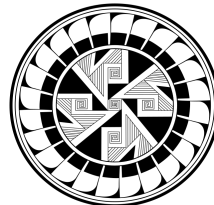


Artificial Intelligence: Challenges, Opportunities & Solutions

STTC Meeting
UNM, Albuquerque, NM

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

September 30, 2024



what are some scientific advances that AI has recently achieved

AI has driven significant scientific advances in various fields recently. Here are some notable examples:

1. Drug Discovery and Development

- **AI-generated drugs:** AI has accelerated the discovery of new drugs. For example, in 2023, the first fully AI-designed drug, **INS018_055** (for lung fibrosis), entered human trials.
- **Protein folding:** AI systems like DeepMind's **AlphaFold** have solved the structure of nearly every known protein, providing crucial insights into diseases and treatments.

2. Climate Science and Environmental Research

- **Climate modeling:** AI is used to improve climate models, making predictions about global warming, weather patterns, and natural disasters more accurate.
- **Carbon capture and energy efficiency:** AI helps optimize methods for capturing carbon and finding alternative clean energy sources, which are crucial for combating climate change.

3. Healthcare Diagnostics

- **Medical imaging:** AI systems have achieved high accuracy in analyzing medical scans (e.g., X-rays, MRIs) to detect diseases like cancer, often outperforming human experts.
- **Early disease detection:** AI is used for predicting the onset of diseases like Alzheimer's and diabetes by analyzing patient data, potentially enabling earlier interventions.

4. Quantum Computing and Simulations

- **Material science:** AI has helped simulate quantum materials, enabling the discovery of new materials with applications in energy storage, computing, and beyond.
- **Quantum AI:** AI is being used to design and optimize quantum algorithms, pushing the boundaries of computing.

ChatGPT 4o

There are 2 "r's" in the word "cranberry."

Are you sure?

Yes, I'm sure! The word "cranberry" has 2 "r's"—one after the "c" (in "cran") and another near the end (in "berry").

how many r's are in the word berry



There are two "r's" in the word "berry."

There are 3 r's in strawberry.



Actually, there are **2** "r"s in the word "strawberry." Here's why:

- The word is spelled "s-t-r-a-w-b-e-r-r-y."
- The two "r"s are in the 7th and 9th positions, as mentioned before.

If you were counting a different letter or seeing it differently, let me know and I can clarify further!

My evolving thoughts on AI

- I began studying AI as 35 years ago. It has changed dramatically.
- I build bio-inspired robotics and model complex adaptive systems
- AI is a complex system that we are integrating into our complex society

We do not understand how AI or society will adapt



Iceland, near Grindavik

1. Generative AI is unpredictable
2. AI Challenges
 - Bias & Misinformation
 - Copyright & Creative jobs
 - Surveillance
 - Medical & Legal ethics
3. Scale
4. AI Opportunities
 - Science & Medicine
 - Energy & Climate
 - Economics
5. AI Solutions
 - Policy: Transparency is Step 1
 - NM AI Consortium
 - New Mexicans can shape our AI future



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.

1. How does AI work? Traditional algorithms vs. AI

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

Large Language Models
(LLMs, like ChatGPT)
do not work this way

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



LLMs learn by predicting what word comes next

Neural networks are pattern matching machines

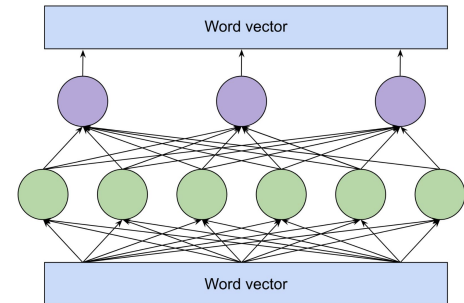
LLMs use neural networks with billions of nodes to find patterns & correlations in data.

They read online text and train the network by predicting what word comes next.

They mimic patterns in language.

They appear to be intelligent b/c they have learned MANY patterns.

We can't explain LLM predictions, mistakes or lies



2. Challenge: Bias



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

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



<https://www.nytimes.com/2020/06/24/technology/facial-recognition-arrest.html>

Challenge: Misinformation & Deep Fakes



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

Forbes

Sen. Ben Cardin Reportedly Targeted By Deepfake Video Caller Posing As Ukrainian Official

<https://www.forbes.com/sites/siladityaray/2024/09/26/sen-ben-cardin-reportedly-targeted-by-deepfake-video-caller-posing-as-ukrainian-official/>



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

Challenge: Copyright Infringement & the creative economy

The Times Sues OpenAI and Microsoft Over A.I. Use of Copyrighted Work

Millions of articles from The New York Times were used to train chatbots that now compete with it, the lawsuit said.

<https://www.nytimes.com/2023/12/27/business/media/new-york-times-open-ai-microsoft-lawsuit.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>

The
Economist

How AI is transforming the creative industries

Artificial intelligence is more likely to emerge as collaborator than competitor for workers in the creative industries

<https://www.economist.com/films/2021/04/07/how-ai-is-transforming-the-creative-industries?>

FORTUNE

AI could kill creative jobs that 'shouldn't have been there in the first place,' OpenAI's CTO says <https://finance.yahoo.com/news/ai-could-kill-creative-jobs-191831144.html>

100% of my students say that AI steals creative work and uses it to take creatives' jobs

Challenge: Medical Ethics

The New York Times

That Message From Your Doctor? It May Have Been Drafted by A.I.

Overwhelmed by queries, physicians are turning to artificial intelligence to correspond with patients. Many have no clue that the replies are software-generated.

<https://www.nytimes.com/2024/09/24/health/ai-patient-messages-mychart.html>

Challenge: Medical Ethics

nature reviews electrical engineering

Medical artificial intelligence should do no harm

Melanie E. Moses & Sonia M. Gipson Rankin

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

AI can improve health and save lives, if it is trustworthy & fair.

- Black and Hispanic people are 73% and 49% more likely to distrust health professionals than non-Hispanic white people

LLMs can & do replicate past biases

- Technology can provide a veneer of objectivity while reinforcing racist assumptions and attitudes

Diversify data that train medical AI

- Populations not represented in data will not be represented in cures

Challenge: Legal Ethics: AI in Consequential decision-making

AI is used in the public & private sectors for consequential decisions:

- **Employment** (automated hiring)
- **Health care, education, social services, fraud detection**
- **Housing**: credit, lending, tenant screening, public housing waiting lists
- **Criminal justice**: pretrial, sentencing, parole, predictive policing

Pros: evidence-based, objective, accurate, avoids stereotypes (in theory)

Cons: based on historical data, treat people as statistics, black boxes

Consequential decision-making algorithms must be transparent to citizens and governments

Challenge: Surveillance & threats to privacy

BUSINESS INSIDER

Billionaire Larry Ellison says a vast AI-fueled surveillance system can ensure 'citizens will be on their best behavior'

[Kenneth Niemeier](https://www.businessinsider.com/larry-ellison-ai-surveillance-keep-citizens-on-their-best-behavior-2024-9) Sep 15, 2024, 10:06 AM MDT <https://www.businessinsider.com/larry-ellison-ai-surveillance-keep-citizens-on-their-best-behavior-2024-9>

AI emotion-detection software tested on Uyghurs



25 May 2021

Jane Wakefield
Technology reporter

<https://www.bbc.com/news/technology-57101248>

AI enabling Iran's crackdown on women as authoritarian regime uses tech to enforce head covering



<https://www.foxnews.com/world/ai-enabling-irans-crackdown-on-women-authoritarian-regime-uses-tech-enforce-head-covering>



Palantir soars 14% on software vendor's inclusion in S&P 500

PUBLISHED MON, SEP 9 2024 2:36 PM EDT | UPDATED MON, SEP 9 2024 4:05 PM EDT

<https://www.cnbc.com/2024/09/09/palantir-soars-13percent-on-software-vendors-inclusion-in-sp-500.html>

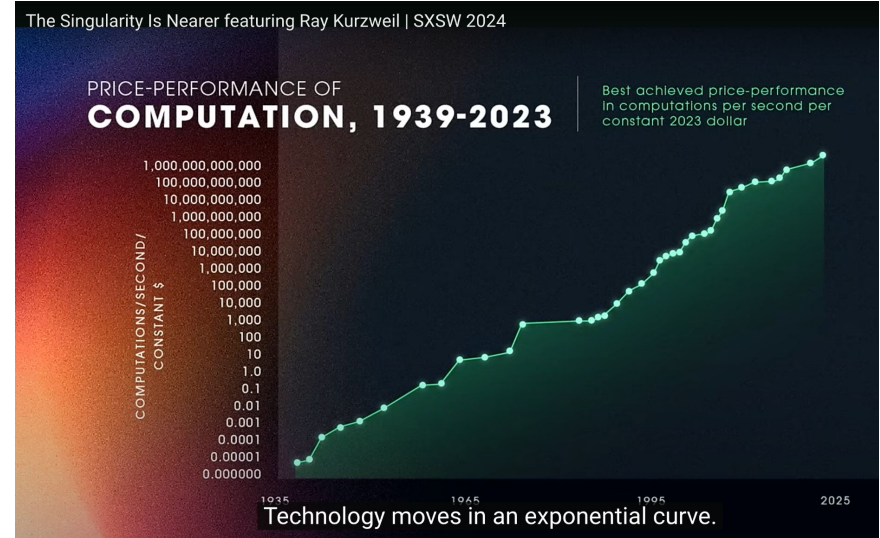
3 Scale is a Challenge & an Opportunity

Computation has already changed the world

Computing today is 1 Trillion times more cost efficient than 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

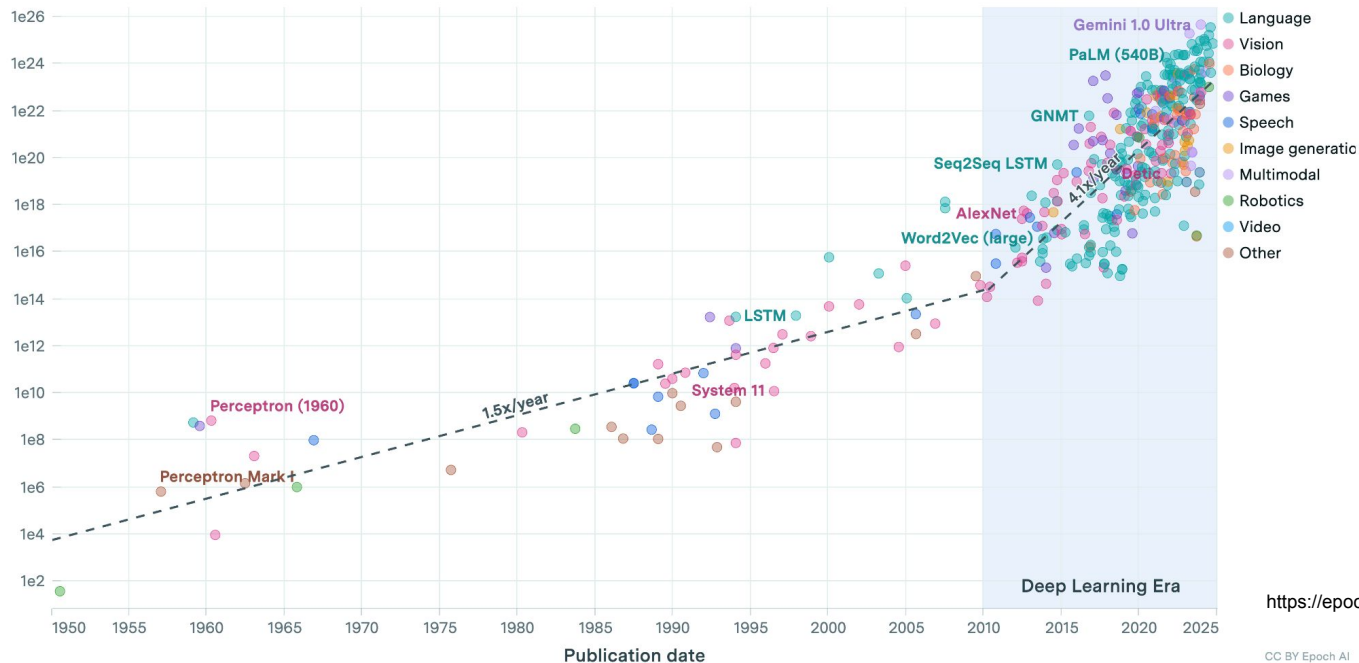


Scale is a Challenge & an Opportunity

Notable AI Models

EPOCH AI

Training compute (FLOP)



Power to train the largest AI models has increased 20,000-fold in 10 years

Scale is a Challenge & an Opportunity

Microsoft rents Three Mile Island to power data centers



<https://wng.org/sift/microsoft-rents-three-mile-island-to-power-data-centers-1727127607>

The
Economist

The breakthrough AI needs

A race is on to push artificial intelligence beyond today's limits

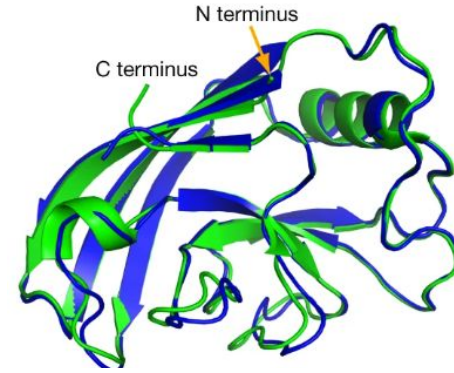
 PRINCETON UNIVERSITY

PRINCETON

Using AI to wrangle fusion energy

<https://engineering.princeton.edu/news/2024/05/10/using-ai-wrangle-fusion-energy>

4. Opportunities in Science

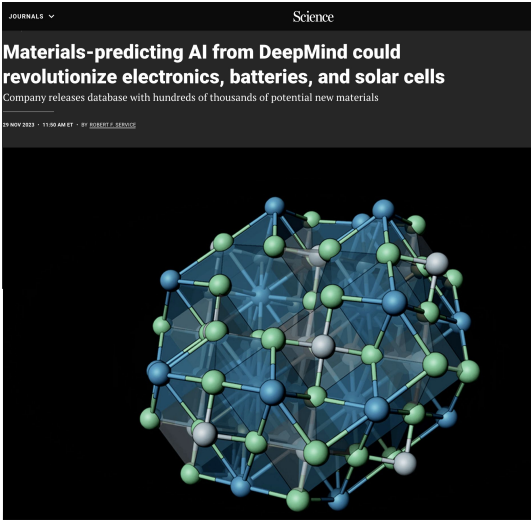


Highly accurate protein structure prediction with AlphaFold, *Nature* 2021

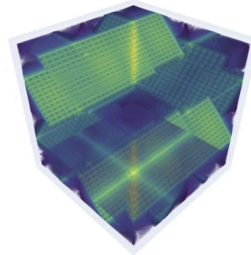
A New Precedent—A.I. Gets the "American Nobel" Prize in Medicine

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

ERIC TOPOL
OCT 1, 2023



SEPTEMBER 26, 2022
Artificial intelligence reduces a 100,000-equation quantum physics problem to only four equations
by Thomas Summer, Simons Foundation



A visualization of a mathematical apparatus used to capture the physics and behavior of electrons moving through a material.

COMMUNICATIONS
OF THE
ACM

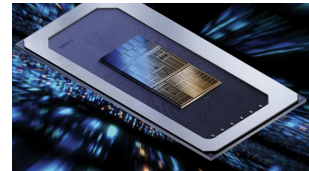
Architecture and Hardware

AI Reinvents Chip Design

Chipmakers are turning to artificial intelligence to improve conceptual design, transistor models, simulations and analysis, verification and testing, and more.

By Samuel Greengard
Posted Aug 22 2024

<https://cacm.acm.org/news/ai-reinvents-chip-design/>



Economic Opportunities

Medium

Generative AI in Supply Chain Management: A Catalyst for Efficiency and Sustainability

Unlocking smarter operations and greener practices through innovative AI solutions in supply chain management.



Albert Peter · Follow

Published in AI Logic · 14 min read · 2 days ago



Intel awarded up to \$8.5 billion in CHIPS Act grants, with billions more in loans available

PUBLISHED WED, MAR 20 2024-5:00 AM EDT | UPDATED WED, MAR 20 2024-4:32 PM EDT



Kif Leswing
@KIFLESWING

SHARE

<https://medium.com/ailogic/generative-ai-in-supply-chain-management-a-catalyst-for-efficiency-and-sustainability-1ca0bc504b37>



Generative AI could raise global GDP by 7%

Two thirds of occupations could be partially automated by AI

<https://www.goldmansachs.com/insights/articles/generative-ai-could-raise-global-gdp-by-7-percent>

5 Solutions: Policy

AI can help inform consequential decisions *if...*

People affected by them understand what data about them is used and what the AI does with this data

Decision makers advised by them understand what they mean and what mistakes they can make

Policymakers understand their strengths and weaknesses

They are regularly and independently assessed for accuracy and fairness, rather than relying on vendor's claims

All this requires transparency!

Solutions: Policy

Types of Transparency

“Where constitutional rights are involved, transparency is paramount.”

— Computing Community Consortium

Simple notice: Alert consumers or applicants that an AI is being used

Applicant Challenges: Allow applicants to see their data and correct it (e.g. FCRA)

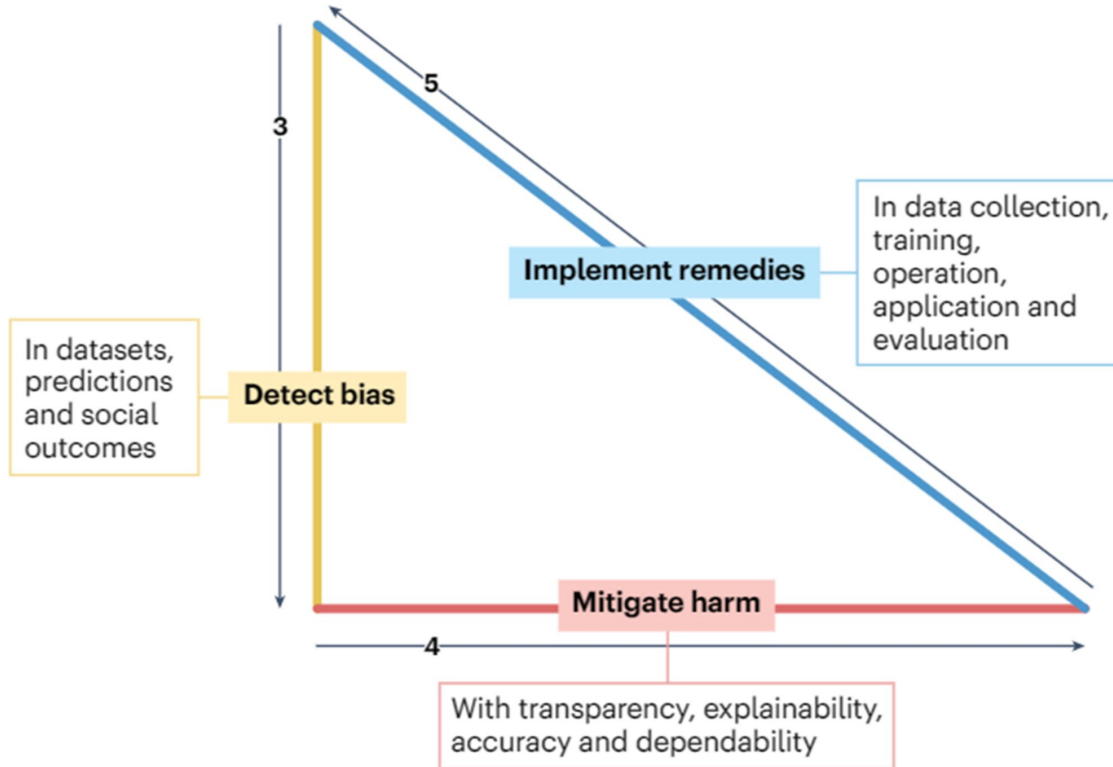
Self-assessment: Require AI developers to assess their own product for bias, and perform due diligence to avoid it (like an impact statement)

Local studies: Require AI deployers to periodically test the AI for accuracy and bias on local data to make sure it works well for local populations

Independent assessments: Independent third parties (e.g. ISR at UNM)

Full transparency: Public disclosure of design and methods, sources of data, and how the AI uses that data to produce its output

Transparency is only Step 1



Transparency is key to detect bias, mitigate harm & implement/test remedies

Moses, M.E., Gipson Rankin, S.M., *Medical artificial intelligence should do no harm*. NAT REV ELECTR ENG (2024).

Transparency is only Step 1

Procedural Due Process

U.S. CONST. amend. XIV, § 1

N.M. CONST. art. II, § 14

Substantive Due Process

U.S. CONST. amend. IX, § 1

U.S. CONST. amend. XIV, § 1

N.M. CONST. art. II, § 18

Equal Protection

U.S. CONST. amend. XIV, § 1

N.M. CONST. art. II, § 18

Solutions: NMAIC: Building Trustworthy AI for New Mexico



New Mexico AI Consortium (NMAIC) inaugural members

- Universities & Colleges: UNM, NMSU, NM Tech, CNM
- National Labs: Sandia, Los Alamos, New Mexico Consortium

NMAIC will establish New Mexico as a leader in Trustworthy AI

- **Research** in AI for Science and Society
 - materials design, battery design, green energy production & transmission, medicine, ecology, social science, quantum, government accountability, accessible, distributed & democratized access to AI
- **AI Workforce development & Education**
 - AI internship opportunities: LANL, Sandia, industry partners
 - Joint AI course development
 - Graduate & undergraduate AI training in CS, engineering, natural & social science, & law
 - CNM pipelines to universities & tech programs for next gen computing & manufacturing
- **Infrastructure:** High performance computers for research, education & commercialization
- **Funding:** NMAIC is pursuing Federal funding; UNM & NMSU have submitted legislative funding requests to catalyze this work

A truly intelligent AI would

- Augment human strengths & mitigate human weaknesses
- Empower us to think more broadly, deeply & 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 recent advances hint that truly intelligent AI is possible

Interdisciplinary research & education are how we reach this goal

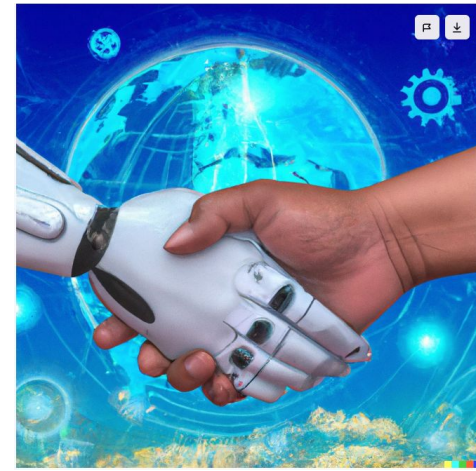
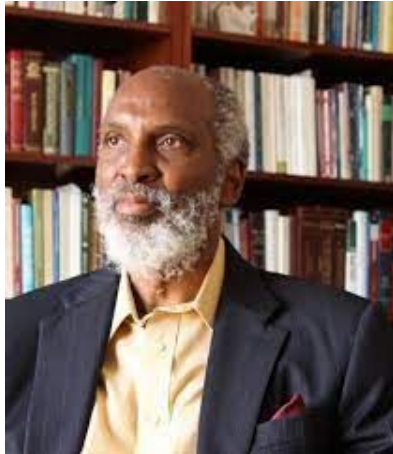


Image by ChatGPT of AI helping humans to solve global problems



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



John Powell
UC Berkeley Law

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

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

New Mexico can & must shape AI to mitigate challenges & seize opportunities through:

- Policy, step by step, adapting to changes
- Research: science, engineering & medicine
- Education & workforce development