Large Language Models as Analogical Reasoners

Michihiro Yasunaga[2], Xinyun Chen[1], Yujia Li[1], Panupong Pasupat[1], Jure Leskovec[2], Percy Liang[2], Ed H. Chi[1], Denny Zhou[1]

[1]Google DeepMind, [2]Stanford University

Problem: Can we improve chain-of-thought prompting (CoT) for solving reasoning tasks?

Our inspiration: Analogical reasoning — to solve new problems, humans draw from relevant past experiences (Polya 2004)

0-shot

Model Input

Q: What is the area of the square with the four vertices at (-2, 2), (2, -2), (-2, -6), and (-6, -2)?

0-shot CoT

Model Input

Q: What is the area of the square with the four vertices at (-2, 2), (2, -2), (-2, -6), and (-6, -2)?

Think step by step.

- Generic guidance of reasoning

Few-shot CoT

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?

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

...

Q: What is the area of the square with the four vertices at (-2, 2), (2, -2), (-2, -6), and (-6, -2)?

- Need labeled exemplars of reasoning

Our method: Analogical prompting

- Prompt language models to first self-generate relevant exemplars or knowledge in the context, and then solve the given problem

Analogical Prompting (Ours)

Model Input

Q: What is the area of the square with the four vertices at (-2, 2), (2, -2), (-2, -6), and (-6, -2)?

Instruction:
Recall relevant exemplars:
Solve the initial problem:

Model Output

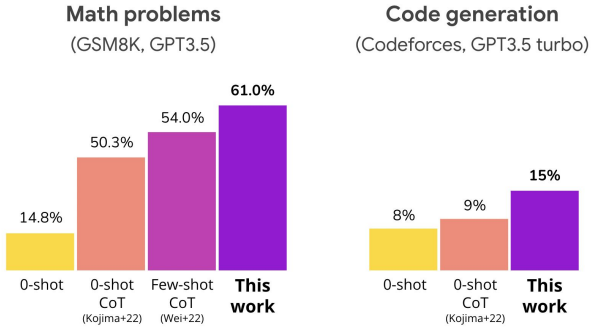
 # Relevant exemplars:
Q: What is the area of the square with a side length of 5?
A: The area of a square is found by squaring the length of its side. So, the area of this square is 5^2 = 25. ...

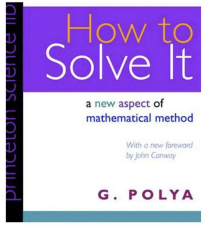
 # Solve the initial problem:
To find the area of the square, we need to find the side length. The length is ... \sqrt{(2 - (-2))^2 + (-2 - 2)^2} = \sqrt{32}. So, the area of the square is (\sqrt{32})^2 = 32.

- Exemplars are **automatically** generated and **tailored** to each problem ✓

Results:

- Analogical prompting outperforms 0-shot CoT and manual few-shot CoT





Do you know a related problem? We can scarcely imagine a problem absolutely new, unlike and unrelated to any formerly solved problem; but, if such a problem could exist, it would be insoluble. In fact, when solving a problem, we always profit from previously solved problems, using their result, or their method, or the experience we acquired solving them. And, of course, the problems from which we profit must be in some way related to our present problem. Hence the question: *Do you know a related problem?*

There is usually no difficulty at all in recalling formerly solved problems which are more or less related to our present one. On the contrary, we may find too many such problems and there may be difficulty in choosing a useful one. We have to look around for closely related problems; we LOOK AT THE UNKNOWN, or we look for a formerly solved problem which is linked to our present one by GENERALIZATION, SPECIALIZATION, or ANALOGY.