times to decide which plan is best.



Yao et al., 2023