

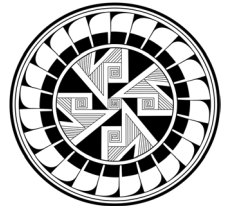
AI (R)evolution

How did we get here & where are we going?

Legislative Finance Committee Meeting
UNM Campus, Albuquerque, NM

Melanie Moses
UNM Professor of Computer Science
External Faculty, Santa Fe Institute
<https://moseslab.cs.unm.edu/>

September 17, 2024



What are some ways that AI can spur economic growth in New Mexico?



AI can spur economic growth in New Mexico in several key ways:

1. Boosting Key Industries

- **Energy:** AI can optimize the extraction and production of natural resources like oil and gas. It can help in predictive maintenance, improve safety, and enhance efficiency in renewable energy projects, especially solar and wind.
- **Agriculture:** AI can optimize crop yields by using data analytics for weather forecasting, soil analysis, and water management, making farming more efficient and sustainable in New Mexico's arid regions.
- **Tourism:** AI-powered tools can personalize visitor experiences, recommend activities, and manage resources for sustainable tourism, which is an important industry in New Mexico.

2. Supporting Small Businesses

- AI can help small businesses in New Mexico streamline operations, reduce costs, and improve customer service through tools like chatbots, inventory management systems, and predictive analytics for market trends.

3. Improving Workforce Development

- AI-based educational platforms can provide personalized learning experiences, helping to upskill and reskill workers, particularly in tech and energy sectors. This can create a more competitive and skilled workforce.

4. Advancing Research and Innovation

- New Mexico is home to research institutions like Sandia National Laboratories and Los Alamos National Laboratory. AI can accelerate research in fields like materials science, climate modeling, and quantum computing, attracting investment and high-paying jobs.

...and many more from tourism to public safety to fire management

ChatGPT 4o

how many times does the letter "r" appear in strawberry

ChatGPT 4o

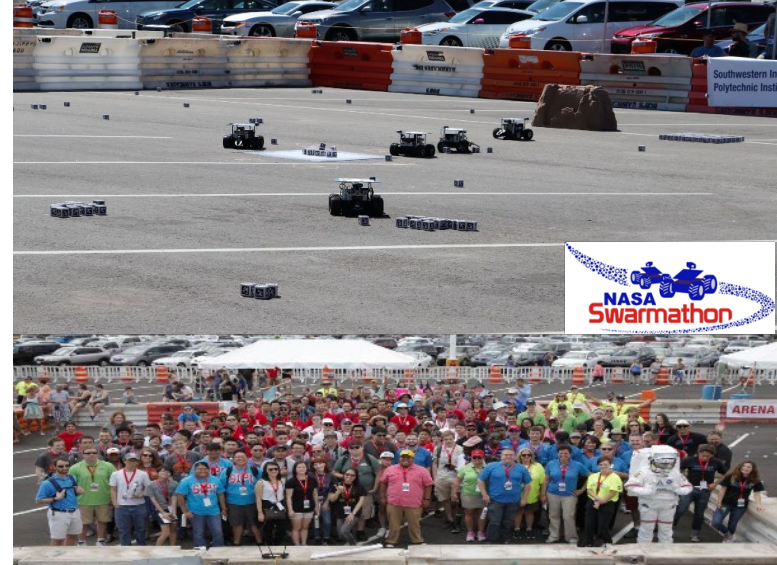
how many times does the letter "r" appear in strawberry



The letter "r" appears 2 times in the word "strawberry."

My evolving thoughts on AI

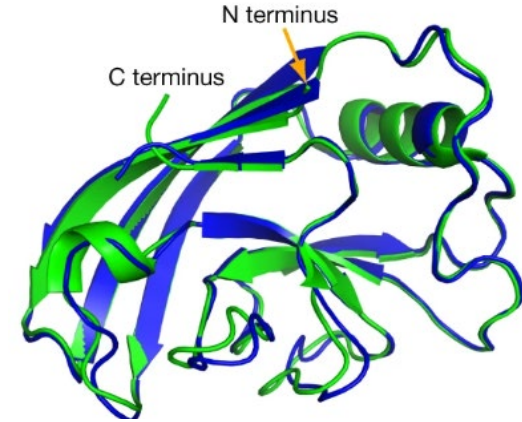
- I began studying AI as an undergrad 35 years ago.
- PhD in Biology from UNM in 2005
- Now I build bio-inspired robotics and model complex adaptive systems
- I think of AI as a complex adaptive system that we are integrating into our complex socio-technical system



Iceland, near Grindavik

My evolving thoughts on AI

- AI is exciting and scary!
 - AI will help solve scientific problems
 - Current AI encodes biases, promotes surveillance & concentrates power
 - AI codes even better than it writes
 - How will humans co-evolve with AI?



Highly accurate protein structure prediction with AlphaFold, *Nature* 2021

AI-assisted science is potentially revolutionary!
Biomedicine: Antibiotics, therapeutics, diagnoses, vaccines ...

Clean energy: materials for batteries, biodegradable plastics, smart grids, fusion(!?)

Business: logistics, supply chain management, boosting creativity

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Finance worker pays out \$25 million after video call with deepfake 'chief financial officer'



By Heather Chen and Kathleen Magramo, CNN

2 minute read · Published 2:31 AM EST, Sun February 4, 2024



<https://www.cnn.com/2024/02/04/asia/deepfake-cfo-scam-hong-kong-intl-hnk/index.html>



George R.R. Martin and other authors sue OpenAI for copyright infringement

<https://www.theverge.com/2023/9/20/23882140/george-r-r-martin-lawsuit-openai-copyright-infringement>

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www.dailymaverick.co.za/article/2021-04-16-this-weekend-were-watching-coded-bias/

<https://www.codedbias.com/>

States' Automated Systems Are Trapping Citizens in Bureaucratic Nightmares With Their Lives on the Line



The New York Times

Wrongfully Accused by an Algorithm

In what may be the first known case of its kind, a faulty facial recognition match led to a Michigan man's arrest for a crime he did not commit.


```
python Copy code

import numpy as np
import matplotlib.pyplot as plt

def logistic_map(r, x):
    return r * x * (1 - x)

def plot_logistic_map():
    r = np.linspace(2.5, 4.0, 10000) # Values of r
    x = 1e-5 * np.ones_like(r) # Initial condition for x

    iterations = 1000
    last = 100 # We'll only display the last few iterations to see the steady state

    for i in range(iterations):
        x = logistic_map(r, x)
        # Only display the bifurcation diagram for the last few iterations
        if i >= (iterations - last):
            plt.plot(r, x, 'k', alpha=0.25)

    plt.xlim(2.5, 4)
    plt.ylim(-0.1, 1.1)
    plt.xlabel('r')
    plt.ylabel('x')
    plt.title('Bifurcation diagram of the logistic map')
    plt.show()

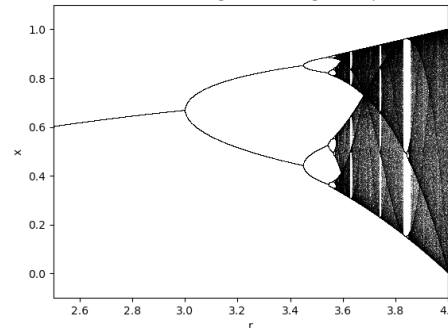
plot_logistic_map()
```

How it started
Yikes! ChatGPT
Can do my
students'
homework!

My evolving thoughts on AI

- AI is exciting and scary!
 - AI will help solve scientific problems
 - Current AI encodes biases, promotes surveillance & concentrates power
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Bifurcation diagram of the logistic map



How it's going
Students: Use
ChatGPT to do
your homework!

My evolving thoughts on AI

- AI is exciting and scary!
 - AI will help solve scientific problems
 - Current AI encodes biases, promotes surveillance & concentrates power
 - AI codes even better than it writes
 - **How will humans co-evolve with AI?**



Generate DALL-E prompts ...

GPT4: A market scene in 2150 where humans buy tech enhancements for their bodies, while robots buy organic parts to feel more human.

How does AI work? Traditional algorithms vs. AI

Traditional algorithms vs. AI

Traditional computer programs are like recipes: step by step instructions to achieve a specified outcome.

A simple cake recipe

1. Preheat oven to 350 degrees F
2. Mix 2 cups sugar and 4 sticks butter
3. Add 8 eggs
4. Mix in 3 cups flour

...

Bake in greased pan for 50 minutes



How does AI work? Traditional algorithms vs. AI

Traditional computer programs are like recipes: step by step instructions to achieve a specified outcome.

Traditional algorithms can fail, but we usually understand why

Generative AI is different: we usually can't explain its predictions or its mistakes

A simple cake recipe

1. Preheat oven to 350 degrees F
2. Mix 2 cups sugar and 4 sticks butter
3. Add 8 eggs
4. Mix in 3 cups flour

...

Bake in greased pan for 50 minutes



Unless you are at
7000 feet

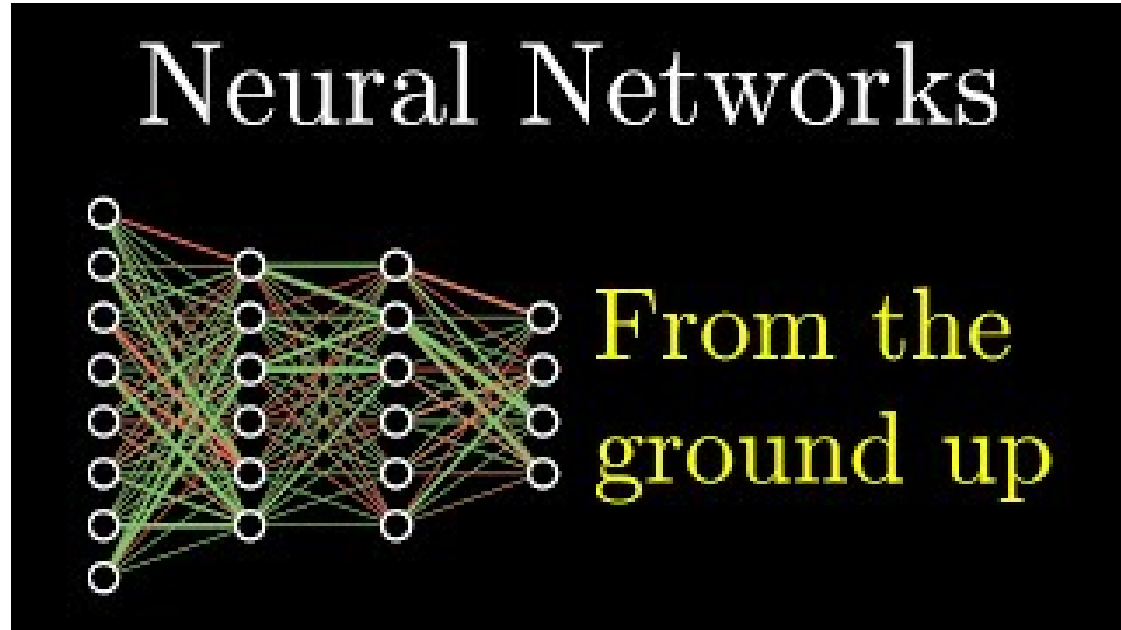
Context matters!

How does generative AI work?

Large Language Models (LLM, like ChatGPT) use neural networks to find patterns & correlations in data.

Patterns are used to make predictions.

Neural networks are pattern matching machines

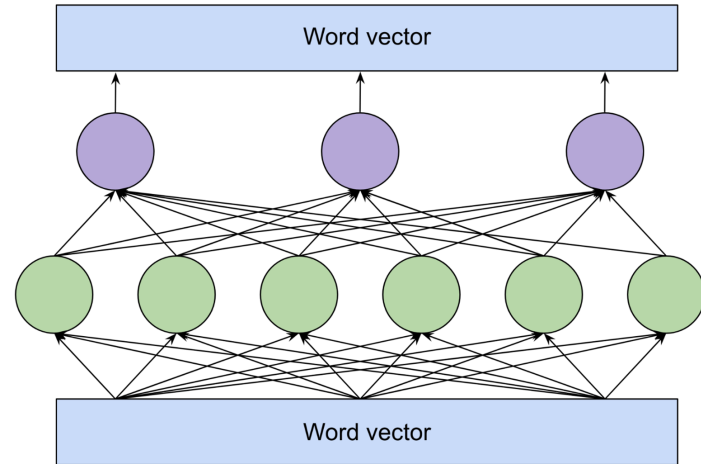


LLMs learn by predicting what word comes next

Roses are red, violets are xxx

Cherries are red, grapes are xxx

Green means go, red means
yvv

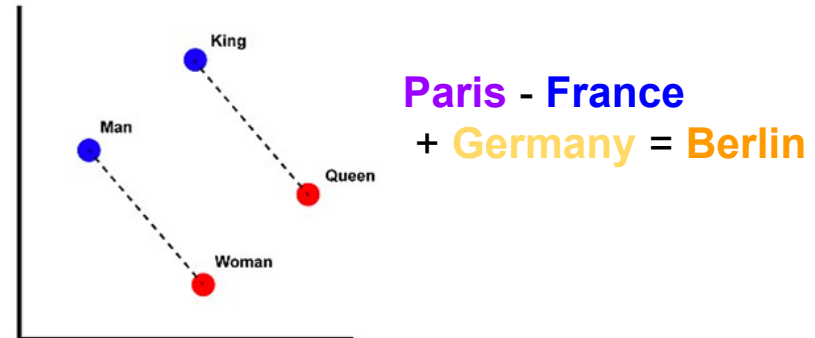
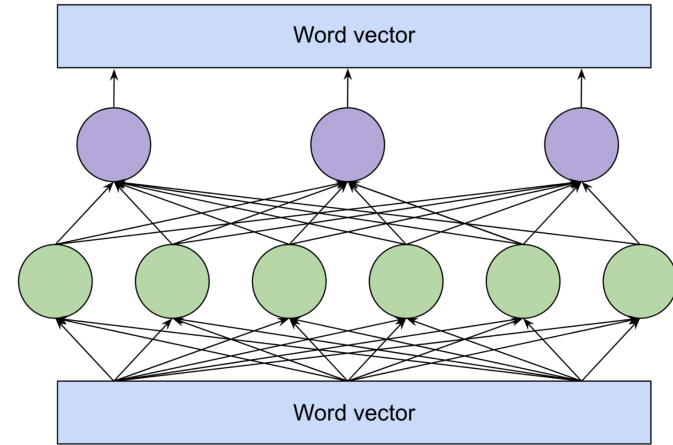


How does generative AI work?

Billions of nodes trained on billions of texts predict what word is likely to come next

Each word is a vector with 1000's of numbers, grouped by similarity

Neural networks are pattern matching machines



This is tricky!

GPT = Generative Predictive Transformer

Transformers: “attention mechanisms” disambiguate multiple possible meanings, for example of **BANK**

LLMs can give wrong but plausible guesses

It is particularly difficult to recognize plausible falsehoods (BS!)



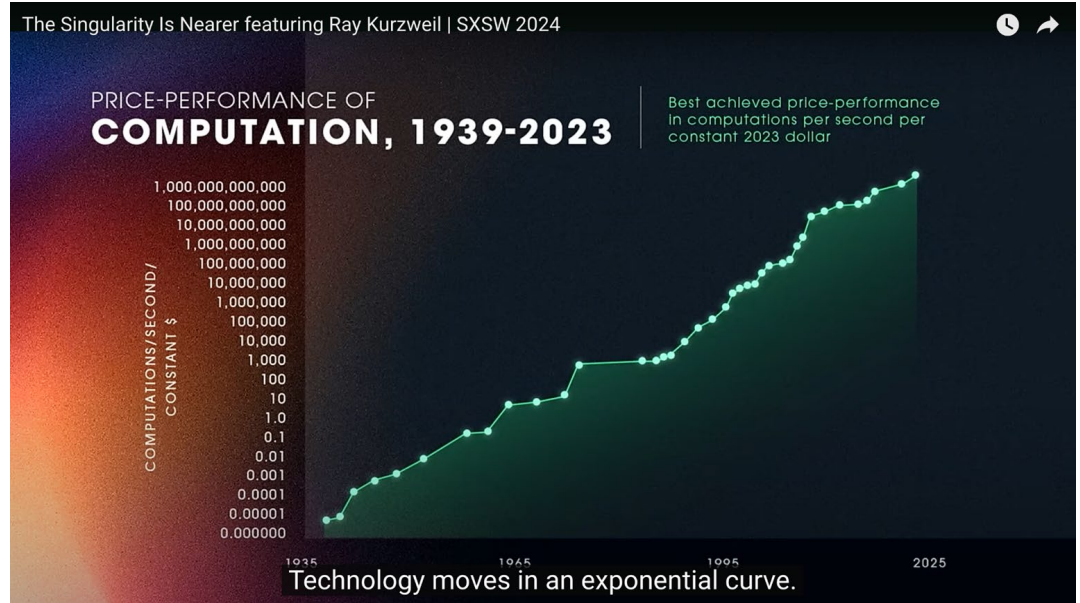
Is scale all you need?

Computing today is
a Trillion times more cost efficient
than it was 35 years ago.

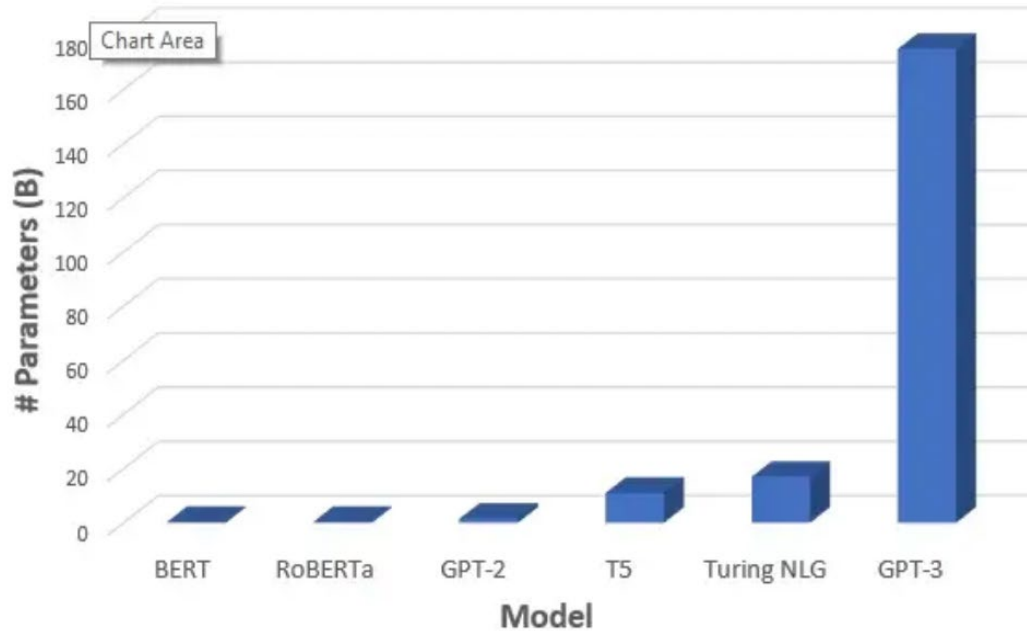
And a Trillion Trillion times more cost
efficient than 35 years before that.



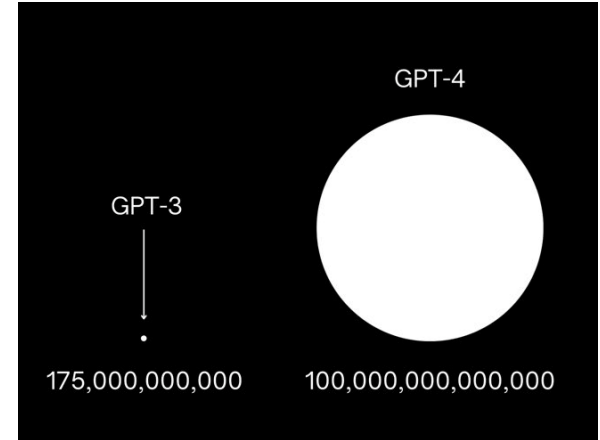
- More transistors
- Faster computation
- More efficiency
- More memory
- More data
- Faster algorithms
- Bigger data centers
- Faster innovation



Is scale all you need?



300 billion trillion calculations to train GPT-3 on 500 billion words.



GPT-4 still makes up answers!

It's been 18 months and GPT-5 is not here yet

Scale is what big tech companies have!



<https://medium.com/@johnadjanohoun/microsoft-and-openai-to-forge-100-billion-supercomputer-for-ais-next-leap-2d5bbcf189f6>

A LinkedIn post from the account 'ombrulla.com'. The post features a background image of a city at night with a blue map of Saudi Arabia overlaid. The map has a white atomic symbol with 'AI' in the center. Text on the post reads: "Saudi Arabia plans \$40 billion investment in AI". Below the image is a blue button that says "Visit >".

ombrulla.com

Saudi Arabia plans
\$40 billion
investment in AI

Saudi Arabia Goes Big on AI: A \$40 Billion Investment [Visit >](#)

<https://www.linkedin.com/pulse/saudi-arabia-goes-big-ai-40-billion-investment-ombrulla-d3eic>



Max Tegmark ✓
@tegmark

You know that AI is taking off when...Microsoft plans to power data centers with nuclear reactors:

[jobs.careers.microsoft.com/global/en/job/...](https://jobs.careers.microsoft.com/global/en/job/)

We are building Trustworthy AI for Science & Society

New Mexico AI Consortium (NMAIC):
UNM, Los Alamos & Sandia National Labs,
NMSU, NMTech, CNM & industry partners
are

- Building trustworthy AI
- Training the AI workforce in New Mexico

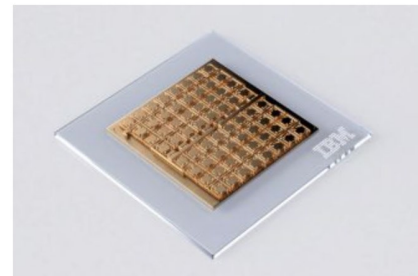
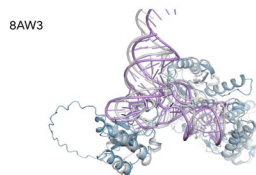
A New Precedent—A.I. Gets the "American Nobel" Prize in Medicine

AlphaFold was the first A.I. to receive the Lasker Award since these began in 1945

ERIC TOPOL

OCT 1, 2023

AlphaFold Server: A free and easy-to-use research tool

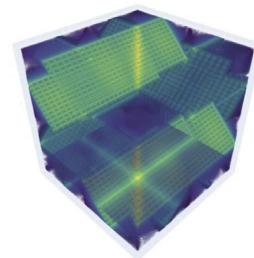


IBM Research unveils breakthrough analog AI chip for efficient deep learning

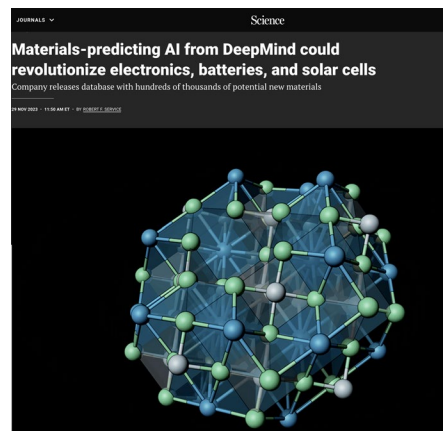
SEPTEMBER 26, 2022

Artificial intelligence reduces a 100,000-equation quantum physics problem to only four equations

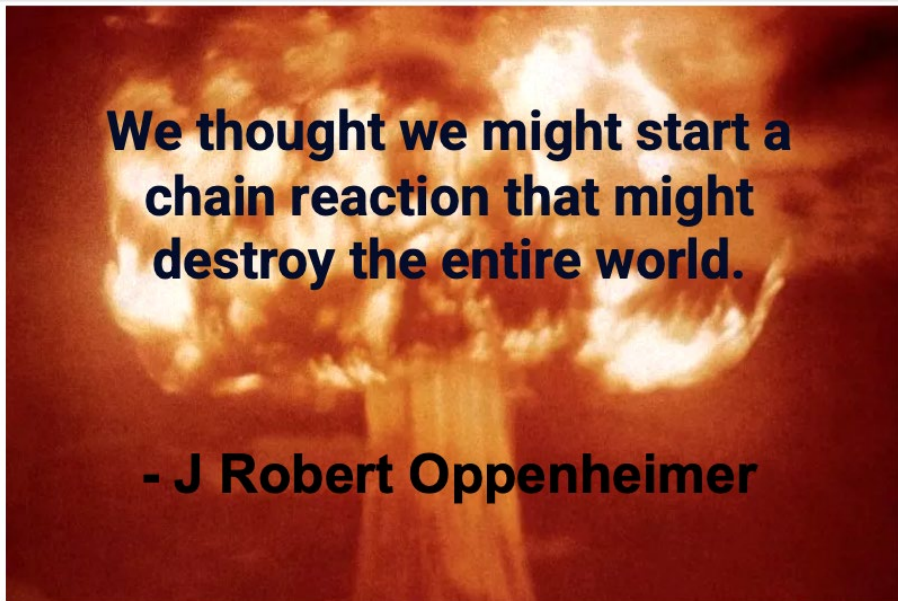
by Thomas Sumner, Simons Foundation



A visualization of a mathematical apparatus used to capture the physics and behavior of electrons movi...



Our AI future



Atomic bomb Trinity test.

UNIVERSAL HISTORY ARCHIVE/UIG VIA GETTY IMAGES



A truly intelligent AI would

- Augment human strengths & mitigate human weaknesses
- Empower us to think more broadly & deeply and from multiple perspectives
- Help us to leverage our collective human intelligence & extraordinary ability to communicate & collaborate to solve pressing problems

LLMs and Generative AI have not yet met this goal,
but they hint that truly intelligent AI is possible



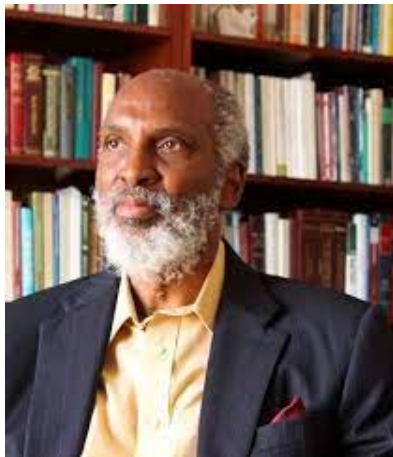
Image by ChatGPT of AI helping humans to solve global problems



Kennedy told America that we ALL had to contribute for America to reach the moon

**AI is trained on data from
(almost) all of humanity**

**All of humanity needs to be engaged
to shape the future of AI**



John Powell
UC Berkeley Law

Write a haiku about the promise of AI

Silent mind, awake,
AI's promise, boundless skies,
Humanity's guide.

Resources

How AI works

<https://arstechnica.com/science/2023/07/a-jargon-free-explanation-of-how-ai-large-language-models-work/>

Politico: legislation for transparency and audits

<https://www.politico.com/news/magazine/2024/04/30/ai-legislation-states-mistake-00155006>

Complexity & AI

<https://www.newamerica.org/planetary-politics/policy-papers/how-complexity-thinking-can-help-the-world-navigate-ai/>

Moses & Gipson Rankin article on Trustworthy AI in Medicine

<https://www.nature.com/articles/s44287-024-00049-2>

AI and Algorithmic Justice Resources @UNM & SFI

<https://airesources.unm.edu/students.html>

<https://algorithmicjustice.cs.unm.edu/index.html>

<https://www.santafe.edu/research/projects/algorithmic-justice>

melaniem@unm.edu <https://moseslab.cs.unm.edu>

