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Sustainability Considerations of Generative A.I.

Thomas Pantazes

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SUSTAINABILITY RESEARCH and PRACTICE SEMINAR

FEBRUARY 14, 2024

Dr. Thomas Pantazes

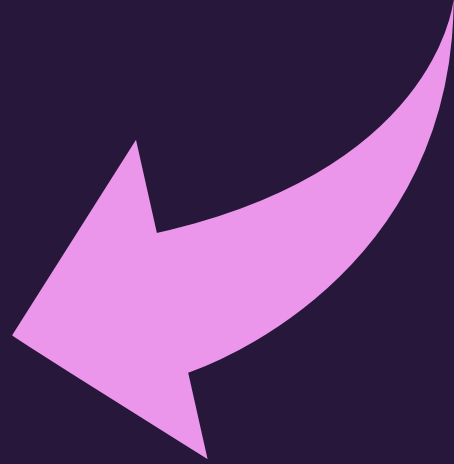
Teaching & Learning Center

Sustainability Considerations
of Generative A.I.

**Wednesday, 12:00 to 12:50 pm in person (255 A/B Sykes Student Union)
and in our Zoom room: <https://wcupa.zoom.us/j/92058580576>, passcode: 711670**



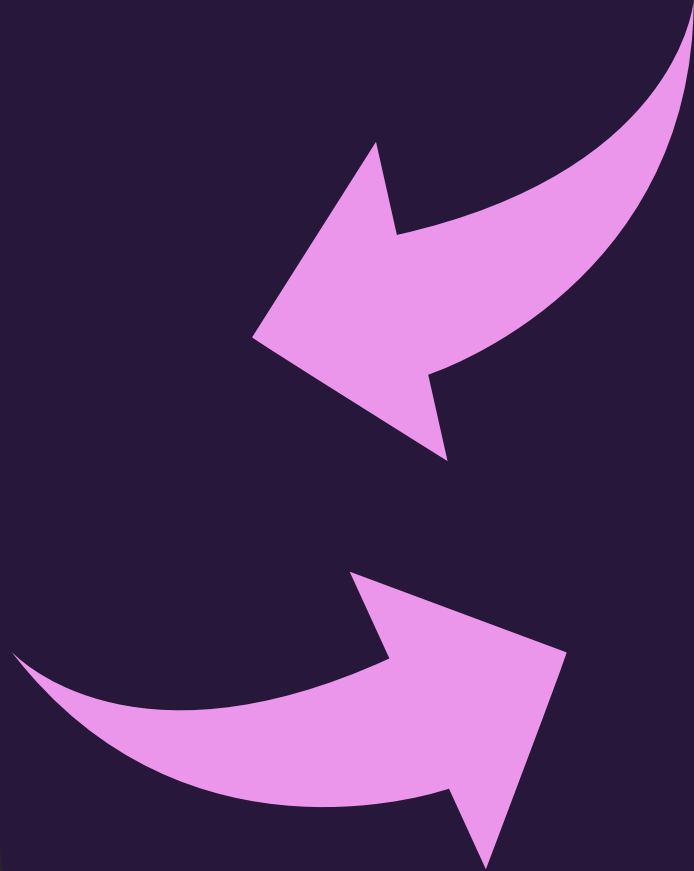
Not an Expert



tpantazes@wcupa.edu



Not an Expert



Just sharing

tpantazes@wcupa.edu

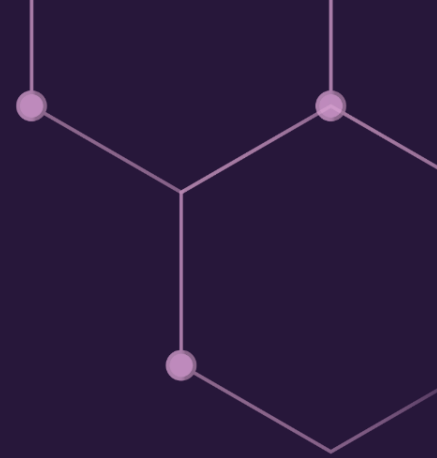
TLC Gen A.I. events

2023

- February 14 Strategies for Teaching & Assessment
- May 8 Teaching with AI: An Exploratory Session
- August 8 AI and the Writing Classroom
- August AI Toolkit released
- September 9 Conversations with Students webinar
- October 13 Creating Learning Activities webinar
- November 13 Creating Assessments webinar
- November 22 Generative AI in Teaching Podcast Part 1
- November 29 Generative AI in Teaching Podcast Part 2

2024

- January 17 Faculty Fusion AI panel
- February 1 Introduction to Generative AI History Department presentation
- February 14 Sustainability Considerations of Generative AI
- March 21 Ethical Considerations of Generative AI webinar
- April 25 Enhancing Your Productivity with Generative AI webinar



WCU AI Resources

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WCU HOME > THE TEACHING & LEARNING CENTER > GENERATIVE AI

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GENERATIVE AI

Overview

This page will explore the topic of generative AI, including its impact on the classroom as well as potential instructional uses for generative AI tools.

We recognize that there are different approaches to teaching across disciplines and do not assume that all faculty will incorporate generative AI or do it the same way. Whatever way you may choose to engage (or not) with generative AI in your courses, it is important to do so thoughtfully and strategically. We hope this page will be helpful in this regard. The toolkit includes a wide range of approaches and strategies for you to consider incorporating into your courses. It is not meant to be a 'how-to' guide for integrating generative AI but more of a resource to help you think through and decide what options are best suited for your teaching context. We encourage you to think about your teaching approach and context as you review the strategies shared in this document.

GENERATIVE A.I. IN TEACHING WITH DR. FAMIGLIETTI & DR. RADEMAEKERS PART 1





New Podcast Episode

Generative A.I. in Teaching with Dr. Famiglietti & Dr. Rademaekers- Part 1


ODLI on Air

THE TEACHING AND LEARNING CENTER

We support, inspire, and celebrate teaching excellence and innovation at WCU.

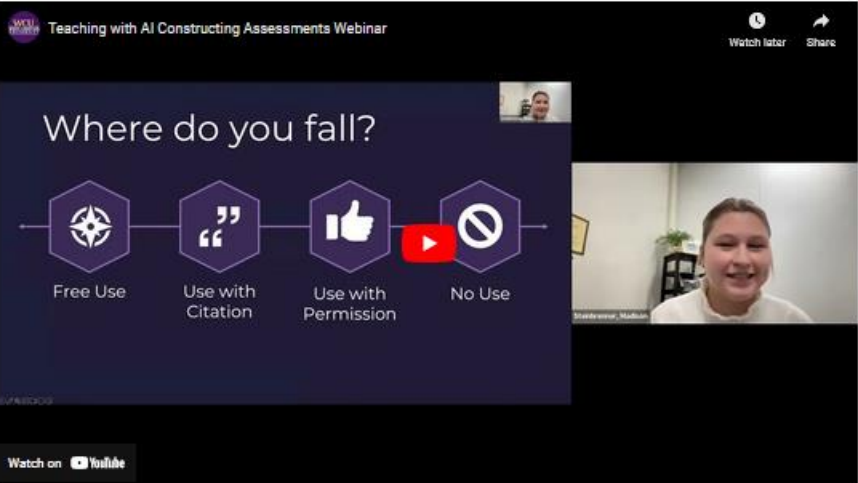
November 14, 2023 | Tom Pantazes


Teaching with AI: Assessment of Learning Webinar Recap



Held on Monday, November 13 from 10:00 am to 11:00 am.

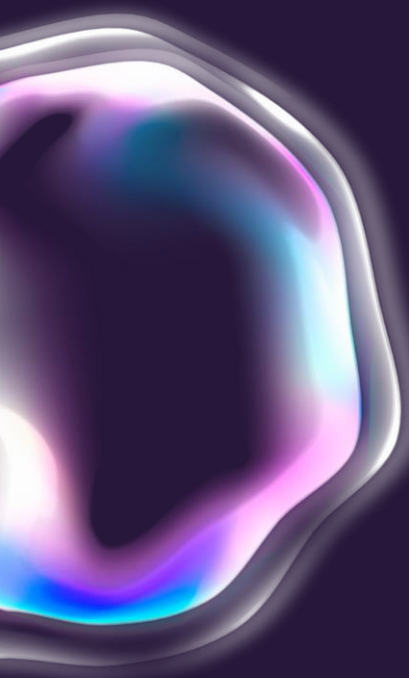
Here is the recording:



Watch on  [YouTube](#)



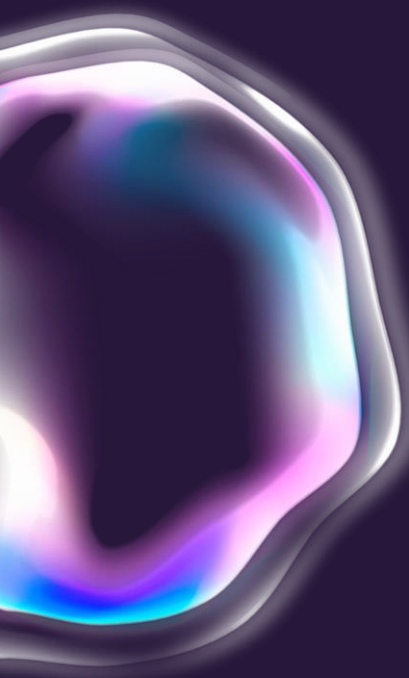
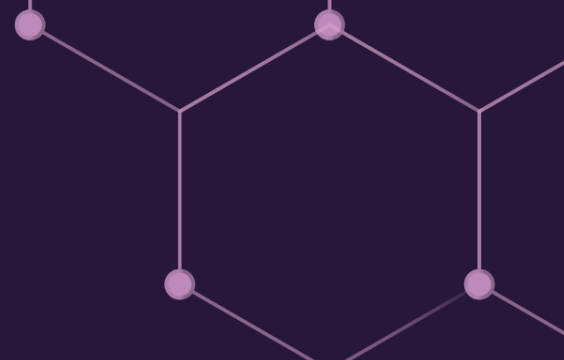
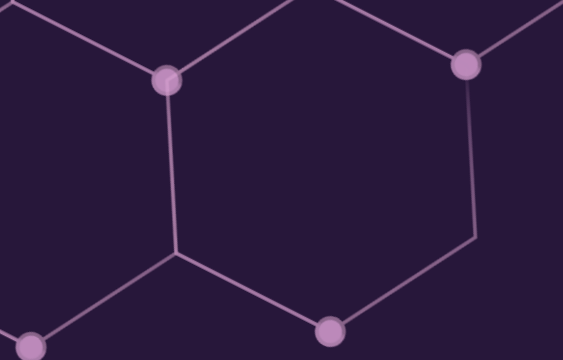
Navigating Digital Learning



“The train will always return
and there is still time to catch
the next one.”

Laura Dumin

via Lance Eaton



"AI is a mystery. To many, it's a threat.

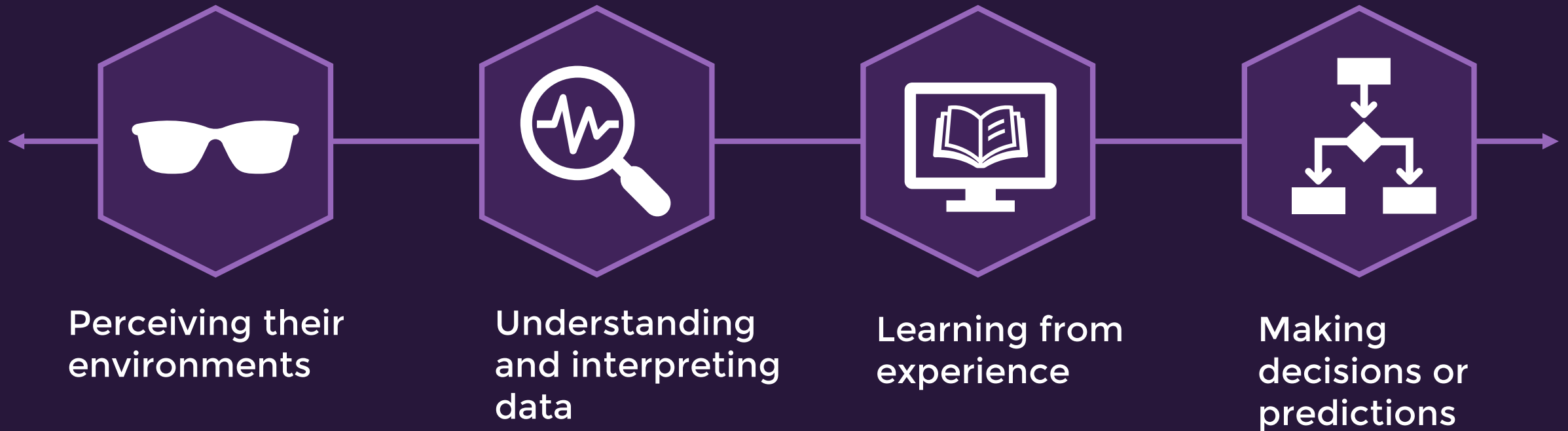
It turns out that understanding a mystery not only makes it feel less like a threat, it gives us the confidence to make it into something better."

Seth Godin

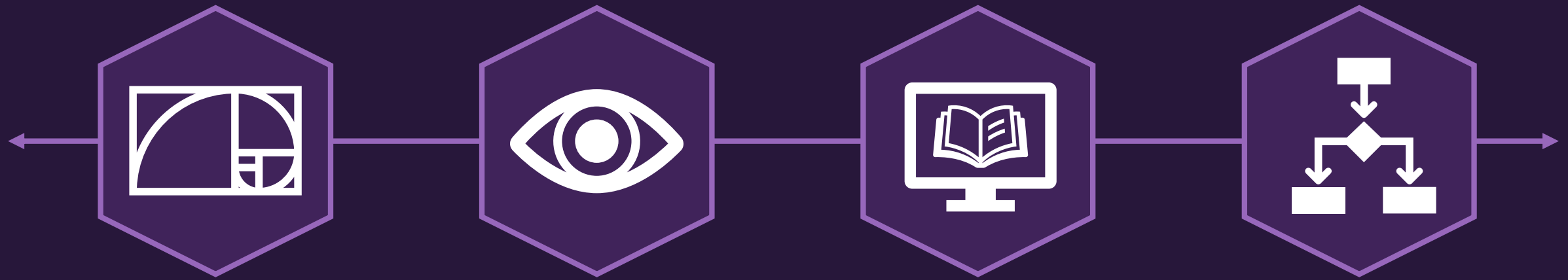
AGENDA

- Definitions
- How Gen A.I. models work
- Energy Use
- Resource Use
- How AI Supports Sustainability

What is Artificial Intelligence?



What is Artificial Intelligence?



Problem solving

Pattern
recognition

Natural
Language
Processing

Decision-
Making

A.I. is in lots of things



Freeing Our
Hands



Guiding What
We See

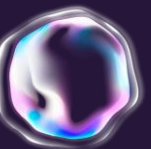


Making Hard
Things Easy

What is Generative Artificial Intelligence?



A set of AI tools which create content that appears to be generated by humans. The tools learn from a massive amount of existing data and then use that knowledge to produce outputs.

"Generative artificial intelligence ("AI") tools use machine learning models to create new, human-realistic content in response to a prompt. "





Popular Gen A.I. Tools



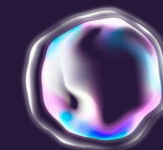
AI Tool	Pricing	Description
ChatGPT	Free & Paid versions	Generative text from OpenAI.
Claude	Free	Generative text from Anthropic – able to handle large text files
Bing 	Free	Microsoft's AI which is connected to the Internet, can do images, and runs on ChatGPT
Bard	Free	Google's AI tool which is connected to search
Dalle	Free & Paid versions	OpenAI's generative image tool.
MidJourney	Free trial – paid version	Generative image tool, connected to Discord
Firefly 	Free	Adobe's image generation tool

Popular Gen A.I. Tools



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Bard Gemini	Free	Google's AI tool which is connected to search
DALL-E	Free & Paid versions	OpenAI's generative image tool.
MidJourney	Free trial – paid version	Generative image tool, connected to Discord
Firefly 	Free	Adobe's image generation tool

Academic Gen A.I. Tools



AI Tool	Description
Elicit.org	Elicit is research assistant that helps researchers automate parts of their workflows. Elicit uses language models to find relevant papers and summarize key information from those papers. Elicit can also help researchers brainstorm research questions, identify search terms, and define terms.
Scite.Ai	analyze scientific literature and measure the veracity of scientific work
NOLEJ	decentralized skills platform that creates interactive courseware and a global knowledge graph. The platform is designed to automate courseware creation and facilitate global knowledge sharing.
Consensus	search engine that provides evidence-based answers to user queries. The tool uses AI and machine learning techniques to analyze peer-reviewed research papers and extract and distill data from scientific research.
Khanmigo	chatbot that helps students learn at their own pace. Khanmigo uses machine learning to track student progress and provide personalized feedback. It can also be used as a virtual tutor and debate partner.
Quillbot	writing tool that helps users create, edit, and improve their text.

THERE'S AN AI FOR THAT

9,390 AIs for 2,402 tasks and 4,847 jobs.



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11,504

16,605



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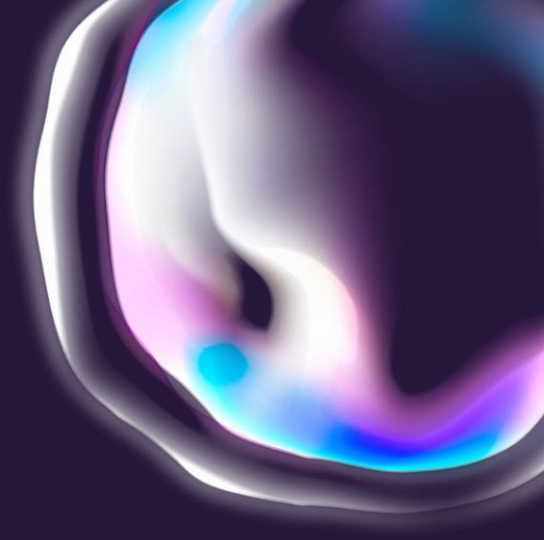
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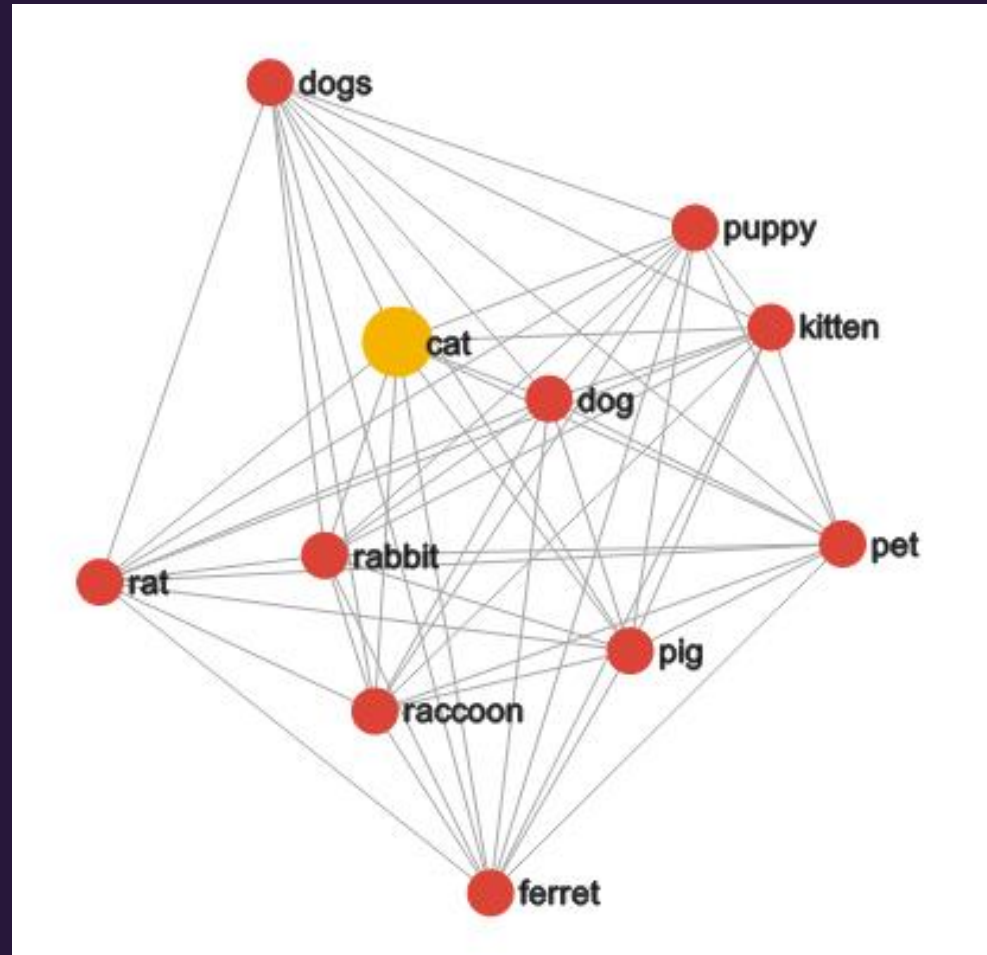
How do these tools work?



“No one on Earth fully understands the inner workings of Large Language Models (LLMs).”

~ Timothy B Lee &
Sean Trott

Mapping Words & Relations



Transforming

John wants his bank to cash the



Transformer – finds verbs

John **wants** his bank to **cash** the



Transforming by Layers

John wants his bank to cash the



Transformer – finds verbs

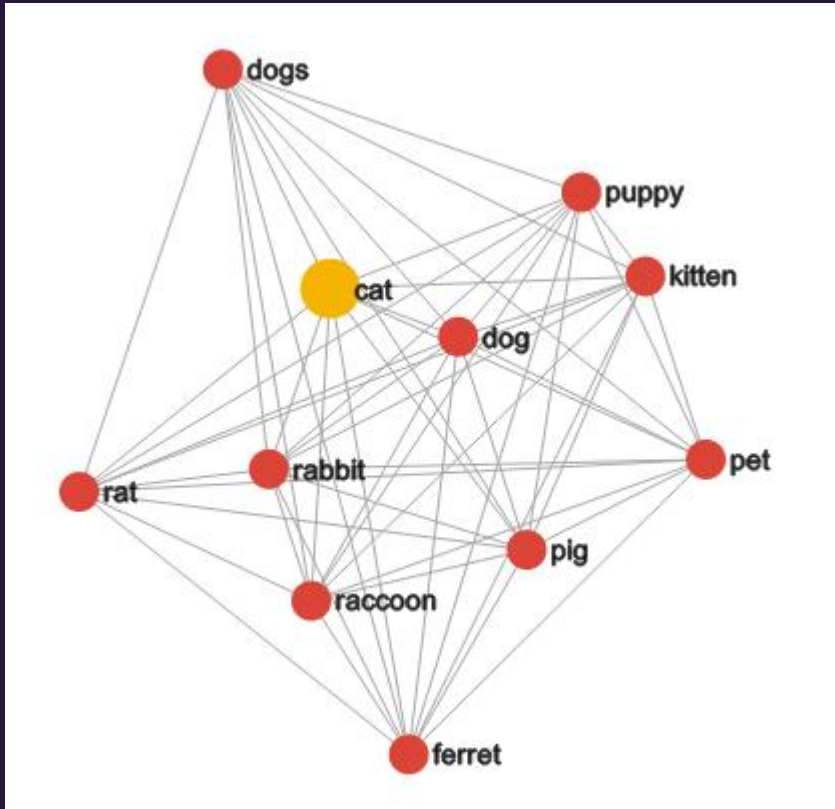
John **wants** his bank to **cash** the



Transformer – adds clarity

John **wants** his (*John's*) bank (*financial place*) to **cash** the

LOTS of data for each word



JOHN

- Main character,
- male,
- married to Cheryl,
- cousin of Donald,
- from Minnesota,
- currently in Boise,
- trying to find his missing wallet

In each

Transformer

1. Attention Step – “matchmaking”
2. Feed-Forward – “think to predict”

Training the Model



Quick summary of

Understanding AI

Large language models, explained with a minimum of math and jargon

Want to really understand how large language models work? Here's a gentle primer.



TIMOTHY B LEE AND SEAN TROTT

JUL 27, 2023

Large Data Centers

1 - 1.3%

Global Electricity Demand

What percentage of Google's energy use in 2021 went towards A.I.?

What percentage of Google's energy use in 2021 went towards A.I.?

10 to 15%

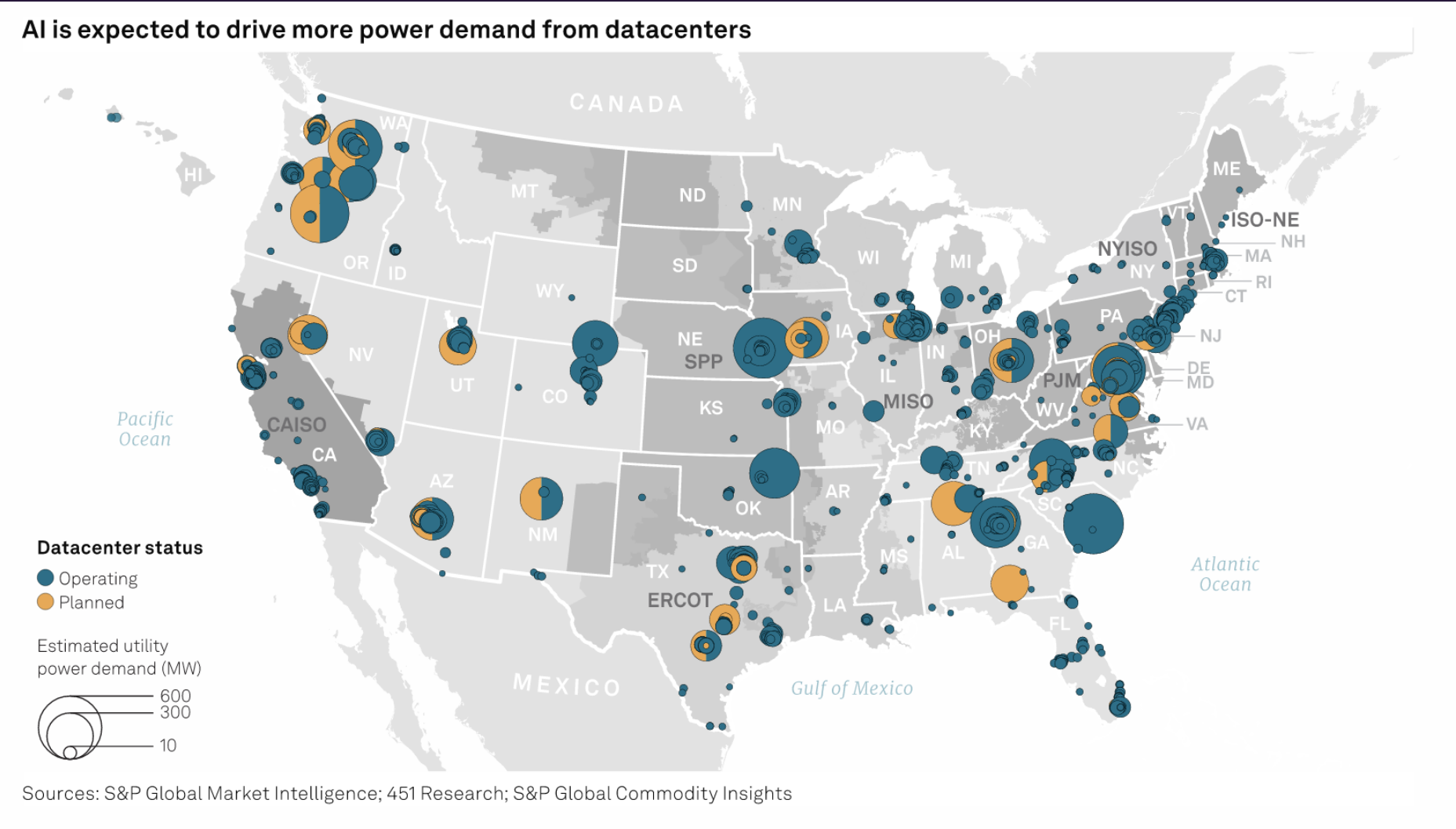
Big Tech Energy Use

Company	2021 TWh	2022 TWh	Gen AI -15%
Apple	2.8	3.19	0.48
Google	18.3	21.7	3.25
Meta	9.4	11.5	1.72
Microsoft	14.1	18.6	2.79
Amazon	30.9	???	4.63
Total	74.4		12.87 / 340

AI Energy Use
3.7% of 1%
of Global CO2 emissions

so tiny in comparison

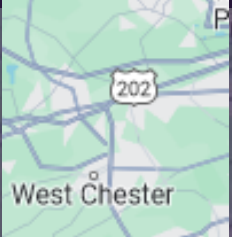
U.S. Data Center Power Demand



“Dominion Energy serves the largest datacenter market in the world in Loudoun County, Virginia, about 30 miles west of Washington, DC.



...electricity demand from datacenters in Virginia increased by about 500% from 2013 to 2022.”

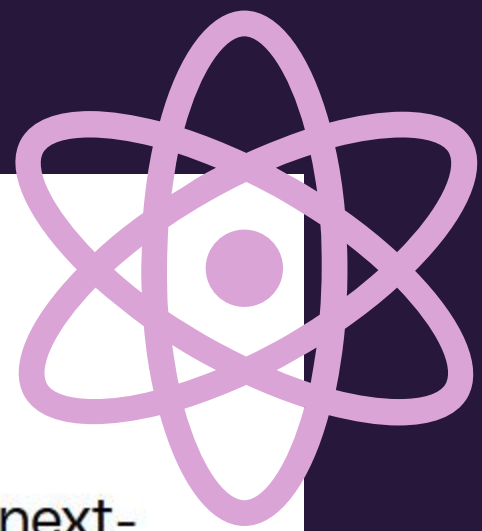


CLIMATE / ENERGY / SCIENCE

Microsoft is going nuclear to power its AI ambitions



Satya Nadella, CEO of Microsoft, speaks during an interview in Redmond, Washington, on Wednesday, March 15th, 2023. Image: Chona Kasinger / Bloomberg via Getty Images



/ Microsoft is looking at next-generation nuclear reactors to power its data centers and AI, according to a new job listing for someone to lead the way.

By [Justine Calma](#), a senior science reporter covering climate change, clean energy, and environmental justice with more than a decade of experience. She is also the host of *Hell or High Water: When Disaster Hits Home*, a podcast from Vox Media and Audible Originals.

Sep 26, 2023, 10:32 AM EDT | [35 Comments](#) / [35 New](#)

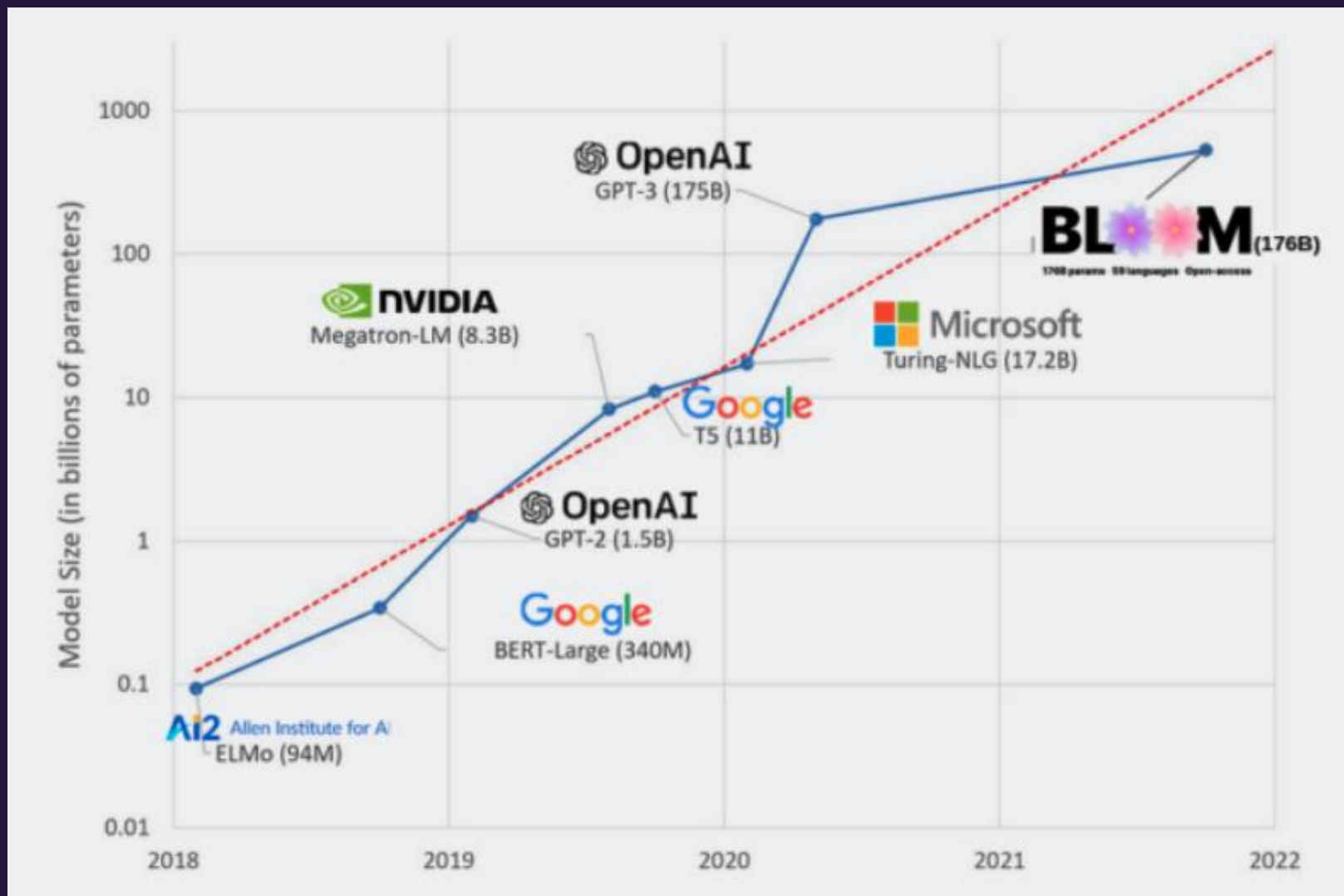


Power Allocation of A.I. Models

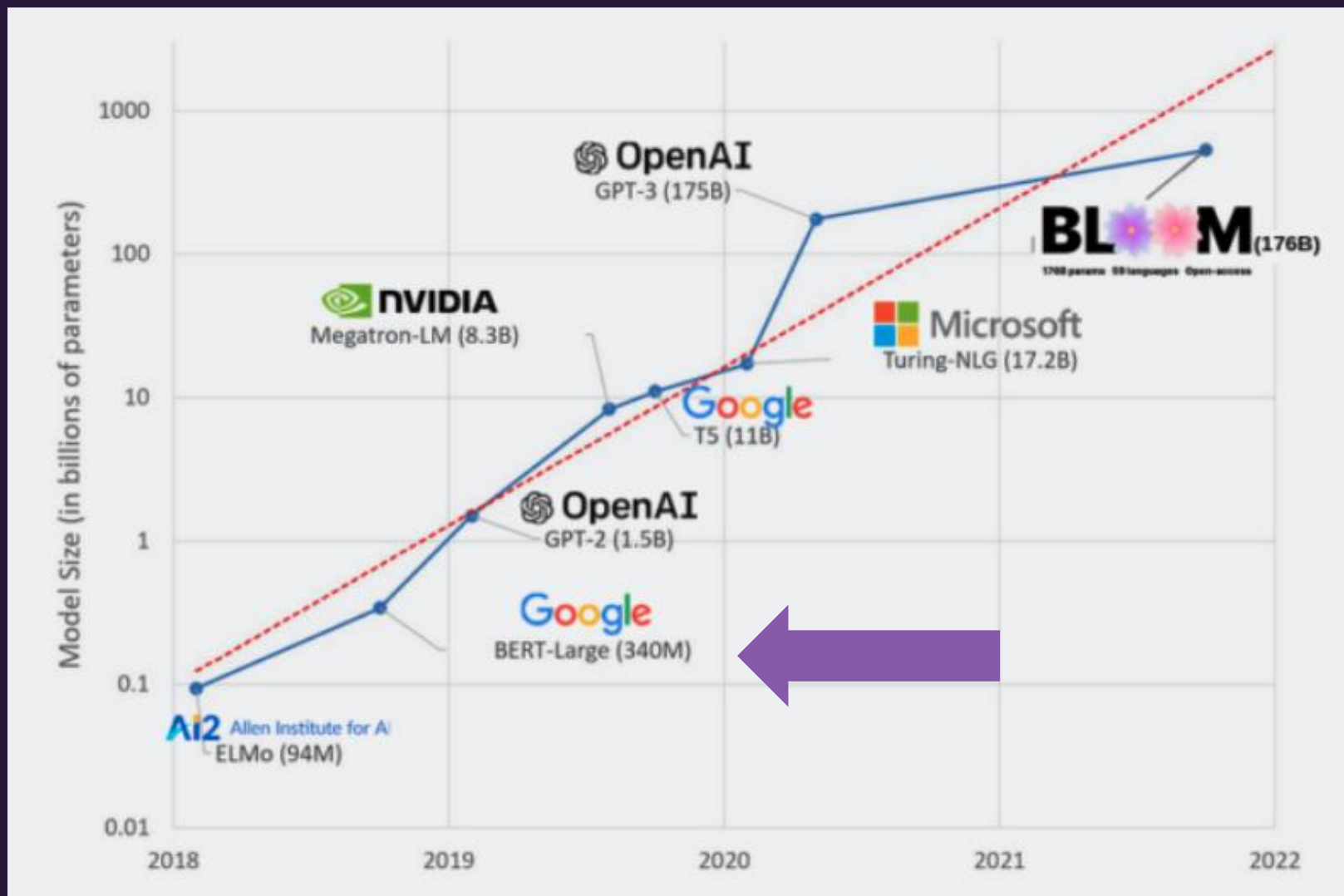


Experimentation

More Parameters = More Energy



More Parameters = More Energy



Not all AI Models Created Equally

2019

Model: BERT

213 million parameters

280 metric tons of carbon emissions

2021-2022

Model: BLOOM

176 billion parameters

30 metric tons of carbon emissions

Model name	Number of parameters	Datacenter PUE	Carbon intensity of grid used	Power consumption	CO ₂ eq emissions	CO ₂ eq emissions × PUE
GPT-3	175B	1.1	429 gCO ₂ eq/kWh	1,287 MWh	<i>502 tonnes</i>	552 tonnes
Gopher	280B	1.08	330 gCO ₂ eq/kWh	<i>1,066 MWh</i>	<i>352 tonnes</i>	380 tonnes
OPT	175B	1.09 ²	<i>231 gCO₂eq/kWh</i>	<i>324 MWh</i>	70 tonnes	<i>76.3 tonnes</i> ³
BLOOM	176B	1.2	57 gCO ₂ eq/kWh	433 MWh	25 tonnes	30 tonnes

Table 4: Comparison of carbon emissions between BLOOM and similar LLMs. Numbers in *italics* have been inferred based on data provided in the papers describing the models.

Big Tech – Renewal Energy

Renewable Energy #1

World's largest corporate purchaser of renewable energy for the third year in a row

We're on a path to powering our operations with 100% renewable energy by 2025—five years ahead of our original target of 2030.



Carbon negative

By 2030, we'll be carbon negative, and by 2050, we'll remove our historical emissions since our founding in 1975.



Water positive

By 2030, we'll be water positive across our direct operations.



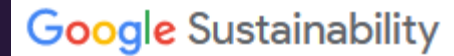
Zero waste

By 2030, we'll be zero waste across our direct waste footprint.



Protect and preserve ecosystems

We'll protect more land than we use by 2025 and build a Planetary Computer.



Net-zero carbon

[Learn more](#)

TARGET	TARGET YEAR	2022	STATUS
CARBON REDUCTION Reduce 50% of our combined Scope 1, 2 (market-based), and 3 absolute emissions before 2030. Invest in nature-based and technology-based carbon removal solutions to neutralize our remaining emissions.	Before 2030	10.2 million tCO ₂ e* total GHG emissions.	Ongoing
*Due to changes in methodologies, we are not reporting progress towards our emissions reduction target this year (see here for more information).			
CARBON-FREE ENERGY² Run on carbon-free energy 24/7, such as wind and solar, on every grid where we operate by 2030.	2030	64% global average carbon-free energy across our data centers and offices.	Ongoing

Code Carbon



[ABOUT](#) [HOW IT WORKS](#) [CALL FOR ACTION](#) [TEAM](#) [CONTACT US](#)

Track and reduce CO2 emissions from your computing

AI can benefit society in many ways but, given the energy needed to support the computing behind AI, these benefits can come at a high environmental price.

CodeCarbon is a lightweight software package that seamlessly integrates into your Python codebase. It estimates the amount of carbon dioxide (CO2) produced by the cloud or personal computing resources used to execute the code.

It then shows developers how they can lessen emissions by optimizing their code or by hosting their cloud infrastructure in geographical regions that use renewable energy sources

Power Allocation of A.I. Models



Experimentation

Generating an image using a powerful AI model takes as much energy as _____?

1. Running a lightbulb for five minutes
2. Fully charging your smartphone to 100%
3. Using your laptop for eight hours
4. Powering an average size US house for a day

Generating an image using a powerful AI model takes as much energy as _____?

1. Running a lightbulb for five minutes
2. Fully charging your smartphone to 100%
3. Using your laptop for eight hours
4. Powering an average size US house for a day

One of my early chats



ChatGPT

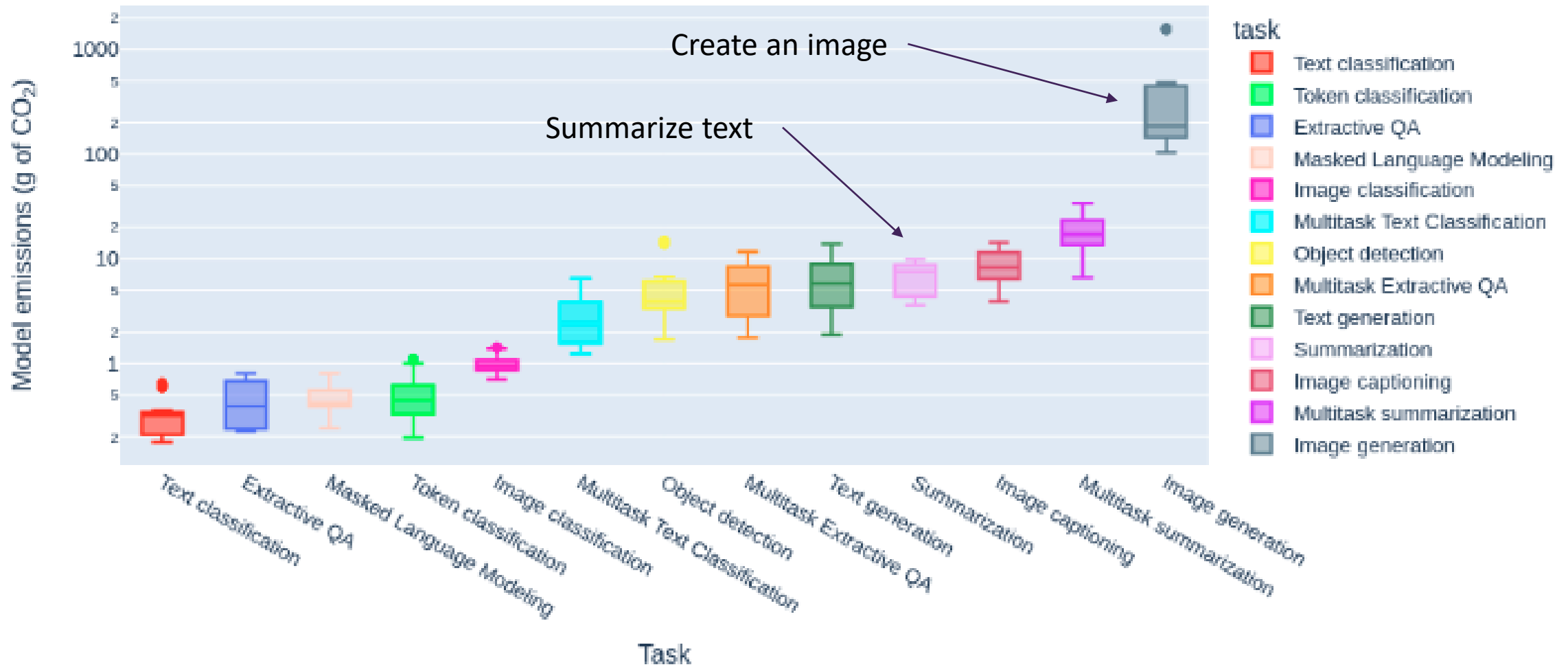
Certainly! Here's a set of Star Trek and Star Wars-themed jokes:

1. Why did Spock visit Tatooine? To find the logical droids!
2. How many Klingons does it take to change a lightbulb? None, they prefer the dark side!
3. Why did Yoda become a Starfleet officer? To explore strange new worlds, he did!
4. What did Captain Kirk say to Han Solo? "May the warp speed be with you!"
5. Why did Darth Vader join the Borg collective? He heard they had the dark side of the Force!
6. How did Worf become a Jedi? He mastered the Klingon art of lightsaber bat'leth combat!
7. What do Starfleet and the Rebel Alliance have in common? Both have a talent for finding hidden bases!
8. Why did Luke Skywalker always lose at poker on the USS Enterprise? He couldn't use the Force to read Spock's mind!
9. Why did Chewbacca visit Quark's bar? To challenge him in a game of dabo and see who's the hairiest!
10. What did Jean-Luc Picard say when he encountered a lightsaber-wielding Sith? "Engage the phasers, Number One!"

These jokes should bring a smile to the faces of both Star Trek and Star Wars fans on



Impact of various AI tasks



Material Resources

Impacts include resources



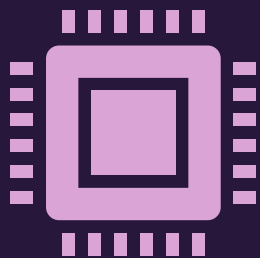
Nvidia expected to deliver 100,000 AI servers in 2023.

More Hardware – Used Faster

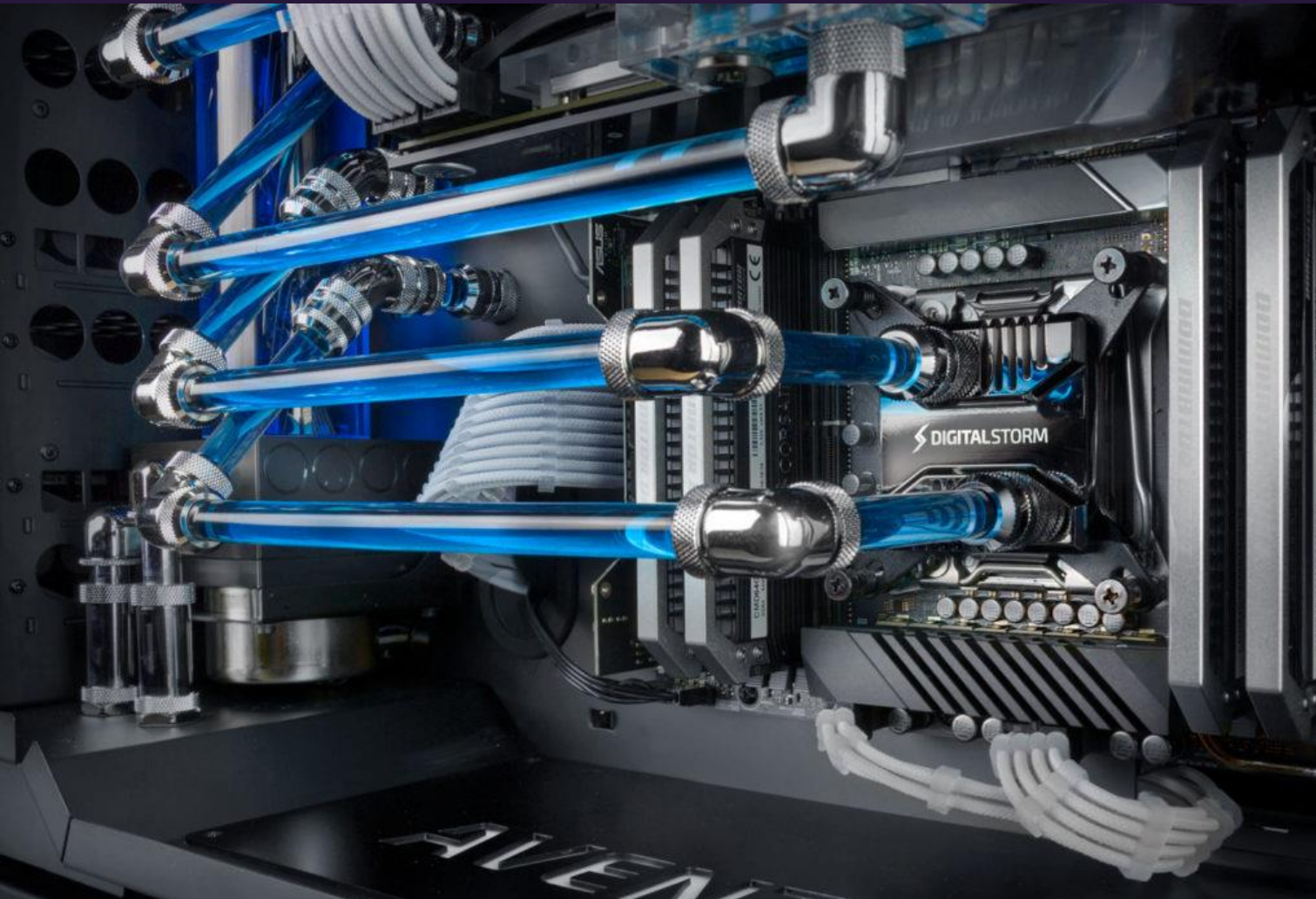
More hardware

Cycles through hardware faster

Leads to more e-waste and continued demand for rare earth mining



Water Use for Data Centers



CHAT GPT uses about 500 ml of water for a conversation of 20 to 50 answers in the United States.

Source: [Save the Water](#)

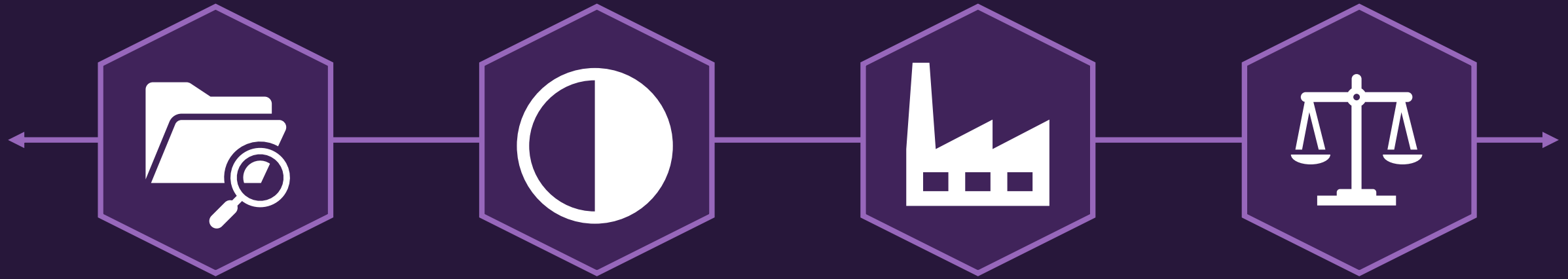
Companies working on efficiencies



Water positive

By 2030, we'll be water positive across our direct operations.

A.I. Concerns



Used training data without consent of those who created it.

Uses of AI can discriminate against communities

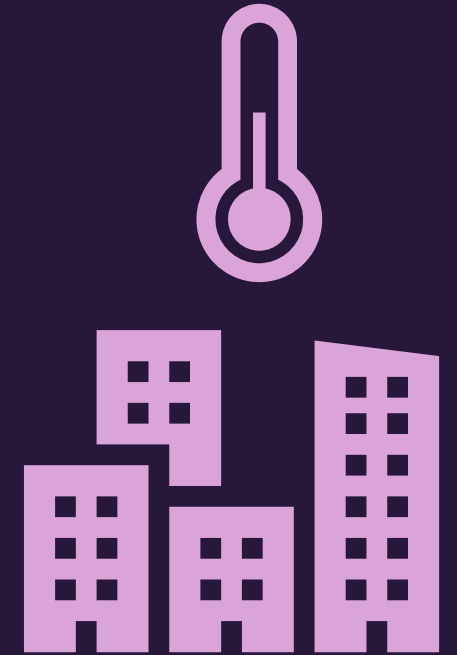
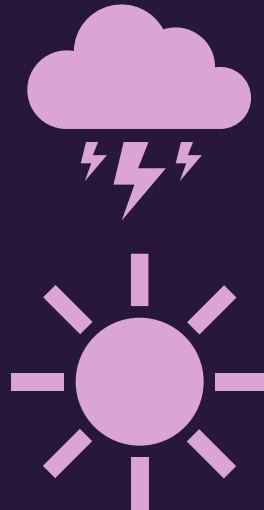
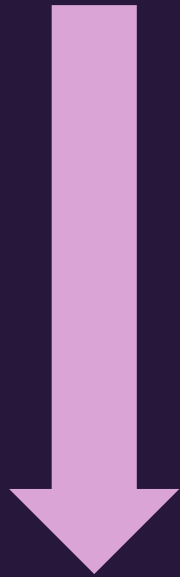
Resource Intensive

Biases

Focusing on future risks, misses the current risks

Positives of AI

Positive Environmental Possibilities



Efficiencies

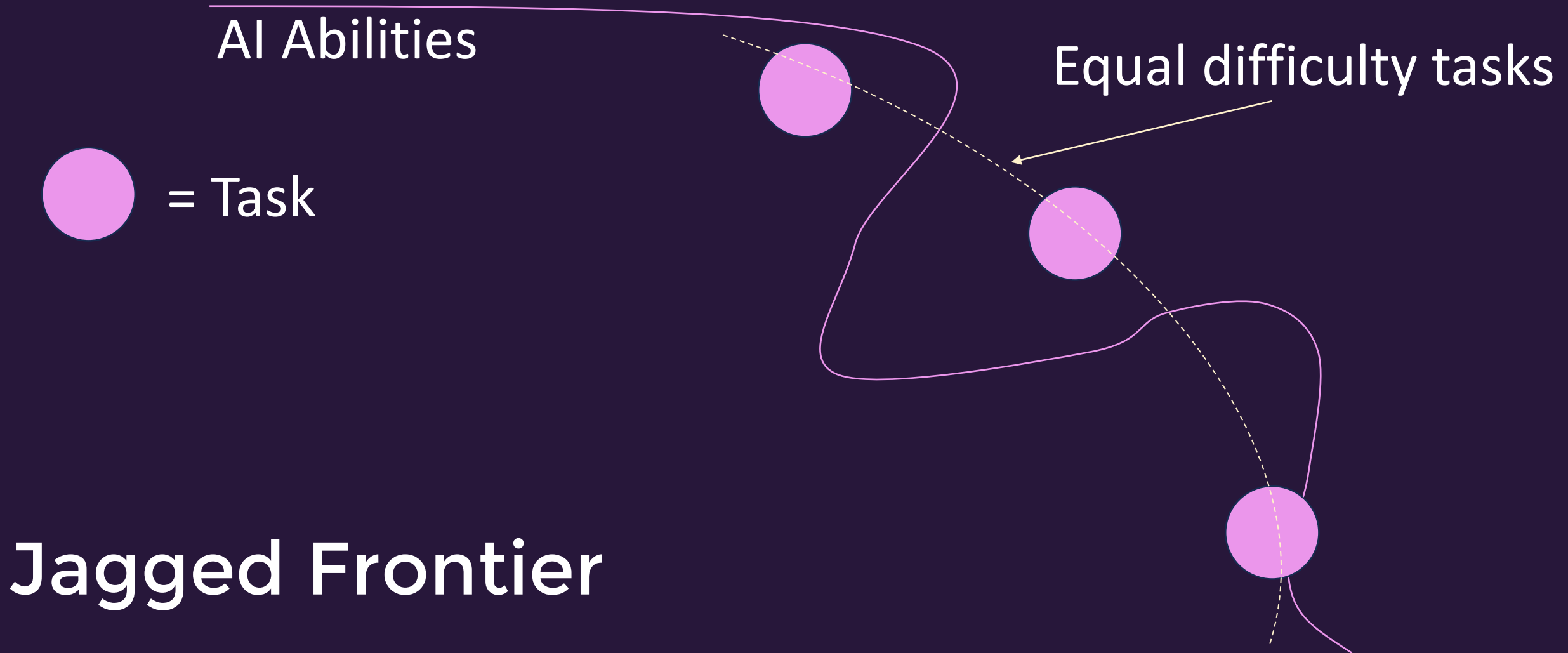


Tips for Use



Does this task need generative A.I.?

But still figuring out with what



Long term goals



Andy Famiglietti · 19d

@afamiglietti.bsky.social



Helping students build a critical understanding of Deep Learning AI generally and LLMs is almost certainly an important task for educators. Teaching "Prompt Engineering" is almost certainly NOT since UI changes will make all current methods (possibly the whole idea) obsolete in months.

Oct 18, 2023 at 11:13 AM

