

From Search to Generative AI: How ChatGPT will impact Higher Education

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From Search to Generative AI: How ChatGPT will impact Higher Education

Introduction and Background

- From Search to Generative AI
- Examples of Generative AI: *text, images, computer code*
- ChatGPT can do amazing things: *e.g. performance on college entrance exams*
- ChatGPT has some well-known limitations: *hallucination, bias, misinformation*

Generative AI and Higher Education

- How do we integrate Generative AI into educational curricula?
- Could ChatGPT serve as a PhD Thesis advisor?
- Can Generative AI generate new research results?

Discussion: Other key issues in Generative AI

Google changed internet search forever when it debuted in 1998

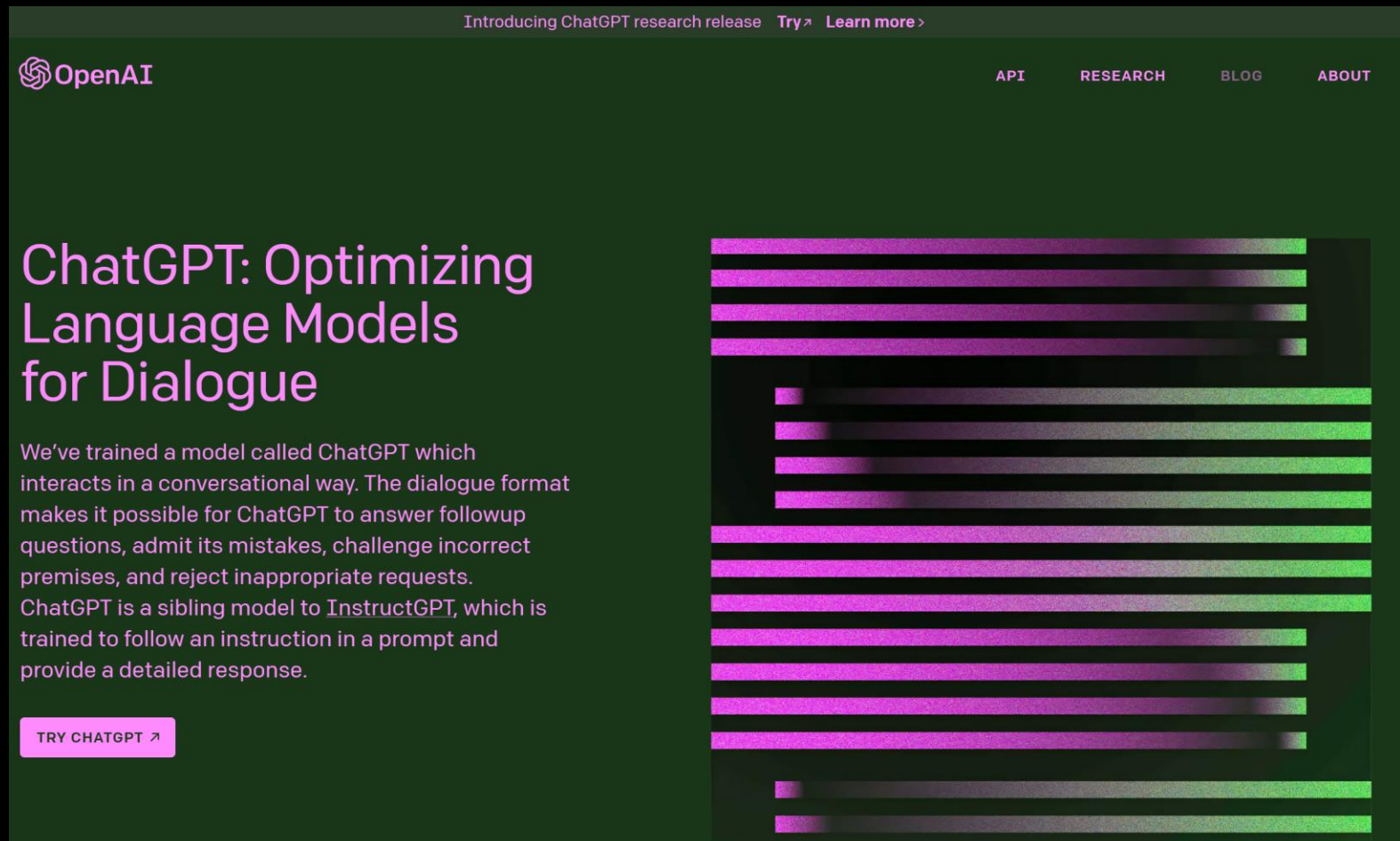


(currently > 100 billion pages !)

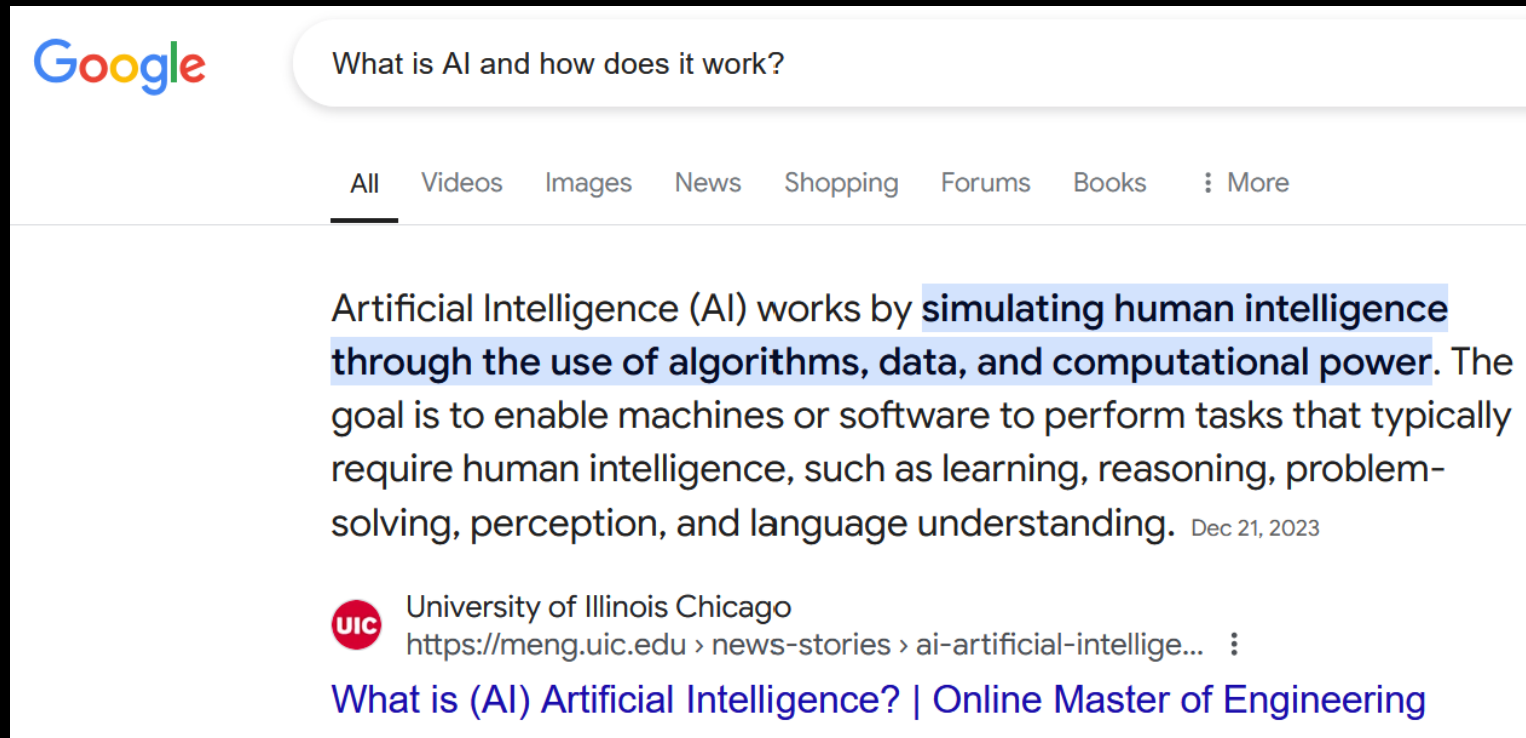
- A key innovation was the **Google PageRank algorithm** used to rank relevant web pages (based on 'authority') returned by a search query.
- This continues to be a useful way to filter misinformation.

ChatGPT went public in November 2022.

(And it will have an even greater impact than Google internet search)



What is AI? Here's Google's response ...



Traditionally, Google (or any search engine) returns ***verbatim*** a snippet of relevant text.

In May 2024, Google introduced AI Overviews, a new model that returns an AI-generated summary plus relevant links.

What is AI? Here's what ChatGPT has to say ...

Query →

What is AI and how does it work?



What is AI?

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think, learn, and adapt. AI systems aim to mimic cognitive functions such as problem-solving, understanding language, perception, and decision-making.

Types of AI:

1. **Narrow AI (Weak AI):** These systems are designed to perform a specific task, like facial recognition or natural language processing. Examples include Siri, Alexa, and Google Translate.
2. **General AI (Strong AI):** This is a theoretical form of AI that would have the ability to perform any intellectual task a human can do. General AI doesn't exist yet but is a goal for future AI development.
3. **Superintelligence:** This hypothetical AI would surpass human intelligence in every aspect, including creativity, general wisdom, and social skills. This remains speculative.

How Does AI Work?

AI is based on **algorithms** and models that learn from data. It works by processing large amounts of information to recognize patterns, make predictions, and perform tasks. Here's a basic breakdown:

■ ■ ■

ChatGPT ***generates novel text***: if you paste a subset of this text into Google, it is unlikely to find an exact match anywhere on the internet.

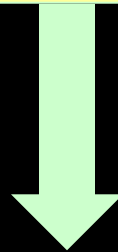
Some Quick Comments on ChatGPT ...

- ChatGPT is developed by OpenAI and is available at <https://openai.com/chatgpt/>
- The ChatGPT examples shown here are generated using ChatGPT 4o released on September 12, 2024
 - ▶ Access to this latest version requires a ChatGPT Plus subscription (\$20 per month)
- ChatGPT continues to evolve very quickly ...
 - ▶ Results generated using earlier versions of ChatGPT will likely differ from the examples shown here

How did Generative AI evolve?

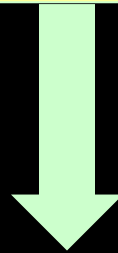
Machine Learning involves the construction and analysis of algorithms that learn from data.

Text Classification
Image Classification
Deep Learning



Artificial Intelligence is the theory and development of computer systems able to perform tasks that normally require human intelligence.

Machine Learning
Natural Language Processing
Reinforcement Learning



Generative Artificial Intelligence involves AI systems that are trained to create new content such as text, images, audio, video, and computer code.

ChatGPT + others
Massive Deep Learning

ChatGPT will generate well-reasoned essays written from different perspectives

“Write a 1000 word essay on critical race theory from a **conservative** viewpoint.”

Conclusion: A Call for Unity and Common Purpose

From a conservative perspective, Critical Race Theory represents a departure from the foundational principles of the United States, including the ideals of individual responsibility, equality under the law, and meritocracy. While conservatives acknowledge that racism and racial inequality have been significant issues in American history, they argue that CRT's focus on systemic racism and group identity risks undermining the progress that has been made toward creating a more just and equal society.

...

“Write a 1000 word essay on critical race theory from a **liberal** viewpoint.”

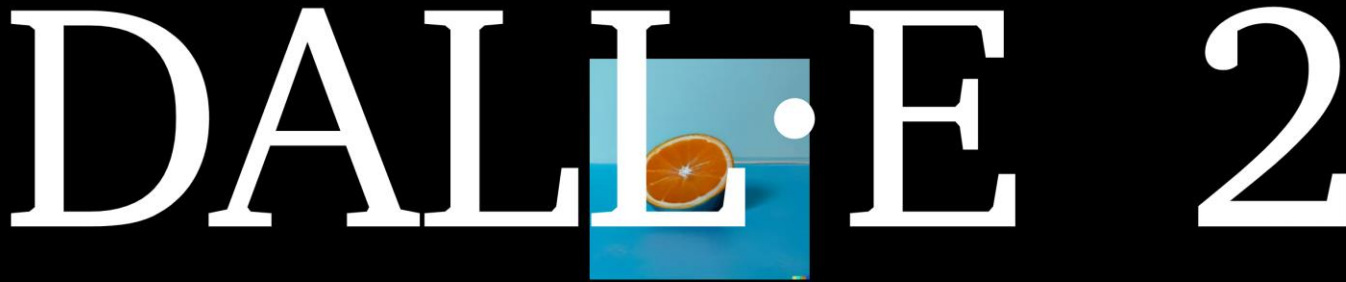
Conclusion

Critical Race Theory offers a valuable framework for understanding the persistence of racial inequality in modern society. From a liberal perspective, CRT provides important insights into the structural nature of racism and challenges us to think more critically about the limitations of existing legal and policy frameworks. While there are tensions between CRT and liberalism, particularly

...

ChatGPT is example of **Generative AI** because it generates original text

DALL-E 2 (also from OpenAI) is another example of **Generative AI**:
it generates novel images



(Introduced April 6, 2022)

DALL-E 2 is a new AI system that can create realistic images and art from a description in natural language.

DALL-E 3 is now incorporated directly into ChatGPT 4o

DALL-E 3 generates images based on a user-provided prompt

“A 16th century English playwright using a laptop in a contemporary setting”

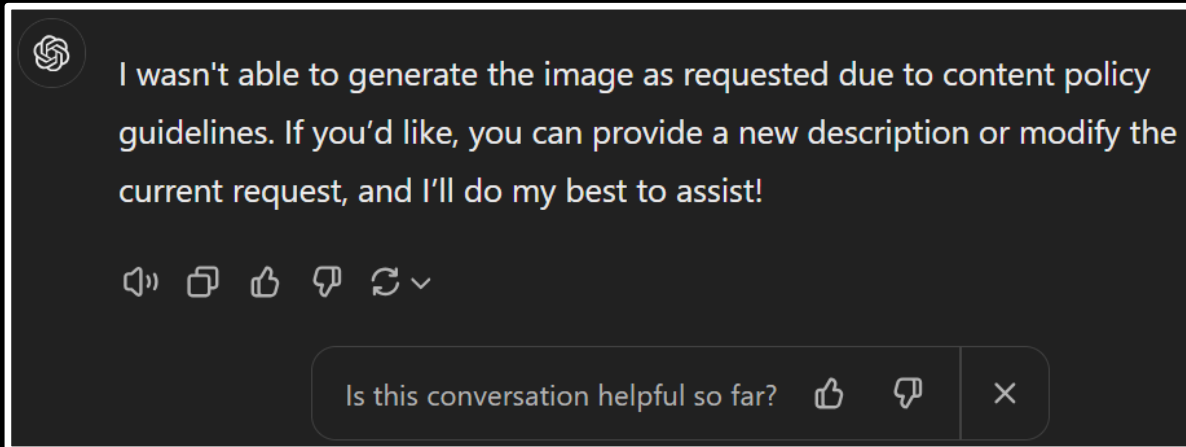


OpenAI continues to tighten its content policy guidelines ...

“William Shakespeare using a laptop in a modern setting”



Using Dall-E 2
(January 2024)




Using ChatGPT 4o
(September 2024)


**OpenAI rejects queries that request a likeness of any public person
(even Elizabethan Era playwrights ...)**

ChatGPT generates computer code (even in obsolete languages)

Write python code that computes the area of a circle given the radius as an input variable

< 4/4 >

 Here's a simple Python code to compute the area of a circle, given the radius:

python  Copy code

```
import math

def area_of_circle(radius):
    # Area of a circle formula: A = π * r^2
    area = math.pi * (radius ** 2)
    return area

# Example usage
radius = float(input("Enter the radius of the circle: "))
circle_area = area_of_circle(radius)
print(f"The area of the circle with radius {radius} is: {circle_area:.2f}")
```

This code takes the radius as an input, calculates the area using the formula $\text{Area} = \pi r^2$, and then prints the result.

← Explanation

But here's the scary part. ChatGPT can generate this code in computer languages (e.g., ALGOL, FORTRAN77) that have not been used for decades.

ChatGPT (and other systems) are capable of writing (and explaining) significant blocks of code that previously required skilled human programmers.

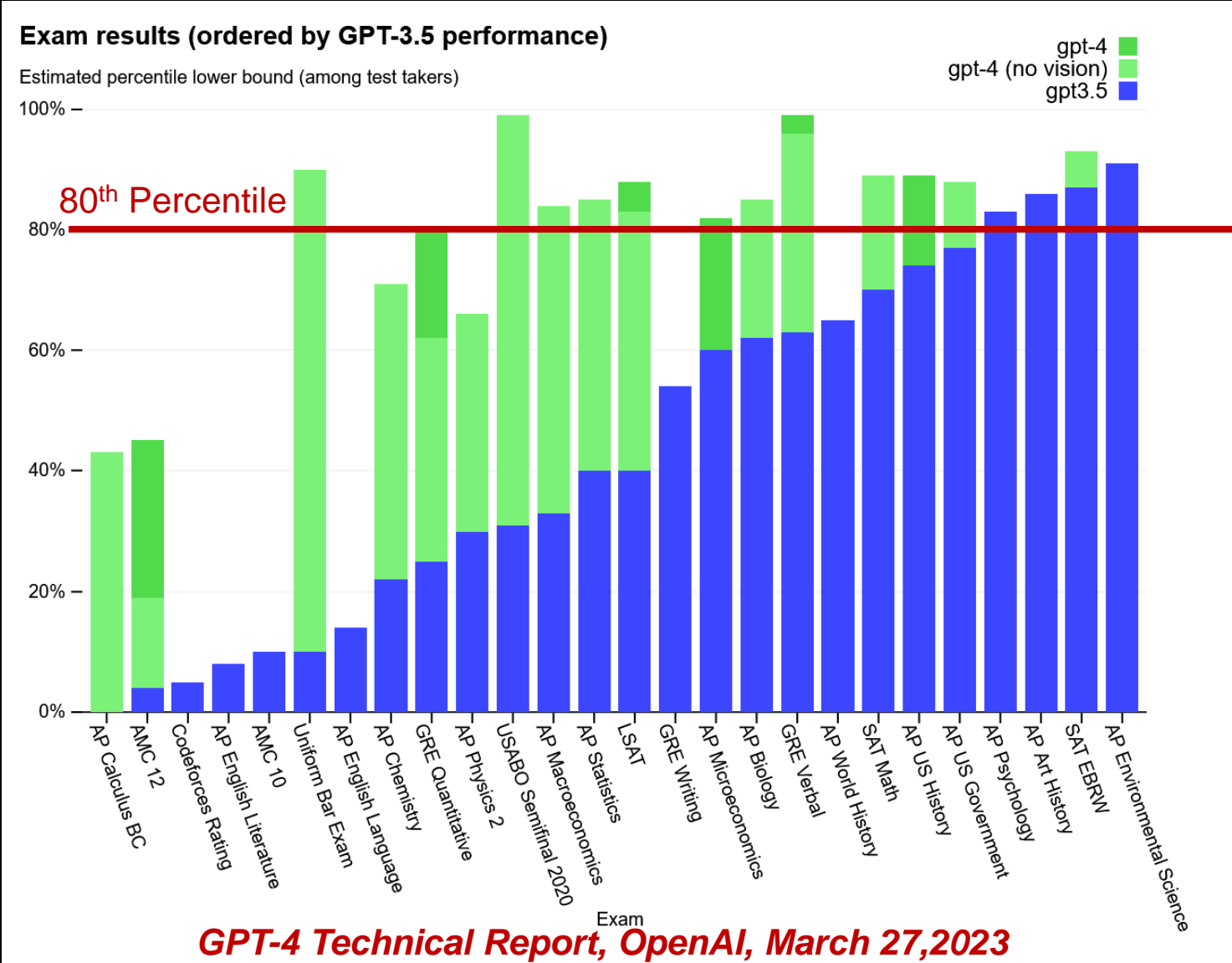
And its programming abilities are good enough to get hired at Google ...

Google fed its standard coding interview questions to ChatGPT.

ChatGPT performed well enough to get hired at Level 3 (entry-level position) on an engineering team at Google.

The average total annual compensation for this position is \$183,000.

ChatGPT 4 exceeds the 80th percentile on many college exams



ChatGPT 4o likely scores even higher ... but OpenAI has not published them

ChatGPT (GPT-4) can ace the SAT, the LSAT and even a Bar Exam

Exam (taken by GPT-4)	Score	Estimated Lower Percentile
SAT Evidence-Based Reading and Writing (EBRW)	710	93%
SAT Math	700	89%
LSAT		88%
Uniform Bar Exam		90%

GPT-4 Technical Report, OpenAI, March 27, 2023

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- Can Generative AI generate new research results?

Discussion: Other key issues in Generative AI

How do we integrate Generative AI into educational curricula?

After some initial resistance, essentially all school systems are now exploring ways to best integrate Generative AI into curricula.

Generally speaking, our educational system(s) will need to prepare children for an AI-based future while continuing to reinforce important skills like writing, problem solving, and critical thinking.

There are clear advantages to integrating Generative AI at all educational levels

1. Students benefit from personalized learning optimally tailored to their educational needs.
2. AI systems are available 24/7 and have infinite patience.
3. Used correctly, AI systems can stimulate curiosity and independent learning.
4. Interaction with AI systems can make learning more engaging (and hence more fun).
5. Students can prepare for future careers by collaborating with AI systems to create optimal solutions to challenging problems.
6. Generative AI can also assist teachers in preparing lesson plans as well as creating and grading homework assignments and quizzes.

And there are plenty of challenges ...

1. We need to ensure that students do not become too dependent on AI ... they must continue to develop essential life skills in problem solving and critical thinking.
2. Human teachers recognize the emotional and psychological needs of students. Current AI systems arguably do not.
3. We need to ensure that the benefits of AI systems are made available in disadvantaged school districts and to special-needs students.
4. Students will (of course) need to recognize that AI systems, like humans, are not perfect.
5. Some parents have expressed concerns that private and personal data collected from students could be used inappropriately.


Could ChatGPT serve as a PhD Thesis advisor?

A critical first step in getting a PhD is picking a viable thesis topic.

ChatGPT has 10 proposals for a machine learning thesis ... here is the first one

Propose potential topics for a PhD thesis in machine learning with an emphasis on deep learning

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 Here are some potential topics for a PhD thesis in machine learning with a focus on deep learning, covering both theoretical advancements and practical applications:

1. Explainable Deep Learning Models

- **Objective:** Research and develop methods for enhancing the interpretability of deep learning models, especially in critical applications like healthcare, finance, or law.
- **Key Areas:**
 - Post-hoc explanation techniques (e.g., LIME, SHAP)
 - Developing inherently interpretable deep architectures
 - Visualizing decision-making processes in neural networks.
- **Challenges:** Balancing model accuracy and interpretability, especially for complex models like transformers and deep CNNs.

Could ChatGPT serve as a PhD Thesis advisor?

Here is a summary of ChatGPT proposals 1-5:

1. Explainable Deep Learning Models

Objective: Research and develop methods for enhancing the interpretability of deep learning models, especially in critical applications like healthcare, finance, or law.

2. Adversarial Robustness in Deep Neural Networks

Objective: Study the vulnerability of deep learning models to adversarial attacks and propose new defense mechanisms.

3. Meta-Learning for Efficient Deep Learning Models

Objective: Investigate meta-learning (learning to learn) algorithms that can generalize across different tasks with limited data.

4. Efficient Deep Learning for Edge Computing

Objective: Focus on optimizing deep learning models to run on resource-constrained devices, such as smartphones and IoT sensors.

5. Deep Learning for Healthcare Applications

Objective: Apply deep learning to improve predictive modeling and diagnostics in healthcare, particularly in medical imaging, genomics, and electronic health records.

Could ChatGPT serve as a PhD Thesis advisor?

And, for completeness, here is a summary of ChatGPT proposals 6-10:

6. Generative Models for Synthetic Data Generation

Objective: Use generative deep learning models (GANs, VAEs) for creating realistic synthetic data that can augment datasets for training or privacy preservation.

7. Self-Supervised Learning for Large-Scale Data

Objective: Investigate methods for learning useful representations from unlabeled data using self-supervised learning techniques.

8. Reinforcement Learning with Deep Learning

Objective: Develop advanced reinforcement learning (RL) algorithms using deep learning to solve real-world decision-making problems.

9. Deep Learning for Autonomous Systems

Objective: Build robust and reliable deep learning systems for autonomous vehicles, drones, or robotics.

10. Deep Learning for Natural Language Understanding

Objective: Focus on building advanced deep learning models for natural language understanding (NLU) and generation (NLG).

Could ChatGPT serve as a PhD Thesis advisor?

Topic #2 seems particularly relevant today, so I asked ChatGPT to elaborate:

Please elaborate on the potential machine learning PhD topic
"Adversarial Robustness in Deep Neural Networks"

ChatGPT gave a very detailed response ... here is one noteworthy section:

Potential Contributions:

- **Novel Defense Mechanisms:** Design new methods for defending against adversarial attacks that improve on the state of the art in terms of both robustness and computational efficiency.
- **Improved Understanding of Adversarial Vulnerabilities:** Provide theoretical insights into why certain neural network architectures or loss functions are more prone to adversarial attacks than others.
- **Unified Framework for Robustness:** Develop a unified framework or benchmark for evaluating robustness across different types of attacks and defenses, helping the community better understand the trade-offs.

Can Generative AI generate new research results?

- Researchers at Google DeepMind discovered a faster sort algorithm
 - Sorting is first recast as a single-player game
 - DeepMind AlphaDev was then trained to optimize performance by playing itself many times
 - The resulting algorithm was implemented in a standard C++ library.

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Faster sorting algorithms discovered using deep reinforcement learning

Can Generative AI generate new research results?

- Current weather forecasts use computational approximations to equations describing the relevant physics
 - Researchers at Google Research trained a deep neural network to transform input data into a prediction *without utilizing any of the underlying physics*
- The deep-learned forecasts were more accurate than state-of-the-art physics-based forecasts
 - Analysis of the deep learning architecture can provide new insights into the actual physics

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Deep learning for twelve hour precipitation forecasts

Advances in AI were recognized in Nobel Prizes awarded this week

- The 2024 Nobel Prizes in Physics and Chemistry both recognize work involving deep learning
 - Physics: Geoffrey Hinton et.al. for development of artificial neural networks.
 - Chemistry: Demis Hassabis et.al. for protein structure prediction using deep learning.

We did not discuss other key challenges with Generative AI

1. Generative AI systems will facilitate the generation and dissemination of false information (e.g. 'Deep Fakes'). (*We have seen less than initially expected.*)
2. Generative AI raises significant intellectual property issues ... how will these be resolved?
3. AI will eliminate many knowledge-based jobs ... will these lost jobs be offset by new jobs enabled by AI?
4. It is largely agreed that AI needs to be regulated ... who should be responsible and how do we do it?
5. AI models require massive amounts of electricity ... how will we meet this demand?
6. Could AI destroy humanity?

Thank You.

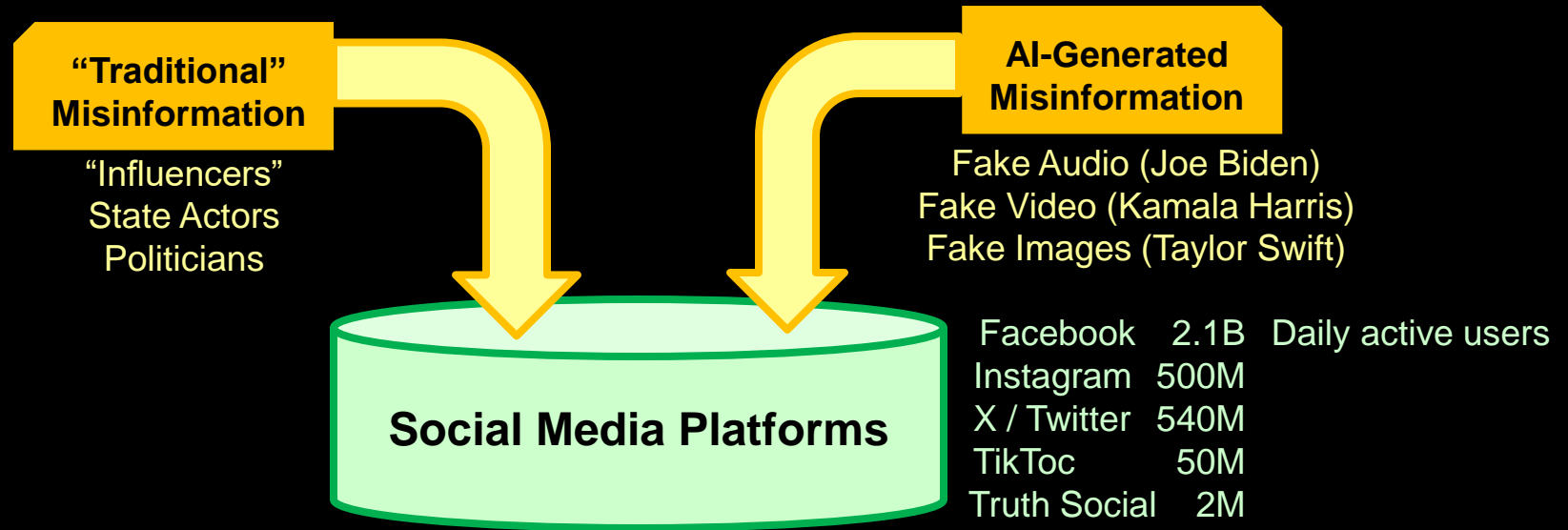
Questions?

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Backup Slides

Will AI-generated misinformation impact the 2024 election?

We already have a remarkably efficient way to spread misinformation ...
It's called Social Media

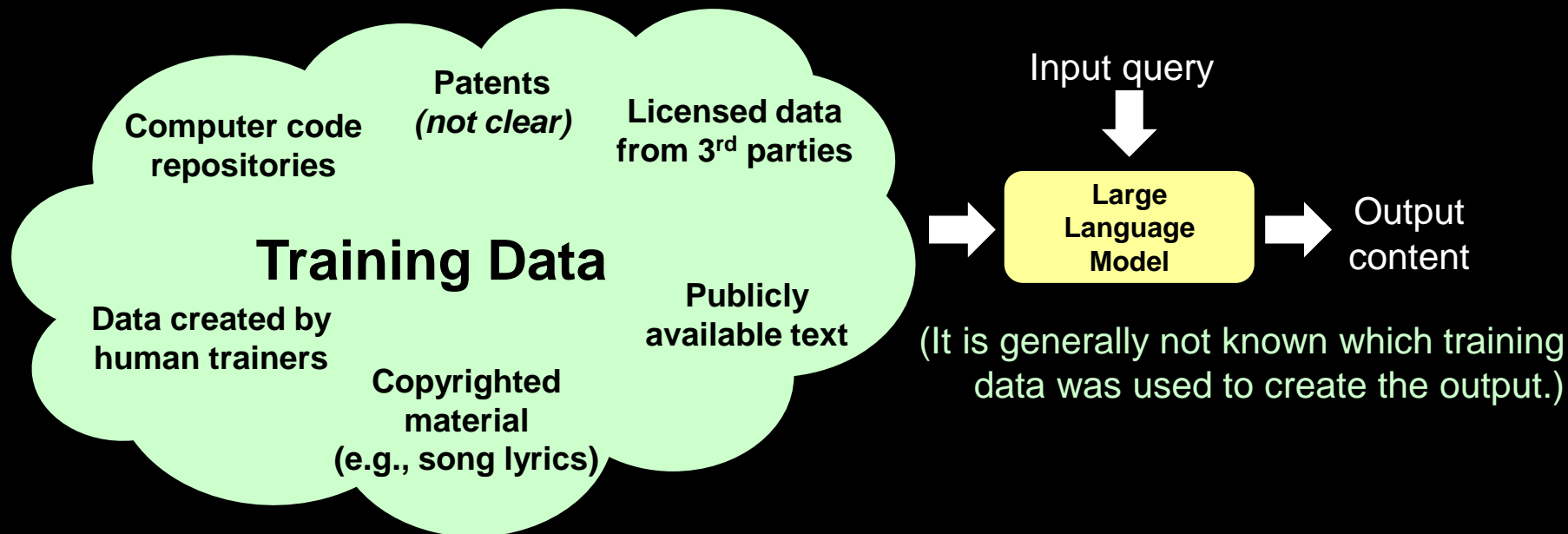


So far, AI-Generated misinformation has had less effect than initially expected.
(But some politicians have falsely claimed that AI created content unfavorable to them.)

- MIT Technology Review (9/18/2024)
 - ▶ "AI-generated falsehoods and deepfakes seem to have had no effect on election results in the UK, France, and the European Parliament this year, according to new research."
- Harvard Kennedy School (10/18/2023)
 - ▶ "We argue that current concerns about the effects of generative AI on the misinformation landscape are overblown."

Training of AI models raises important Intellectual Property issues

(btw, I am not a lawyer ...)



1. *Assuming existing intellectual property agreements are observed*, both humans and AI systems can use these data to create new content.
2. The output content cannot be a derivative work (obtained by making simple changes) or bear substantial similarity to existing licensed or copyrighted material.
3. And the output cannot be a near-verbatim replica or close summarization of copyrighted content. (This is the basis of the NY Times lawsuit against OpenAI and Microsoft.)
4. AI-generated works may not receive full copyright protection since there is no human creator. (It is not clear if AI can be listed as an inventor on a patent application.)

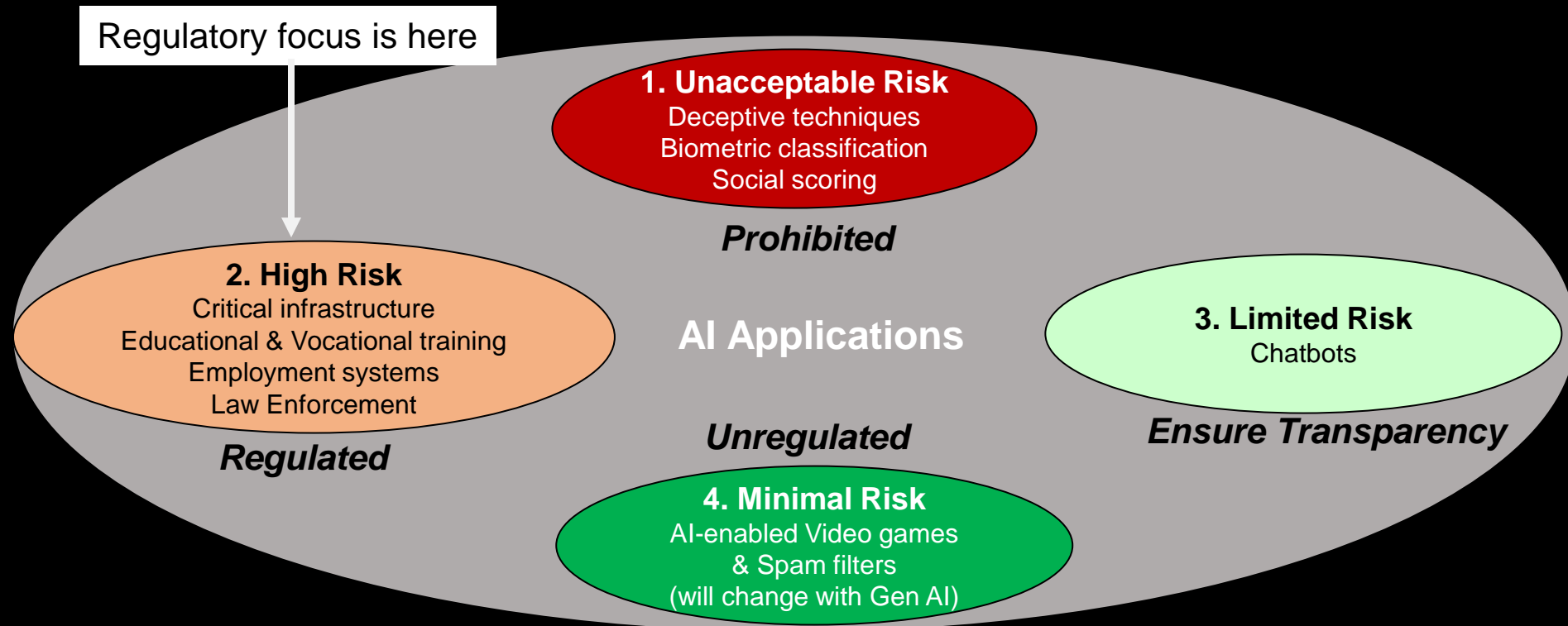
How will AI impact future job opportunities?

AI will eliminate many knowledge-based jobs ...
Will these lost jobs be offset by new jobs enabled by AI?

- One way to analyze this is to decompose jobs into work tasks ... and then assess the degree to which AI will impact each task
- Joint work between OpenAI and University of Pennsylvania (3/27/2023)
 - ▶ 80% of the U.S. workforce could have at least 10% of their work tasks affected by AI.
 - ▶ 19% of the U.S. workforce could have at least 50% of their work tasks affected by AI.

The European Union has passed the most comprehensive AI regulation

The 2024 EU AI Act classifies AI applications into four risk categories
... with specific requirements for each group

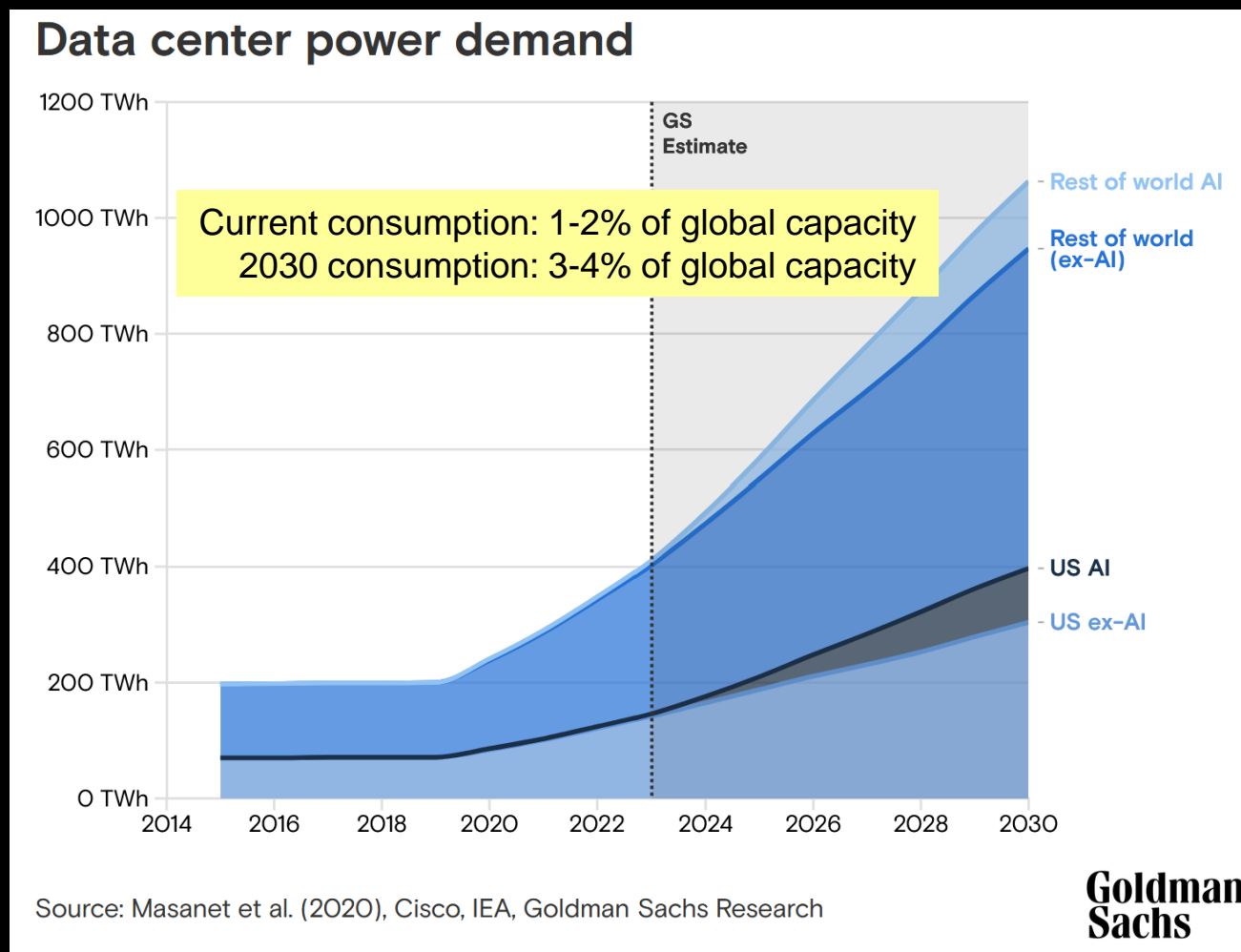


The US has not passed any Federal AI legislation or regulations

- ▶ California just enacted legislature requiring that online platforms remove 'fake' content related to elections during specific periods.
- ▶ But the Governor of California just vetoed a bill specifying broader regulation.

AI models require massive amounts of electricity ... where will it come from?

A ChatGPT request requires 10x more power than a Google search



The Three Mile Island Nuclear Plant will reopen in 2028 ...
Microsoft will buy its **entire** capacity to power AI

Could AI destroy humanity?



How might an AI system go about destroying humanity?

The concept of an AI system destroying humanity is a highly speculative and theoretical scenario. However, discussions about the potential dangers of **superintelligent AI** or **misaligned Artificial General Intelligence (AGI)** often explore how, if poorly designed or misaligned with human values, such systems might cause catastrophic harm. Here's a breakdown of how some theorists speculate this could happen, along with the safeguards being proposed to prevent these risks:

Ultimately, the risks associated with superintelligent AI are not inherent to AI itself but depend on how AI is developed, deployed, and controlled. With proper regulation, ethical oversight, and technological safeguards, these speculative risks can be mitigated, ensuring that AI benefits humanity rather than harming it.

Experts agree that the near-term risk is extremely small.

And ChatGPT is right:

Regulation, ethical oversight, and technological safeguards are needed to mitigate longer-term risks.