

Chain-of-Thought Prompting Elicits Reasoning in Large Language Models

Introduction

Problem Scaling up LLM is insufficient for arithmetic, commonsense and symbolic reasoning.

Prior

- ▶ Teaching natural language rationale
- ▶ In-context few-shot prompting

Limit

- ▶ Costly to get rationale training dataset
- ▶ Few-shot prompting is not so effective on reasoning

Prop. Use *Chain-of-Thought Prompting*:

$\langle \text{input}, \textit{chain of thought}, \text{output} \rangle$

Chain-of-Thought Prompting

Chain of thought

Chain of intermediate reasoning steps that leads to the final answer.

Chain-of-Thought Prompting

The goal of this paper is to equip LLMs with ability to generate chain of thought through *Chain-of-Thought Prompting*, where few exemplars of chain-of-thought reasoning are provided by few-shot prompting.

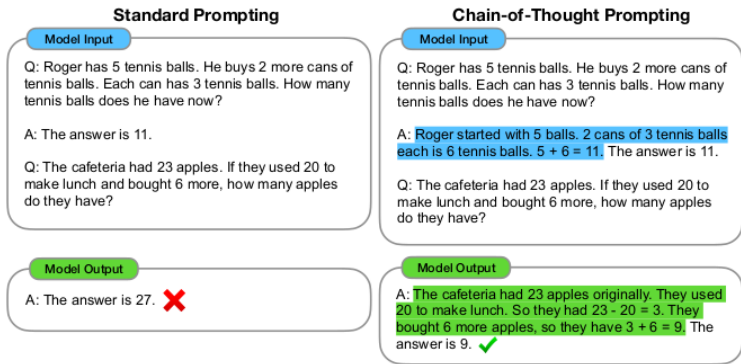


Figure 1: Chain-of-thought prompting

Chain-of-Thought Prompting

What chain-of-thought prompting attractive?

- ▶ Enables model to break down a complex problem into series of simpler problems
- ▶ Provides interpretation on how model arrive at the answer
- ▶ Widely applicable to any problem that can be solve via language
- ▶ Easily applied to off-the-shelf LLMs

Arithmetic Reasoning

Dataset	N	Example problem
GSM8K	1,319	Josh decides to try flipping a house. He buys a house for \$80,000 and then puts in \$50,000 in repairs. This increased the value of the house by 150%. How much profit did he make?
SVAMP	1,000	Each pack of dvds costs 76 dollars. If there is a discount of 25 dollars on each pack. How much do you have to pay to buy each pack?
ASDiv	2,096	Ellen has six more balls than Marin. Marin has nine balls. How many balls does Ellen have?
AQuA	254	A car is being driven, in a straight line and at a uniform speed, towards the base of a vertical tower. The top of the tower is observed from the car and, in the process, it takes 10 minutes for the angle of elevation to change from 45° to 60° . After how much more time will this car reach the base of the tower? Answer Choices: (a) $5\sqrt{3} + 1$ (b) $6\sqrt{3} + \sqrt{2}$ (c) $7\sqrt{3} - 1$ (d) $8\sqrt{3} - 2$ (e) None of these
MAWPS: SingleOp	562	If there are 7 bottle caps in a box and Linda puts 7 more bottle caps inside, how many bottle caps are in the box?
MAWPS: SingleEq	508	Benny bought a soft drink for 2 dollars and 5 candy bars. He spent a total of 27 dollars. How much did each candy bar cost?
MAWPS: AddSub	395	There were 6 roses in the vase. Mary cut some roses from her flower garden. There are now 16 roses in the vase. How many roses did she cut?
MAWPS: MultiArith	600	The school cafeteria ordered 42 red apples and 7 green apples for students lunches. But, if only 9 students wanted fruit, how many extra did the cafeteria end up with?

Figure 2: Math word problems

Arithmetic Reasoning

1. CoT is an emergent ability of model scale
2. CoT has more benefit when task is more challenging
3. In GPT and PaLM, CoT is comparable to SoTA

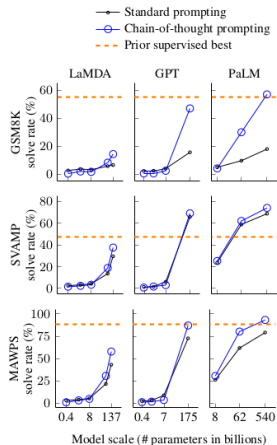


Figure 3: Results

Arithmetic Reasoning

1. Equation only:

$\langle \text{input}, \textit{equation}, \text{output} \rangle$

2. Variable compute only:

$\langle \text{input}, \# \textit{required equations}, \text{output} \rangle$

3. CoT after answer:

$\langle \text{input}, \text{output}, \textit{chain of thought} \rangle$

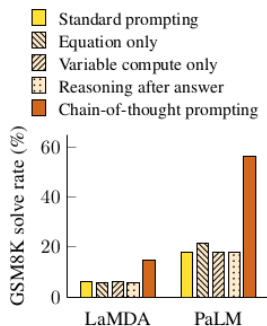


Figure 4: Ablation study

Commonsense Reasoning

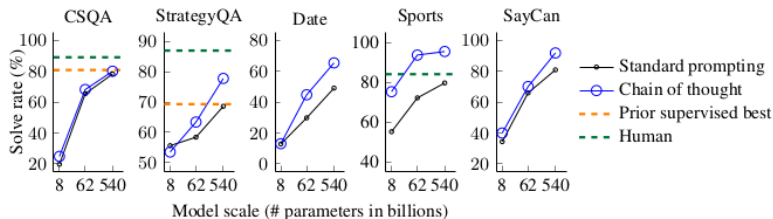


Figure 5: Commonsense reasoning result

Symbolic Reasoning

- ▶ Last letter concatenation: concatenate the last letters of words in a name e.g. *Amy Brown* → *yn*
- ▶ Coin flip: answer whether coin is still heads up after people either flip or don't flip e.g. *A coin is heads up. Phoebe flips the coin. Osvaldo does not flip the coin. Is the coin still heads up?* → *no*

Symbolic Reasoning

1. In domain: same number of steps as training and exemplars
2. OOD: evaluation examples have more steps than exemplars

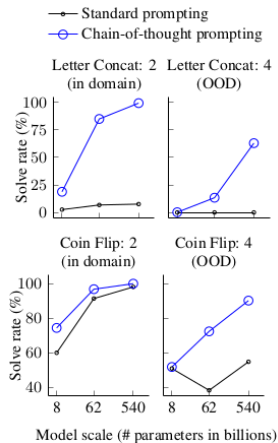


Figure 6: Ablation study

Thank You

Q & A