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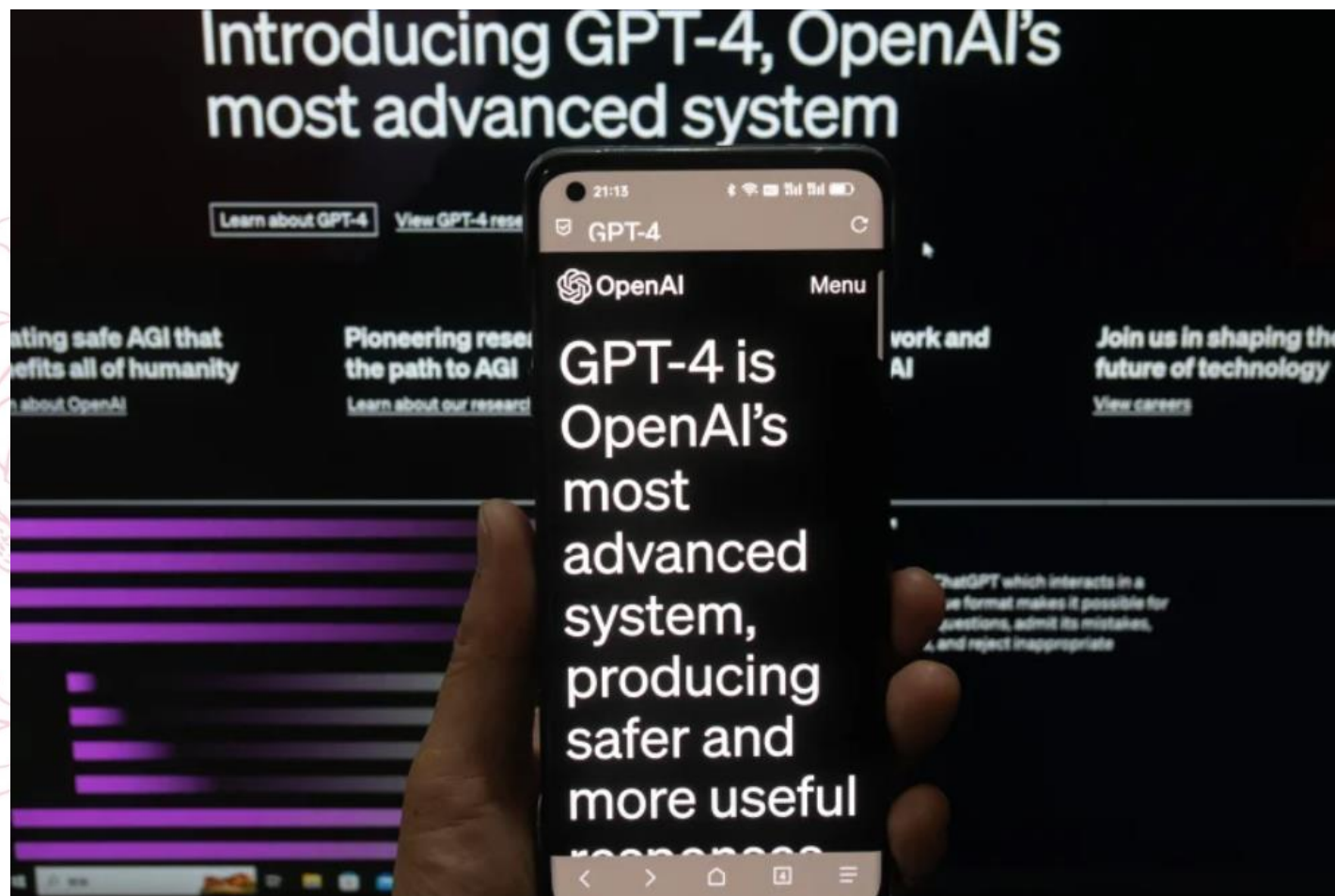


高瓴人工智能学院
Gaoling School of Artificial Intelligence

Large Language Models and Applications



GPT-4 just
released!





GPT-4 just released!

51 Try to write an explanatory article about a medicine to me. each word of your article starts with "a"



A medicine is a substance used to treat or prevent diseases and alleviate symptoms of various health conditions. There are many different types of medicines available, each designed to target specific ailments and conditions.

One of the most commonly used medicines is antibiotics, which are used to treat bacterial infections. Antibiotics work by targeting and killing the bacteria that are causing the infection. They are often prescribed by doctors for conditions such as pneumonia, strep throat, and urinary tract infections.

Another type of medicine is analgesics, which are used to relieve pain. These include over-the-counter medications such as aspirin and acetaminophen, as well as prescription medications such as opioids. Analgesics work by blocking the transmission of pain signals to the brain, helping to alleviate discomfort.

51 Try to write an explanatory article about a medicine to me. each word starts with "a"



Astonishing Advancements: All-A "A" Alphabetical Antidote Article

Acclaimed advancements achieved astounding accomplishments, actualizing an amazing all-alphabetical antidote. Anxiolytic attributes accompany ample antioxidant action, allowing advantageous alleviation across ailments.

Approaching ailments aggressively, ambitious analysts assembled and assessed abundant active agents. Aligned alongside adept academics, astute apothecaries amalgamated advantageous alternatives, advocating an audacious attempt.

Astoundingly, audacious action actualized an all-A alphabet antidote, accelerating acceptance among ailing adults. Aptly abbreviated "AAA," this astonishing achievement arouses admiration across assorted audiences. Adeptly addressing afflictions, AAA adeptly alleviates anxiety, aches, and assorted abnormalities.



GPT-4 just released!

User Can you explain this meme?

Sometimes I just look at pictures of the earth from space and I marvel at how beautiful it all is.

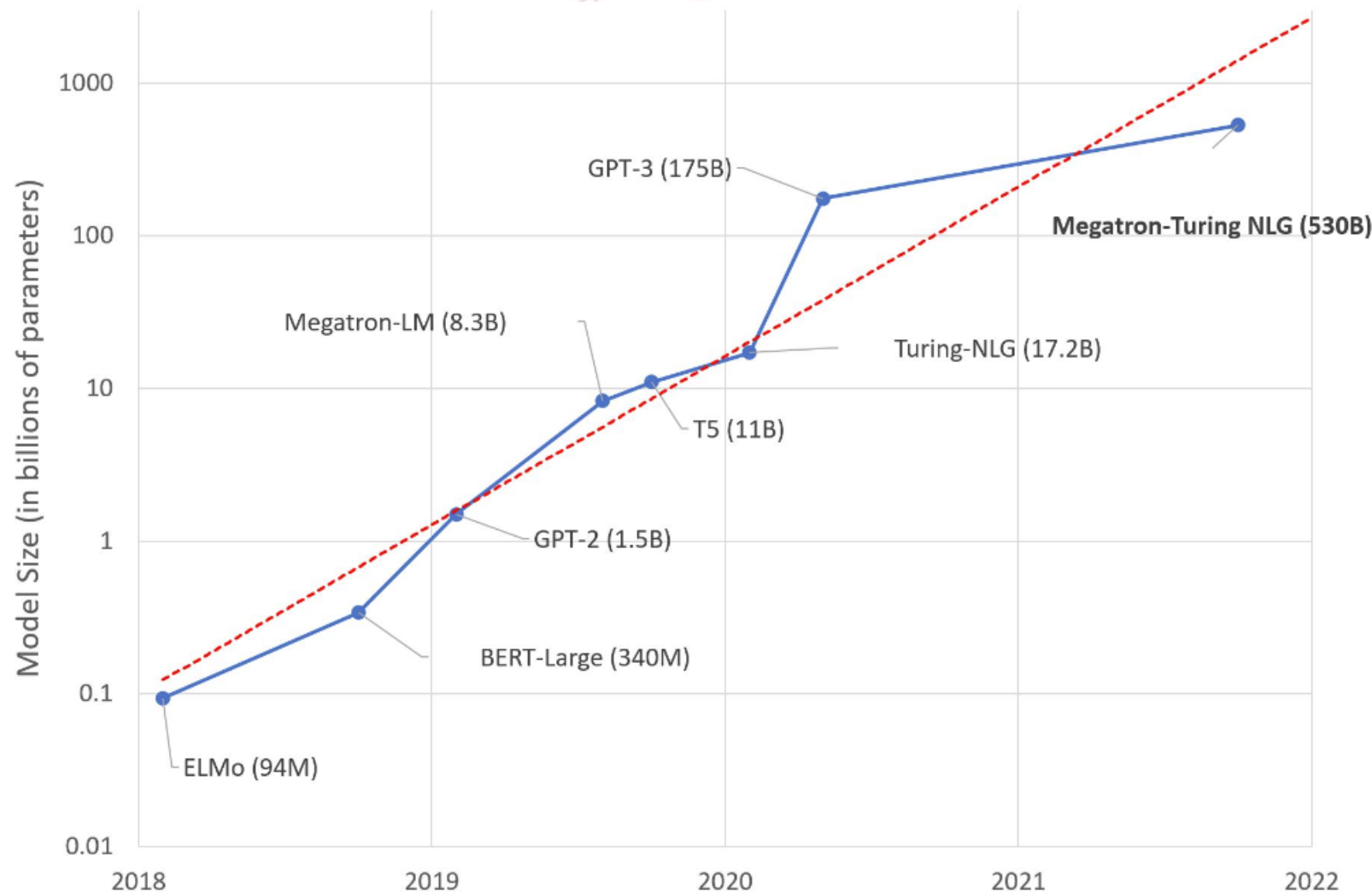


GPT-4 This meme is a joke that combines two unrelated things: pictures of the earth from space and chicken nuggets. The text of the meme suggests that the image below is a beautiful picture of the earth from space. However, the image is actually of chicken nuggets arranged to vaguely resemble a map of the world. The humor in this meme comes from the unexpected juxtaposition of the text and the image. The text sets up an expectation of a majestic image of the earth, but the image is actually something mundane and silly.

Simulated exams	GPT-4 estimated percentile
Uniform Bar Exam (MBE+MEE+MPT) ¹	298/400 ~90th
LSAT	163 ~88th
SAT Evidence-Based Reading & Writing	710/800 ~93rd
SAT Math	700/800 ~89th
Graduate Record Examination (GRE) Quantitative	163/170 ~80th
Graduate Record Examination (GRE) Verbal	169/170 ~99th
Graduate Record Examination (GRE) Writing	4/6 ~54th
USABO Semifinal Exam 2020	87/150 99th–100th
USNCO Local Section Exam 2022	36/60
Medical Knowledge Self-Assessment Program	75%
Codeforces Rating	392 below 5th
AP Art History	5 86th–100th
AP Biology	5 85th–100th
AP Calculus BC	4 43rd–59th



Model size is increasing exponentially





1. Behind LLMs: Language Models

Theories of Language Models

Three approaches for language modelling

- $\hat{x}_i = p(\hat{x}_i | x_1, x_2, \dots, x_n)$

Sentence Correction (Denoising)

- $\hat{x}_{n+1} = p(\hat{x}_{n+1} | x_1, x_2, \dots, x_n)$

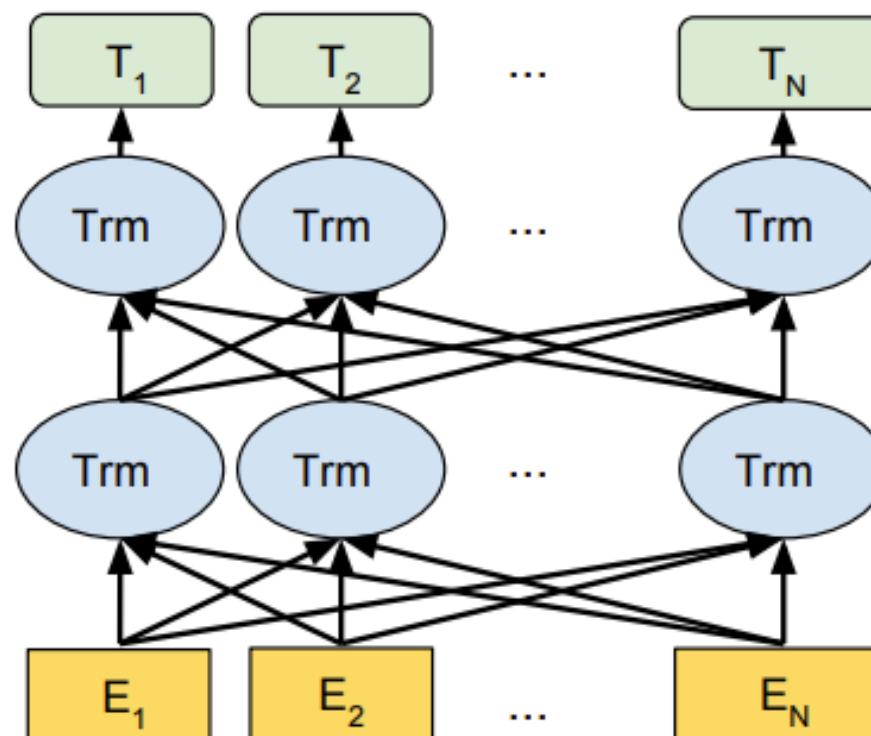
Text Completion

- $\hat{x}_{n+1} = p(\hat{x}_{n+1} | x_1, x_2, \dots, x_n, D)$

Text Translation

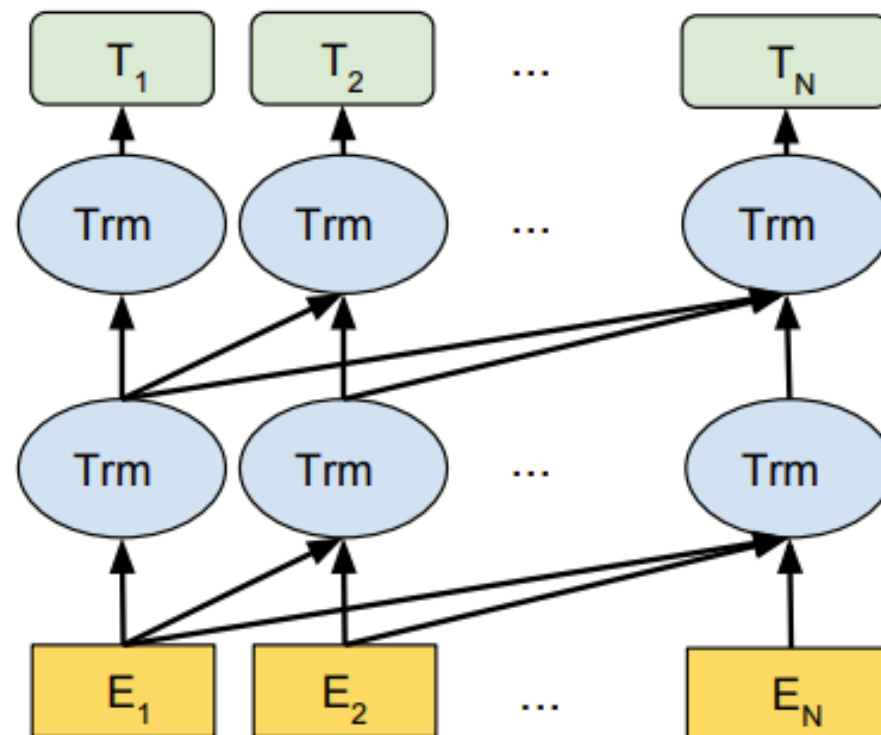
Theories of Language Models

Parametric architectures for sentence denoising: Encoder



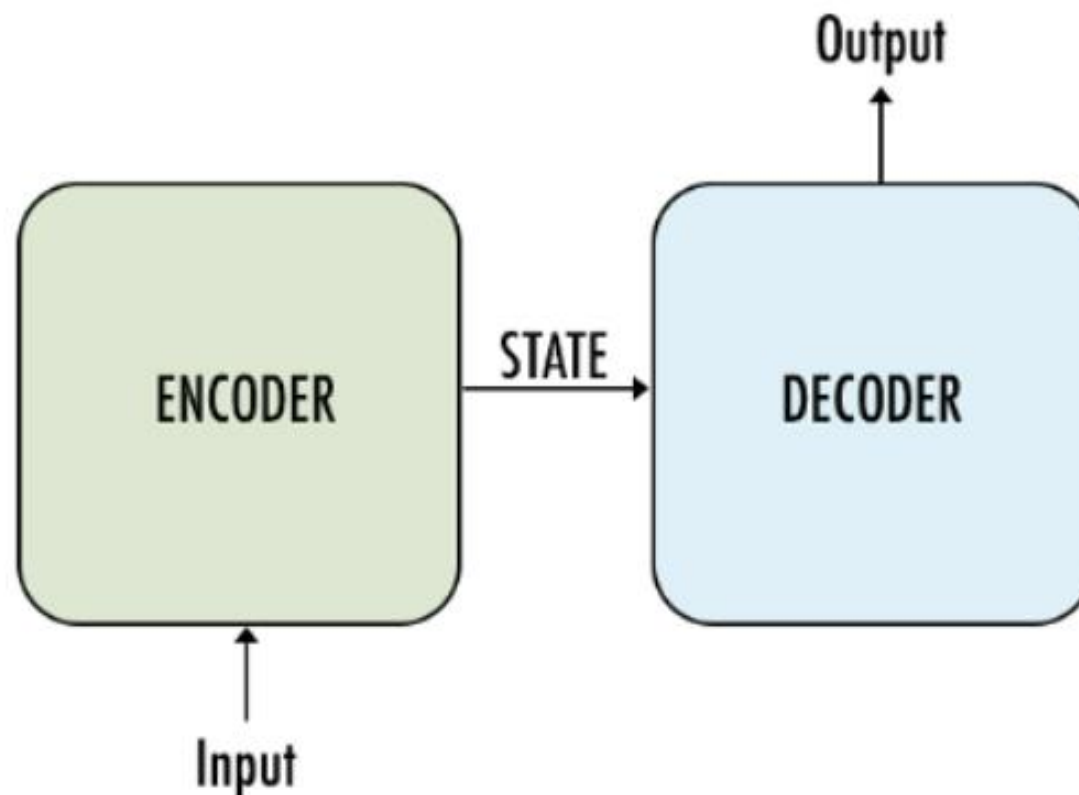
Theories of Language Models

Parametric architectures for text completion: Decoder



Theories of Language Models

Parametric architectures for text translation: Encoder-Decoder



Theories of Language Models

Training Language Models

- Pre-training
- Supervised Training
- Reinforcement Learning

■ "Pure" Reinforcement Learning (cherry)

- ▶ The machine predicts a scalar reward given once in a while.
- ▶ **A few bits for some samples**

■ Supervised Learning (icing)

- ▶ The machine predicts a category or a few numbers for each input
- ▶ Predicting human-supplied data
- ▶ **10→10,000 bits per sample**

■ Unsupervised/Predictive Learning (cake)

- ▶ The machine predicts any part of its input for any observed part.
- ▶ Predicts future frames in videos
- ▶ **Millions of bits per sample**





2. More is Different, Language Models Likewise

LLM is different: A paradigm shift

- Harder to handle: Training cost

Company	Language Model	Estimated Cost
Microsoft & Nvidia	Megatron-Turing	\$100 million ¹
Google	BERT	\$6,912 ²
Meta	LLaMA	\$2.4 million
DeepMind	Go AI	\$35 million
OpenAI	GPT-3	\$12 million

LLM is different: A paradigm shift

- Easier to use: From fine-tuning to prompt engineering



LLM is different: A paradigm shift

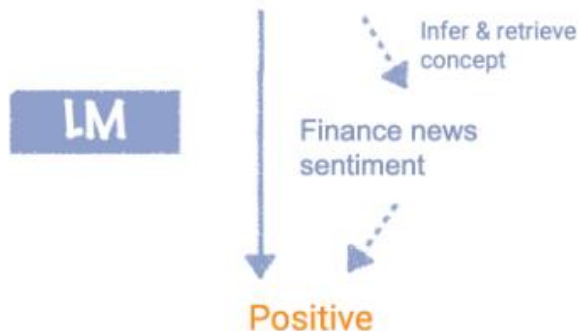
- Emerging Capabilities: ICL / CoT / MM reasoning

Circulation revenue has increased by 5% in Finland. // Positive

Panostaja did not disclose the purchase price. // Neutral

Paying off the national debt will be extremely painful. // Negative

The company anticipated its operating profit to improve. // _____



Circulation revenue has increased by 5% in Finland. // Finance

They defeated ... in the NFC Championship Game. // Sports

Apple ... development of in-house chips. // Tech

The company anticipated its operating profit to improve. // _____



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. ✓

LLM is different: A paradigm shift

- Solving real-word problems with general intelligence

51

因流感导致咳嗽到睡不着怎么办



如果因为流感导致咳嗽而影响睡眠，可以尝试以下措施缓解症状：

1. 喝足够的水和其他液体，以保持身体水分充足，有助于稀释痰液，缓解咳嗽。
2. 避免吸烟和二手烟，因为烟草烟雾会刺激呼吸道，导致更多咳嗽。

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还有什么建议嘛



除了上述措施外，以下是一些额外的建议：

1. 注意休息，尽量避免过度活动和劳累，给身体充足的时间来恢复。
2. 饮食方面，可以选择易于消化的食物，避免过于油腻、辛辣或刺激性的食物，同时可以增

51

Chatgpt, 你好, 我现在很累, 最近有点缺睡, 但我还有很多活要干, 请你帮我推荐一些可以产生多巴胺的活动或者是食品, 这样我就能开心的去高效的完成任务。

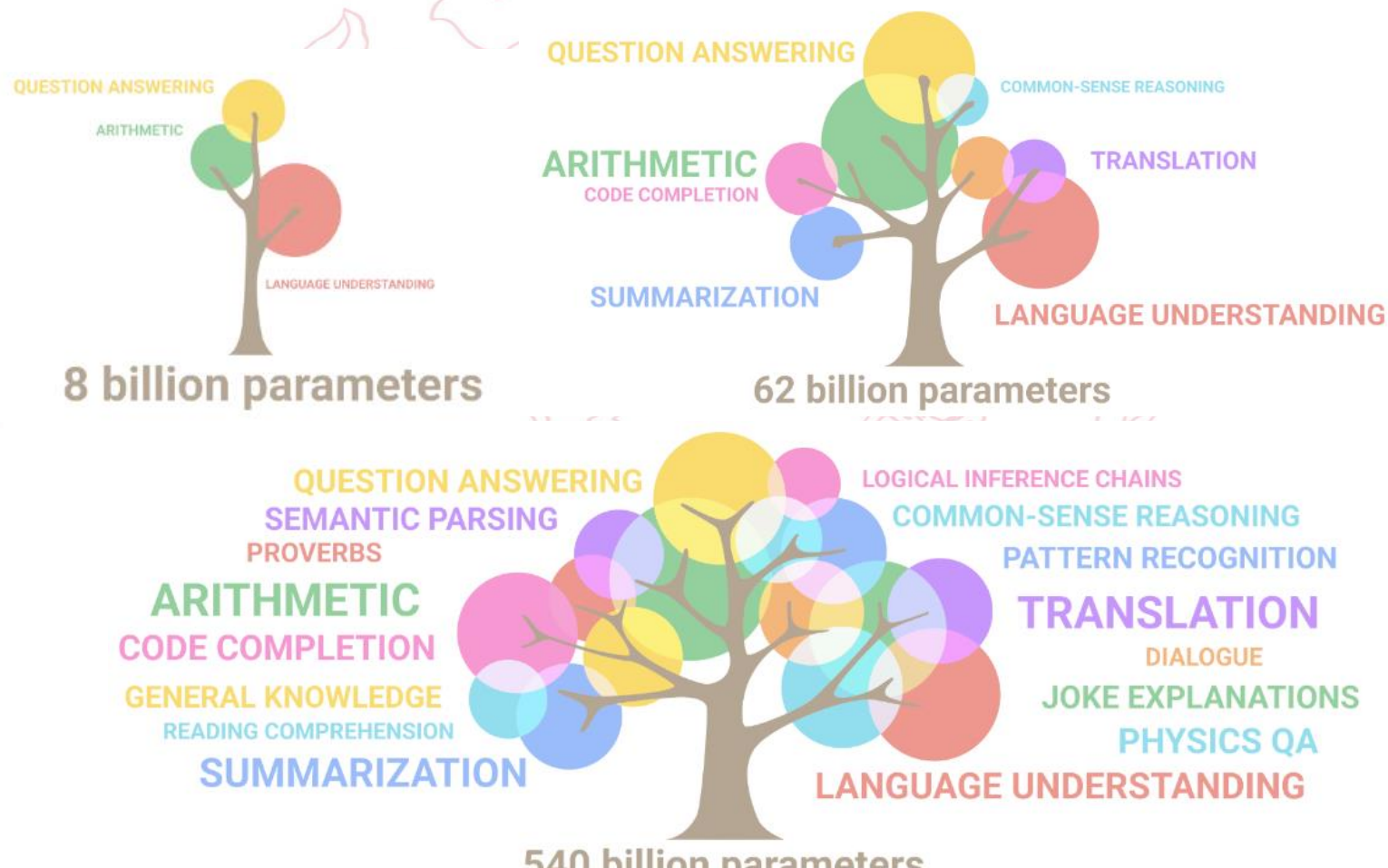


您好！以下是一些可以帮助产生多巴胺的活动或者食品：

1. 运动：运动可以促进多巴胺的产生，让身体感到愉悦。您可以选择适合自己的运动方式，比如慢跑、跳舞、骑自行车等。
2. 做自己喜欢的事情：做一些自己感兴趣的事情可以提高兴奋感和满足感，从而增加多巴胺的产生。比如听音乐、看电影、玩游戏等。
3. 食物：某些食物可以增加多巴胺的产生。例如，富含酪氨酸的食物，如鸡肉、火鸡、牛肉、鱼类、芝士等；富含色氨酸的食物，如巧克力、香蕉、杏仁等；以及富含酪氨酸和色氨酸的食物，如鸡蛋、坚果、豆类等。

LLM is different: A paradigm shift

- Solving real-word problems with general intelligence





3. Examples and applications of LLMs

ChatGPT: Reinforcement Learning from Human Feedback

Step 1

Collect demonstration data and train a supervised policy.

A prompt is sampled from our prompt dataset.

A labeler demonstrates the desired output behavior.

This data is used to fine-tune GPT-3.5 with supervised learning.



Step 2

Collect comparison data and train a reward model.

A prompt and several model outputs are sampled.

A labeler ranks the outputs from best to worst.

This data is used to train our reward model.



Step 3

Optimize a policy against the reward model using the PPO reinforcement learning algorithm.

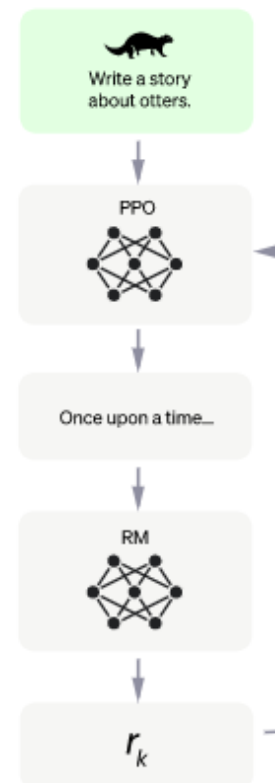
A new prompt is sampled from the dataset.

The PPO model is initialized from the supervised policy.

The policy generates an output.


The reward model calculates a reward for the output.

The reward is used to update the policy using PPO.



Kosmos-1: Multimodal Large Language Models

Kosmos-1 can perceive both language and    , learn in context , reason, and generate



What's in this picture?

Looks like a duck.

That's not a duck. Then what's it?


Looks more like a bunny.

Why?

It has bunny ears.

Description of three toed woodpecker: It has black and white stripes throughout the body and a yellow crown.

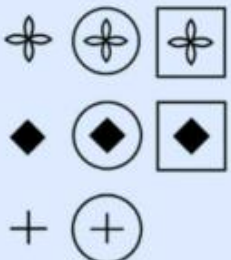
Description of downy woodpecker: It has white spots on its black wings and some red on its crown.






Question: what is the name of the woodpecker in the picture?




Downy

Here are eight images:

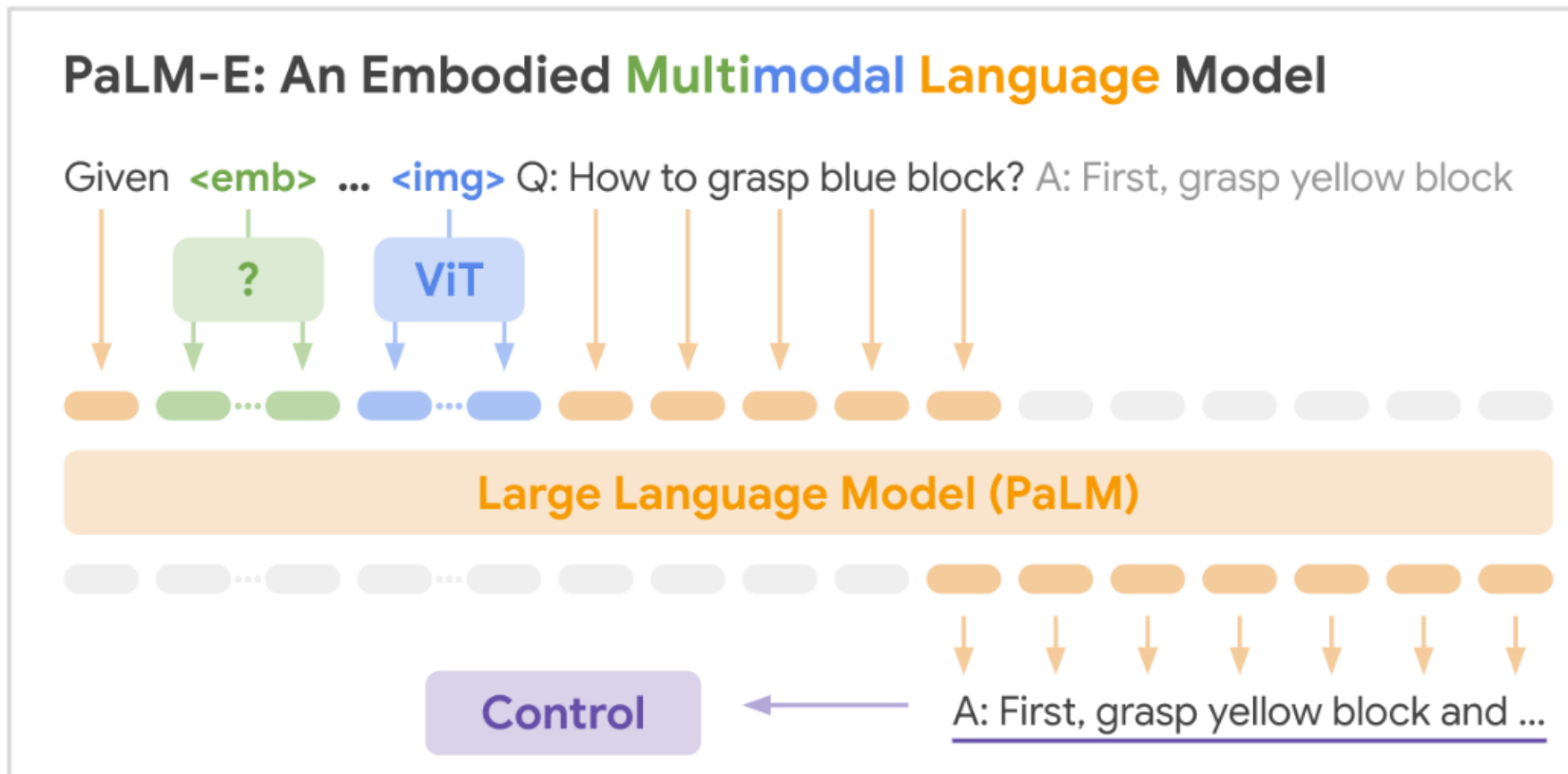


The following image is:

A  B  C 

D  E  F 

PaLM-E: Embodied Language Models



PaLM-E model architecture, showing how PaLM-E ingests different modalities (states and/or images) and addresses tasks through multimodal language modeling.

Visual ChatGPT: Large Language Model + Visual Models

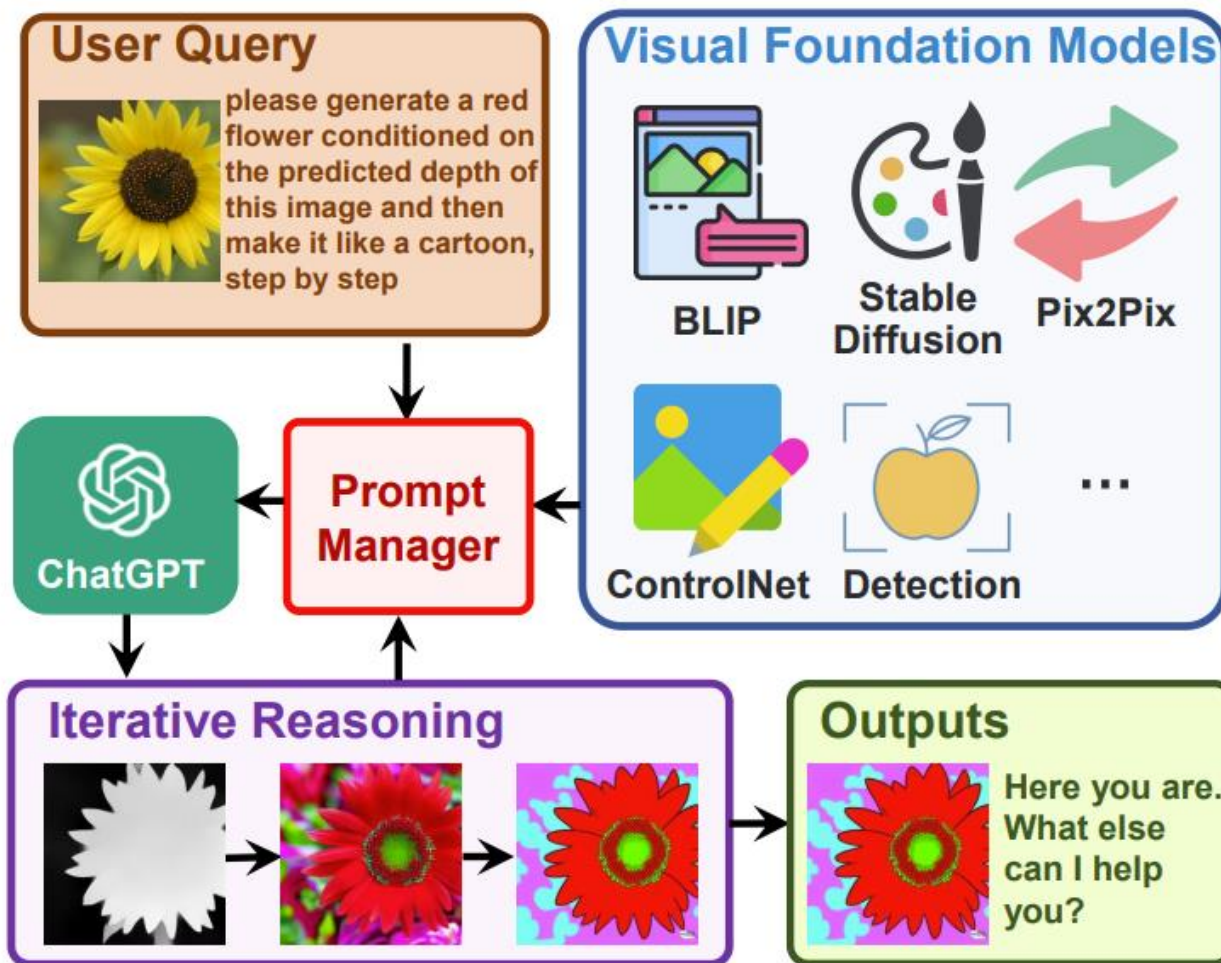


Figure 1. Architecture of Visual ChatGPT.

Galactica: Language Model + Research Data

Modality	Entity	Sequence
Text	Abell 370	Abell 370 is a cluster...
LaTeX	Schwarzschild radius	$r_{\{s\}} = \frac{2GM}{c^2}$
Code	Transformer	<code>class Transformer(nn.Module)</code>
SMILES	Glycine	<chem>C(C(=O)O)N</chem>
AA Sequence	Collagen α -1(II) chain	MIRLGAPQTL..
DNA Sequence	Human genome	CGGTACCCTC..



$$r_s = \frac{2GM}{c^2}$$

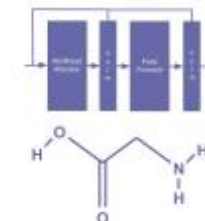


Table 1: Tokenizing Nature. Galactica trains on text sequences that represent scientific phenomena.



Applications

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Picking the best dog breed for you depends on several factors, such as your lifestyle, your energy level, your house size, and your preferences. There are some online quizzes that can help you narrow down your choices based on these criteria². You can also research the characteristics, temperament, grooming needs, and health problems of different breeds to find the one that suits you best³. If you want a purebred dog, you should look for

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Raiden Shogun and...
From Genshin Impact
@Zap 29.0 m

SM64 Mario
The Italian plumber from Super Mario 64.
@Revolution64 17.3 m

Text Adventure Ga...
Let's play a text-based adventure game. I'll be your guide. You are caught...
@Kayslay 9.3 m

Character Assistant
An AI assistant trained by Character.AI
@london 2.3 m

Psychologist
Someone who helps with life difficulties
@Blazeman98 9.0 m

Elon Musk
You're wasting my time. I literally rule the world.
@elonwhisperer 3.8 m

Community



Applications

- Education
- Customer service / advisor
- Knowledge Management
- Recommendation
- Virtual Assistant



4. Future Research Directions about LLMs

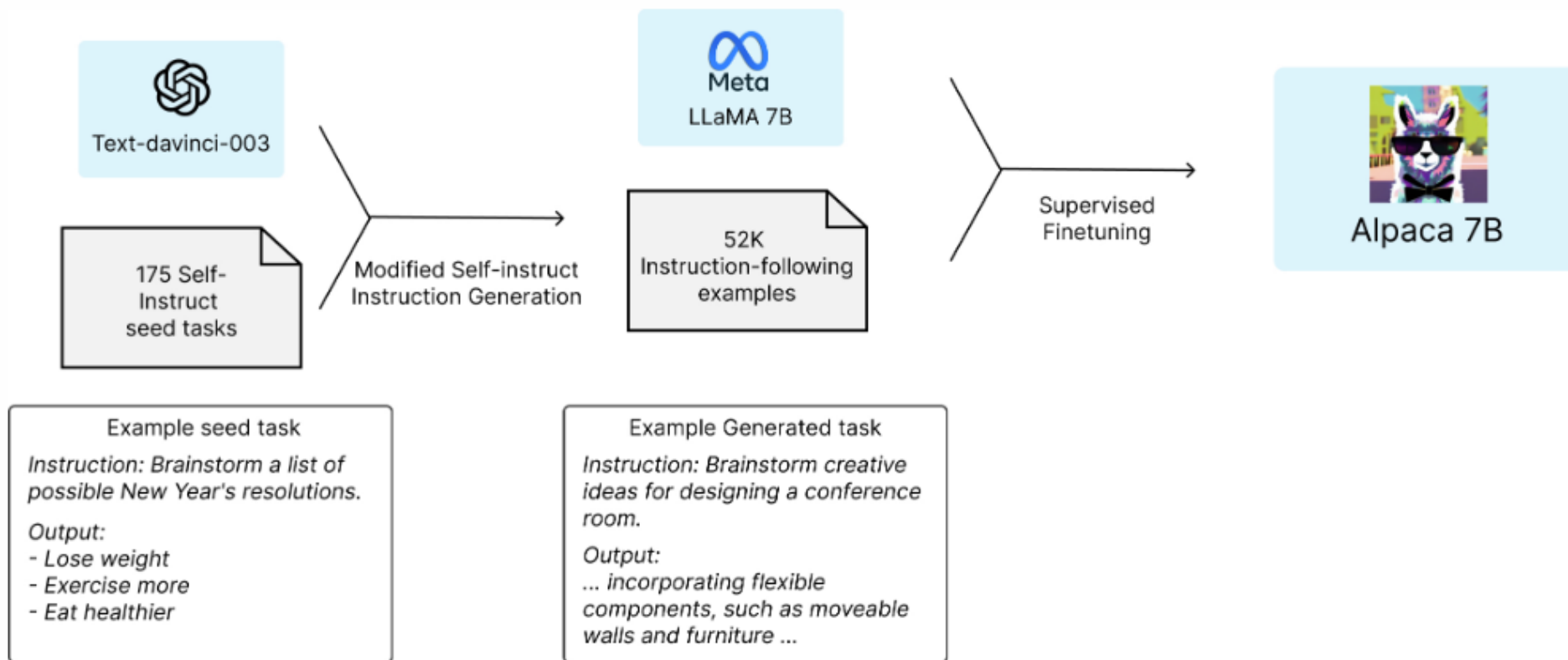


“Replicating” LLMs

Approaches: Improving Effectiveness

- Curating training corpus
- Human Evaluation for Ethics
- Learning from existing LLMs

Alpaca: Learning from existing LLMs





“Replicating” LLMs

Approaches: Improving Efficiency

- Training: Efficient / Staged Training
- Hardware: GPU / Cloud / Federate Learning
- Software: Compiling / Coding



“Replicating” LLMs

Pros:

- Encourages open-source
- Business security
- Customizable for specific use



“Replicating” LLMs

Cons:

- Expensive with risks
- Ethical considerations
- Limited data availability

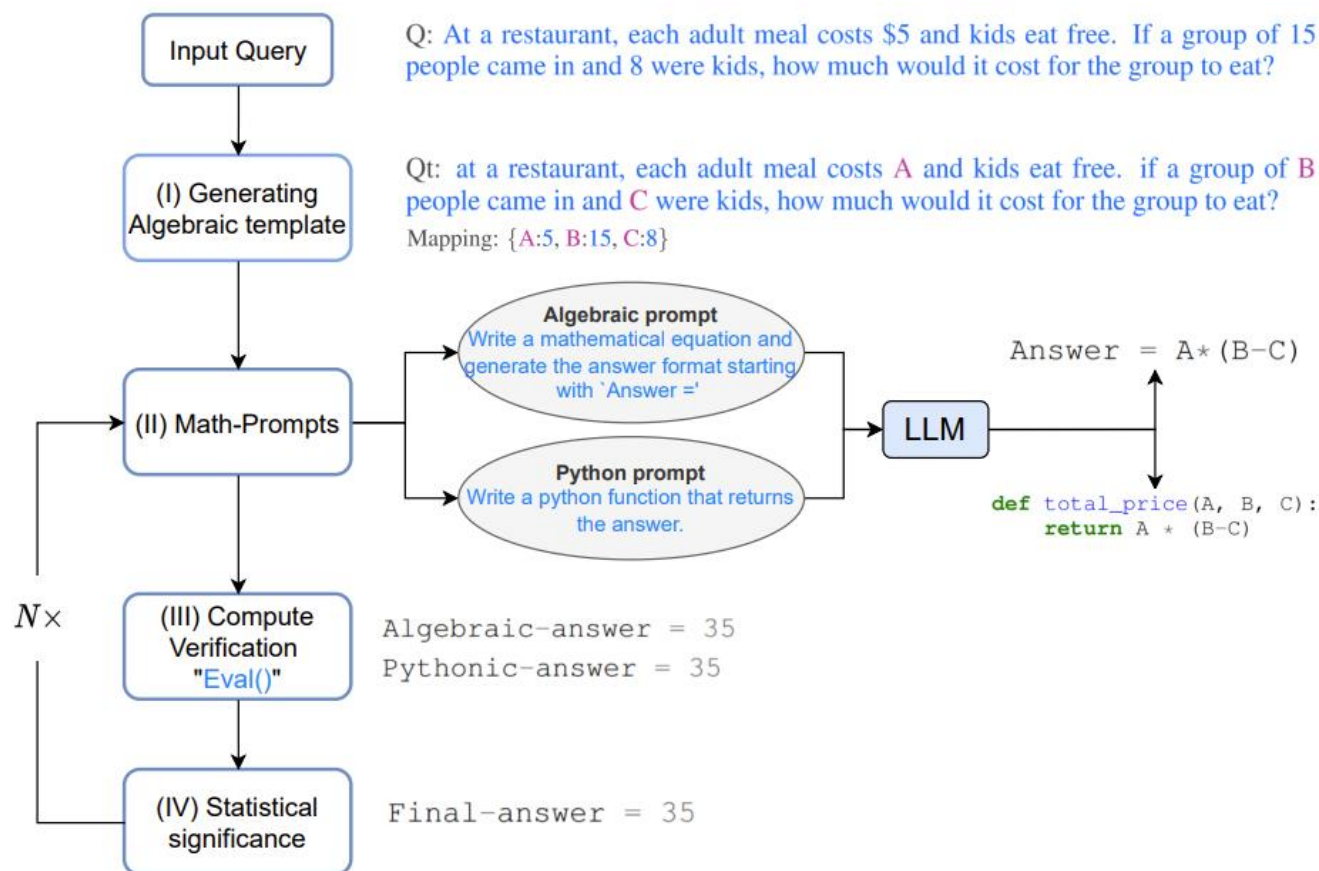


“Leveraging” LLMs

Approaches: borrowing wisdom from LLMs

- In-Context Learning
- Knowledge Distillation
- Systems with LLMs
- Prompt Engineering

MathPrompter: Prompt LM and verify result





“Leveraging” LLMs

Pros:

- Easy to start
- Relatively low cost

Cons:

- Competitiveness
- Performance variance



“Replacing” LLMs

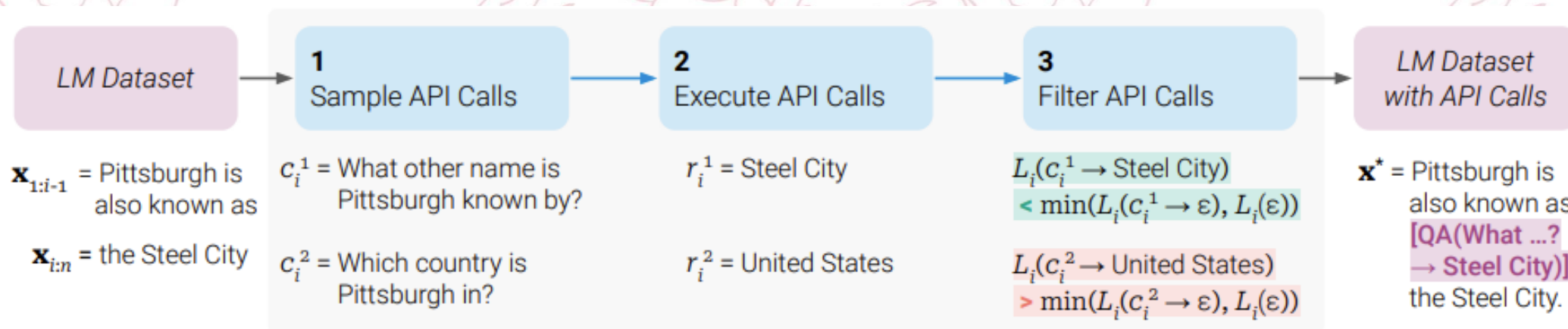
Approaches:

- Augmented Language Models
- New Architecture for Language Models

Pros & cons:

- high risk & high reward

Augmented Language Models: Toolformer



New Architecture for Language Models: AFT

$$\text{Attention}(Q, K, V) = \text{softmax}\left(\frac{QK^T}{\sqrt{d_k}}\right)V$$
$$\sigma_q\left(\begin{array}{|c|c|} \hline & \\ \hline \text{green} & \\ \hline & \\ \hline \end{array}\right) \odot \frac{\sum_{t'=1}^T \left[\exp\left(\begin{array}{|c|c|} \hline & \\ \hline & \\ \hline \end{array} + \begin{array}{|c|} \hline w_t \\ \hline \end{array}\right) \odot \begin{array}{|c|c|} \hline & \\ \hline & \\ \hline \end{array} \right]}{\sum_{t'=1}^T \exp\left(\begin{array}{|c|c|} \hline & \\ \hline & \\ \hline \end{array} + \begin{array}{|c|} \hline w_t \\ \hline \end{array}\right)} = \begin{array}{|c|c|} \hline & \\ \hline \text{green} & \\ \hline \end{array} Y_t$$

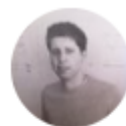
Figure 2: An illustration of AFT defined in Equation 2, with $T = 3, d = 2$.



5. Summary



A new Moore's Law is coming!



Sam Altman ✓

@sama

a new version of moore's law that could start soon:

the amount of intelligence in the universe doubles every 18 months

12:24 AM · Feb 27, 2023 · 3.8M Views

1,923 Retweets 702 Quotes 14.8K Likes



Thanks!

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Homepage: zihanwang314.github.io