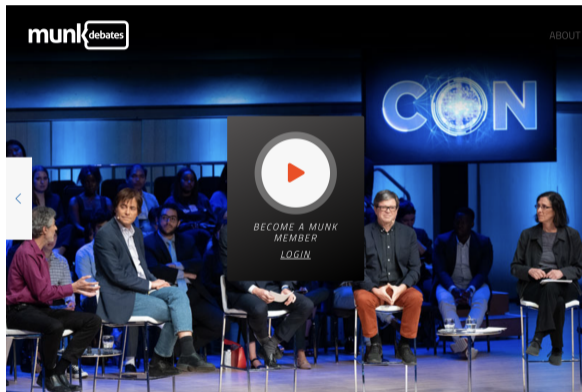


Thinking with Artificial Intelligence: Experiences from Healthcare

BE Chapman, PhD

2023-10-25

Artificial Intelligence and Existential Threats



ABOUT DEBATES DIALOGUES PODCAST FRIDAY FOCUS MEMBERSHIP

JUNE 22, 2023

Artificial Intelligence

Be it resolved, AI research and development poses an existential threat.

Scroll down for details on viewing the Munk Debate on Artificial Intelligence.

✓ PRO

Yoshua Bengio
Max Tegmark

✗ CON

Yann LeCun
Melanie Mitchell

RESULT

Con wins by a 4%
gain.

EXPLORE



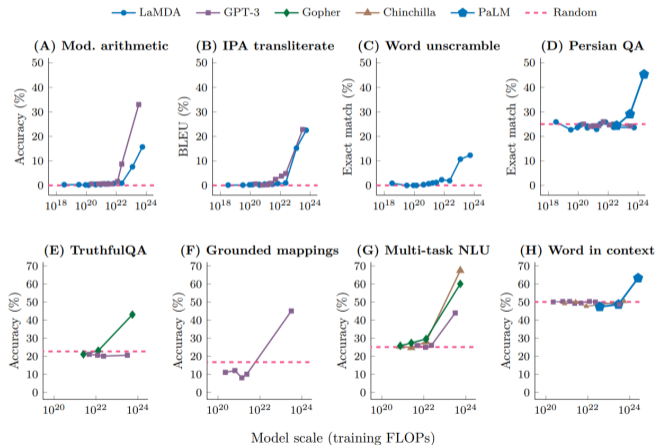
Audio file  Transcript

What I was taught by Al Pryor

“Artificial intelligence is mostly artificial and not very intelligent.”



We are in a data-driven, computationally intensive AI era



Industries threatened by AI and LLMs (Felten, Raj, and Seamans 2023)

Table 2: Top 20 Industries Exposed to AI, Original and with Language Modeling Adjustment

Rank	Top 20 Industries from Original AIOE	Top 20 Industries after Language Modeling Adjustment
1	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	Legal Services
2	Accounting, Tax Preparation, Bookkeeping, and Payroll Services	Securities, Commodity Contracts, and Other Financial Investments and Related Activities
3	Insurance and Employee Benefit Funds	Agencies, Brokerages, and Other Insurance Related Activities
4	Legal Services	Insurance and Employee Benefit Funds
5	Agencies, Brokerages, and Other Insurance Related Activities	Nondepository Credit Intermediation
6	Nondepository Credit Intermediation	Agents and Managers for Artists, Athletes, Entertainers, and Other Public Figures
7	Other Investment Pools and Funds	Insurance Carriers
8	Insurance Carriers	Other Investment Pools and Funds
9	Software Publishers	Accounting, Tax Preparation, Bookkeeping, and Payroll Services
10	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	Business Support Services
11	Agents and Managers for Artists, Athletes, Entertainers, and Other Public Figures	Software Publishers
12	Credit Intermediation and Related Activities (5221 And 5223 only)	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)
13	Computer Systems Design and Related Services	Business Schools and Computer and Management Training
14	Management, Scientific, and Technical Consulting Services	Credit Intermediation and Related Activities (5221 And 5223 only)
15	Monetary Authorities-Central Bank	Grantmaking and Giving Services
16	Office Administrative Services	Travel Arrangement and Reservation Services
17	Other Information Services	Junior Colleges
18	Data Processing, Hosting, and Related Services	Computer Systems Design and Related Services
19	Business Schools and Computer and Management Training	Management, Scientific, and Technical Consulting Services
20	Grantmaking and Giving Services	Other Information Services

Notes: This table lists the top 20 industries most exposed to AI from the original AIOE (Felten et al., 2021) and the top 20 industries most exposed to advances in AI language modeling.

Occupations threatened by AI and LLMs (Felten, Raj, and Seamans 2023)

Table 1: Top 20 Occupations Exposed to AI, Original and with Language Modeling Adjustment

Rank	Top 20 Occupations from Original AIOE	Top 20 Occupations after Language Modeling Adjustment
1	Genetic Counselors	Telemarketers
2	Financial Examiners	English Language and Literature Teachers, Postsecondary
3	Actuaries	Foreign Language and Literature Teachers, Postsecondary
4	Purchasing Agents, Except Wholesale, Retail, and Farm Products	History Teachers, Postsecondary
5	Budget Analysts	Law Teachers, Postsecondary
6	Judges, Magistrate Judges, and Magistrates	Philosophy and Religion Teachers, Postsecondary
7	Procurement Clerks	Sociology Teachers, Postsecondary
8	Accountants and Auditors	Political Science Teachers, Postsecondary
9	Mathematicians	Criminal Justice and Law Enforcement Teachers, Postsecondary
10	Judicial Law Clerks	Sociologists
11	Education Administrators, Postsecondary	Social Work Teachers, Postsecondary
12	Clinical, Counseling, and School Psychologists	Psychology Teachers, Postsecondary
13	Financial Managers	Communications Teachers, Postsecondary
14	Compensation, Benefits, and Job Analysis Specialists	Political Scientists
15	Credit Authorizers, Checkers, and Clerks	Area, Ethnic, and Cultural Studies Teachers, Postsecondary
16	History Teachers, Postsecondary	Arbitrators, Mediators, and Conciliators
17	Geographers	Judges, Magistrate Judges, and Magistrates
18	Epidemiologists	Geography Teachers, Postsecondary
19	Management Analysts	Library Science Teachers, Postsecondary
20	Arbitrators, Mediators, and Conciliators	Clinical, Counseling, and School Psychologists

Notes: This table lists the top 20 occupations most exposed to AI from the original AIOE (Felten et al., 2021) and the top 20 occupations most exposed to advances in AI language modeling.

But AI as a professional threat is not new

- “The most profoundly depressing of all ideas about the future of the human species is the concept of artificial intelligence.” (Lewis Thomas, M.D. New England Journal of Medicine, February 28, 1980 (“Artificial Intelligence” 1980))



Lewis Thomas

What is artificial intelligence?

The field of artificial intelligence (AI) officially started in 1956, launched by a small but now-famous DARPA-sponsored summer conference at Dartmouth College, in Hanover, New Hampshire. . . . From where we stand now, into the start of the new millennium, the Dartmouth conference is memorable for many reasons, including. . . the term ‘artificial intelligence’ was coined there. . . . (Bringsjord and Govindarajulu 2022)

What is AI?

Though the term ‘artificial intelligence’ made its advent at the 1956 conference, certainly the field of AI, operationally defined...was in operation before 1956. (Bringsjord and Govindarajulu 2022)

Precursors of AI: Gottfried Wilhelm Leibniz

When controversies arise, there will be no more need for a disputation between two philosophers than there would be between two accountants [computistas]. It would be enough for them to pick up their pens and sit at their abacuses, and say to each other (perhaps having summoned a mutual friend): ‘Let us calculate.’ (quoted in (Bringsjord and Govindarajulu 2022))



a

^aWikipedia

What is in a name? Herbert Simon

What if instead of “artificial intelligence” we said “complex information processing”?

“What’s in a name? That which we call a rose, by any other word would smell as sweet.” (“Romeo and Juliet”)



a

^aWikipedia

- The term “Artificial Intelligence”...

My thought

- The term “Artificial Intelligence”...
- ...is marketing

What is AI?¹

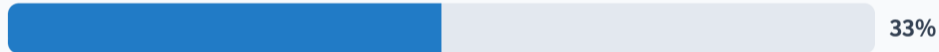
	Human-based	Ideal Rationality
Reasoning-Based	Systems that think like humans.	Systems that think rationally.
Behavior-Based	Systems that act like humans.	Systems that act rationally.

¹(Bringsjord and Govindarajulu 2022)

AI or not AI?

My son becomes interested in learning how to play chess better, and so buys a computer program to play chess against.

AI



33%

Not AI



67%

AI or not AI?

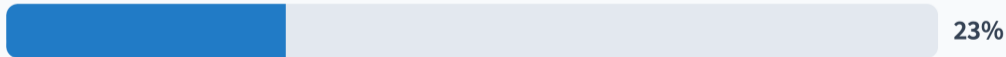
As I type my referral letter, my word processor recognizes my spelling errors, suggests punctuation, and rewording of some of my text for improved clarity.

AI



77%

Not AI



23%

AI or not AI?

As I drive to my oncology appointment, my car automatically maintains my speed to keep a safe distance between my car and keeps me from drifting outside of my lane.

AI

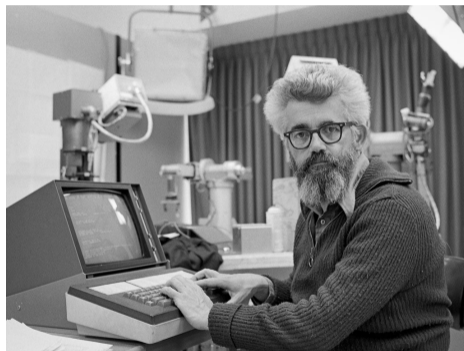


Not AI



AI or not AI?

John McCarthy: “As soon as it works, no one calls it AI anymore.”
(Mitchell 2019)



a

^a[The Independent](#)

What is “Artificial”?

- Created by humans through engineering processes
 - Training pigeons to recognize cancerous cells in histology slides (Fry 2019, 79) would not be artificial
 - Nor would training dogs to recognize GI cancers through smell

What is “Intelligence”?

- Multifaceted and complex cognitive ability that encompasses various mental faculties.
- Capacity to acquire, process, and apply knowledge to:
 - reason, solve problems
 - abstract, conceptualise, comprehend
 - make decisions
 - adapt to new situations
 - learn from experiences

What is “Intelligence”?

- Intelligence can manifest in various forms:
 - logical-mathematical intelligence
 - linguistic intelligence
 - spatial intelligence
 - emotional intelligence

What are brains good for?

What, then, is the role of the biological brain. . . It is expert at recognizing patterns, at perception, and at controlling physical actions, but it is not so well designed. . . for complex planning and long, intricate, derivations of consequences. **It is, to put it bluntly, bad at logic and good at Frisbee.** (Clark 2003)



a

^aThe New Yorker

Human brain exceptionalism

[W]hat is special about human brains, and what best explains the distinctive features of human intelligence, is precisely their ability to enter into deep and complex relationships with nonbiological constructs, props, and aids. This ability, however, does not depend on physical wire-and-implant mergers, so much as on our openness to information-processing mergers. (Clark 2003)

“Information-processing mergers” (Clark 2003)

- External objects that aid the mind’s reasoning
 - Example: paper and pencil to do arithmetic
 - Example: Cell phones
 - “Finnish youngsters have dubbed the cell phone ‘kanny,’ which means extension of the hand.”

Natural-born Cyborgs

Our *minds* think with

- Our biological brains

Natural-born Cyborgs

Our *minds* think with

- Our biological brains
- Our bodies

Natural-born Cyborgs

Our *minds* think with

- Our biological brains
- Our bodies
- External objects

Natural-born Cyborgs

- Our *minds* think with
- Our biological brains
- Our bodies
- External objects

Extended mind theory (extended cognition)

Medicine makes extensive use of extended senses

- Diagnostic imaging
- Stethoscopes
- Microscopes

So why not extend the mind?

Limited Cognitive Capacity: Alfred North Whitehead

Civilization advances by extending the number of important operations which we can perform without thinking about them. (Whitehead 1958)



Francis Bacon: *Idols of the Mind* (Bacon, Jardine, and Silverthorne 2000)

- **Tribe:** Limitations of human understanding “distorts and corrputs [nature]”.
- **Cave:** Biases, limitations of knowledge/experience of the individual man
- **Marketplace:** Limitations of human language (“Plainly words do violence to the understanding, and confuse everything; and betray men into countless empty disputes and fictions.”)
- **Theatre:** Inherited dogmas “which have grown strong from **tradition, belief and inertia**”.

It is hard for humans to think and act rationally

Healthcare has delivery challenges (Braithwaite, Glasziou, and Westbrook 2020)

The three numbers you need to know about healthcare: the 60-30-10 Challenge

Jeffrey Braithwaite^{1*}, Paul Glasziou² and Johanna Westbrook³

Braithwaite et al. *BMC Medicine* (2020) 18:102

<https://doi.org/10.1186/s12916-020-01563-4>

Received: 30 July 2019 Revised: 11 March 2020

Accepted: 17 March 2020 Published online: 04 May 2020

Abstract

Background: Healthcare represents a paradox. While change is everywhere, performance has flattened: 60% of care on average is in line with evidence- or consensus-based guidelines, 30% is some form of waste or of low value, and 10% is harm, the 60-30-10 Challenge has persisted for three decades.

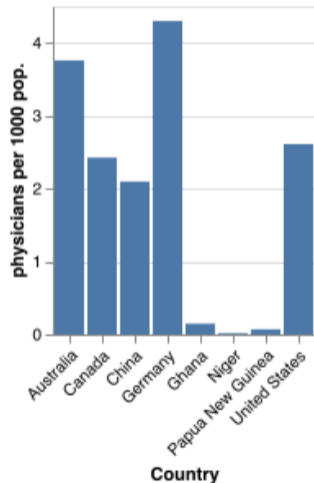
Main body: Current top-down or chain-logic strategies to address this problem, based essentially on linear models of change and relying on policies, hierarchies, and standardisation, have proven insufficient. Instead, we need to marry ideas drawn from complexity science and continuous improvement with proposals for creating a deep learning health system. This dynamic learning model has the potential to assemble relevant information including patients' histories, and clinical, patient, laboratory, and cost data for improved decision-making in real time, or close to real time. If we get it right, the learning health system will contribute to care being more evidence-based and less wasteful and harmful. It will need a purpose-designed digital backbone and infrastructure, apply artificial intelligence to support diagnosis and treatment options, harness genomic and other new data types, and create informed discussions of options between patients, families, and clinicians. While there will be many variants of the model, learning health systems will need to spread, and be encouraged to do so, principally through diffusion of innovation models and local adaptations.

Conclusion: Deep learning systems can enable us to better exploit expanding health datasets including traditional and newer forms of big and smaller-scale data, e.g. genomics and cost information, and incorporate patient preferences into decision-making. As we envisage it, a deep learning system will support healthcare's desire to continually improve, and make gains on the 60-30-10 dimensions. All modern health systems are awash with data, but it is only recently that we have been able to bring this together, operationalised, and turned into useful information by which to make more intelligent, timely decisions than in the past.

Keywords: Learning health system, Complexity, Complexity science, Change, Evidence-based care, Clinical networks, Quality of care, Patient safety, Policy, Healthcare systems

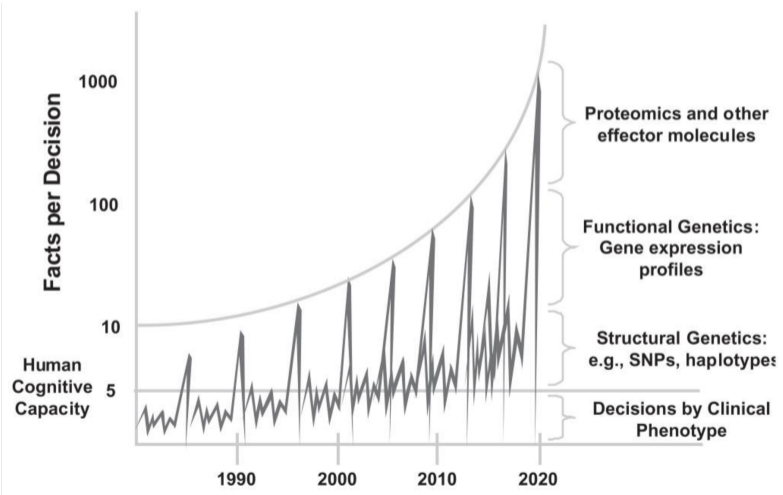
Healthcare delivery challenge ²

Does AI in healthcare need to look the same everywhere?



²Data are taken from the World Bank

Overwhelming amount of information (Medicine et al. 2008)



(Less) Imperfect Decision Making

AI-augmented clinical decision making



Friedman's Fundamental Theorem of Informatics (Friedman 2009)

“A person working in partnership with an information resource is ‘better’ than that same person unassisted”

Human + AI >
Human >
AI

Shift focus of AI tools from **end-to-end decision making** to **supporting humans** to make better clinical decisions

Three flavors of AI (in historical order)

- Probability (1960s and 1990s)
 - Represent knowledge as as probabilities and use Bayes' theorem to make inferences
- Logic/Expert Systems (1970s and 1980s)
 - Represent knowledge as computable rules and relationships
- Machine Learning (our current era)
 - Learn implicit or explicit relationships between data (input) and classifications, predictions, etc. (output)

Early Expert System AI in Healthcare: MYCIN (Shortliffe et al. 1973)

But with MYCIN, the program that diagnoses disease and prescribes treatment, the experts were not willing to do away with the doctor and let the computer dispense pills to each patient in the hospital.

“If a program such as MYCIN were acting independently of a physician, I think that would be inappropriate,” said Professor Buchanan, who has a computer terminal in his home. “The problem is that human diseases are open-ended.

Experts Argue Whether Computers Could Reason, and if They Should

By LEE DEMBART

Can machines think? Should they? The computer world is in the midst of a fundamental dispute over those questions because an eminent computer scientist wrote a book arguing that machines could never be made to reason like people and, what was more, should not be.

Twenty years ago, in the infancy of the computer revolution, before problems began cropping up, the public was told that computers would be smarter than brains. Computer chess champions and machine translation, for example, were just around the corner. So far, neither has been accomplished successfully, and neither is likely to be any time soon.

Nor have computers had much success in making decisions that require judgment. They can rattle off the Manhattan telephone directory unerringly time after time, which no human can do, but they cannot begin to distinguish one face from another, as babies can.

Computer scientists have always said, “Give us more time. The problem is more complex than we thought.” Then one of them, Joseph Weizenbaum, a professor of computer science at the Massachusetts Institute of Technology, wrote a book saying that the project was fundamentally unsound and dangerous to pursue, partly, he said, because the computers’ and humans’ ways of thought would always be alien, and because knowledge might become limited to what a computer could understand.

The elders of the artificial intelligence community reacted with outrage. Even those who agreed with his premises criticized the book as being too harsh in tone, too personal in its attacks. Computer journals have bristled over the last year with reviews, comments and replies provoked by Professor Weizenbaum’s book, “Computer Power and Human Reason” (W. H. Freeman & Co., 1976). Now the controversy has spilled into the prestigious publication Science,

Continued on Page 34, Column 3

Continued on Page 23, Column 1

Casinos Bring Atlantic City Woes

By MARTIN WALDRON
Special to The New York Times

ATLANTIC CITY, May 7—Fires, the condemnation of slum housing and the destruction of small hotels are driving out many elderly and poor as this seaside resort begins to experience sociological consequences in a prelude to the opening of gambling casinos.

Under a measure in the New Jersey Legislature, casinos could be opened only in large hotels. State and city officials hope to rebuild the deteriorating city, once the nation’s premier convention center, by attracting \$500 million worth of these new facilities.

Hotels and other businesses may be

erals of his intention to back Mr. Cuomo all the way in an apparent effort to strengthen Mr. Cuomo’s bid for the Liberal Party’s nomination.

Titular Head Turns Elsewhere

If Mr. Cuomo wins the Liberal nomination but loses that of his own party, it would mean that the Governor would be supporting the Liberal candidate for Mayor rather than the Democratic one.

When Mr. Cuomo was asked about the Larry move, disclosed in The New York Times yesterday, he said it was difficult to believe “the titular head of the Democratic Party would support a candidate of another party rather than his own, especially after all his pretensions about the importance of an open primary.”

“Apparently the Liberal Party is more important to him than the Democratic

Front F
SHOW SU

erected in an area now by slum housing, much of sought by speculators.

City officials deny the policy to try to drive the poor from Atlantic City. A third of the city’s 40,000 permanent residents are on welfare, with unemployment over 20 percent.

About 16,000 of these—mostly black and Hispanic residents—live in the area expected to be in demand soon for the construction of casinos, restaurants and parking facilities.

In all, some 700 to 1,000 people have

Continued on Page 36, Column 3

MYCIN had about 600 expert crafted rules

```
(defrule 165
  if (gram organism is pos)
      (morphology organism is coccus)
      (growth-conformation organism is chains)
  then .7
      (identity organism is streptococcus))

(defrule 52
  if (site culture is blood)
      (gram organism is neg)
      (morphology organism is rod)
      (burn patient is serious)
  then .4
      (identity organism is pseudomonas))
```

Article • Data & Analytics

AI used to read breast cancer screenings a safe success

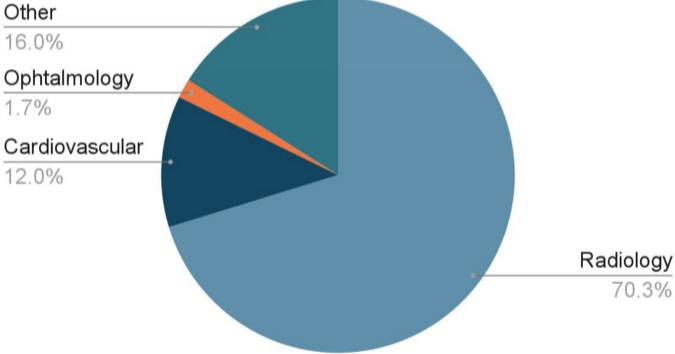
By Amber Jackson

August 03, 2023 • 4 mins

Lead author of the study Dr Kristina Lång, from Lund University in Sweden, said: “The greatest potential of AI right now is that it could allow radiologists to be less burdened by the excessive amount of reading. “While our AI-supported screening system requires at least one radiologist in charge of detection, it could potentially do away with the need for double reading of the majority of mammograms, easing the pressure on workloads and enabling radiologists to focus on more advanced diagnostics while shortening waiting times for patients.”

The most FDA (USA) approved “AI” tools are in imaging (FDA 2022)

FDA Approvals



Why might imaging applications be so common?

- Are radiologist (relatively) stupid?
- Is radiology (relatively) hard?
- Or is it about the availability of the data?

But... Adversarial Example (Mitchell 2019)



FIGURE 18: Original and “adversarial” examples for AlexNet. The left image

LLMs and Generative AI (e.g. ChatGPT)

Fill in the blank: "The cat sat on the ____."



A word cloud containing the following words: dog, mat, fence, wall, hat, couch, splat, and bed. The word 'mat' is the largest and most prominent, rendered in a dark purple color. Other words are smaller and in various colors including green, blue, and red.

Fill in the blank

- “This boy of 6 or 7 years had ——— and came in for studies.”

What is the probability distribution for each **token** in a sequence?

Fill in the blank

- “This boy of 6 or 7 years had ——— and came in for studies.”
- “This boy of 6 or 7 years had hematuria and came in for studies.”

What is the probability distribution for each **token** in a sequence?

How are LLMs (e.g. ChatGPT) created? (adapted form (Szolovits 2023))

- Training task: predict the next word in sentences from giant corpus, perhaps a trillion (10^{12}) tokens
 - Self-supervised: no human annotation is needed
- Model: a giant neural network with around one trillion parameters
 - Trained model represents an approximation to the probability distribution of every sequence of tokens
- Lots of mystery about additional steps (e.g. hardwired rules for safety, policy)
- ChatGPT predicts sequences 32 thousand tokens (words, punctuations marks, etc.) long!

“Generative AI Seems Miraculous...but Science Abhors Miracles”

- Why does a simple training method on vast amounts of human-created text exhibit skills that it as not explicitly trained to do?
- Why do models trained this way nevertheless “hallucinate”?

“Hallucinate”: confidently state factually inaccurate information

The Ghost in the Machine has an American accent: value conflict in GPT-3.

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Microsoft's responsible AI principles

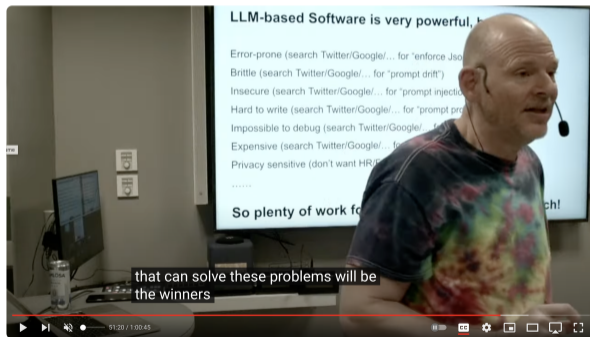
- 1 Fairness - AI systems should treat all people fairly.
- 2 Reliability and safety - AI systems should perform reliably and safely.
- 3 Privacy and security - AI systems should be secure and respect privacy.
- 4 Inclusiveness - AI systems should empower everyone and engage people.
- 5 Transparency - AI systems should be understandable.
- 6 Accountability - People should be accountable for AI systems.

<https://www.microsoft.com/en-us/ai/responsible-ai>

“A Unified Framework of Five Principles for AI in Society” (Floridi and Cowls 2019)

- 1 Beneficence: Promoting Well-Being, Preserving Dignity, and Sustaining the Planet
- 2 Non-Maleficence: Privacy, Security and ‘Capability Caution’
- 3 Autonomy: The Power to Decide (to Decide)
- 4 Justice: Promoting Prosperity, Preserving Solidarity, Avoiding Unfairness
- 5 Explicability: Enabling the Other Principles through Intelligibility and Accountability
 - epistemological sense of ‘intelligibility’ (as an answer to the question ‘how does it work?’)
 - ethical sense of ‘accountability’ (as an answer to the question ‘who is responsible for the way it works?’)

“Our jobs may be automated away, but lets have fun during the process!”



Thank you



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