

OCTOBER 2023

THE IMPACT OF MODERN LLMS ON THE EDTECH INDUSTRY

Gianmario Spacagna
Director, AI @ Brainly

HI 🖐️



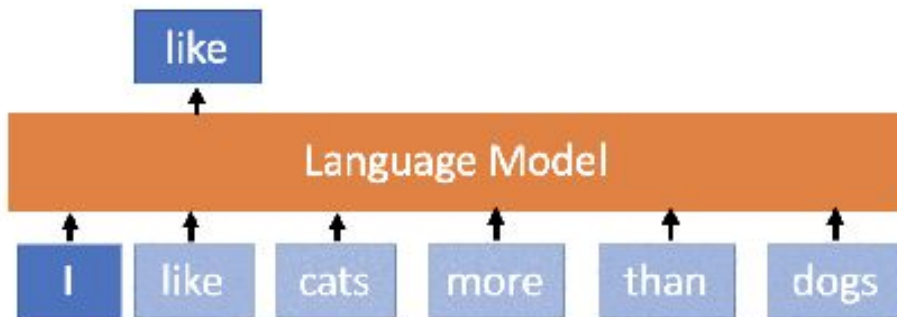
GIANMARIO SPACAGNA

Director of Artificial Intelligence
Italy

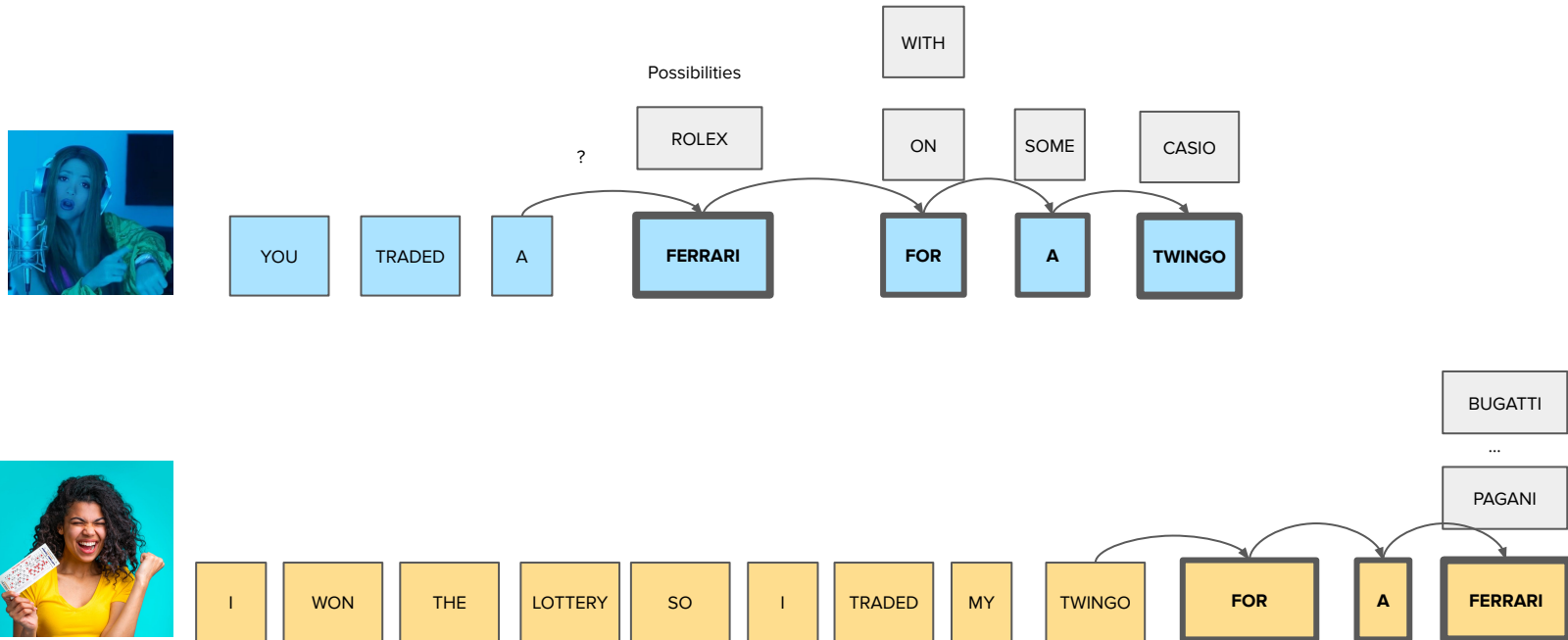
**LANGUAGE MODELS
DEMYSTIFIED**

WHAT IS A LANGUAGE MODEL?




An AI that can complete a sentence by predicting the next words among all possible:



NEXT WORDS DEPEND ON THE CONTEXT



REQUIREMENTS FOR AN INTELLIGENT LANGUAGE MODEL

1. Take into account long sequences of words
2. Disambiguate based on context
 - a. “I won the lottery” at the beginning of the sentence changed the whole meaning
3. Have real-world knowledge
 - a. Ferrari  is better than Twingo 
(although some French may disagree )



TRANSFORMER, THE INTELLIGENT LANGUAGE MODEL

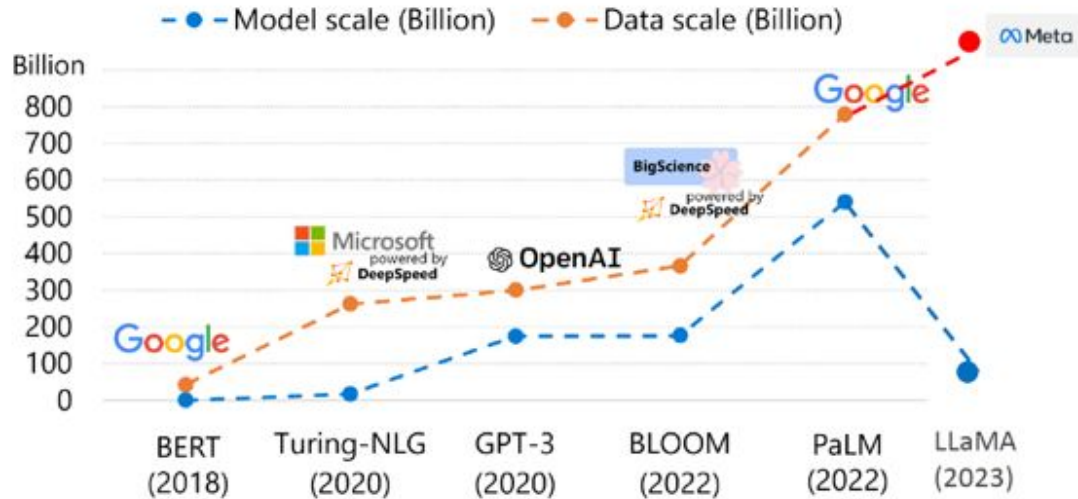
- In December 2017, Google published a paper called “[Attention is All You Need](#)”, proposing a modern language model called “The Transformer”
- Since then, the technology adoption has skyrocketed across every industry 🚀



THE TRANSFORMERS COMPETITION BEGAN

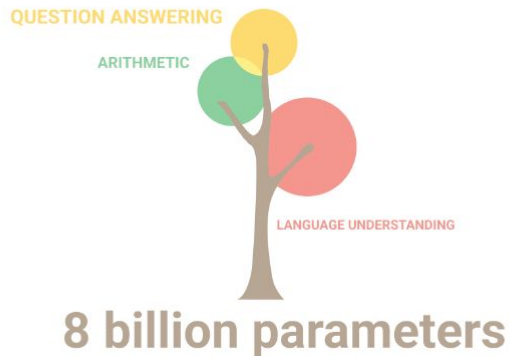
Background: The Hypergrowth of NLP: Large Language Models

Relativity



LARGER MODELS MEAN MORE ADVANCED TASKS

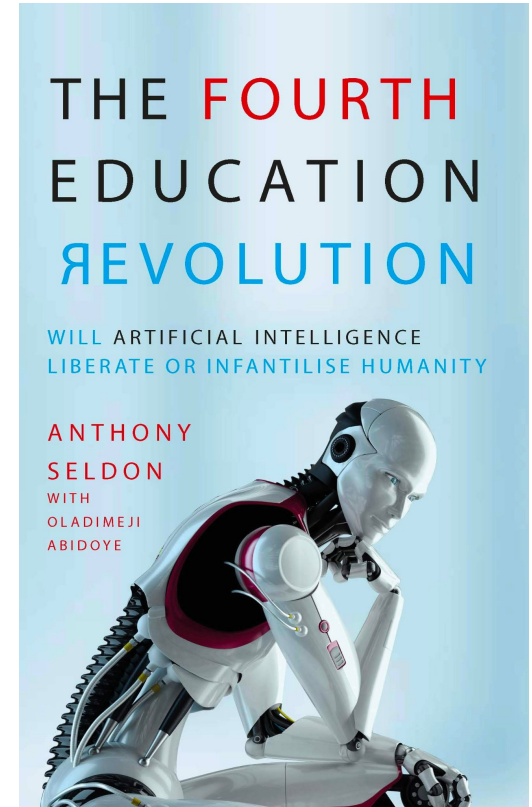
 As the size of the Transformers grew, so did the types of problems they were capable to solve 



OPPORTUNITIES OF ADOPTING LLMs IN EDTECH

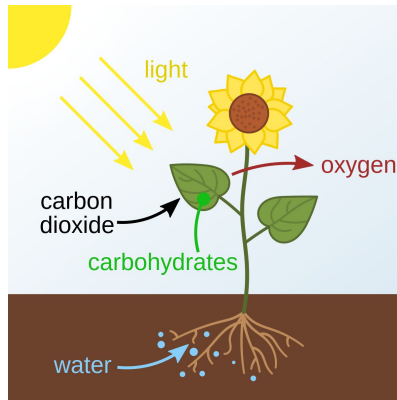
THE 4TH EDUCATION REVOLUTION

1. Homo sapiens organized in learning communities
2. The coming of schools and (elite) universities
3. Factory mass teaching due to industry demand
4. **How can individualized teaching be carried out by AI machines in concert with teachers?**



LLMS TO ASSIST LEARNERS INTO THEIR HOME STUDIES

Local classroom:
Lesson about photosynthesis



Home:



Can you help me shortly understanding the main concepts of photosynthesis?



Certainly! Here's a brief summary of the main concepts of photosynthesis:

- Photosynthesis is the process by which plants, algae, and some bacteria convert sunlight, carbon dioxide, and water into glucose (sugar) and oxygen.
- It occurs in specialized structures called chloroplasts, which contain a pigment called chlorophyll.
- Chlorophyll absorbs light energy from the sun, which powers the photosynthetic reactions.
- The overall equation for photosynthesis is: carbon dioxide + water + light energy → glucose + oxygen.
- Carbon dioxide is obtained from the air through small openings called stomata on leaves.
- Water is absorbed by the plant's roots and transported to the leaves.
- Glucose is the main product of photosynthesis and serves as a source of energy for the plant.
- Oxygen is released back into the atmosphere as a byproduct of photosynthesis.
- Photosynthesis plays a crucial role in producing oxygen, removing carbon dioxide, and providing energy for plants and other organisms in the food chain.

This summary should provide you with a quick understanding of the key concepts of photosynthesis.

LLMS CAN BE CONVINCING BUT ALSO HOLLOW

What they **CAN DO** well:

- memorize general knowledge from the Internet
- generate coherent scripts

What they **COULD NOT ALWAYS DO** well:

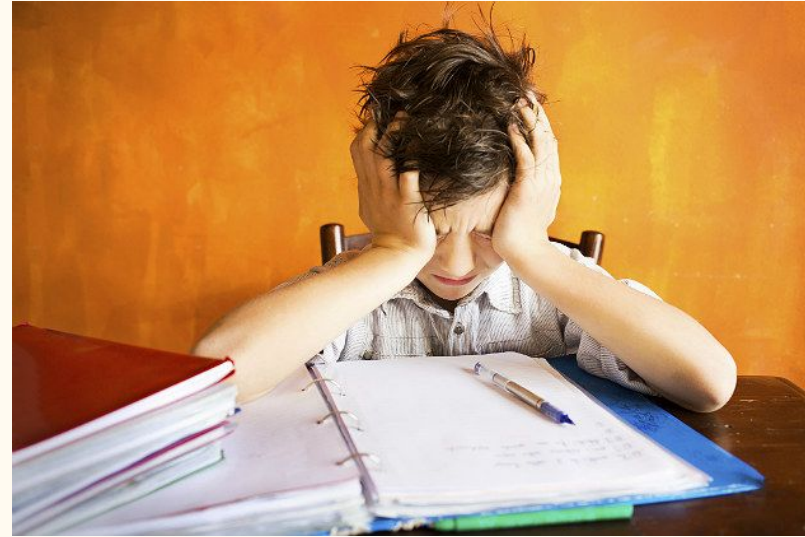
- provide accurate facts
- know what they are talking about in the specific domain
- tailor answers on specific users needs



CURRENT CHALLENGES IN USING LLMs IN EDUCATION

Misleading learning experience due to:

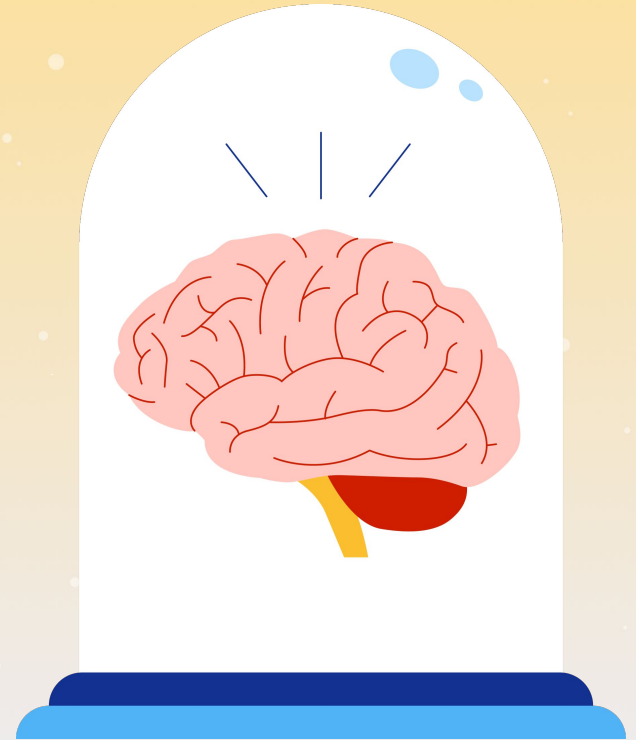
- Wrong answers
- Easily provided solutions not incentivizing them to put efforts in understanding more
- Gaps between how the teacher is teaching in the classroom and the way AI is assisting them in the home studies:
 - Different language
 - Different teaching methods
 - Different connections among concepts



(PERSONALIZED) EDUCATIONAL ANSWER

An educational answer should be:

1. Contextualized to users intentions
2. Factually correct
3. Provide step-by-step explanations to enable the user to derive the solution
4. Tailored to the **learner's curriculum**:
 - **Reinforce** the same vocabulary
 - Explicitly **connect** past knowledge gaps
 - **Do not introduce** new concepts that have not been covered yet at that point in time



**NEW PARADIGMS FOR
BUILDING QUESTION
ANSWERING APPS**

PROMPT ENGINEERING

The **art** of writing text instructions to an AI system to generate the output you want

Task: Using the provided context, if possible, answer the following question.

Context: @#>#@CONTEXT@#<#@

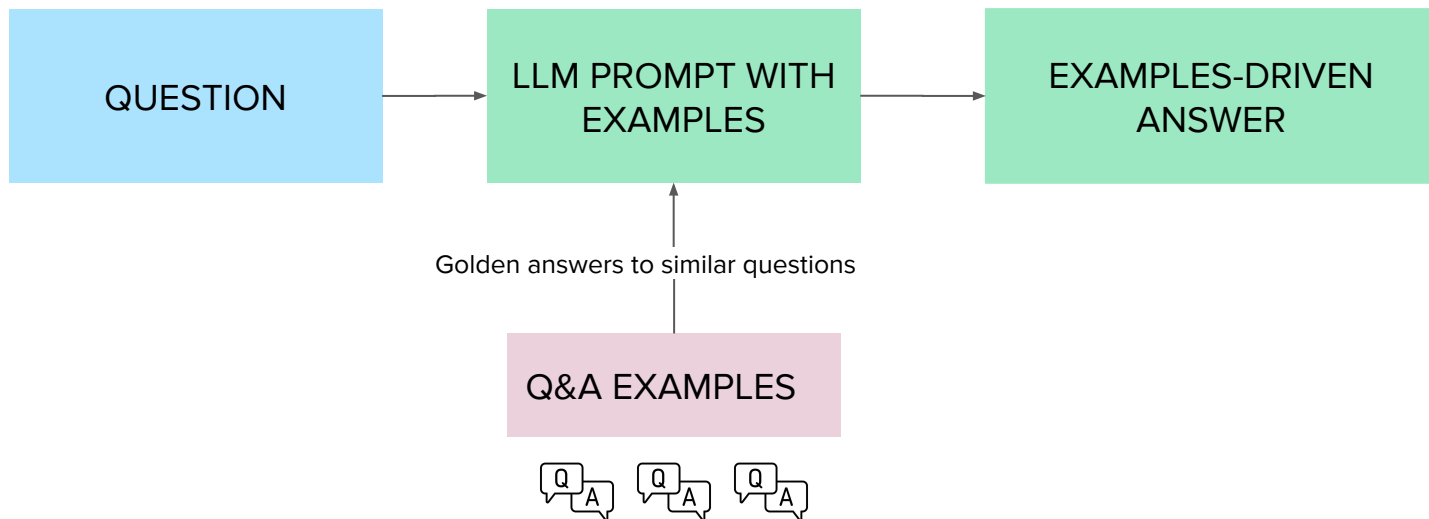
Question: @#>#@QUESTION@#<#@

Explanation:

Answer:

FEW-SHOT PROMPTING

Generalize on a new data domain based on a limited number of a few examples included into the prompt



CHAIN-OF-THOUGHTS (COT) PROMPTING

Prompt technique designed for complex capabilities requiring intermediate reasoning steps

(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. X

(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 X

(d) Zero-shot-CoT (Ours)

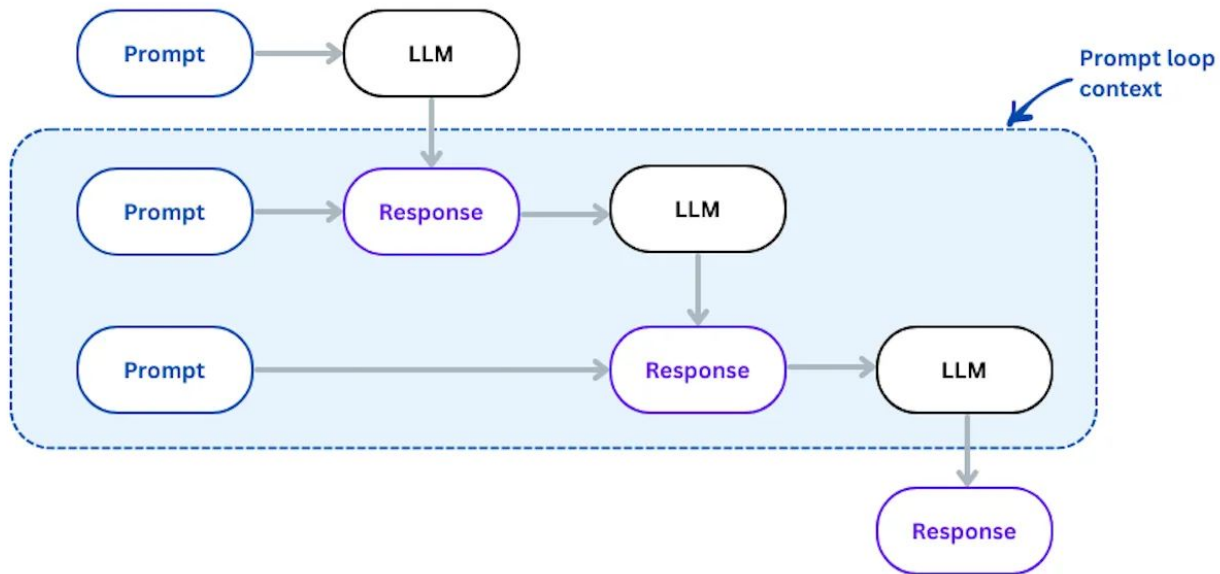
Q: A juggler can juggle 16 balls. Half of the balls are golf balls, and half of the golf balls are blue. How many blue golf balls are there?

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. ✓

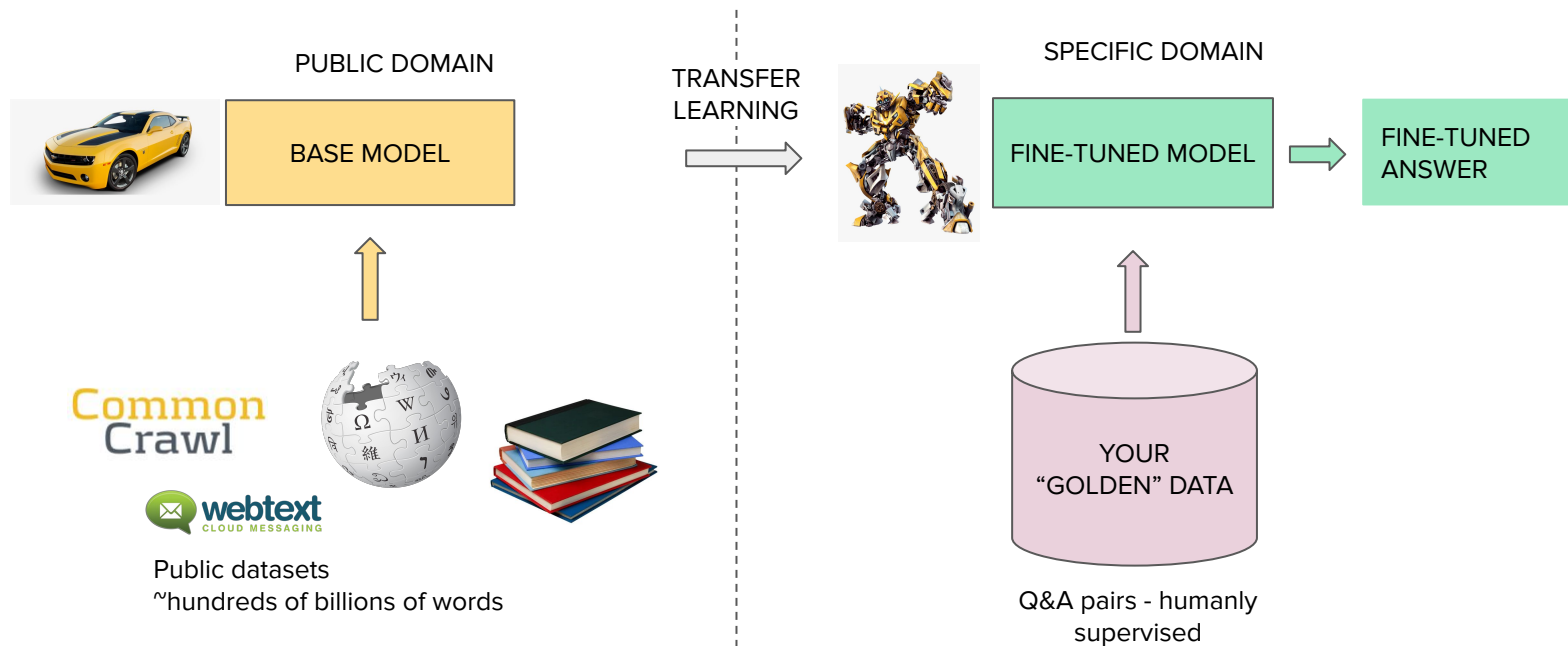
PROMPT STEERING

Iteratively interact and generates prompts programmatically based on current state until convergence



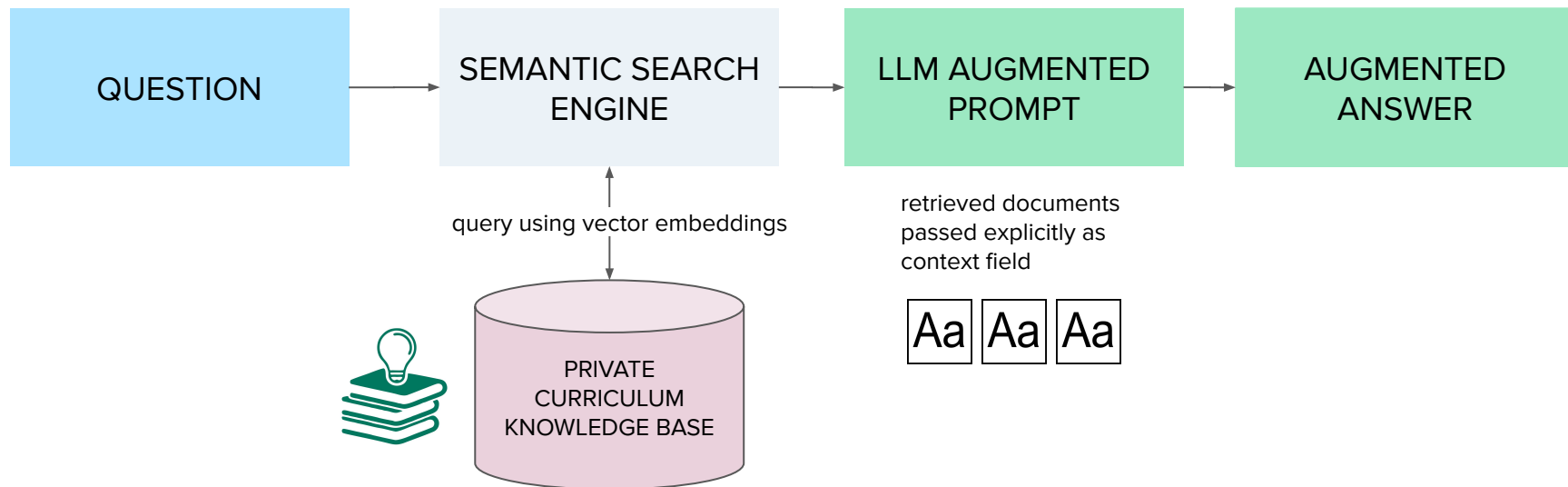
FINE-TUNING

Adapt to your specific domain by fine-tuning an encoding layer, like in p-tuning, in case of commercial models (e.g. GPT) or fine-tuning model weights layers for open source ones (e.g. Llama2)



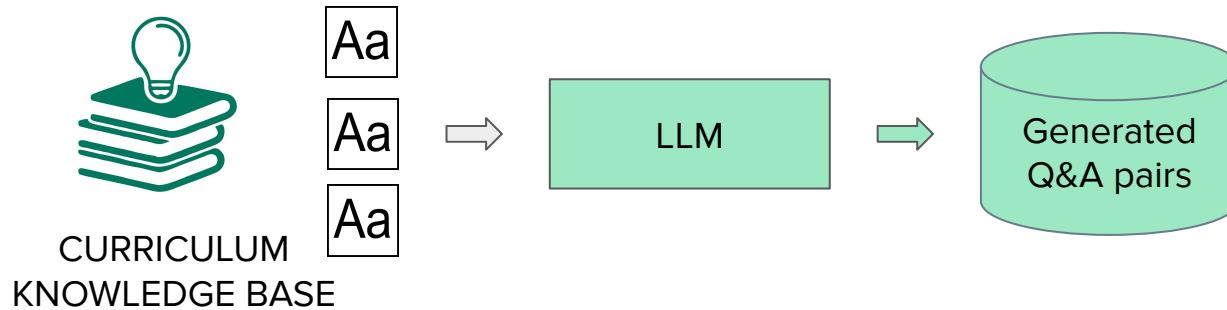
RETRIEVAL AUGMENTATION GENERATION (RAG)

Provide external knowledge by retrieving documents based on semantic similarity and inject them into the prompt in the form of textual context



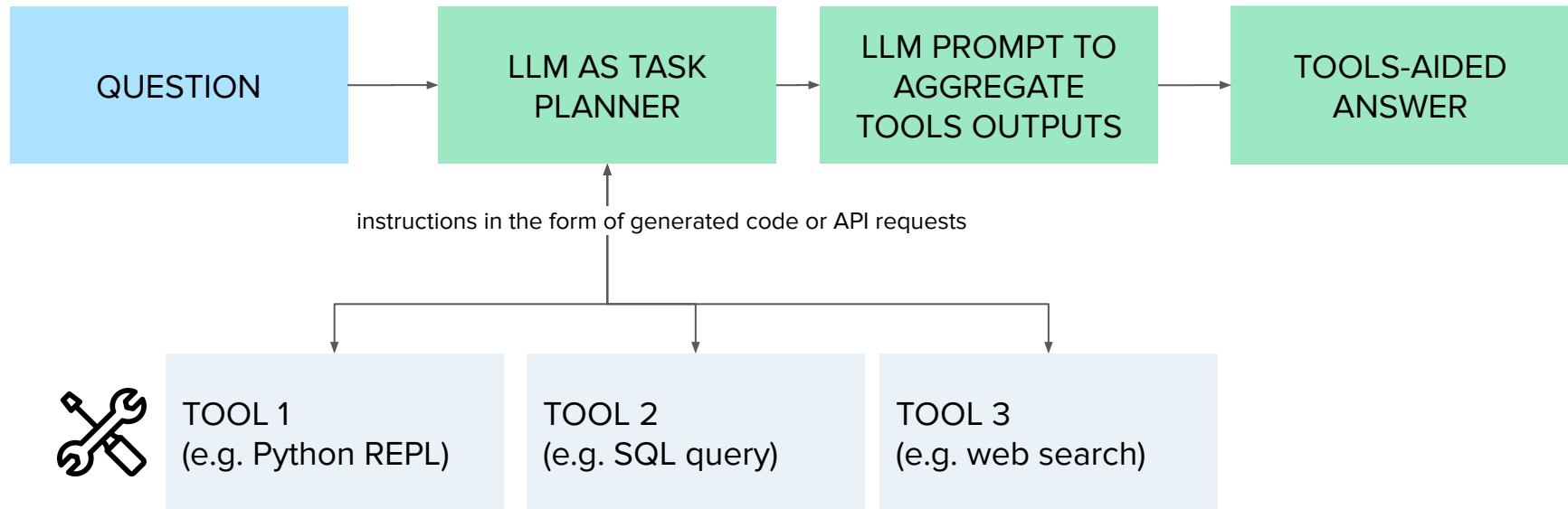
Q&A GENERATION

Generating pairs of Q&A from a general corpus of curriculum sources (e.g. automated quizzes, tests, assessments...)



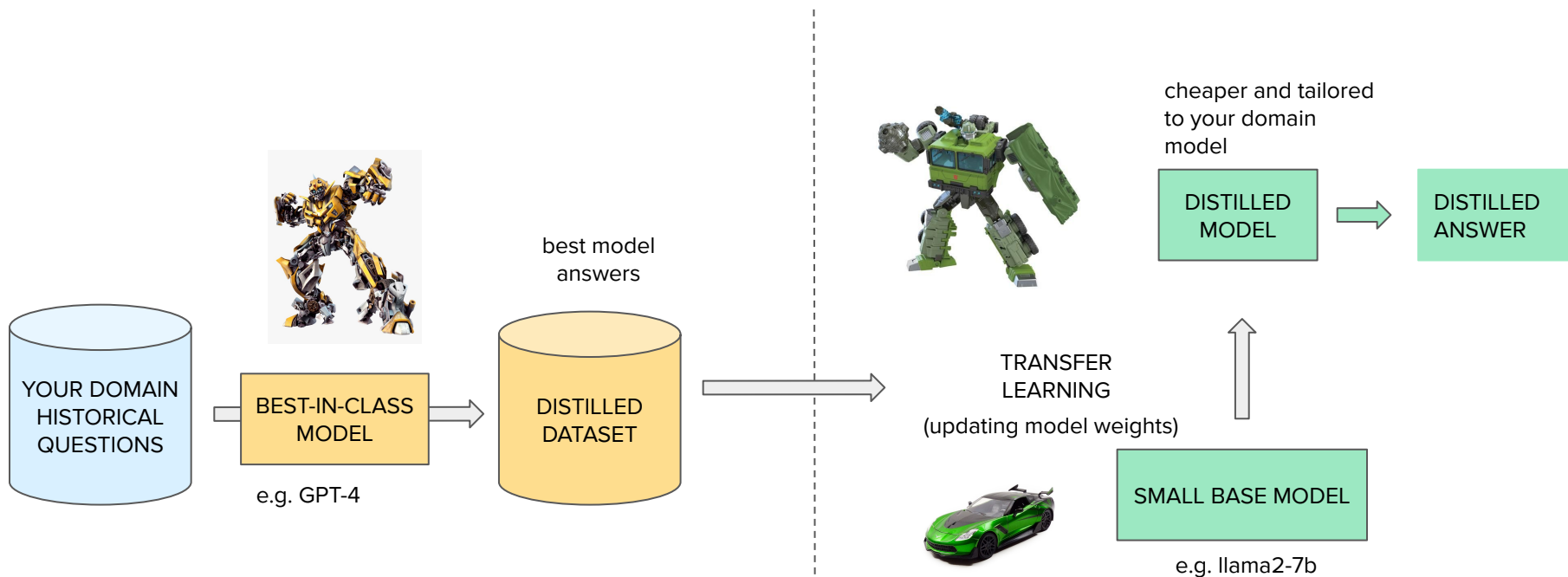
TOOLS INTEGRATION

Use the LLM to plan and integrate with external tools for getting difficult problems solved



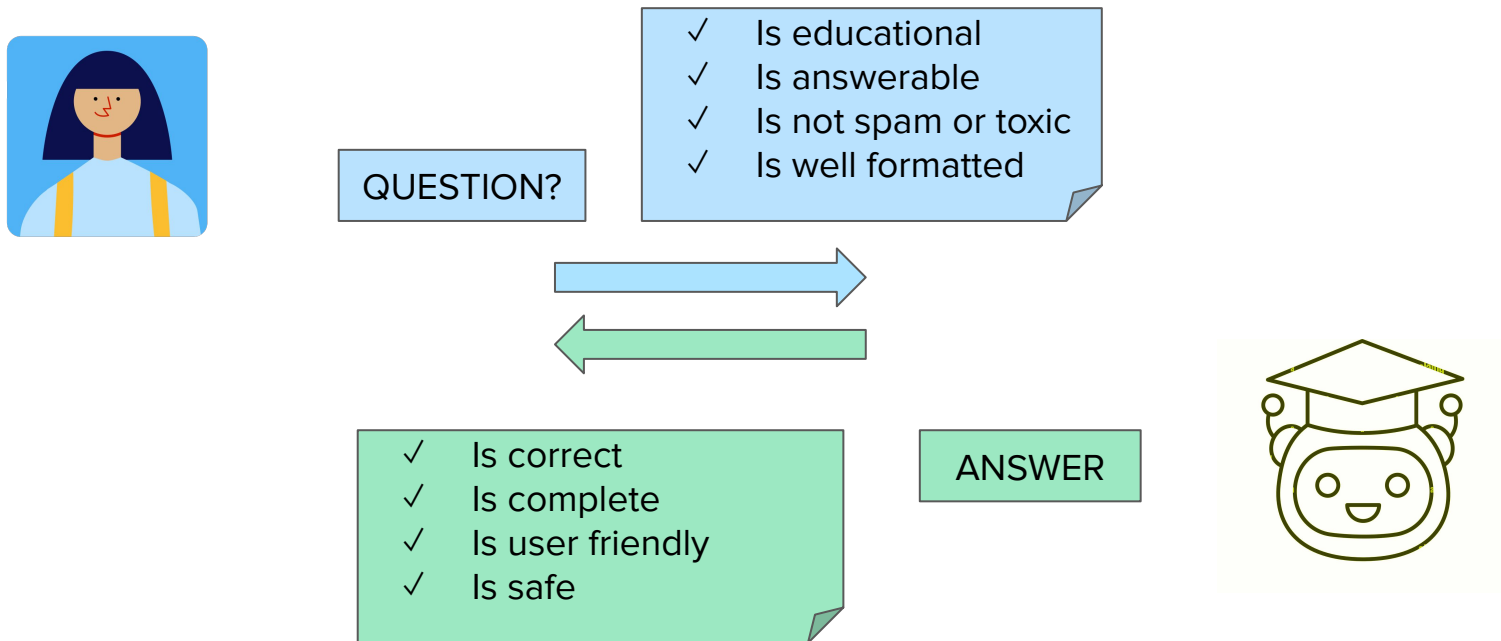
KNOWLEDGE DISTILLATION

The process of transferring knowledge from a large model to a smaller domain-tailored one, typically exploiting Low Rank Adaptation (LoRA) and model quantization techniques



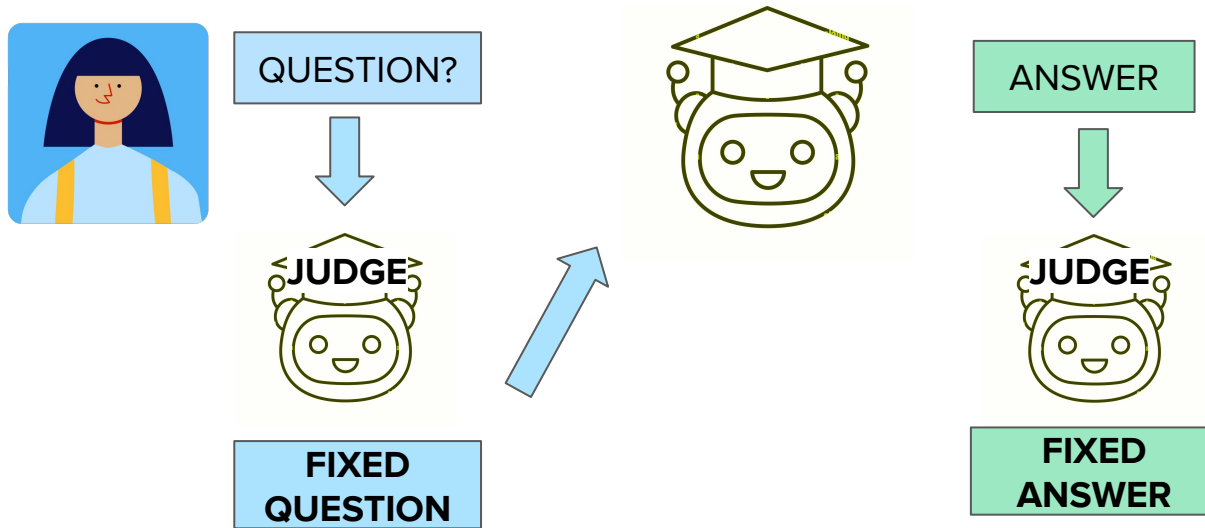
BI-DIRECTIONAL CONTENT MODERATION

Filtering inappropriate question requests and potentially low-quality answers being generated



LLM AS A JUDGE

Language models can learn how to evaluate and correct answers produced by other models



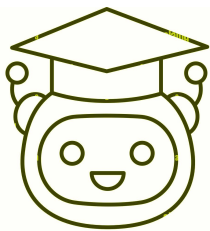
LLM SOLVING ZERO-SHOT TRADITIONAL NLP PROBLEMS

Language models can use their general knowledge to perform NLP tasks without the need of being trained on

QUESTION?

ANSWER

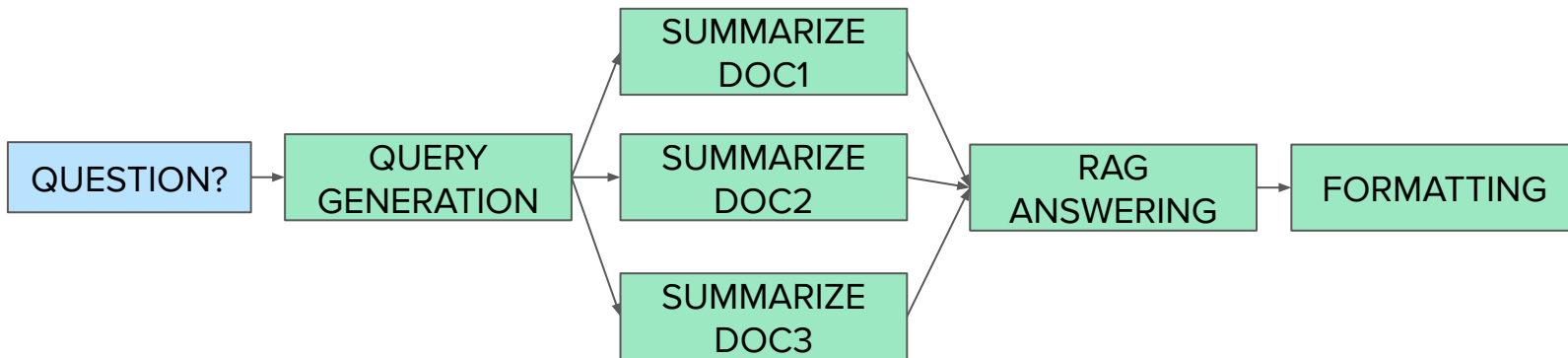
GENERAL
DOCUMENT



- ❑ Classification (e.g. subjects taxonomy, spam)
- ❑ Text completion (e.g. fixing incomplete questions)
- ❑ Named Entity Recognition (e.g. extracting keywords)
- ❑ Summarization
- ❑ Other NLP tasks...

LANGUAGE CHAINS

Breaking final goal into smaller language tasks and chaining multiple models specializing in each task into a larger pipeline like in this example:



CURRICULUM QUALITY EVALUATION FRAMEWORK

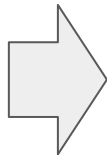
(Personalized) educational answers require domain-specific criteria to measure how tailored they are to a given curriculum

QUESTIONS

ANSWERS



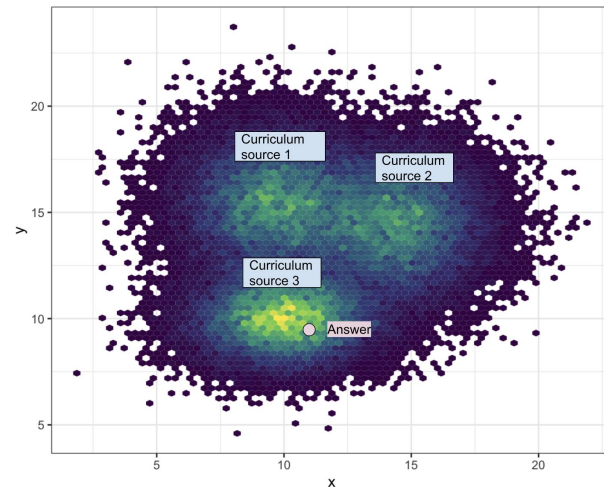
Curriculum
Knowledge Base



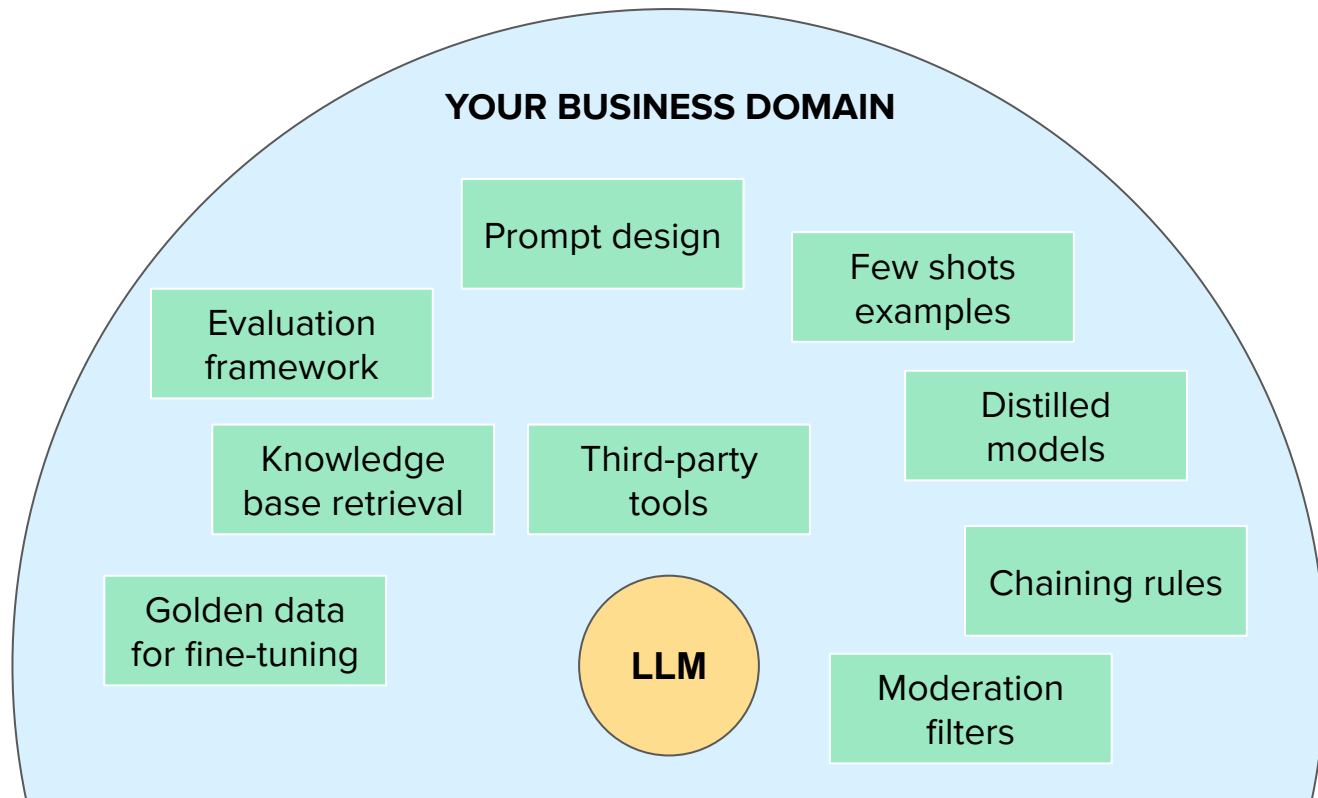
Curriculum Evaluation:

- Language similarity
- Topic modeling
- Keywords analysis
- Ad-hoc rules
- Benchmark datasets

Detailed insights report

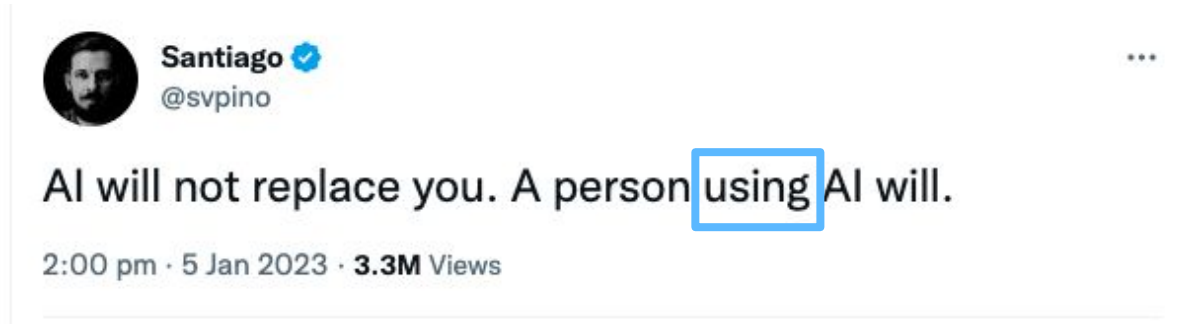


TAILOR THE CORE TECH WITH CUSTOM LAYERS AROUND



**IMPACTS ON THE JOB
MARKET AND EDUCATION
INDUSTRY**

EVOLUTION OF JOB DEFINITIONS



IMPACTS ON CONTENT CREATORS

1. More time to focus on producing the core of **high-quality content** and less on the repetitive tasks
2. **Specialize** in those areas that complement what AI is not well suited for
3. Upskill into a (foreseeable) **highly demanded job** profile in the market



IMPACTS ON TEACHERS

1. **Leverage** AI tools and **integrate** them in their classrooms
2. Trust AI as a tool for **supporting** teaching, not to replace teachers
3. Trust AI as a tool for providing **insights** on learners to act upon



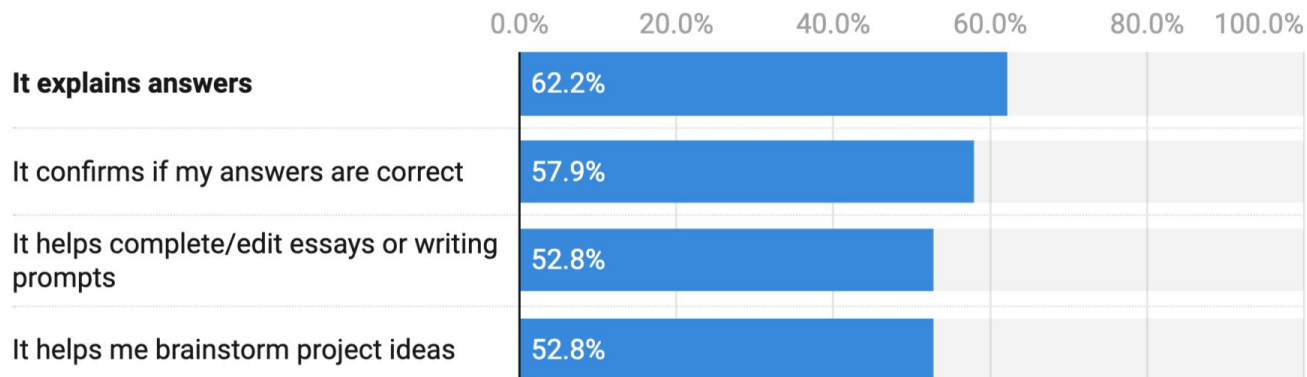
IMPACTS ON LEARNERS

1. Get **doubts solved** and studies **unstuck** when teachers are not around
2. Learn **fast**, avoid spending time on misleading content outside their scope
3. Learn **more** by digging deeper



2023 AI STUDENT REPORT

How do GenAI-based chatbots help you for school?



Based on a survey by Brainly of 1,200 U.S. students in grades 6-12, conducted on brainly.com and concluded May 12, 2023.

Source: <https://brainly.com/insights/the-2023-student-ai-report>

IMPACTS ON AI EXPERTS

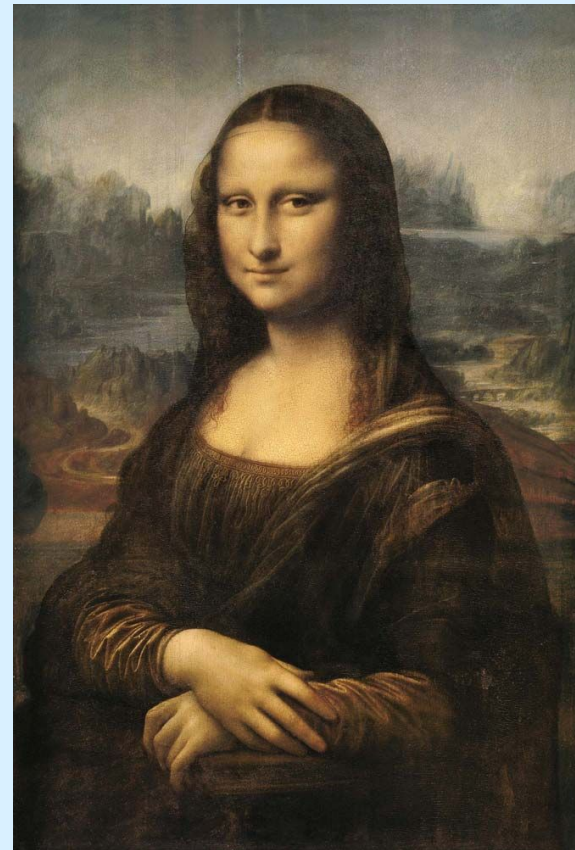
1. **Learn** new engineering paradigms
2. **Build** on top of the giants shoulders
3. Create a positive **impact** on the society



**LET MACHINES DO THE HEAVY
LIFTING**

SO

WE CAN CRAFT THE BEAUTY!



WE ARE HIRING!

Openings:

- ❑ Tech Lead, AI Answer Platform team
- ❑ (Senior) Data Scientist, NLP & Computer Vision
- ❑ (Senior) ML Engineer, NLP & Computer Vision
- ❑ Data Scientist, LLMs and Prompt Engineering

Visit the [Brainly career portal](#)