

Prompt Engineering

Background

LLM Settings

[review]:

- LLMs work by sampling a token from a distribution

[Temperature]: Controls randomness of sampling

- Higher temp → more likely to choose highest probable next token

[top_p]: Controls number of token in sample

- Higher top_p → more tokens used in sampling

Prompt Engineering

- LLM will always output cont. of strings that make sense in provided context
- Want to control behavior of llm
 - Use Instructions, Context, input data, and output indicators

Prompt

The sky is

Output:

blue
The sky is blue on a clear day. On a cloudy day, the sky may be gray or white.



Prompt:

Complete the sentence:
The sky is

Output:

so beautiful today.

Techniques

Zero / Few-shot

[zero-shot]:

- LLM relies only its training
- Don't provide model with any examples

Prompt:

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

Output:

Neutral

[few-shot]:

- Used to fix zero-shot
- Enables In-context learning

Prompt:

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

Output:

Negative

Chain-of-Thought (CoT)

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. ✅

Cot Cont: Zero-Shot CoT

(a) Few-shot

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: A juggler can juggle 16 balls. Half of the balls are golf balls, and half of the golf balls are blue. How many blue golf balls are there?

A:

(Output) The answer is 8. ✗

(b) Few-shot-CoT

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: A juggler can juggle 16 balls. Half of the balls are golf balls, and half of the golf balls are blue. How many blue golf balls are there?

A:

(Output) The juggler can juggle 16 balls. Half of the balls are golf balls. So there are $16 / 2 = 8$ golf balls. Half of the golf balls are blue. So there are $8 / 2 = 4$ blue golf balls. The answer is 4. ✓

(c) Zero-shot

Q: A juggler can juggle 16 balls. Half of the balls are golf balls, and half of the golf balls are blue. How many blue golf balls are there?

A: The answer (arabic numerals) is

(Output) 8 ✗

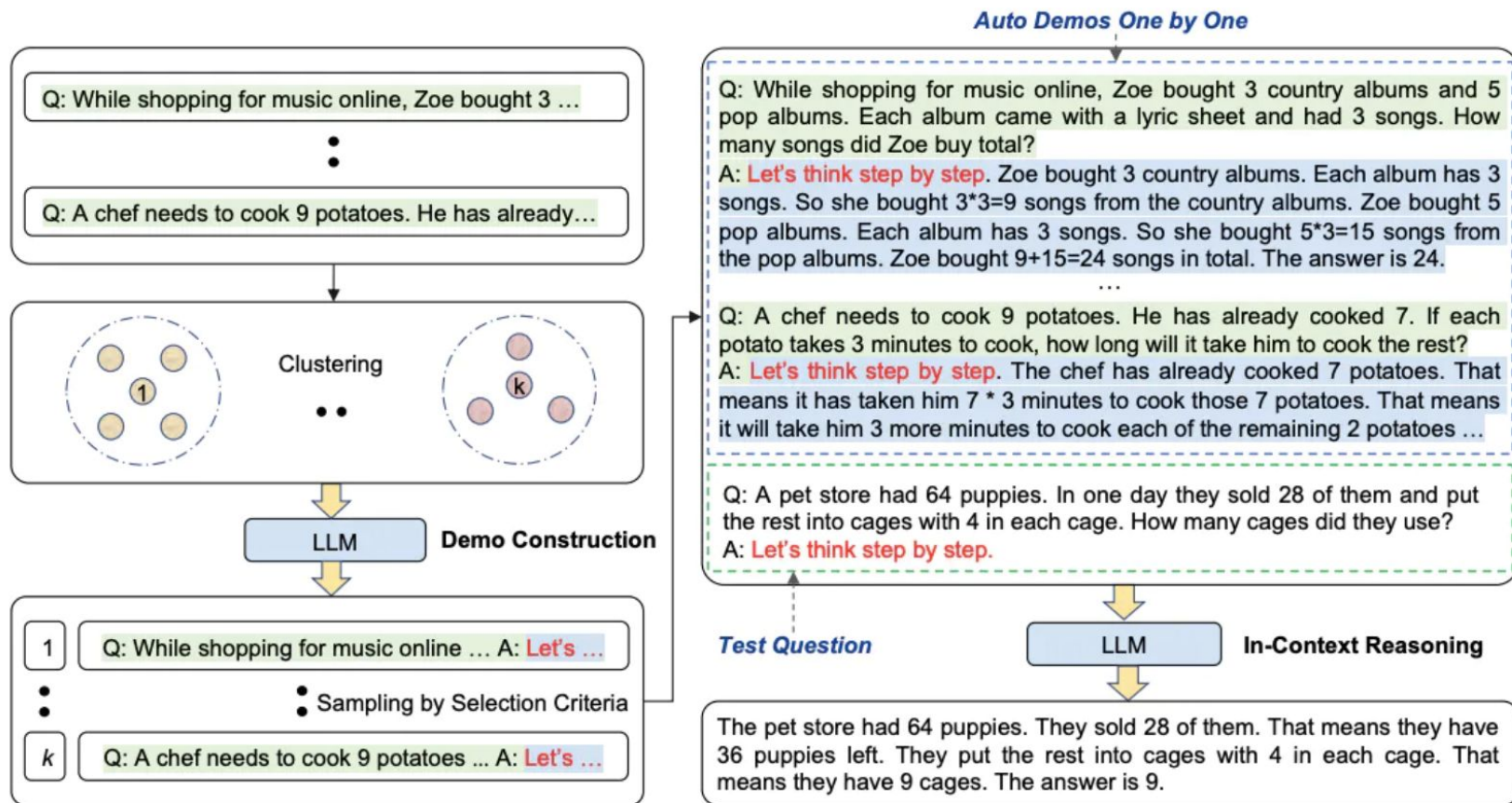
(d) Zero-shot-CoT (Ours)

Q: A juggler can juggle 16 balls. Half of the balls are golf balls, and half of the golf balls are blue. How many blue golf balls are there?

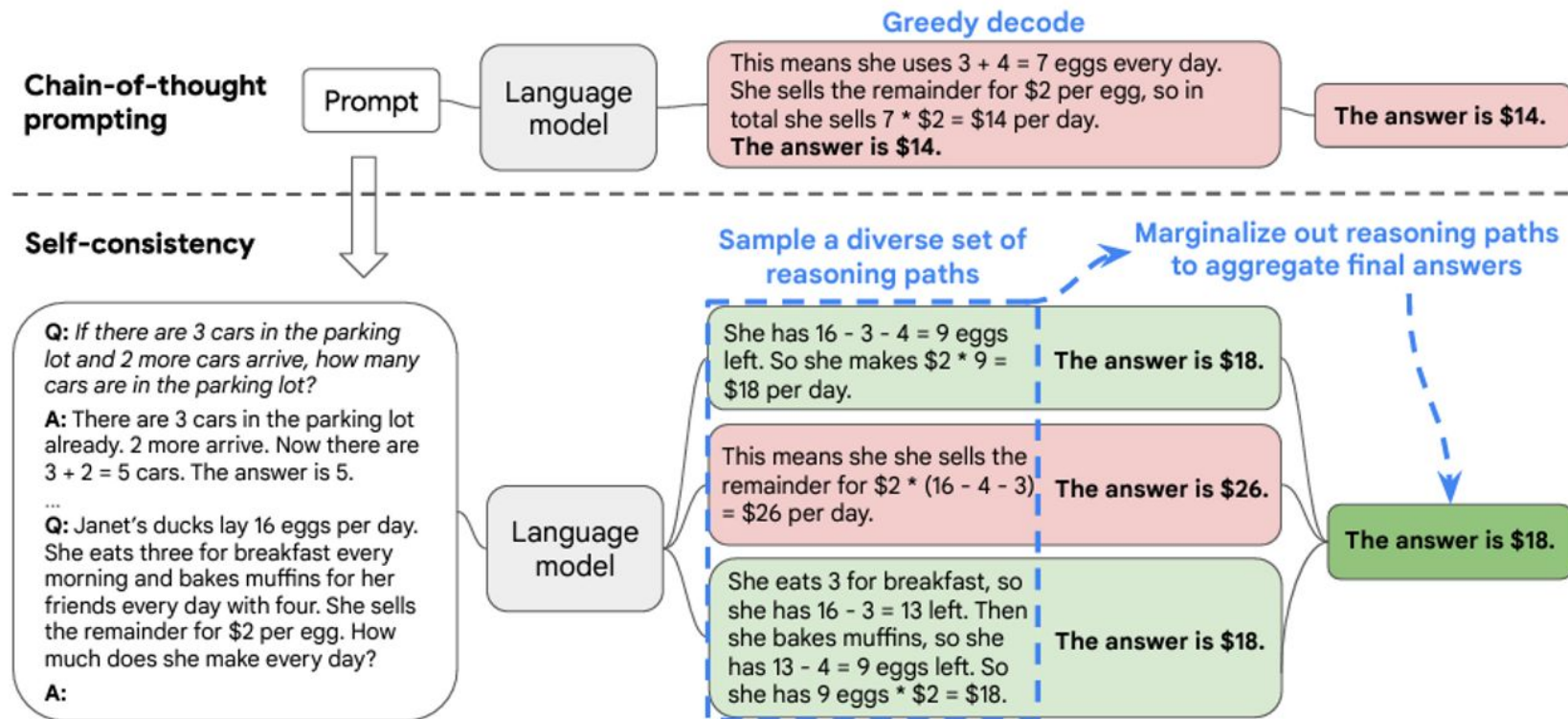
A: **Let's think step by step.**

(Output) There are 16 balls in total. Half of the balls are golf balls. That means that there are 8 golf balls. Half of the golf balls are blue. That means that there are 4 blue golf balls. ✓

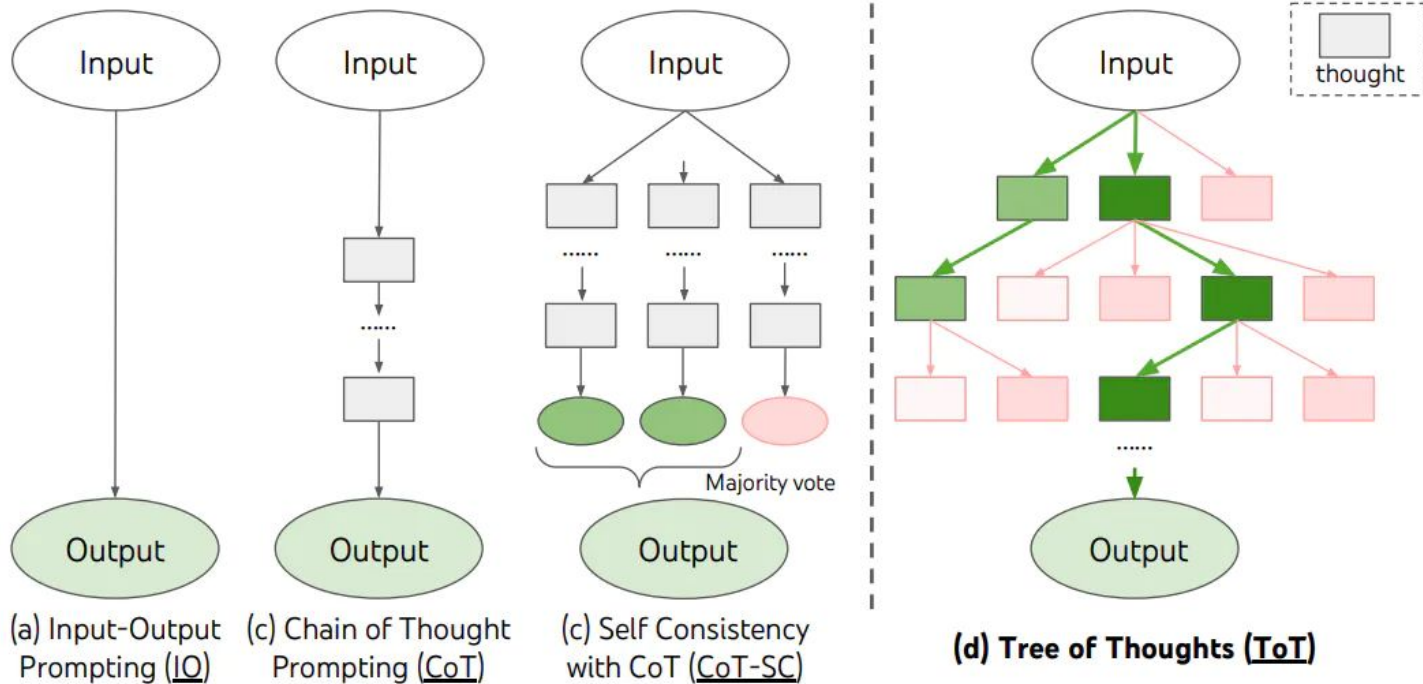
Cot Cont: Auto CoT



Self-consistency

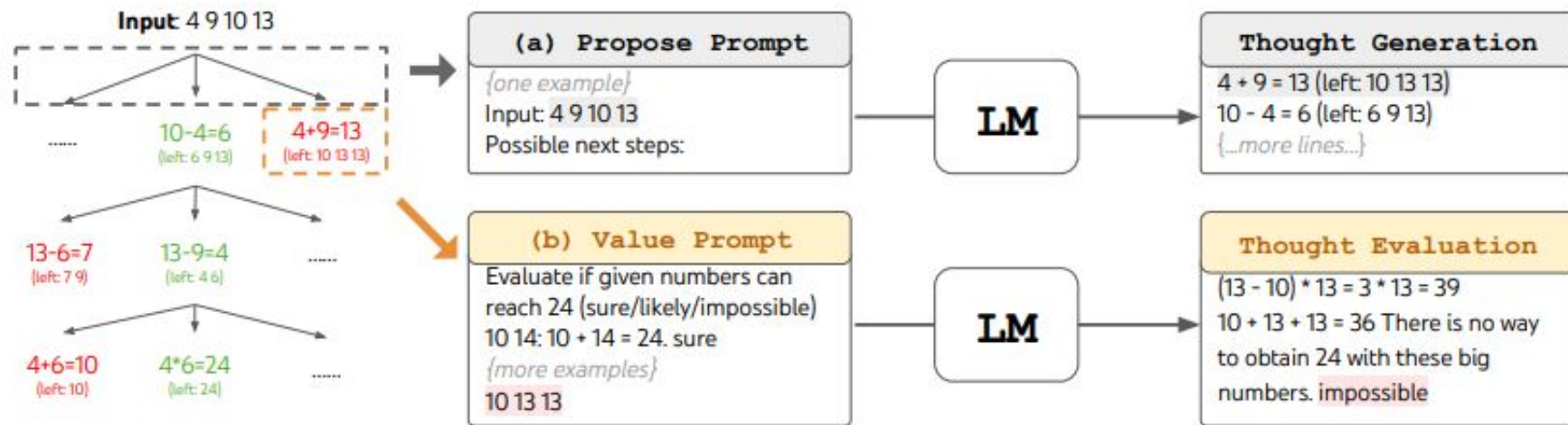


Tree-of thoughts

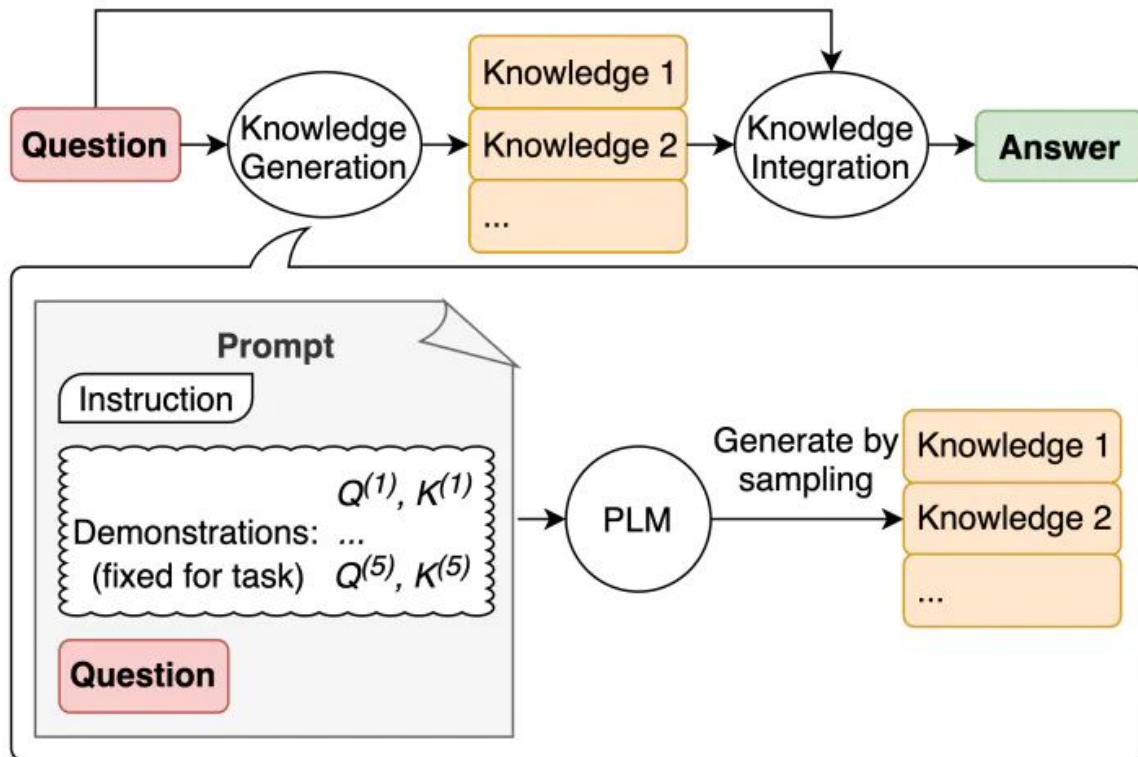


Tree-of thoughts

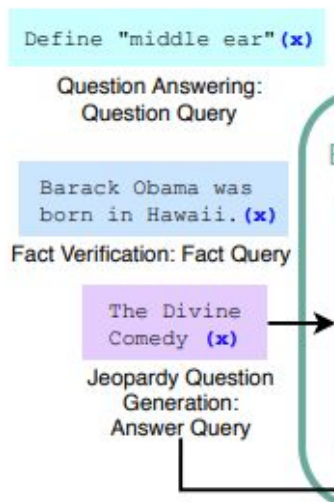
Ex: game of 24



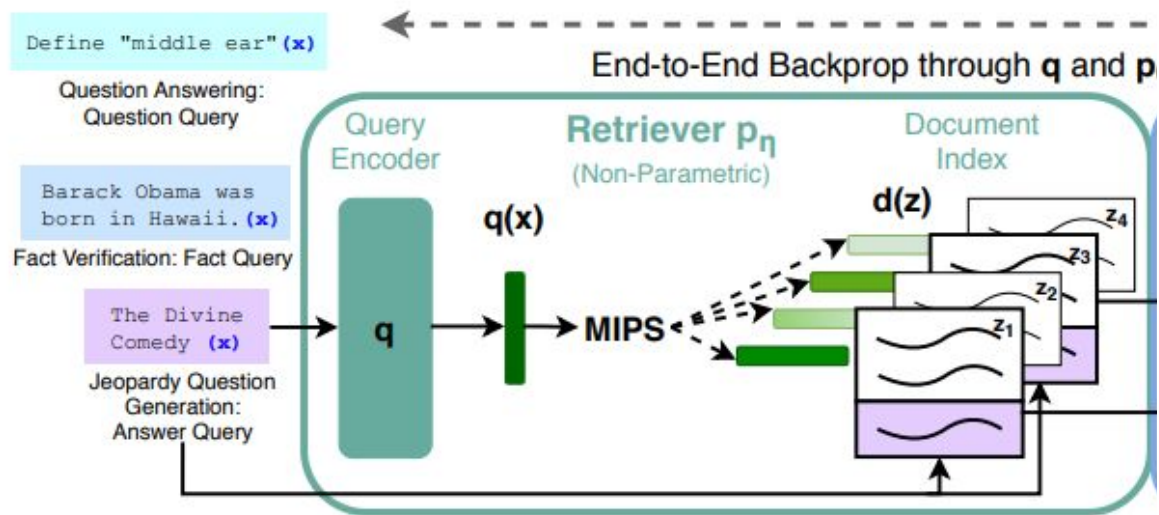
Generate-knowledge-prompting



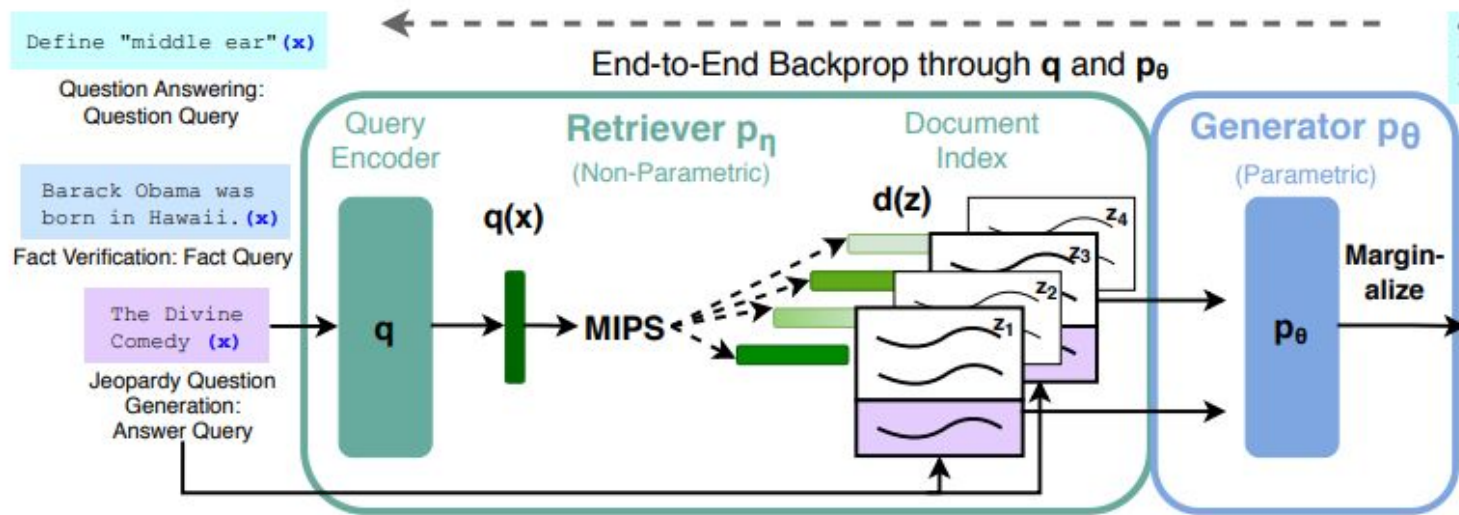
Retrieval-Augmented-Generation (RAG)



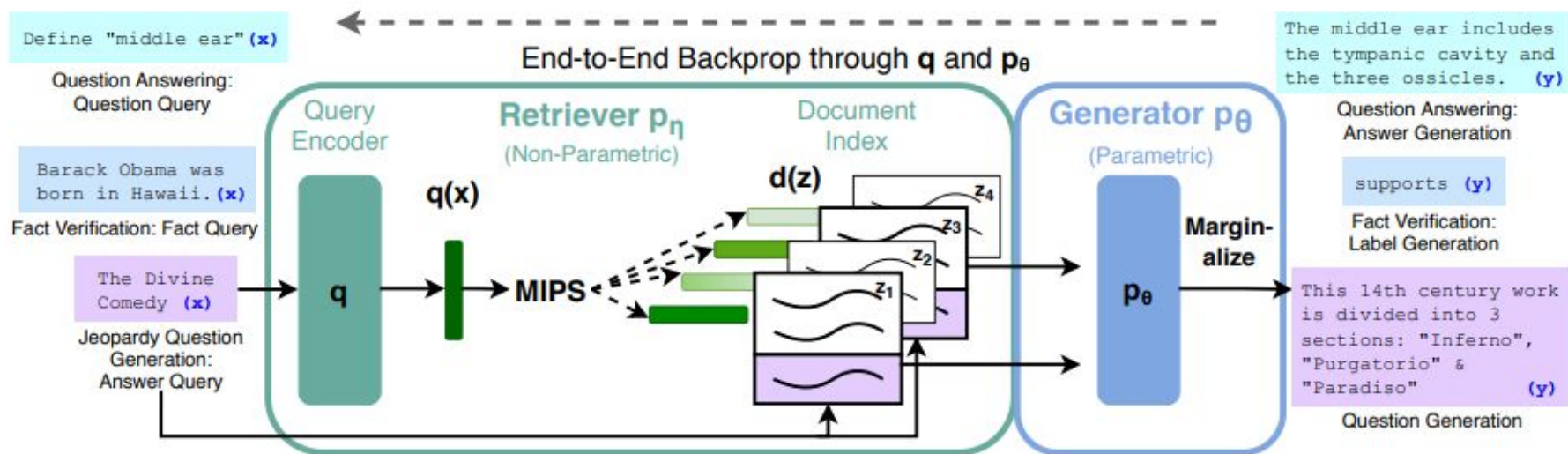
Retrieval-Augmented-Generation (RAG)



Retrieval-Augmented-Generation (RAG)



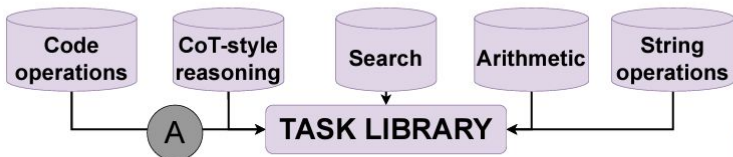
Retrieval-Augmented-Generation (RAG)



Automatic Reasoning & Tool Use

New Task (Physics QA) Answer this high-school physics question

Input: Hector yanks on the chain with a 72.0 N force at an angle of 35.0° above the horizontal. Determine the horizontal components of the tension force.



Solve these arithmetic problems using python code

Input: Viola had 167 breads. Nancy took 137 from him. How many does Viola have now?

Q1: [generate code] Write down arithmetic as python code

#1: viola_bought = 167, nancy_took = 137

ans = viola_bought - nancy_took

Q2: [code execute] Execute snippet **#2:** 30 **Q3:** [EOQ] **Ans:** No

Does the sentence contain an anachronism? Yes/No.

Input: President George H. W. Bush called his generals at the outset of the Gulf War.

Q1: [search] When was President George H. W. Bush, president?

#1: George H. W. Bush's tenure started on January 20, 1989, and ended on January 20, 1993.

Q2: [search] When was the Gulf War fought? **#2:** The Gulf War was a 1990–1991

Q3: [subquestion] Could these entities have co-existed? **#3:** Yes. Their time periods intersect.

Q4: [generate output] Is this an anachronism? **#4:** No **Q5:** [EOQ] **Ans:** No

B

TOOL LIBRARY

Google

Input: Hector yanks on the chain with a 72.0 N force at an angle of 35.0° above the horizontal. Determine the horizontal components of the tension force.

Q1: [search] What is the formula for the horizontal component of the tension force?

#1: The formula for the horizontal component of the tension force is $T \cos \theta$. The horizontal component (F_x) can be calculated as $F_{\text{tens}} \cdot \cos(\theta)$ where θ is the angle which the force makes with the horizontal in radians.

LLM

Input: ... **Q1:** [search] ...

#1: ... can be calculated as $F_{\text{tens}} \cdot \cos(\theta)$ where θ is ...

Q2: [generate code] Use the formula $F_x = F_{\text{tens}} \cdot \cos(\theta)$ to solve: Hank ...

#2: $T = 72.0$, $\theta = 35.0$
 $\text{radians} = \text{math.pi} * \theta / 180$
 $F_x = T * \text{math.cos}(\text{radians})$

OpenAI Codex

Input: ... **Q1:** [search] ... **#1:** ...

Q2: [generate code] Use the formula $F_x = F_{\text{tens}} \cdot \cos(\theta)$ to solve: Hank ...

#2: ... $F_x = T * \text{math.cos}(\text{radians})$

Q3: [code execute] Execute the python code and get the value of "Fx"

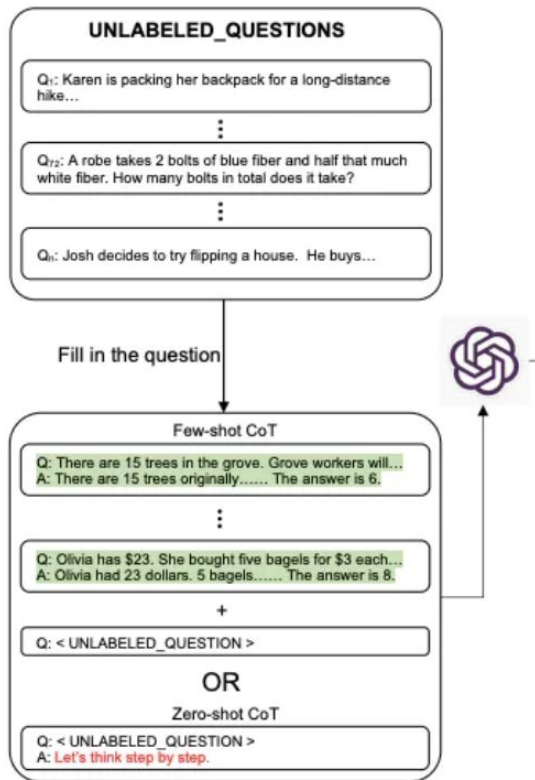
#3: 58.9789

Q4: [EOQ] **Ans:** 58.9789

python

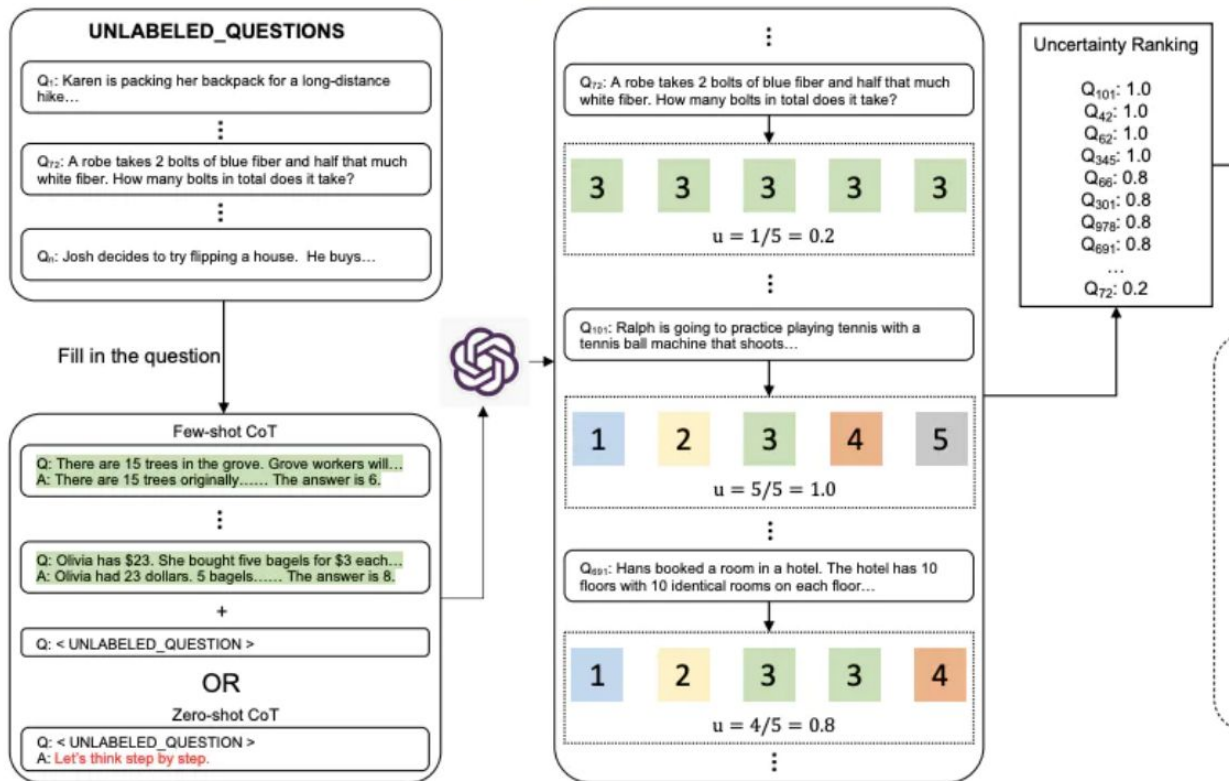
Active Prompt

(1) Uncertainty Est



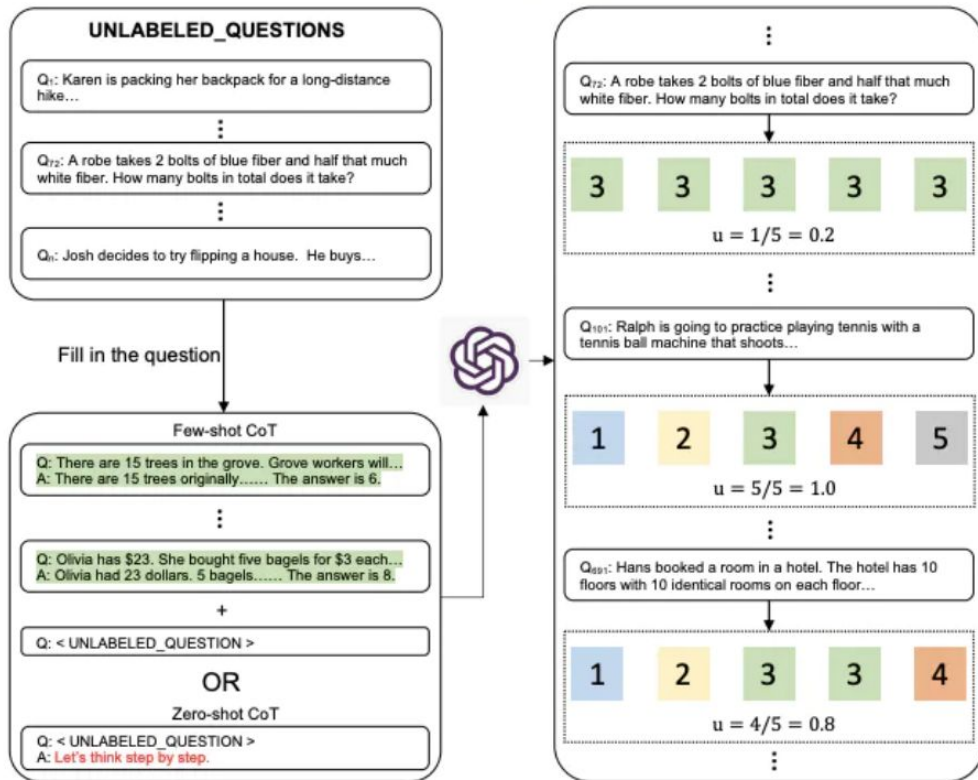
Active Prompt

(1) Uncertainty Estimation

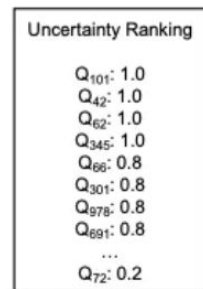


Active Prompt

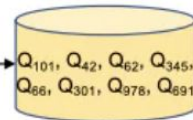
(1) Uncertainty Estimation



(2) Selection



Most Uncertain Questions



(3) Annotation

New Exemplars E

Q₁₀₁: Ralph is going to practice playing tennis with a tennis ball ...
A: Ralph started with 175 tennis balls. He hit 2/5 of the first 100 balls, so he hit $2/5 * 100 = 40$ balls. He hit 1/3 of the next 75 balls, so he hit $1/3 * 75 = 25$ balls. In total he hit $40 + 25 = 65$ balls. He did not hit $175 - 65 = 110$ balls. The answer is 110.

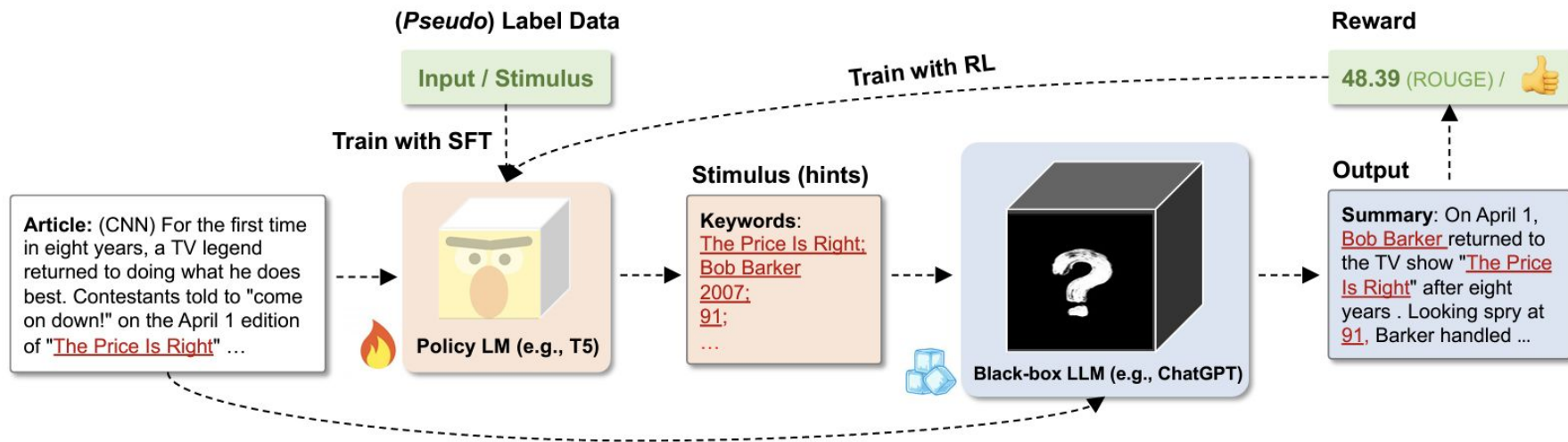
Q₈₉₁: Hans booked a room in a hotel. The hotel has 10 floors ...
A: here are 10 floors with 10 rooms each. The last floor is unavailable. So there are $9 * 10 = 90$ rooms available. The answer is 90.

+ Test Question

Q: Janet's ducks lay 16 eggs per day. She eats three for breakfast...

(4) Inference

Directional Stimulus Prompting



ReAct Prompting

[Prompt]: Aside from the Apple Remote, what other devices can control the program Apple Remote was originally designed to interact with?

(1d) ReAct (Reason + Act)

Thought 1: I need to search Apple Remote and find the program it was originally designed to interact with.

Act 1: `Search`[Apple Remote]

Obs 1: The Apple Remote is a remote control introduced in October 2005 by Apple ... originally designed to control the `Front Row media center` program ...

Thought 2: Apple Remote was originally designed to control the `Front Row media center` program. I need to search `Front Row` next and find what other device can control it.

Act 2: `Search`[Front Row]

Obs 2: Could not find [Front Row]. Similar: ['Front Row Seat to Earth', 'Front Row Motorsports', 'Front Row (software)', ...]

Thought 3: Front Row is not found. I need to search `Front Row (software)` .

Act 3: `Search`[Front Row (software)]

Obs 3: Front Row is a discontinued media center software ...

Thought 4: `Front Row (software)` is controlled by an Apple Remote or the keyboard function keys. So the answer is keyboard function keys.

Act 4: `Finish`[keyboard function keys]

