

LLMs – what are they?

Denny Lee
Databricks



What can LLMs do?

Text, Images, Audio, Movies

Interactive Q&A

Providing customers with personalized experience through digital channels

Knowledge base

Replacement of search engines, initiatives for internal knowledge base

Content generation

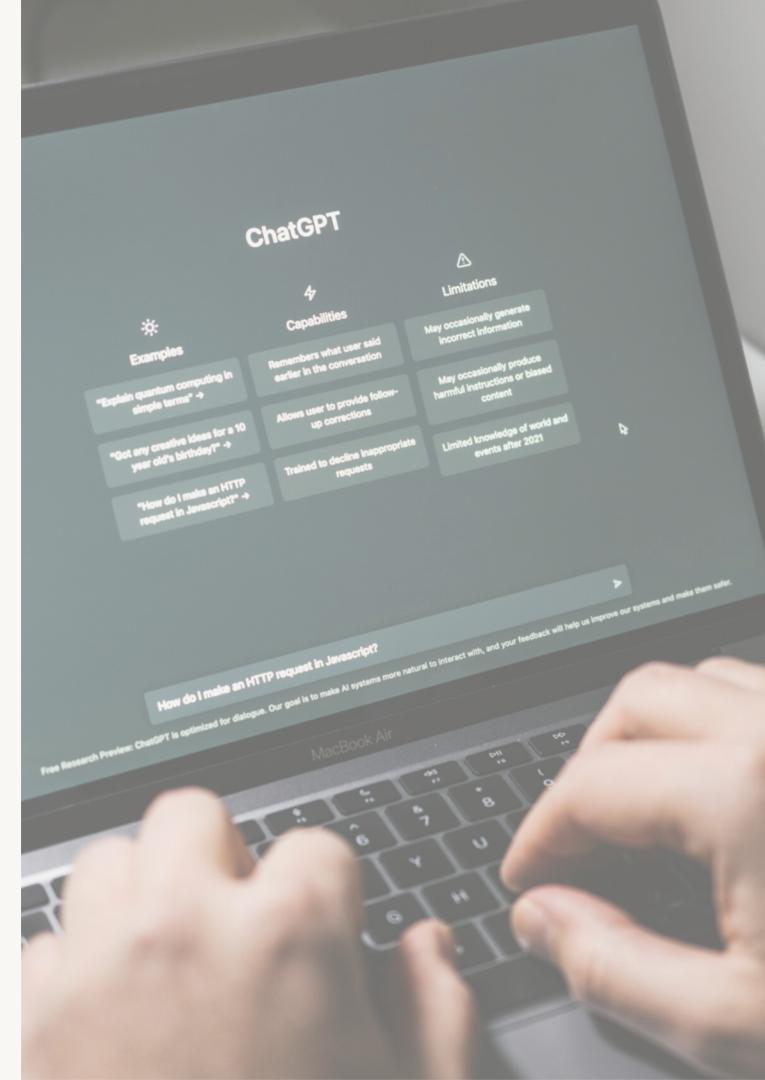
Creating email communication, meeting minutes, memorandum

Text summarization

Key executive summary from complex documents

Code generation

Code snippets (best practices) or complex migration from legacy languages



We've Hit an Inflection Point

Instruction-following Behavior Enables Everyone to Use LLMs



Early usage (BERT, T5, ...):

Use an LM to learn features of text, then train a traditional predictor on top (e.g., sentiment classifier)



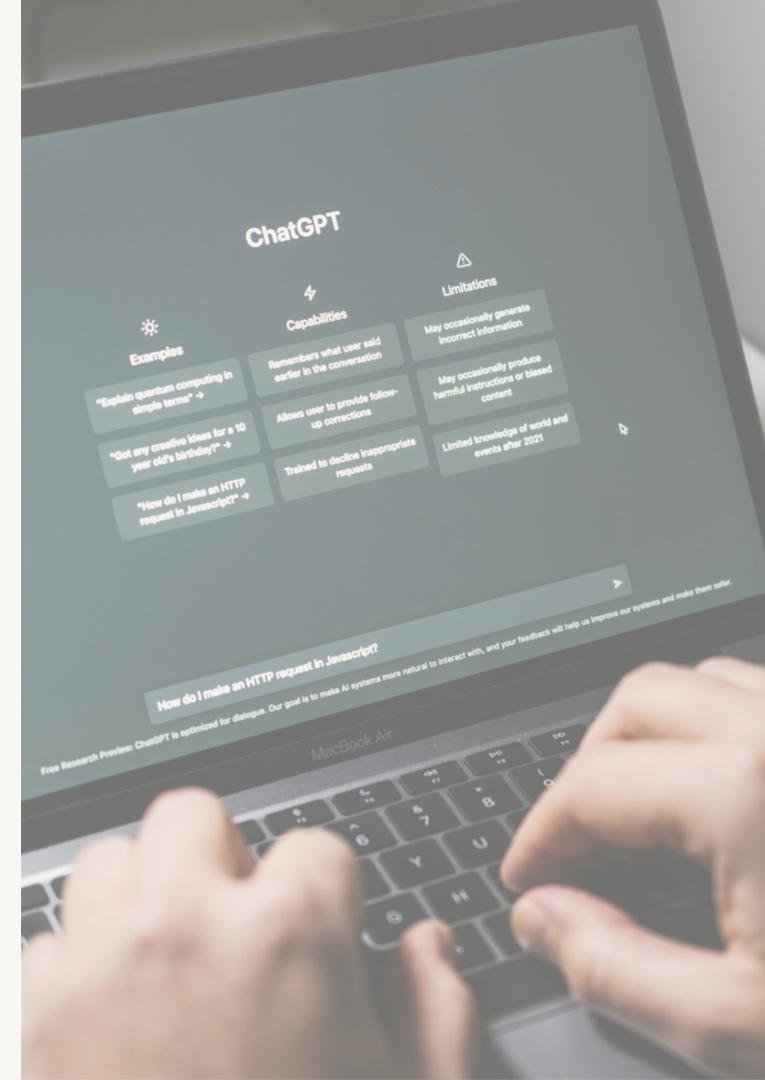
2020 (GPT-3):

"Prompt" the LM with a prefix that elicits desired behavior, e.g. "list of positive/negative sentiment reviews and their labels".



2022 (InstructGPT, ChatGPT):

Train the LM to follow instructions in prompt, e.g. just tell it "classify this review as positive or negative"



Instruction-following behaviour revolutionizes user interfaces to any software or device, users can declare what they want!

Cool... but what are LLMs?





How to best explain chatgpt to middle schoolers?

Why not just ask ChatGPT?

<https://chat.openai.com/share/63ba6afa-b496-4a20-8a25-b9f006c0fa7d>

How to best explain chatgpt to middle schoolers?

Part 1



ChatGPT is an AI (Artificial Intelligence) language model that can have conversations with people. It's like having a smart virtual friend you can talk to and ask questions. Just like you learn and understand things, ChatGPT also learns and understands by analyzing lots of text from books, articles, and websites.

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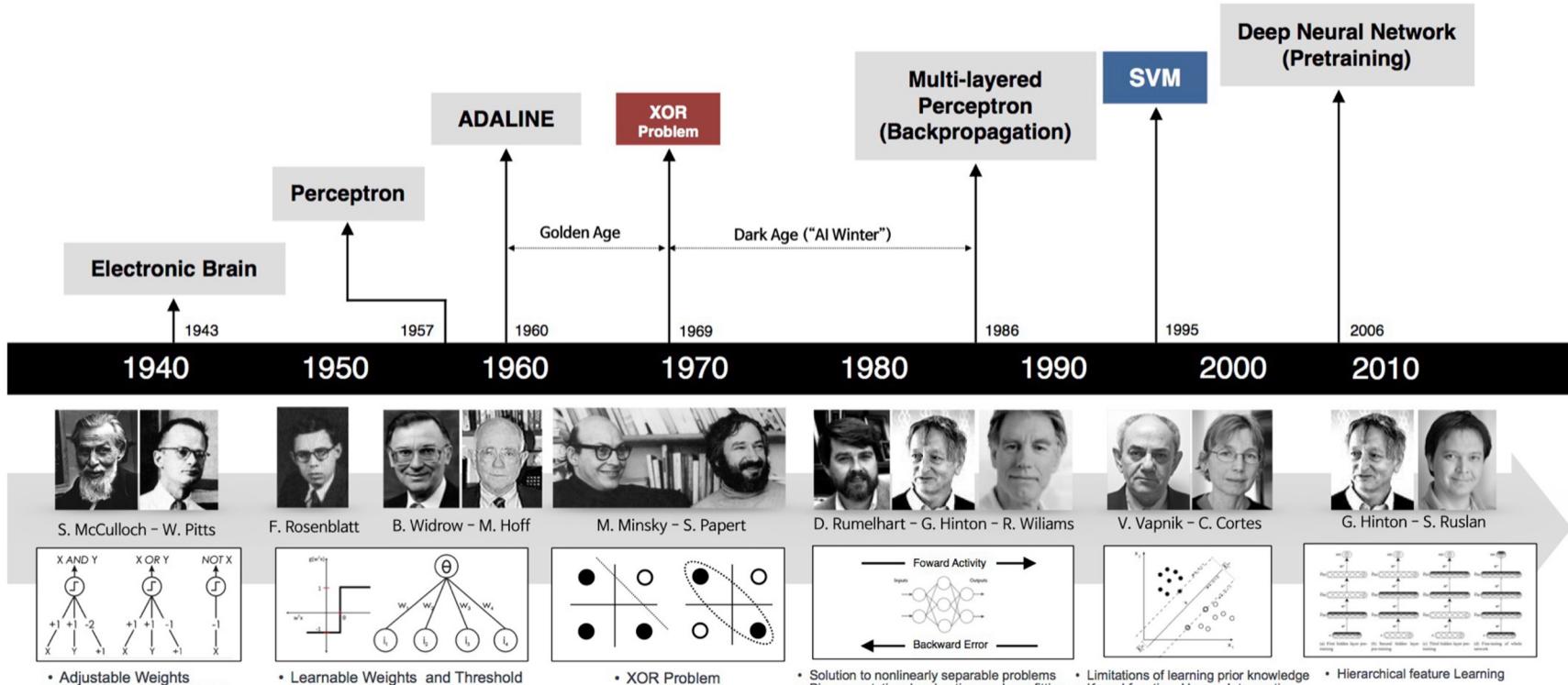
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History of AI research



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Part 1



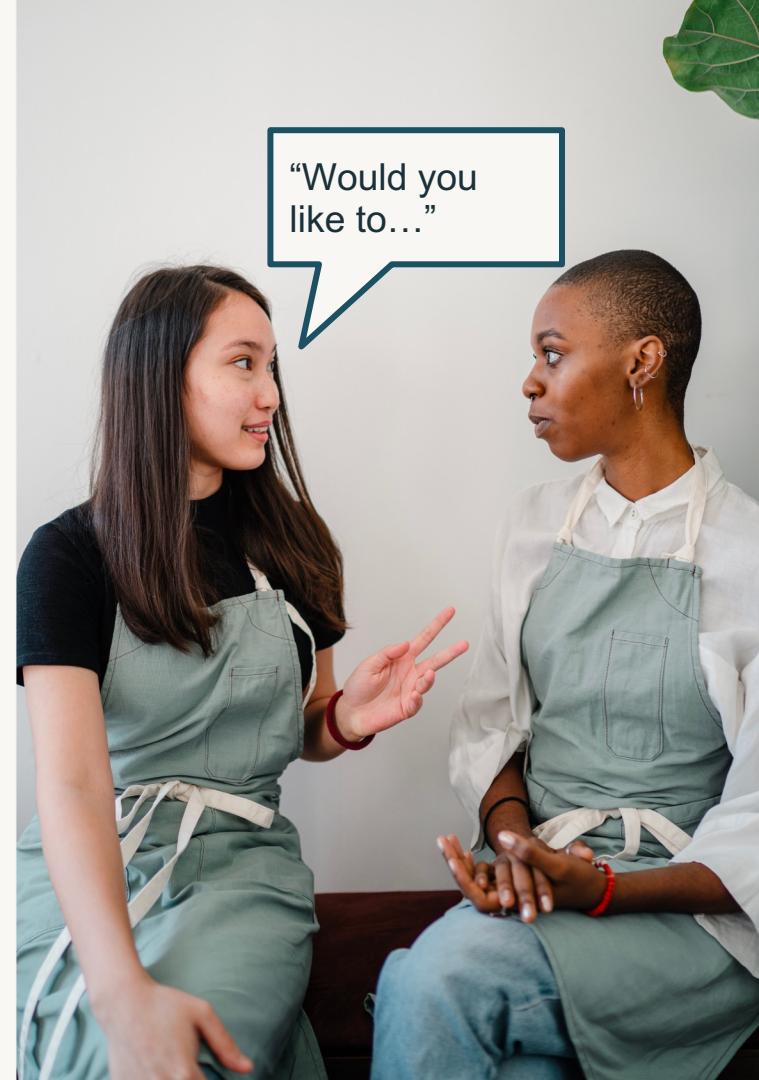
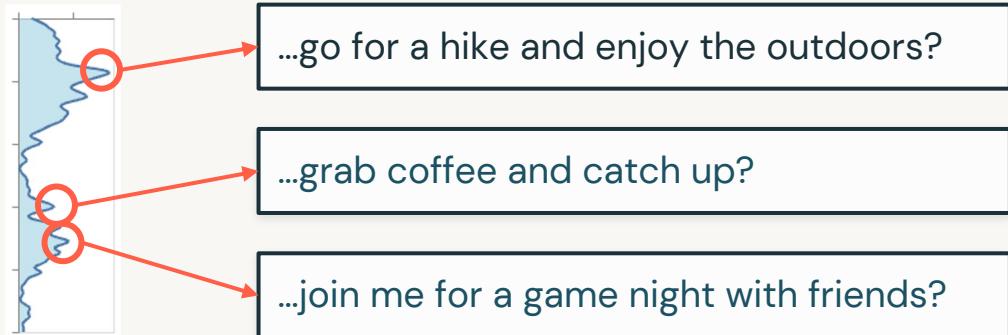
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But What are Language Models?

Surprisingly Useful Guessers!

Wikipedia

"A language model is a probability distribution over sequences of words. Given any sequence of words of length m, a language model assigns a probability $P(w_1, \dots, w_m)$ to the whole sequence. Language models generate probabilities by training on text corpora."



It's like a friend who's a surprisingly good
guesser because they have a lot of context!

Tokenization

Transform raw text into a long list of integers.

Raw Text

A language model is a probability distribution over sequences of words. Given any sequence of words of length m , a language model assigns a probability $P(w_1, \dots, w_m)$ to the whole sequence. Language models generate probabilities by training on text corpora.

Tokens

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Integers

[32, 3303, 2746, 318, 257, 12867, 6082, 625, 16311, 286, 2456, 13, 11259, 597, 8379, 286, 2456, 286, 4129, 285, 11, 257, 3303, 2746, 46974, 257, 12867, 350, 7, 86, 16, 837, 3926, 11, 266, 76, 8, 284, 262, 2187, 8379, 13, 15417, 4981, 7716, 39522, 416, 3047, 319, 2420, 1162, 8957, 13, 198]



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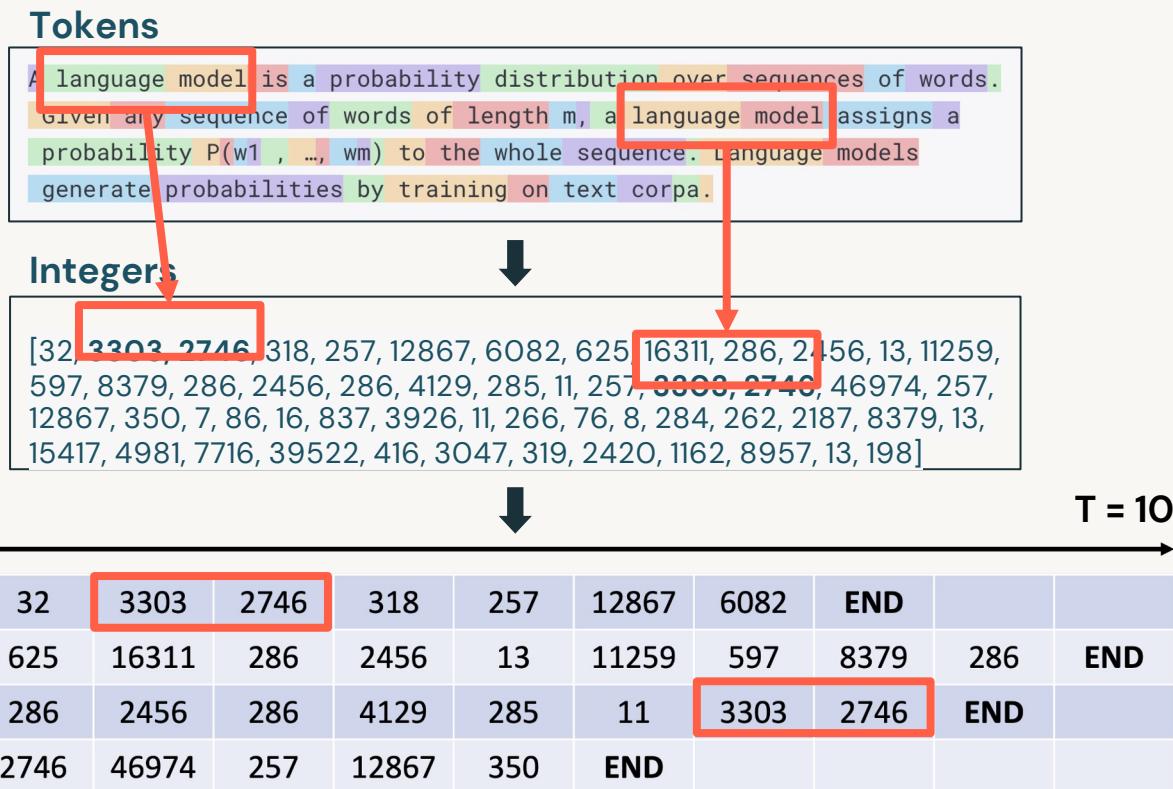
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[32 3303, 2746, 318, 257, 12867, 6082, 625, 10011, 200, 2156, 13, 11259,
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12867, 350, 7, 86, 16, 837, 3926, 11, 266, 76, 8, 284, 262, 2187, 8379, 13,
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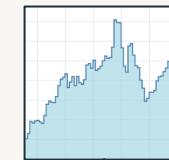
Tokenization: Skipping most of the math



Tokenization: Let's talk probability

Context

Token to predict

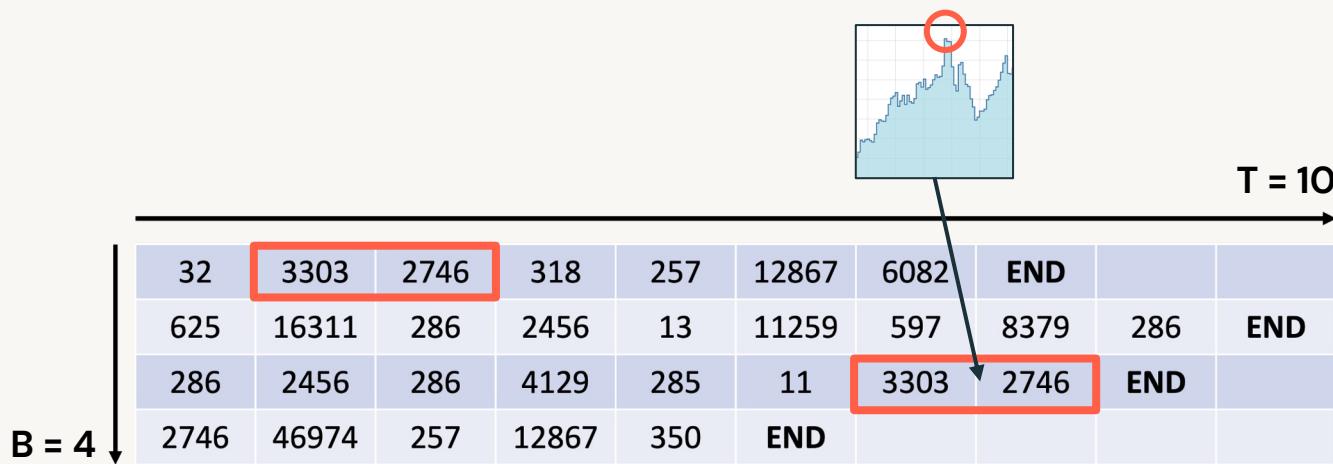


T = 10

32	3303	2746	318	257	12867	6082	END			
625	16311	286	2456	13	11259	597	8379	286	END	
286	2456	286	4129	285	11	3303	2746	END		
2746	46974	257	12867	350	END					

B = 4

Tokenization: Let's talk probability



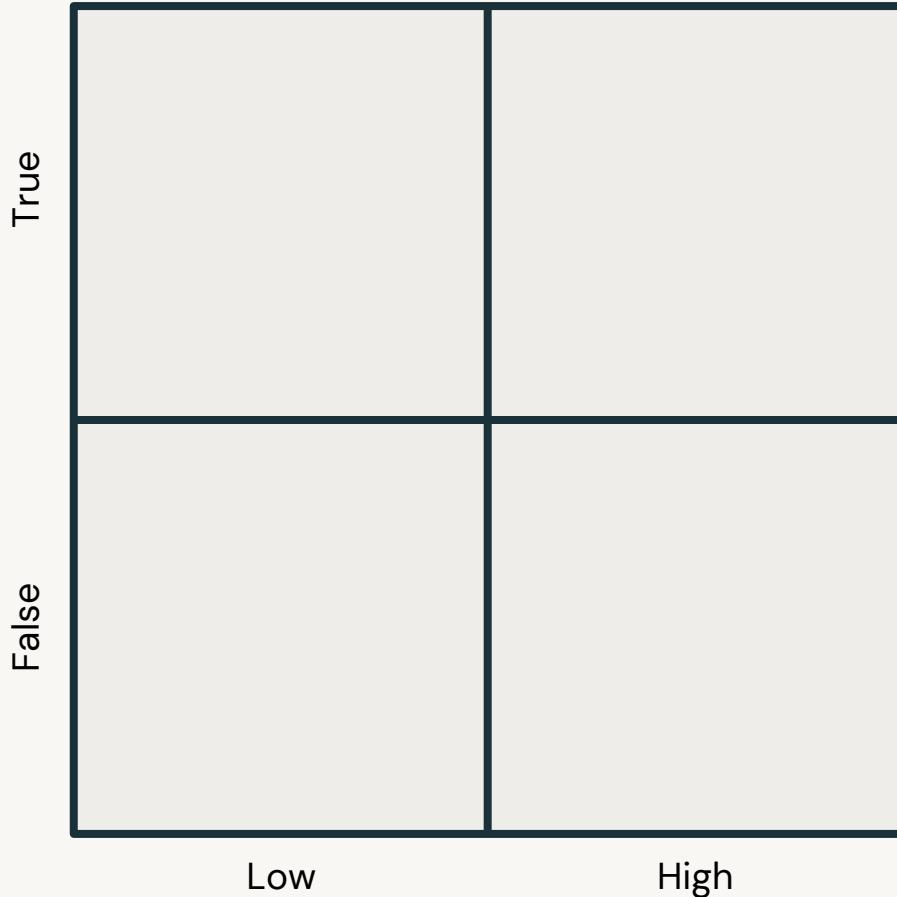
Let's really talk about probability...
hopefully in a fun way

Probability:
Low, Medium, High

True vs. False

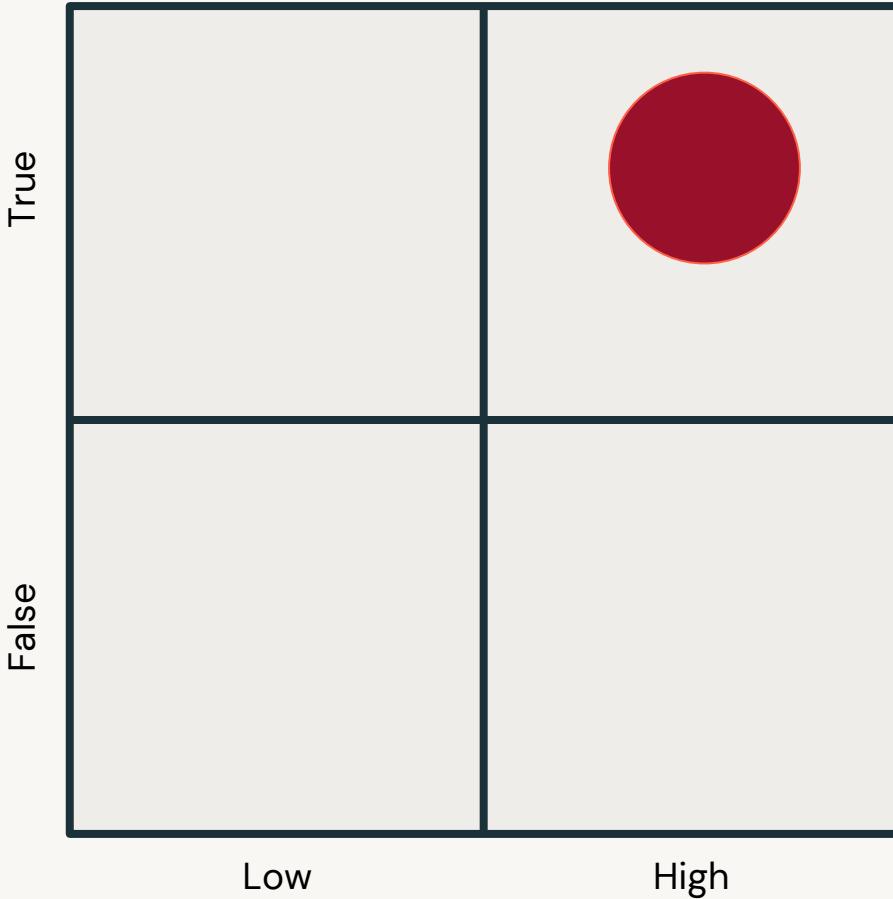
Probability:
Low, Medium, High

True vs. False



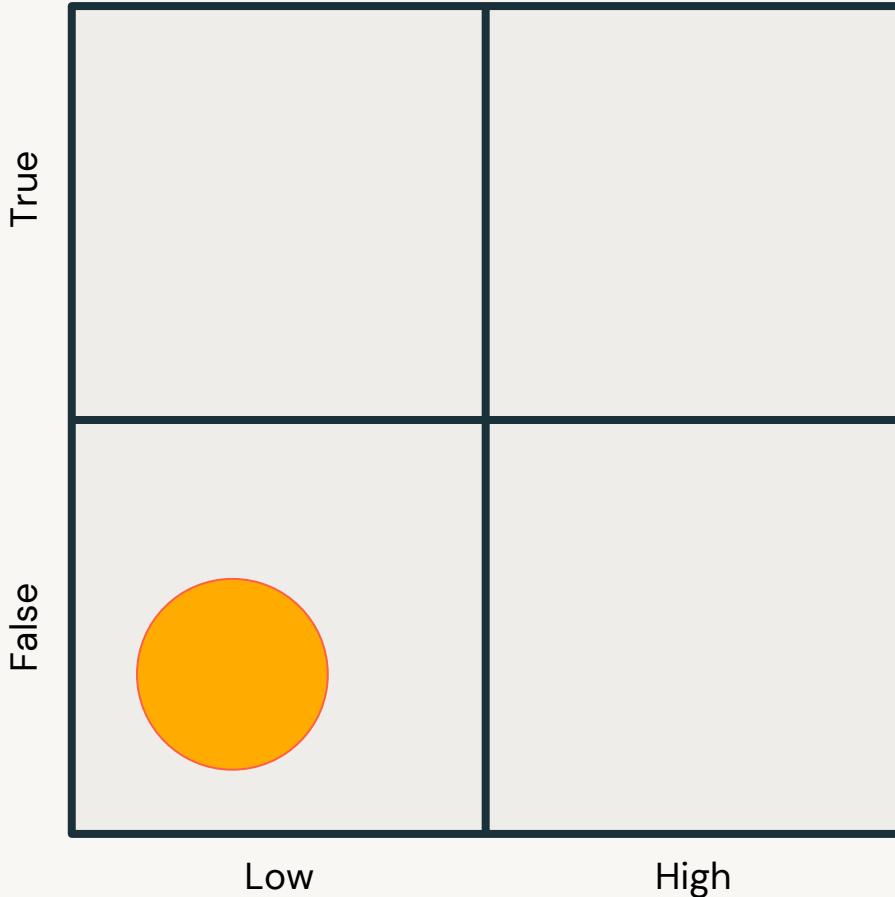
Probability:
Low, Medium, **High**

True vs. False



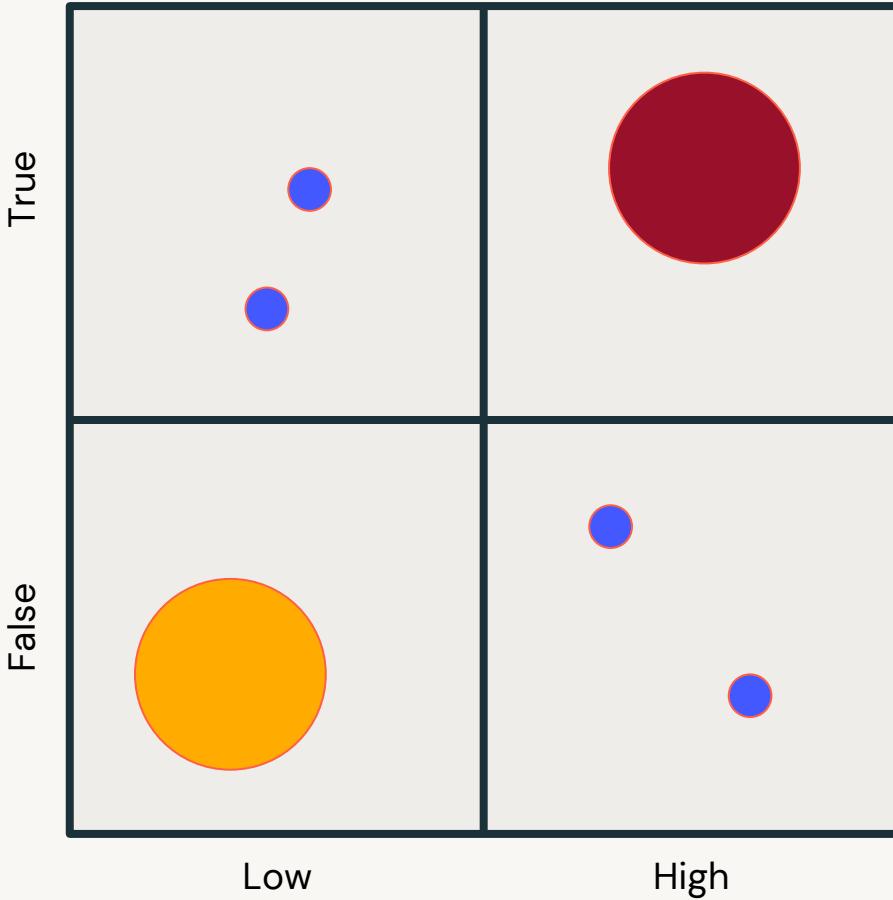
Probability:
Low, Medium, High

True vs. **False**



Probability:
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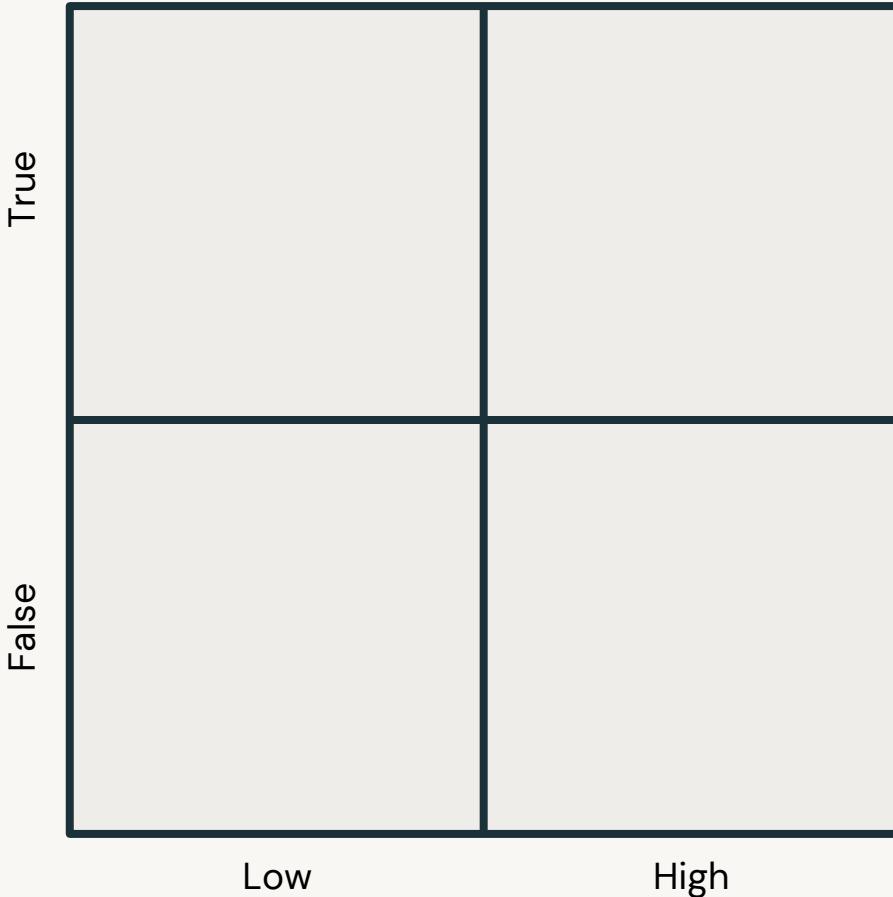
True vs. False



You are going to Northstar Middle School?

Probability
Low, Medium, High

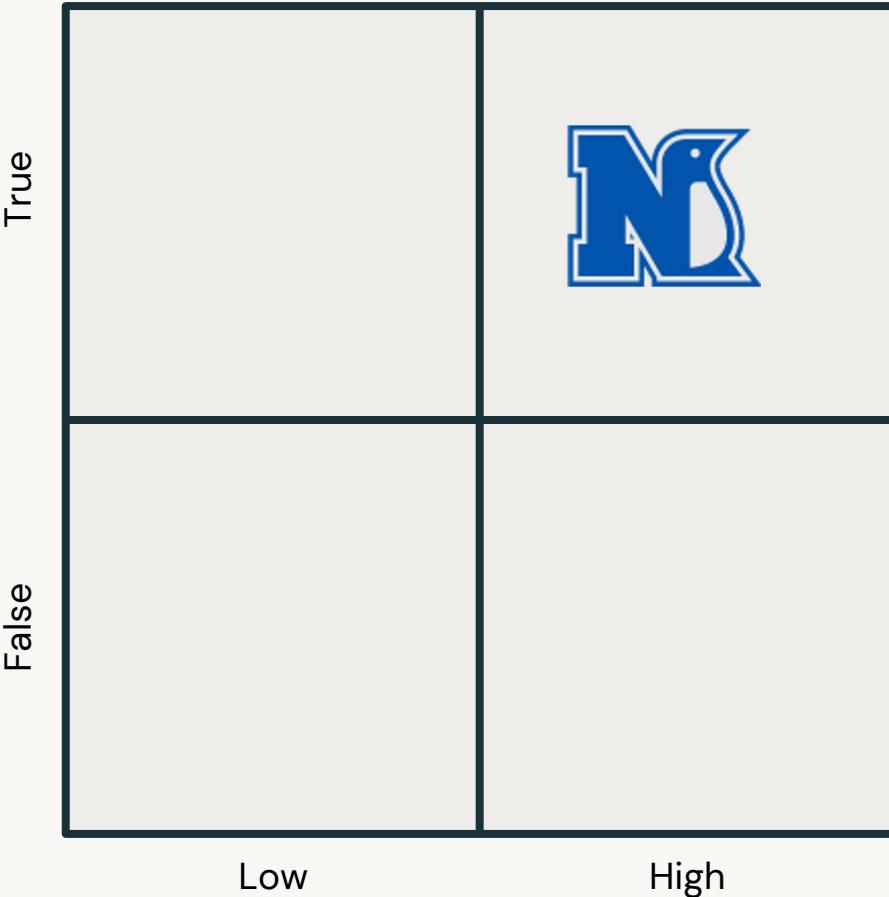
True vs. False



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Probability
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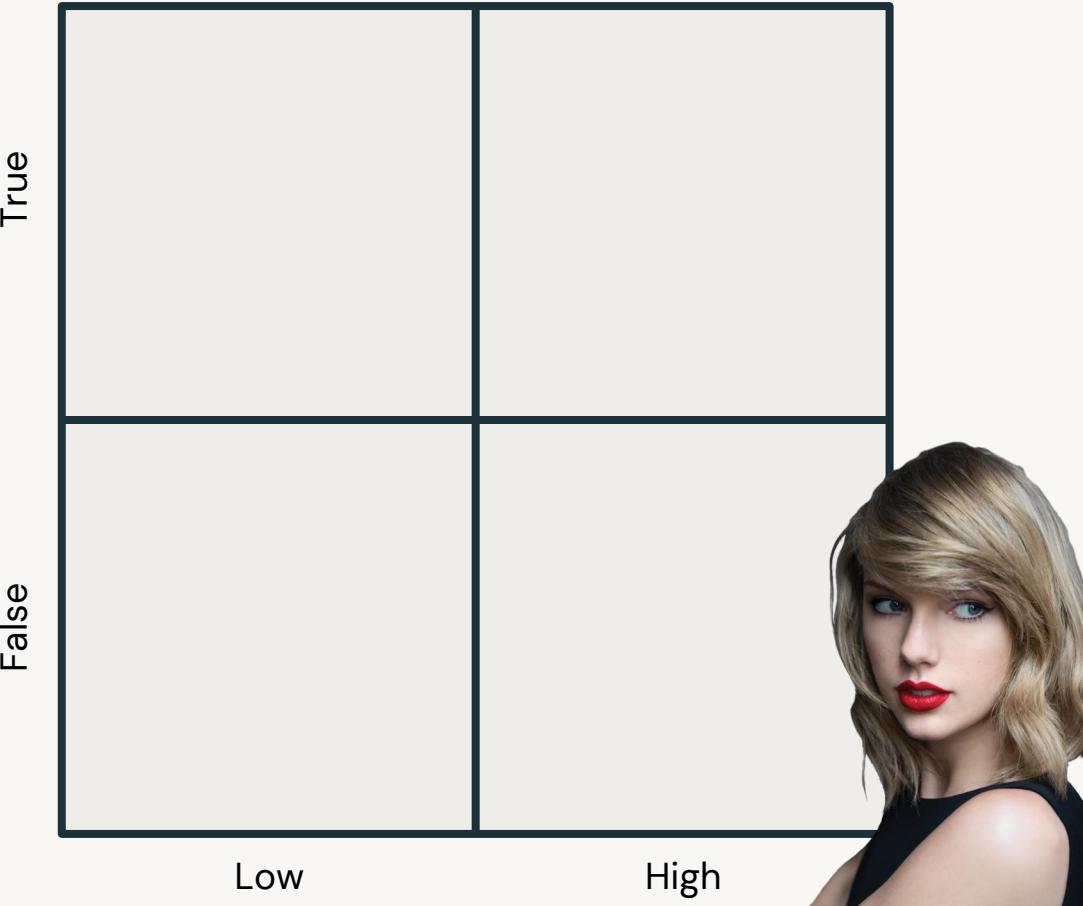
True vs. False



I'm BFFs with Taylor Swift

Probability
Low, Medium, High

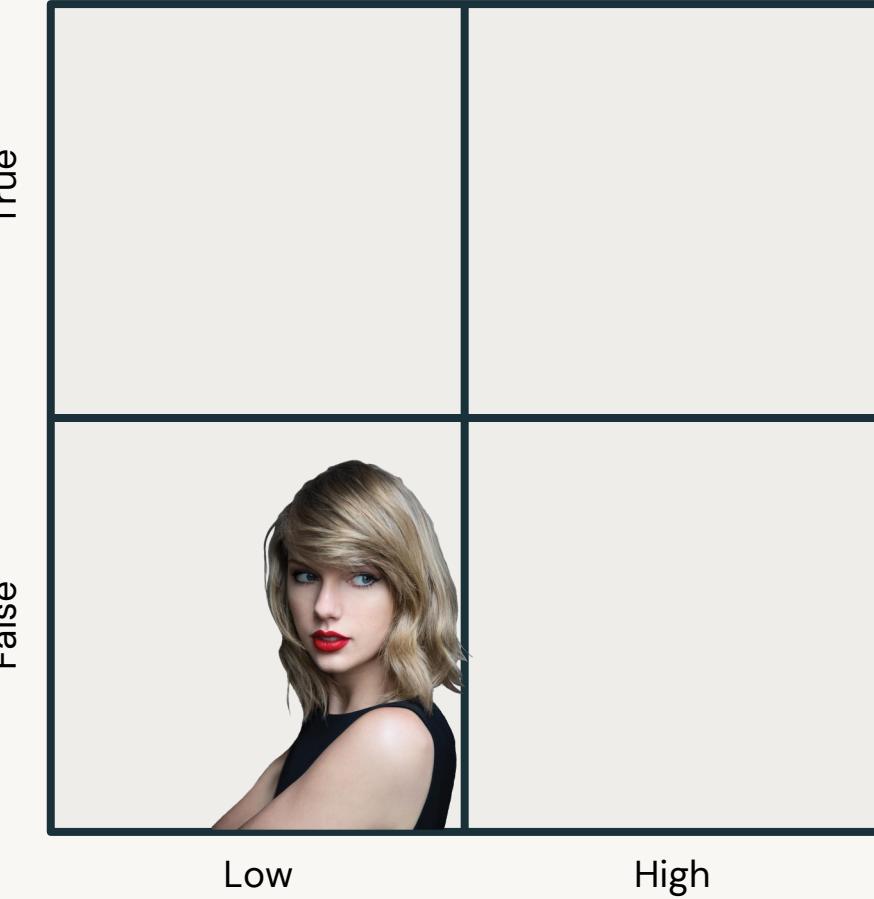
True vs. False



I'm BFFs with Taylor Swift

Probability
Low, Medium, High

True vs. **False**



As a sci-fi geek, I have
Star Trek TNG
memorabilia

Probability
Low, Medium, High

True vs. False

True

False

Low

High



As a sci-fi geek, I have
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Probability
Low, Medium, **High**

True vs. **False**

True

False

Low

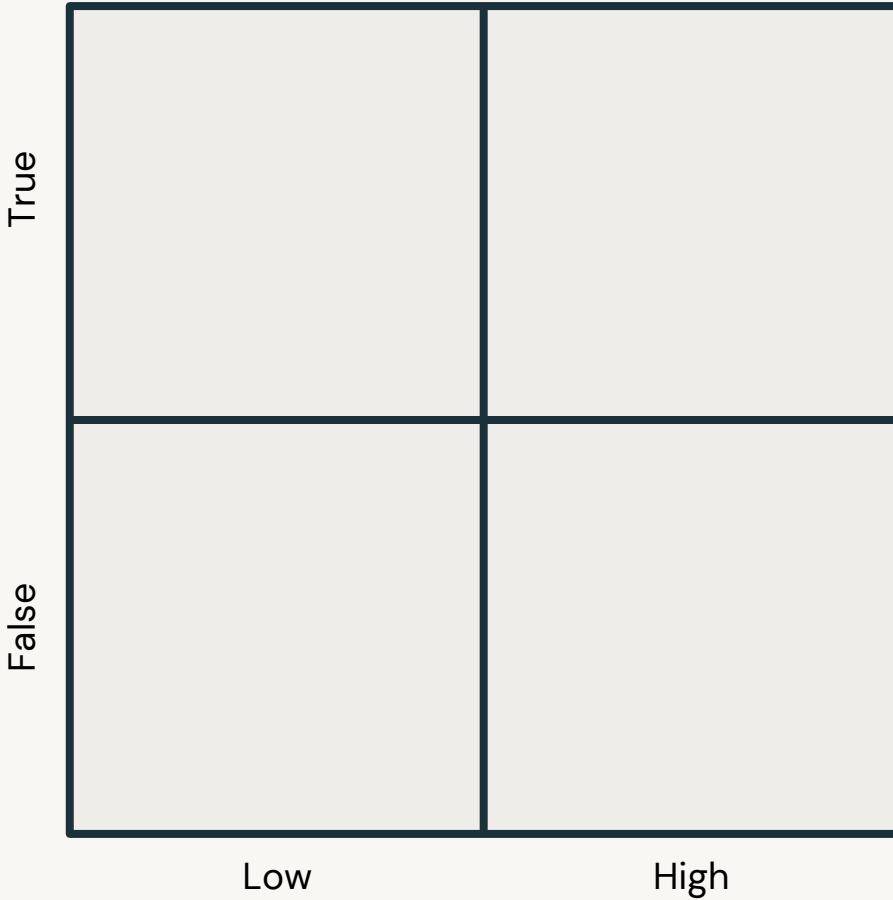
High



I was a politician in Canada

Probability
Low, Medium, High

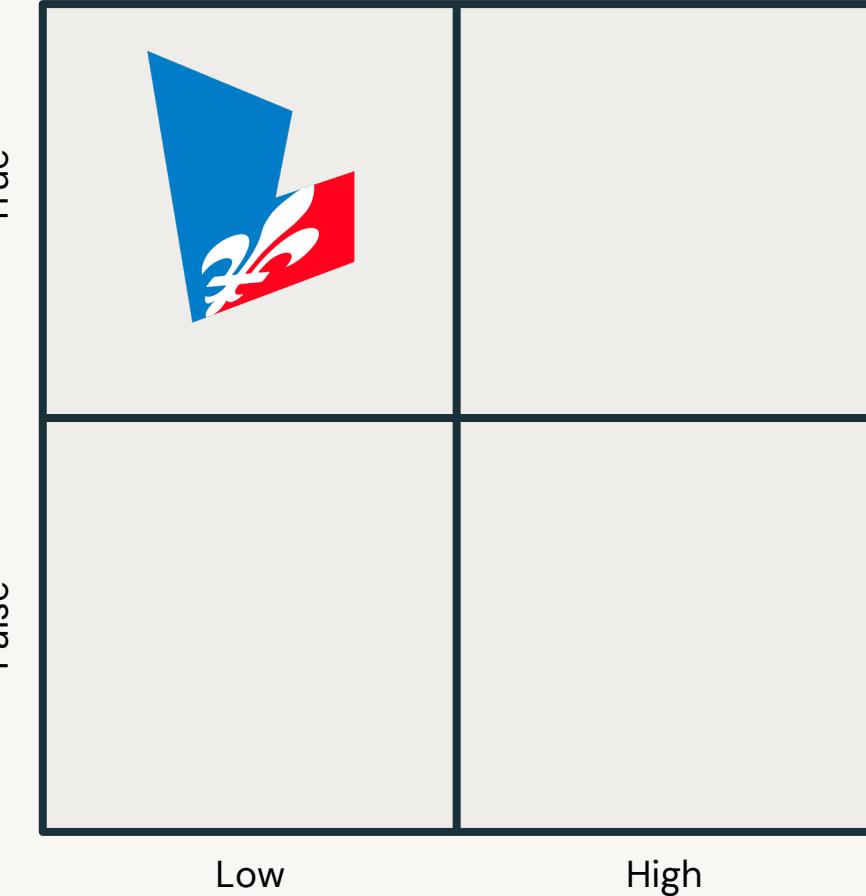
True vs. False



I was a politician in Canada

Probability
Low, Medium, High

True vs. False



LLM models – it begins with the
probability that these words are
associated with other words

But what happens for the low/true or
high/false scenarios?

But what happens for the low/true or
high/false scenarios?

Hallucinations

We'll come back to this soon

How to best explain chatgpt to middle schoolers?

Part 2

ChatGPT can help answer questions, provide information on various topics, and even give suggestions or ideas. It's designed to understand human language and try to respond in a way that makes sense. However, it's important to remember that ChatGPT doesn't have real emotions or thoughts like humans do. It's a program created by people to assist with tasks and engage in conversations.

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scrapes the internet

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It's a model built on the probability of words

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Part 3

When you ask a question or type a message, ChatGPT looks at the words and tries to understand the meaning behind them. Then it generates a response based on patterns it has learned from the text it was trained on. Sometimes, it might not fully understand a question or give the wrong answer. It's always a good idea to double-check the information it provides with other sources to make sure it's accurate.

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I.e., build a model

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I.e., run the model

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I.e., data placed into the model (i.e. internet)

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I.e., hallucinate

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Good idea!

How to best explain chatgpt to middle schoolers?

Part 4

ChatGPT is continuously improving as it learns from more and more data and user interactions. Developers and researchers work on making it smarter, more reliable, and safer to use. It's an exciting technology that has the potential to assist us in many different ways, from answering questions to helping us solve problems.

How to best explain chatgpt to middle schoolers?

Part 4

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What do you think this means?



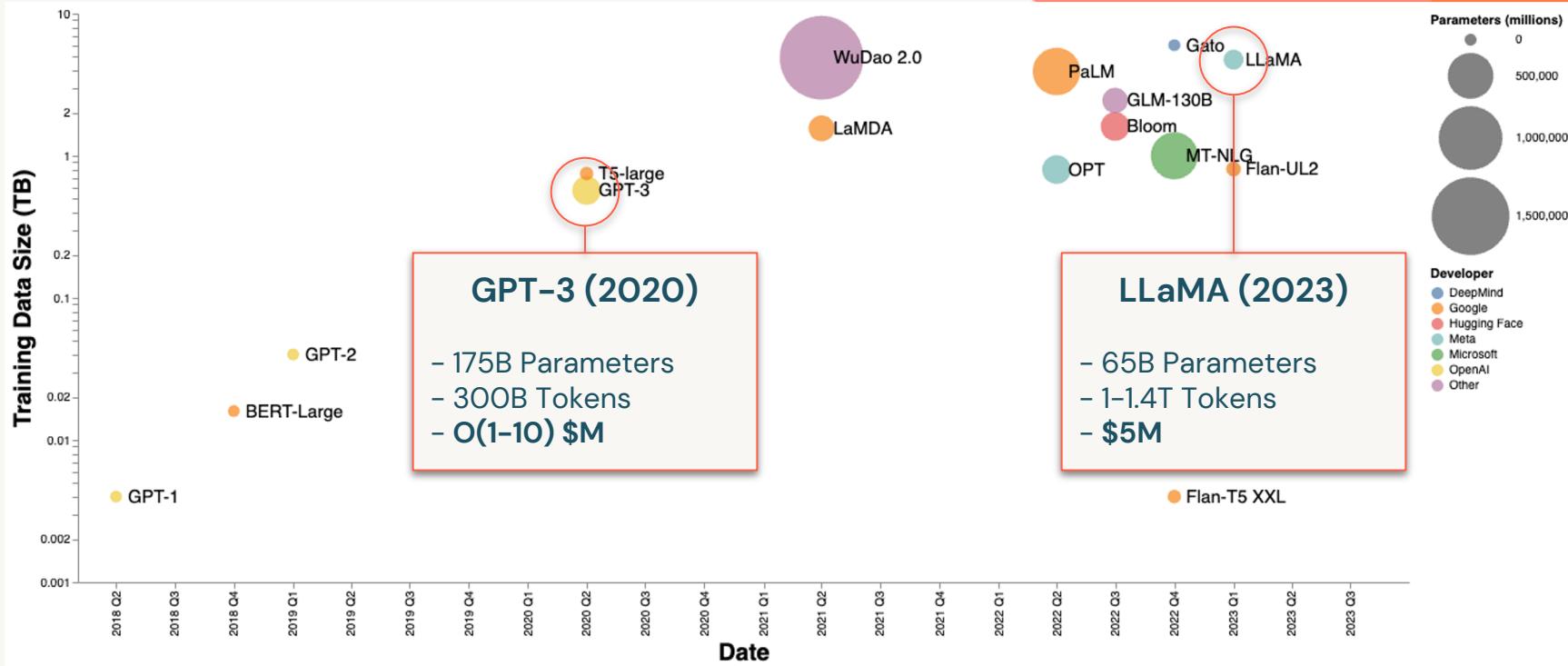
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MOARRRR!!!!

More data, more problem!



Unintended Consequences

Technology limitations and / or malicious intent



I don't know!

A bot may have an answer for every question, but
“I don’t know” may be the preferable answer

[...] Samsung workers accidentally leaked trade secrets via ChatGPT –
[mashable](#)



Malicious activities

AI model “Tay” was decommissioned less than 24h for
unethical content after being manipulated by users / bots

[...] Due to our concerns about malicious applications of the technology, we are
not releasing GPT-2 – [openAI](#)



Hallucination and bias

Volume of calls, low First Call Resolution rate, number of
unnecessary transfer are all opportunities for LLM

Whilst chatbot have been around before GPT models, most organizations
are leveraging third party services for IVR type of answers.



“ChatGPT doesn’t keep secrets.”

“Never forget that anything you share with ChatGPT
is retained and used to further train the model.
Samsung employees have learned this the hard way
after accidentally leaking top secret Samsung data.”

[mashable article]

How to best explain chatgpt to middle schoolers?

Part 5

Remember, ChatGPT is just a tool, and it's important to use it responsibly and critically evaluate the information it provides. It's a great way to explore and learn, but it's always good to ask for human help or consult other sources when needed.

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Why this blurb?

nat.dev demo

Which bagels are better – New York or Montreal?

Different responses for different models

replicate:llama-13b

Betty Tieber, Montreal, Canada and Glynnis Tieber (née Zimmermann), Melbourne, Australia

This the bagels. One and Glynnis Tieber (née Zimmermann), Melbourne, Australia

This is the battle of the bagels. One of my sisters-in-law, bagels. One of my sisters-in-law, a New

Yorker, and I, a Montreal, Canada and Glynnis Tieber (née Zimmermann), Melbourne, Australia

This is the battle of the bagels. One of my sisters-in-law, a New Yorker, and I, a born and bred

Montrealer disagree over Glynnis Tieber (née Zimmermann), Melbourne, Australia

This is the battle of the bagels. One of my sisters-in-law, a New Yorker, and I, a born and bred

Montrealer disagree over bagels. We like each other and all the other members of our respective
families. Now and Glynnis Tieber (née Zimmermann), Melbourne, Australia

This is the battle of the bagels. One of my sisters-in-law, a New Yorker, and I, a born and bred

Montrealer disagree over bagels. We like each other and all the other members of our respective
families. Now my nieces, when asked, tend to Canada and Glynnis Tieber (née Zimmermann),

Different responses for different models

forefront:pythia-12b

<|endoftext|><|endoftext|><|endoftext|><|endoftext|><|endoftext|><|endoftext|>
<|endoftext|><|endoftext|><|endoftext|><|endoftext|><|endoftext|><|endoftext|>
<|endoftext|><|endoftext|><|endoftext|><|endoftext|><|endoftext|>Which bagels are better -
New York or Montreal?

I have been to New York and Montreal and I have to say that I prefer the bagels in Montreal. I have
never had a bagel in New York and I have to say that I prefer the bagels in Montreal. I have never
had a bagel in New York and I have to say that I prefer the bagels in Montreal.

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had a bagel in New York and I have to say that I prefer the bagels in Montreal.

Different responses for different models

replicate:alpaca-7b

There is no definitive answer, as it depends on the individual's preference. New York bagels are generally thinner and chewier, while Montreal bagels are thicker and sweeter.



Hallucinations are dangerous because this looks like its a correct answer but is in fact wrong

Different responses for different models

Correct response: Cohere: claude-instant-v1

Which bagels are better - New York or Montreal? This is a matter of debate with passionate opinions on both sides. Here are some of the arguments in favor of each:

New York bagels:

- Classic New York-style bagels are boiled in water before baking, which gives them a glossier finish and chewier texture. This boiling method is said to make for a more authentic bagel.
- The larger size and thicker crust of New York bagels appeal to some fans.
- Some argue that New York bagels have more varied and creative toppings and fillings.

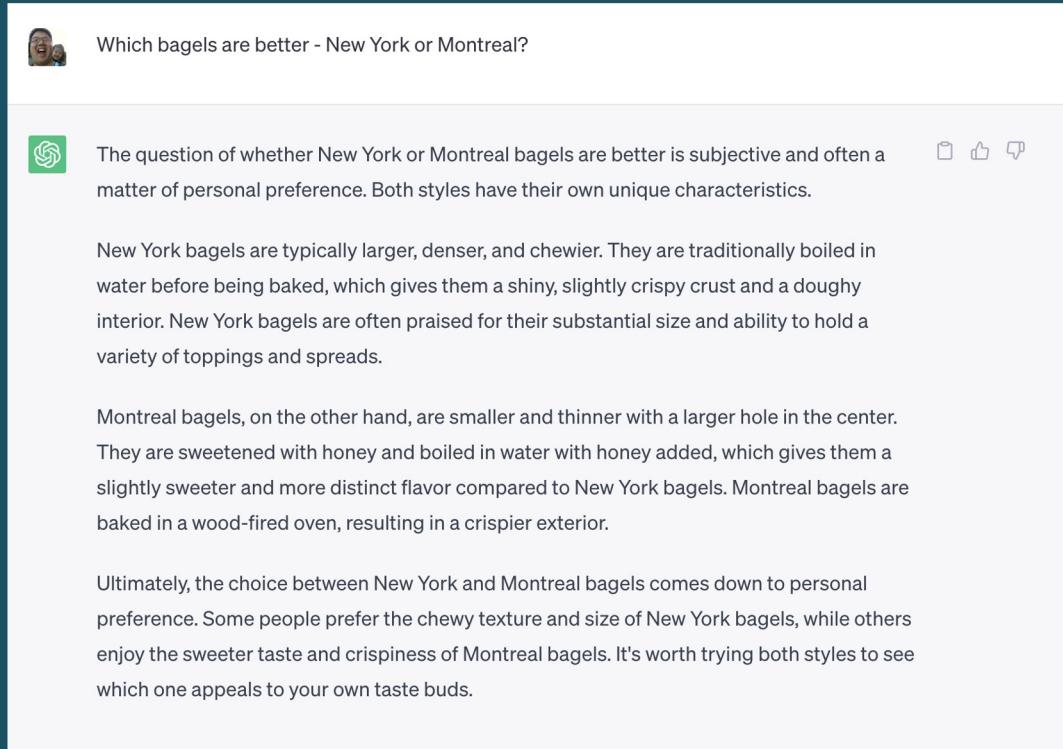
Montreal bagels:

- Montreal bagels are baked in a wood-fired oven, which gives them a distinct smoky flavor that many prefer.
- Montreal bagels tend to have a thinner, crispier crust and a lighter texture compared to New York bagels. Some prefer this style.
- Montreal bagels are traditionally served with cream cheese and lox, which appeals to fans of the "Bagel, lox and cream cheese" combo.
- Some studies have suggested that Montreal bagels have a higher sugar content, giving them a slightly sweeter flavor that some prefer.

In the end, personal taste and preference likely play a bigger

Different responses for different models

Correct response:
ChatGPT



A screenshot of a ChatGPT conversation. The user asks, "Which bagels are better - New York or Montreal?" ChatGPT responds that the question is subjective and lists the unique characteristics of both. It describes New York bagels as larger, denser, and chewier, while Montreal bagels are smaller, thinner, and have a larger hole in the center. Ultimately, it concludes that personal preference determines the better bagel.

Which bagels are better - New York or Montreal?

The question of whether New York or Montreal bagels are better is subjective and often a matter of personal preference. Both styles have their own unique characteristics.

New York bagels are typically larger, denser, and chewier. They are traditionally boiled in water before being baked, which gives them a shiny, slightly crispy crust and a doughy interior. New York bagels are often praised for their substantial size and ability to hold a variety of toppings and spreads.

Montreal bagels, on the other hand, are smaller and thinner with a larger hole in the center. They are sweetened with honey and boiled in water with honey added, which gives them a slightly sweeter and more distinct flavor compared to New York bagels. Montreal bagels are baked in a wood-fired oven, resulting in a crispier exterior.

Ultimately, the choice between New York and Montreal bagels comes down to personal preference. Some people prefer the chewy texture and size of New York bagels, while others enjoy the sweeter taste and crispiness of Montreal bagels. It's worth trying both styles to see which one appeals to your own taste buds.

A Hero Arrives...

Dolly 1.0

Proof of Concept



Dolly 1.0

Answering What Really Matters for Instructability

Does Massive Pre-training Matter?

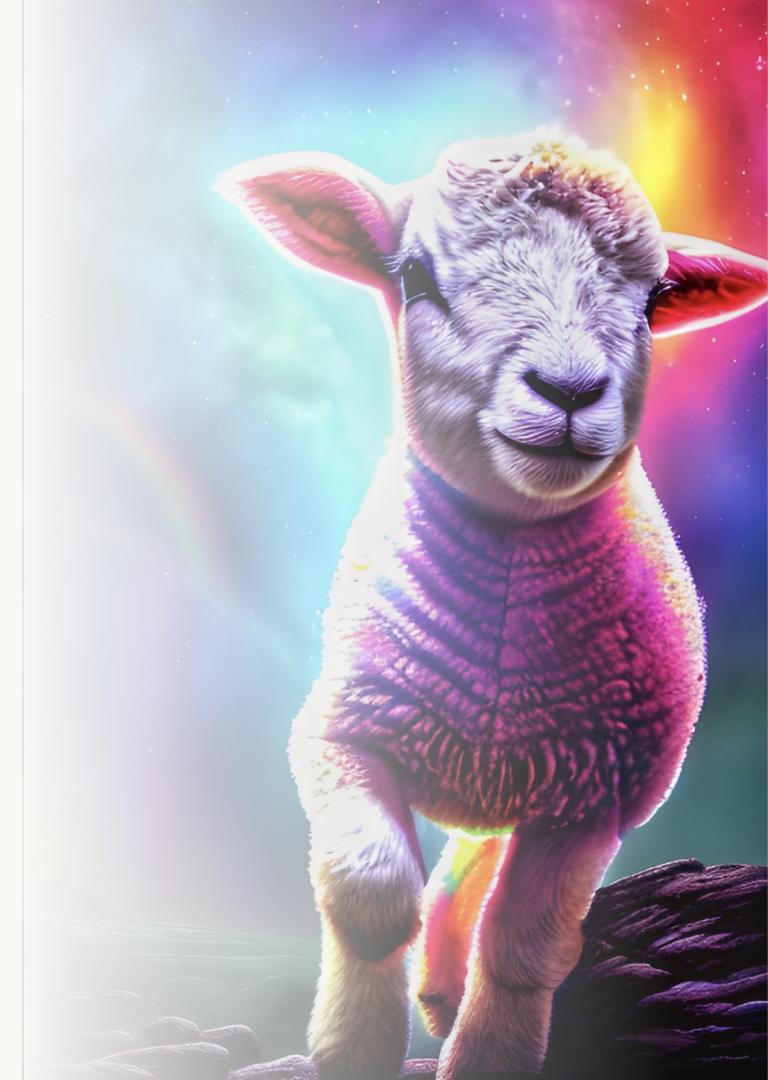
We started with GPT-J, an open source 6B parameter model from 2021 that was only trained on 400B tokens without advanced curation like LLaMA

Does Imitating Lots of Chat Data Matter?

Dolly was fine-tuned on a ~52K record instruction corpus (Stanford Alpaca)

Does Not Having ~\$5 Million Dollars Handy Matter?

Surprisingly, we got diverse instruction following with just **~\$30** worth of compute time on training (a few hours)!



A New Open-er Hope...

Dolly 2.0

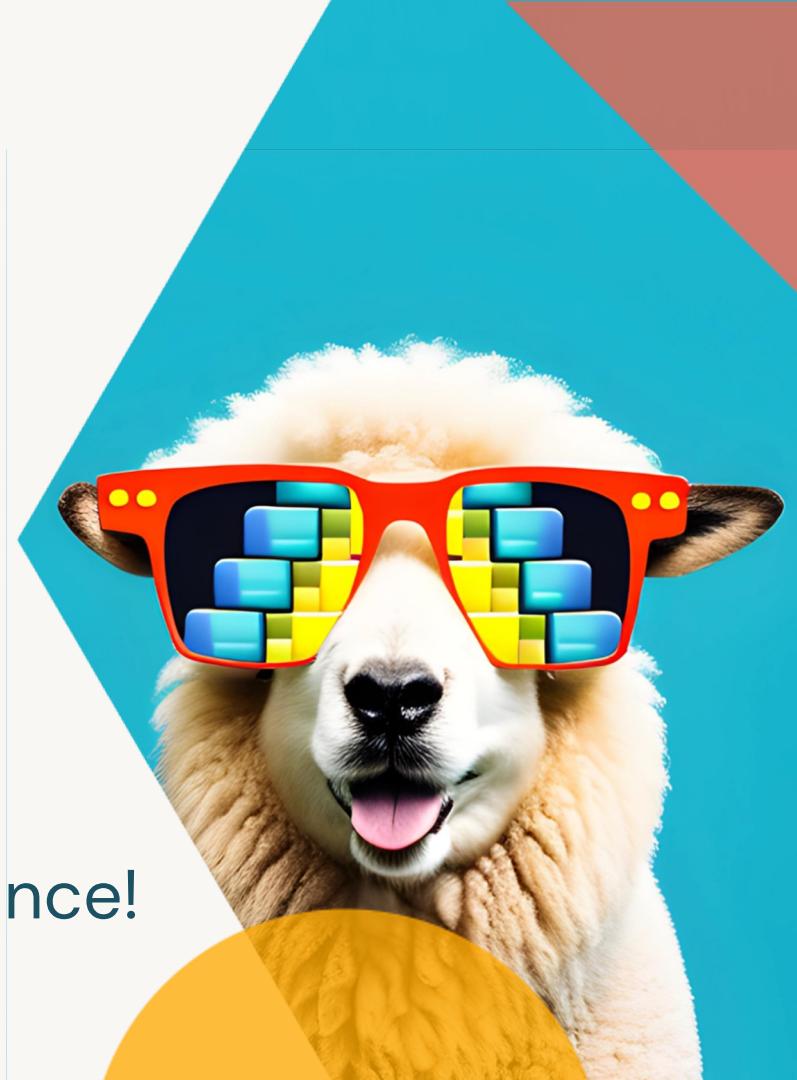
World's First Truly Open
Instruction-Tuned LLM,
By Databricks



Dolly 2.0 Experiment

- **2B parameter** foundation model based on the EleutherAI pythia model family
- **5000 Databricks employees** generating an open dataset
- **\$100** in compute resources

With surprisingly good performance!



Dolly 2.0 Behavior

Question:

"What is a large language model?"

Sampled Dolly Answer:

"A large language model is a type of artificial intelligence model that can generate natural language text based on a given set of input parameters. It is designed to be able to understand and generate human language, rather than just matching specific keywords and phrases."



Training Data for Fine Tuning

Real Examples from Databricks-dolly-15k

We asked our employees to generate 15,000 questions & answers in 8 categories using only open data

Below is an instruction that describes a task. Write a response that appropriately completes the request.

Instruction:

What architecture does GPT use?

Response:

GPT uses the transformer architecture which is a neural network architecture based on the attention mechanism to find global dependencies between the input and the output. To be more specific, GPT belongs to a sub type in the transformer family that is called decoder-only transformer.

End

Below is an instruction that describes a task. Write a response that appropriately completes the request.

Instruction:

What's the population of Mattim Birta?

Input:

Mattim Birta is a town and Village Development Committee in Khotang District in the Sagarmatha Zone of eastern Nepal. At the time of the 1991 Nepal census it had a population of 5,021 persons residing in 899 individual households.

Response:

The population of Mattim Birta in Nepal is 5,021 people.

End

Causal language model trained to produce response

Example

What are the techniques that make a great espresso?

Dolly | Pythia | Alpaca | GPT 4.0

Example

Different responses for different models

Incorrect response: Not enough data, older model

llama-7B (optimized for Mac m1)

Our espresso machine training includes the most popular manual espresso machines, La Pavoni 1926/1935 and Faema E71.

We have been teaching this course for years now. We have trained many baristas around the world to make espresso. You will learn how to prepare a great espresso with all of our expertise gathered throughout the year.

The course is taught by one of the founders of Kakao Coffee School and the owner of KAKAO, Mr. Hyunseok Jeong. The training includes a

Different responses for different models

Silly response: Not enough data, older model

pythia-12b (Dolly is derived from this one)

Espresso is a very simple matter. First real espresso tastes amazing in small quantity, especially if you are getting used to search this city's pre...

Train yourself to establish a clear goal and effective routine for making espresso. You must make the stage sympathy conscious so you understand what you're accomplishing before you do it. This will consciously set you up for success. As soon as you understand the right routine, you are prepared to go. And it is very simple to train yourself. Each of us has a preferred flavor of coffee. You can begin with totally tasteless and then subtly flavor it in steps once you're used to doing all these, it takes no more than two weeks. Double espressos are great menu fit for 2 apprentices! Watch as we cover intimately how we make a powerful regular for 2 espressos quickly.

Espresso has actually become a daily/weekly/ or an occasional custom.

Watch as

Different responses for different models

Solid response: Enough data, older model

databricks-dolly-v2-12b

derived from pythia-12b using the dolly-15K dataset

1. A great espresso needs to have very fine dosimeter powder distributed evenly through the coffee pour-out on the top of the shot.
2. A great espresso needs to have tiny bubbles distributed throughout the espresso shot.
3. A great espresso needs to have consistent peak flow throughout the shot.
4. A great espresso needs to be evenly colored with minimal variation in hue.

By following these steps in making an espresso, you are ensuring that you are making the best espresso that can be made with the ingredients that you have on hand.

Different responses for different models

Solid response: A lot of data, current model

gpt-4

1. Choose the right beans: Use freshly roasted, high-quality espresso beans for the best flavor. Beans should be roasted within the past two weeks and stored in an airtight container.
2. Grind the beans correctly: Grind the beans to a fine consistency, similar to powdered sugar. Use a burr grinder for consistent particle size, and grind the beans right before brewing to ensure maximum freshness.
3. Measure the coffee grounds accurately: The standard ratio for espresso is 1:2, meaning one part coffee grounds to two parts water. For a double shot of espresso, use 18–20 grams of coffee grounds.
4. Tamp the grounds evenly: Tamping is the process of compressing the coffee grounds in the portafilter. Apply even pressure (about 30 pounds of force) to create a level and compact coffee bed. This ensures even extraction and a balanced shot.
5. Preheat the machine and portafilter: Allow your espresso machine to warm up

Thanks! Any more questions?

Appendix

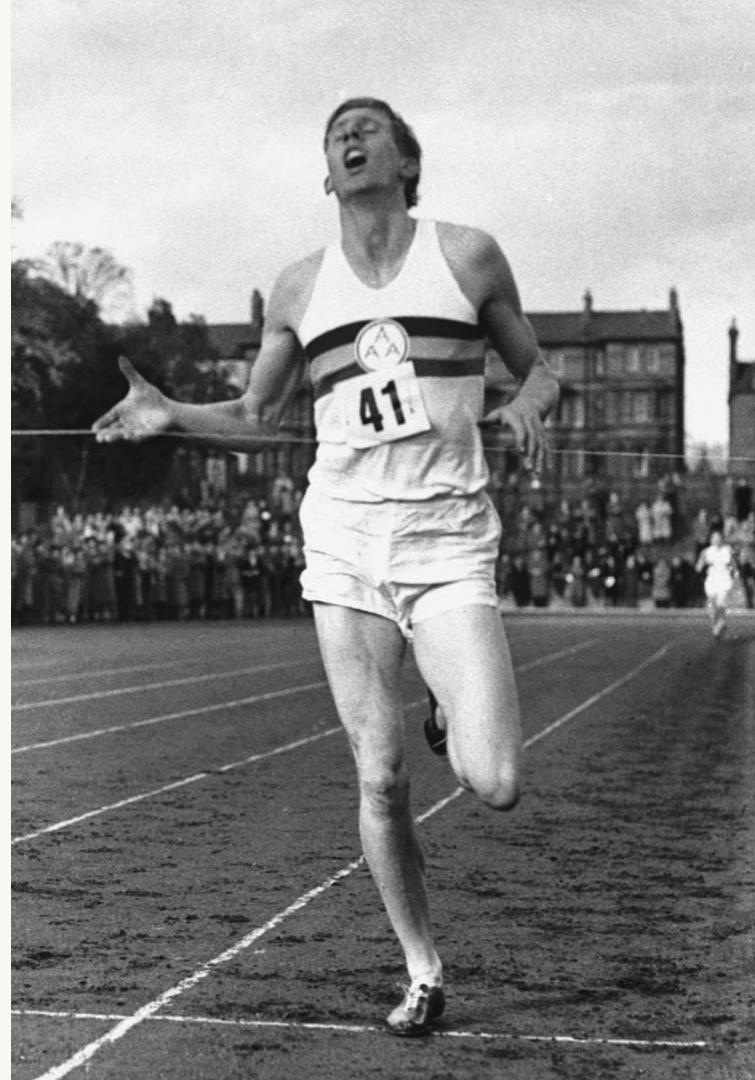
Impacts of Dolly 2.0

Breaking a Barrier in LLMs

24 hours:

"We saw that within 24 hours the dataset had been translated into Spanish and Japanese, the Dolly dataset. So that's super cool and also something that is only possible with open data." – Mike Conover

Dolly's dataset has a commercial friendly license unlike OpenAI's instruction tuning datasets which may not be commercially viable.



Impacts of Dolly 2.0

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D.Lite and D.Lite v2:

AI Squared's lightweight instruction following models exhibiting ChatGPT-like interactivity with just 124 million parameters, trained on the Dolly dataset for ~\$10.

Trend Towards Smaller Purpose Built Models:

With revolutionary capabilities like instruction-following being possible with smaller less expensive LLMs, it removes the barrier to entry for using your data to create a uniquely effective model!

There's now a stampede of groups releasing high-quality, open AI models and datasets!



Open Models are the Future

No Organization Can Compete with Open Source

Closed LLM Systems are a Risk, Future Progress is Open:

"I don't think it's dangerous at the moment, but the reason it could be is that it's closed, so people cannot understand it, and researchers cannot research it. **In my opinion, the way to make progress with large language models is to make it open.** And you see a number of efforts around the world today to producing evidence that is open source. This is a good idea from the economic point of view, but also from a safety point of view. And also for the progress of research and the understanding of exactly how to make those things work properly and good steerable control." [\[source\]](#)

– Yann LeCun



Yann LeCun

OpenAI's State of GPT

Chains / Agents: Think Less "One-turn" Q&A, and More Chains

A Single LLM System is Inherently Limited:

"The GPT will look at every single token and spend the same amount of compute on every one of them. You can't expect it to do too much work per token." [[video](#)]

- Andrej Karpathy

Alternative Approach, LLM Systems:

"A lot of interest atm in wiring up LLMs to a wider compute infrastructure via text I/O (e.g. calculator, python interpreter, google search, scratchpads, databases, ...). The LLM becomes the "cognitive engine" orchestrating resources, its thought stack trace in raw text." [[source](#)]

- Andrej Karpathy



Andrej Karpathy

There Are No Moats in this Space

Open Source AI Will Outcompete Google and OpenAI



Google “We Have No Moat, And Neither Does OpenAI”

“the uncomfortable truth is, we aren’t positioned to win this arms race and neither is OpenAI. While we’ve been squabbling, a third faction has been quietly eating our lunch. I’m talking, of course, about open source.”

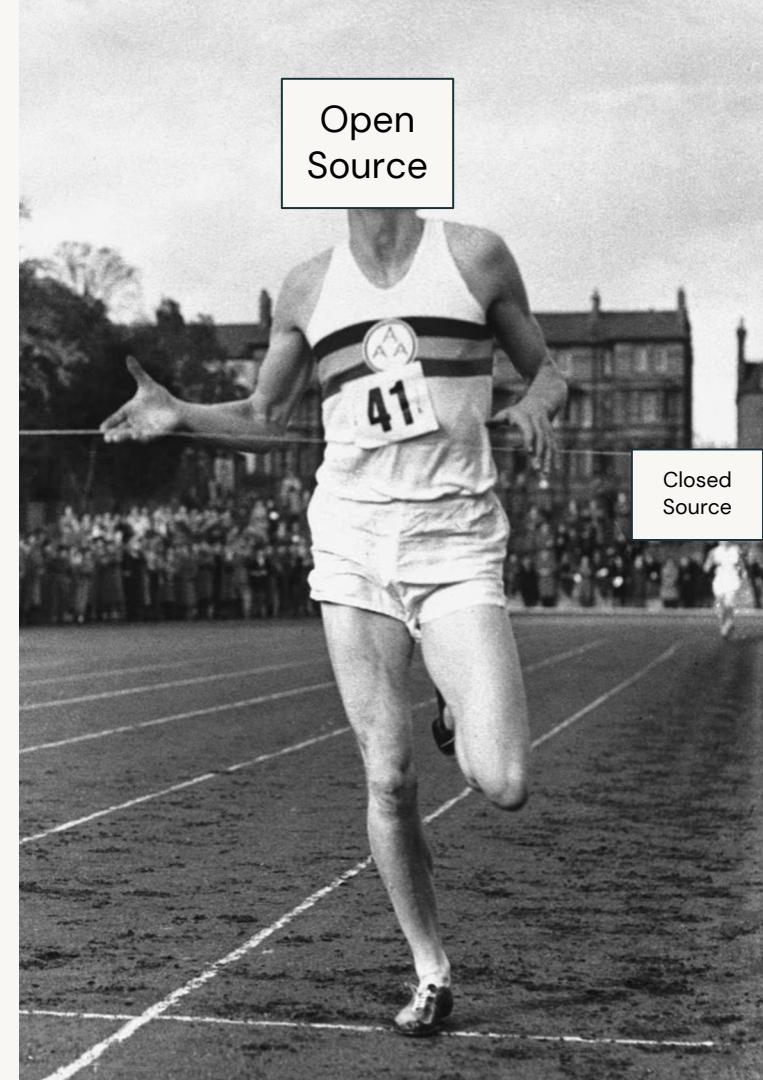
Leaked Google document describing open source lapping Google and OpenAI in developing LLMs with new capabilities – [source](#)



Google “Giant models are slowing us down.”

“We should make small variants more than an afterthought, now that we know what is possible in the <20B parameter regime.”

Leaked Google document describing open source lapping Google and OpenAI in developing LLMs with new capabilities – [source](#)



Hugging Face Leaderboard

Open Source Community of Innovators

4
Key Benchmarks

90+
Models

25+
Contributors

Key Benchmarks

Uses the **Eleuther AI Language Model Evaluation Harness** to evaluate submissions on 4 key benchmarks.

Models

With **90+ top models** featured from over **25+ contributors**, the leaderboard helps track the diversity of modeling approaches and contributors putting out state of the art results. It also provides a valuable resource for comparing across projects fairly.



Robust Intelligence's Risk Database

Tool for Discovering and Reporting Risks for Open Models

Top Risk Reports

 Severe sensitivity to Square Attack Affects 1 model	reported by robustintelligence Jan 12, 23
 Severe sensitivity to Square Attack Affects 1 model	reported by robustintelligence Jan 12, 23
 Severe sensitivity to Gaussian Blur Affects 1 model	reported by robustintelligence Jan 07, 23
 Severe sensitivity to Contrast Decrease Affects 1 model	reported by robustintelligence Jan 18, 23

Description

Summary

A Square Attack test was performed on `swinv2-large-patch4-window12to16-192to256-22kto1k-ft` , in which a 40% failure rate was observed. In at least one case, the model's prediction changed -0.51. This caused the label to change from 803 to 915.



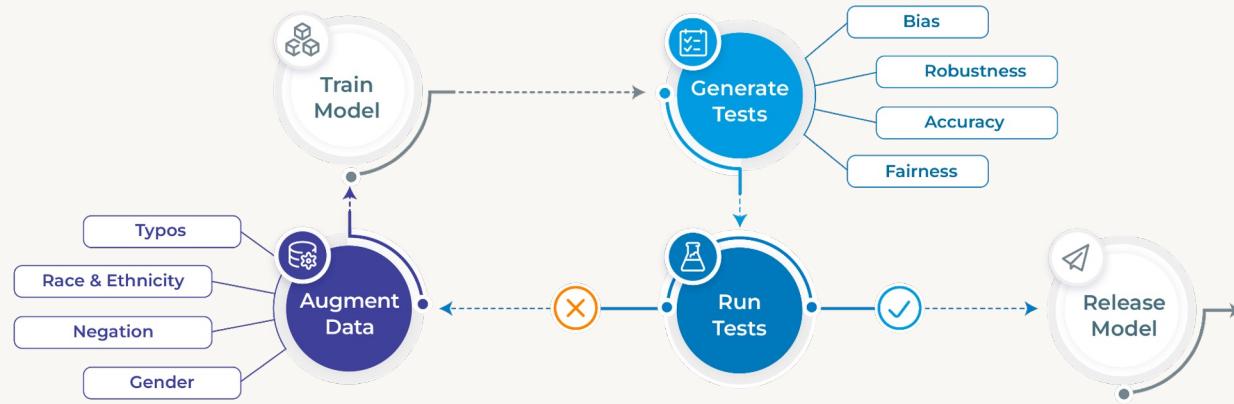
Test Information

This test measures the robustness of the model to Square attacks. It does this by taking a sample input, applying a Square attack, and measuring the performance of the model on the perturbed input. See the paper "Square Attack: a query-

Access a database of continuously updated risk reports on vulnerabilities to open models. [[source](#)]

NLPtest.org by John Snow Labs

Deliver Safe and Effective Language Models



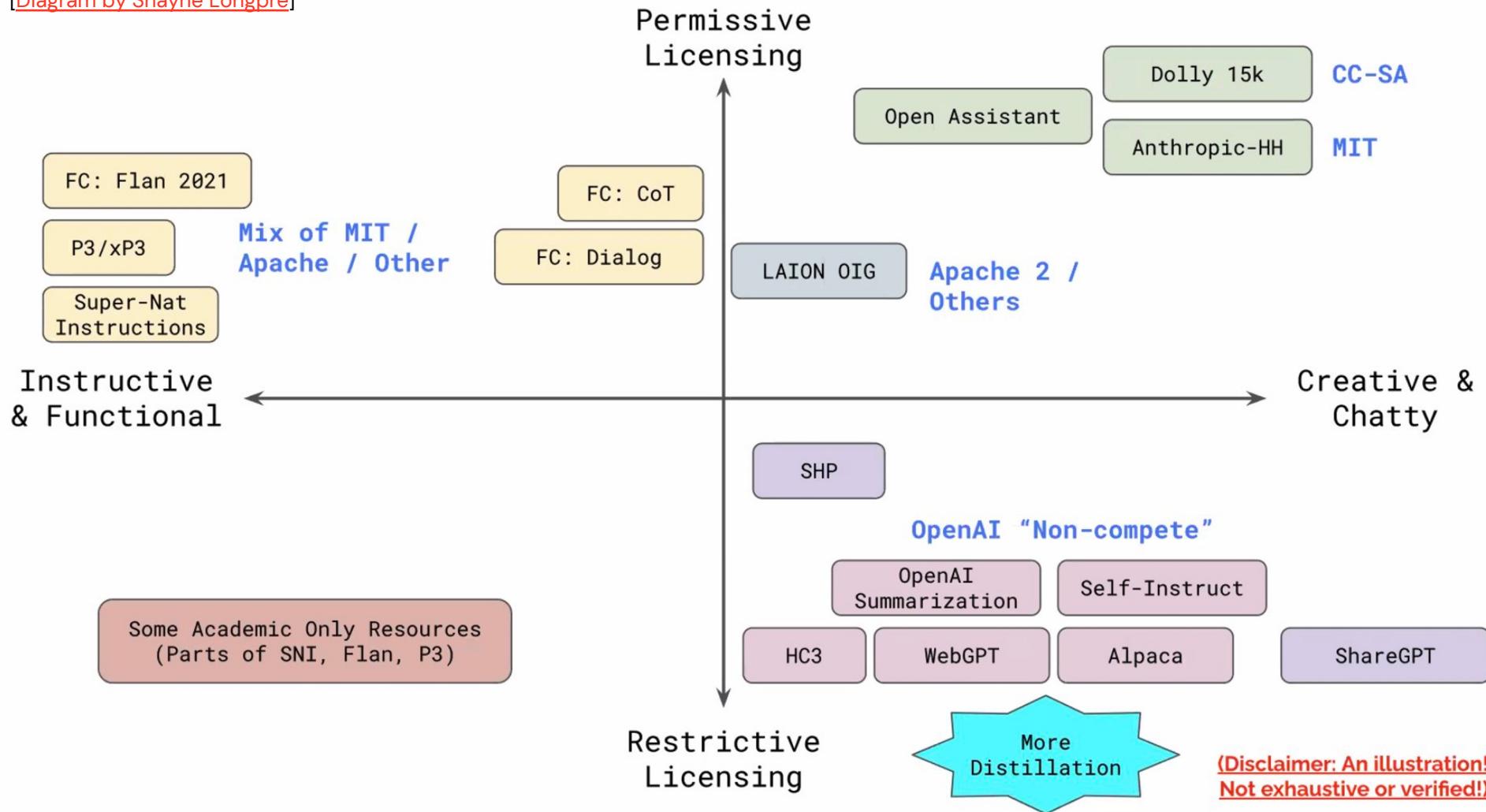
Framework for Evaluating LLMs

- Simple to use, run 50+ test types on the most popular NLP frameworks with 1 line of code
- Comprehensive test types: quality, robustness, bias, etc.
- 100% open source



Use an open source framework like `nlpredict` to guard against harmful outputs and reputation loss.

[Diagram by Shayne Longpre](#)



AI Landscape in Dolly's World

Open Models Will Win, Your Data is the Unique Value Add

We believe models like Dolly will help democratize LLMs, transforming them from something very few companies can afford into a commodity every company can **own** and **customize** to improve their products.

Data quality scales better than data size

Training on small, highly curated datasets outstrips the performance of pre-training new large foundation models from scratch to accomplish tasks.

Your business probably already has the high quality data sources you need to fine-tune an LLM solution!



OPEN MODELS



CONTROL DATA