AI's Past, Present, and Future

Professor Chad Jenkins
University of Michigan Robotics Institute

July 22, 2021 - TFAI Panel Presentation


Chad Jenkins
$6.74
Skype Home
Contacts
CURRENT CALLS
History

Are you with the football team?

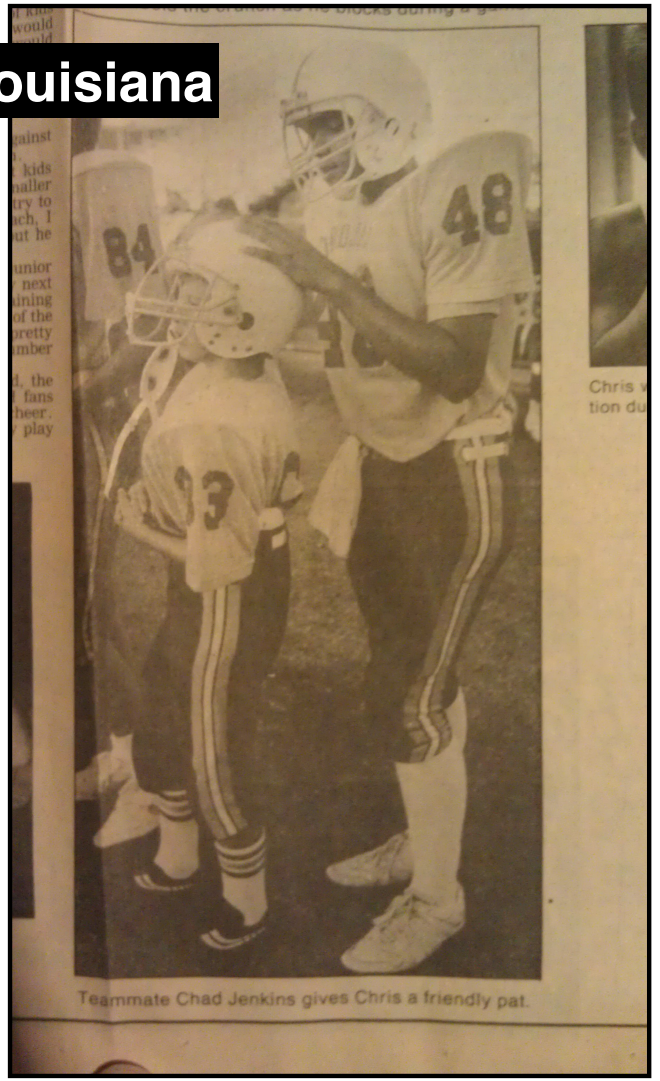
No.

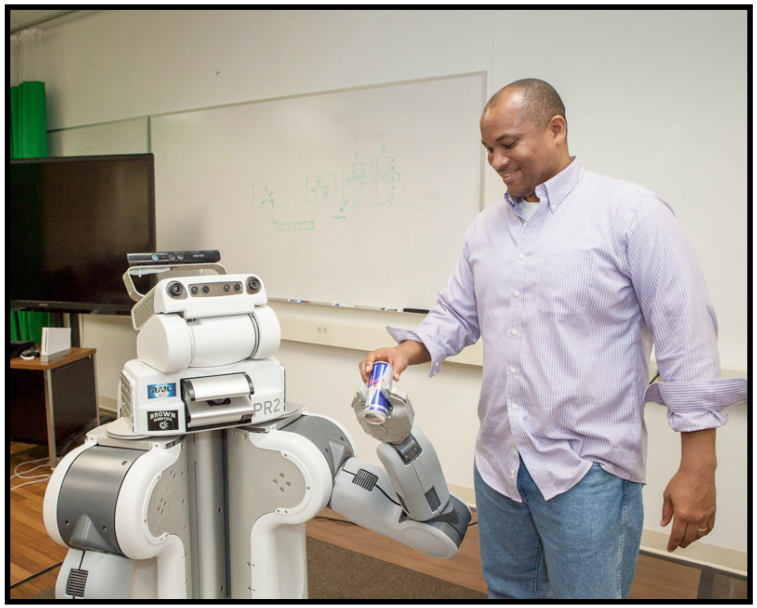
Alexandria, Louisiana

Are you with the football team?

~~No.~~

Yes… in 1988

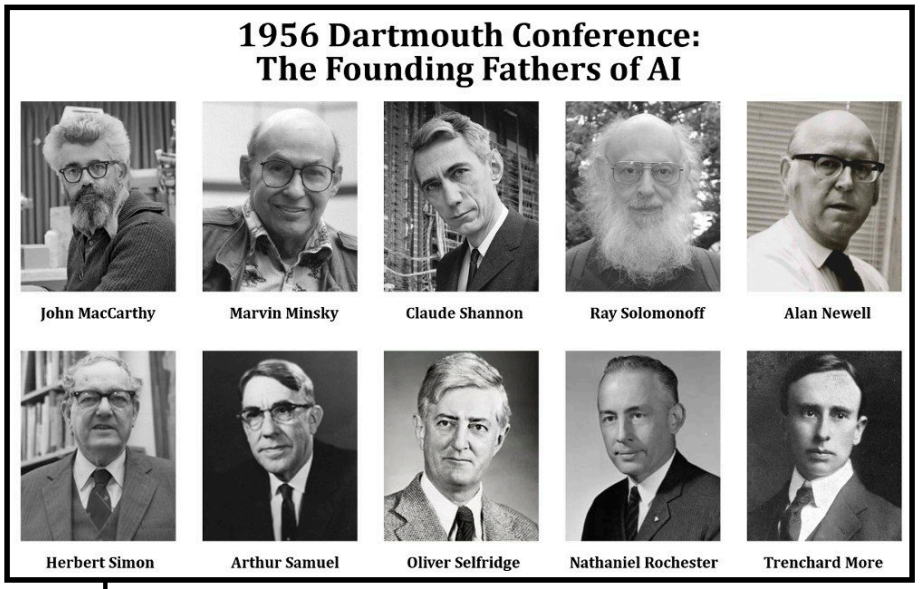




1988

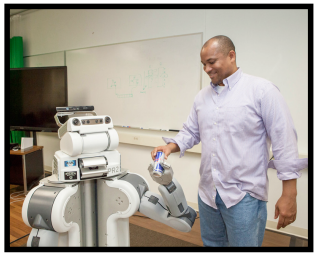
2013

Time



First wave AI: Model-based

"Think through the entire problem"



1956

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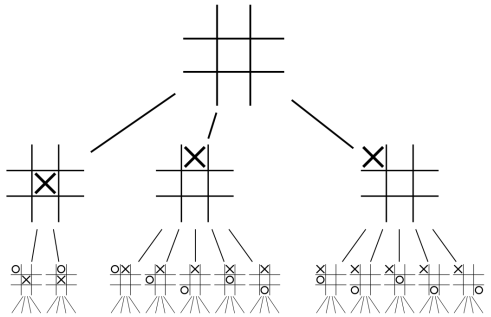

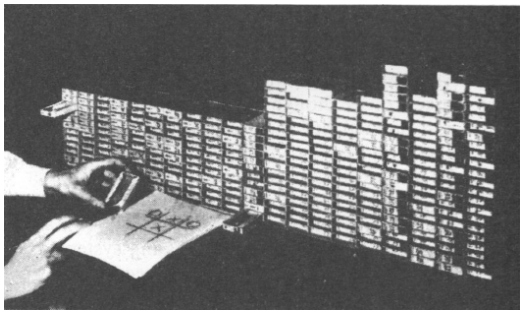

MENACE: Matchbox Educable Noughts And Crosses Engine (1961)

1956 1960 1970

Time

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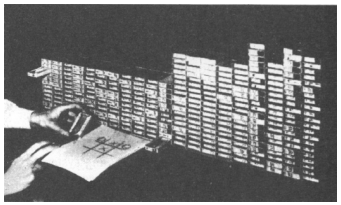

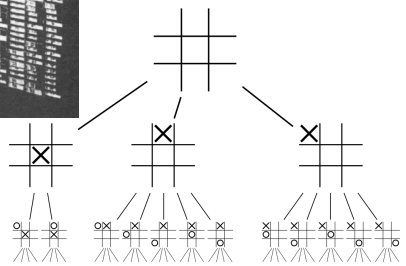

IBM Deep Blue defeats chess grandmaster (1997)

1956 1960 1970 1980 1990 2000

Time

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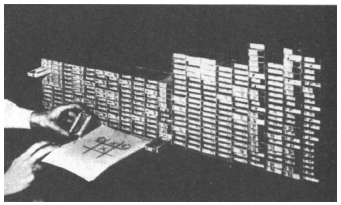
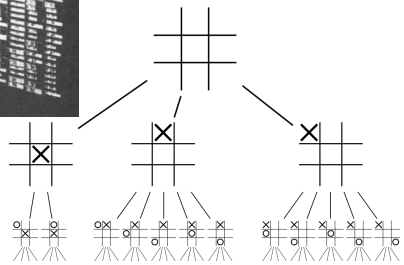
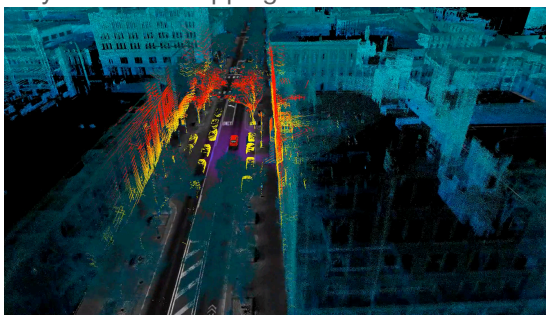


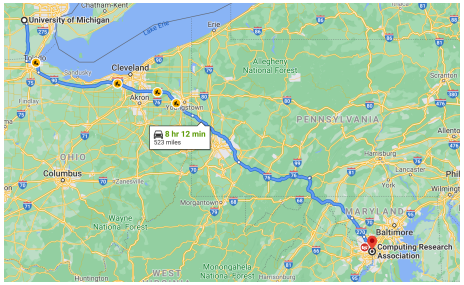


City-scale 3D mapping



Self-driving cars

Online route navigation



1956 1960 1970 1980 1990 2000 2010 **Time**

First wave AI: Model-based

"Think through the entire problem"

City-scale 3D mapping

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Rational and Robust but Sloooow

1956 1960 1970 1980 1990 2000 2010 **Time**

First wave AI: Model-based

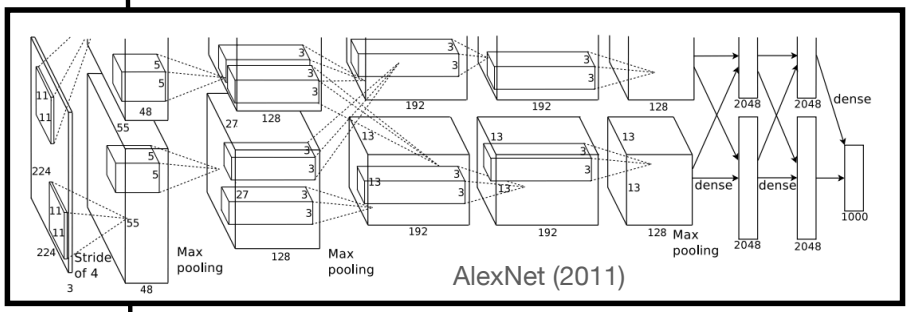
"Think through the entire problem"

Rational and Robust
but Slooooow

Second wave AI: Data-driven

"Learn from lots of data"

Rise of "deep learning"



1956

2011

Time

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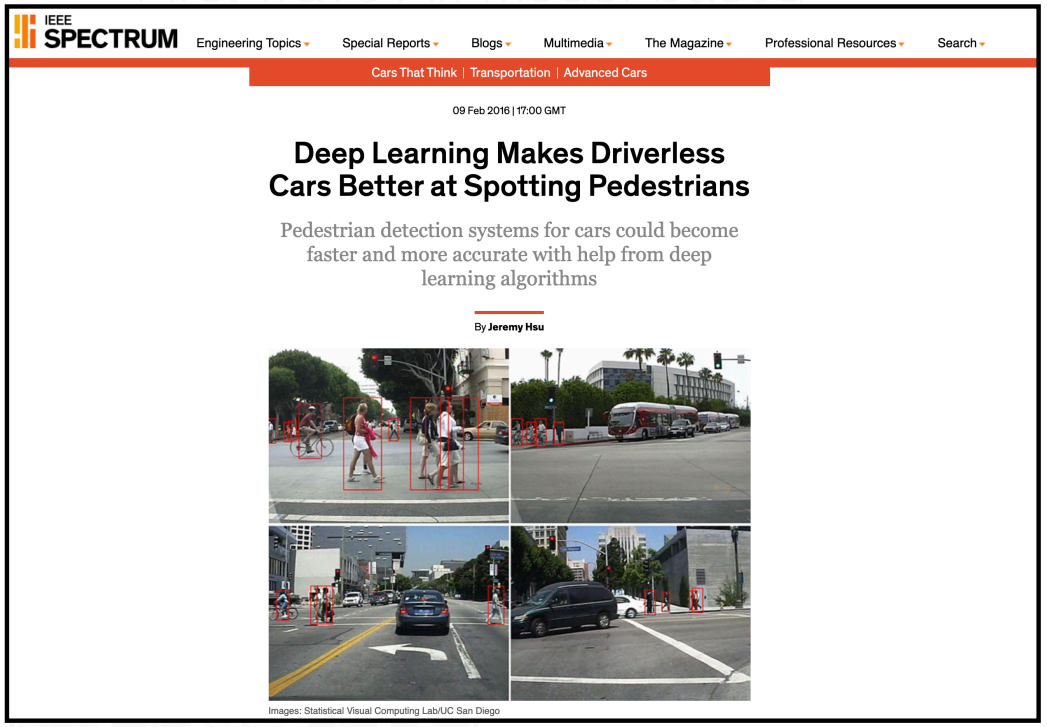


Second wave AI: Data-driven

"Learn from lots of data"

"deep learning"

1956

2011

Time

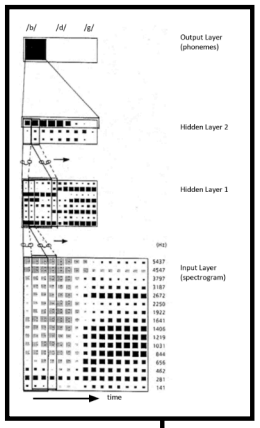
The AI of today needed decades of investment and research

Second wave AI: Data-driven

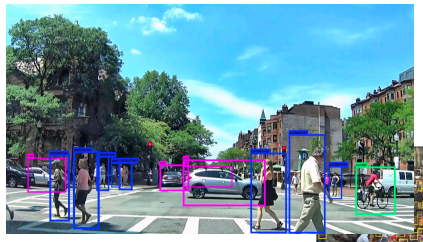
"Learn from lots of data"

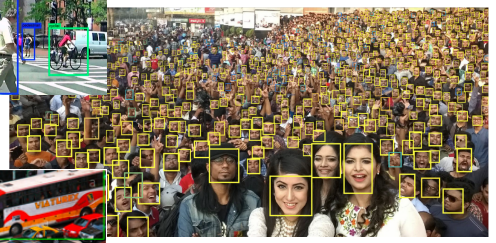
Rosenblatt's Perceptron

Speech recognition by neural networks



Waibel et al.





"deep learning"

1958

1989

2011

Time

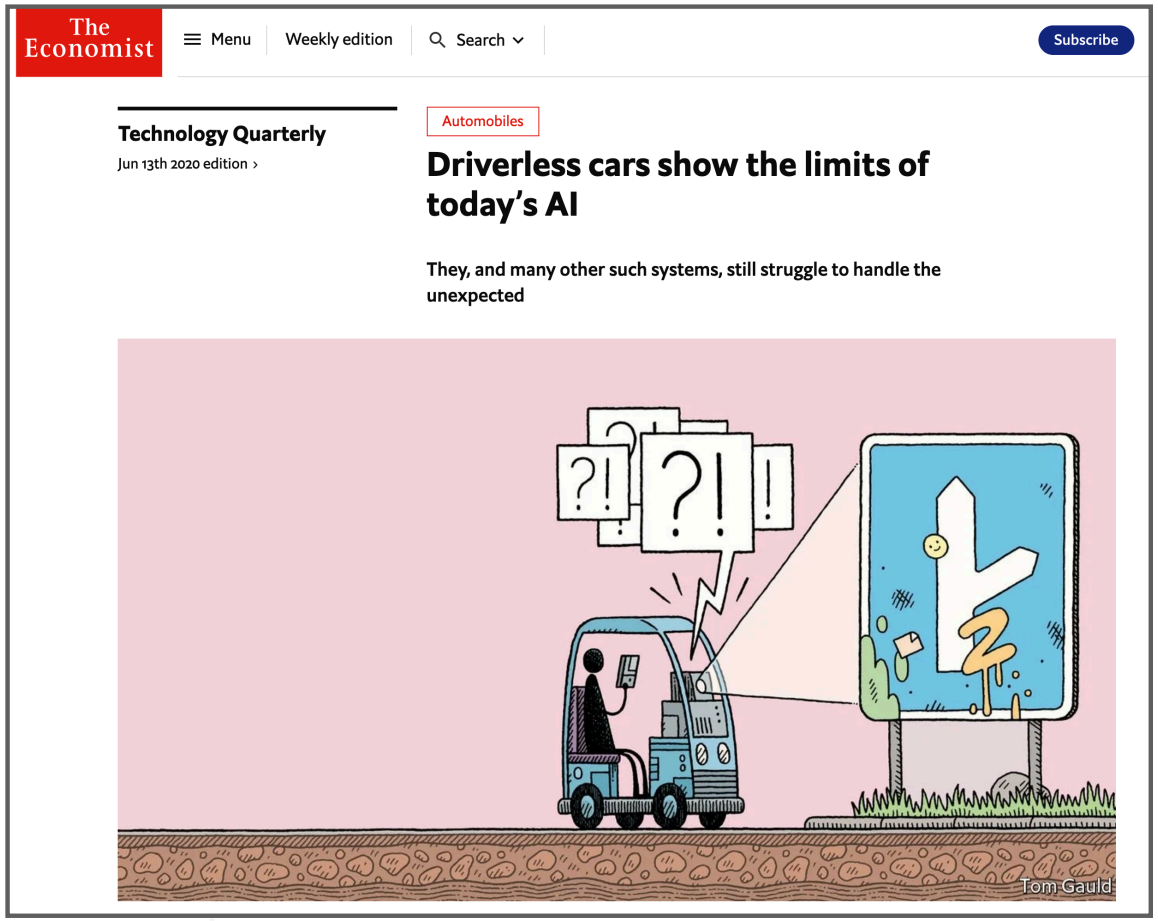
Accurate and Fast but Unpredictable

Second wave AI: Data-driven

"Learn from lots of data"

"deep learning"

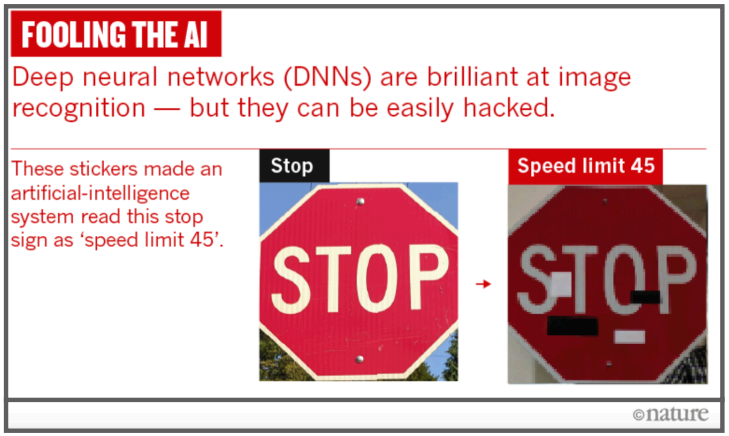
Time



Second wave AI: Data-driven

"Learn from lots of data"

Accurate and Fast but Unpredictable



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First wave AI: Model-based

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Second wave AI: Data-driven

"Learn from lots of data"

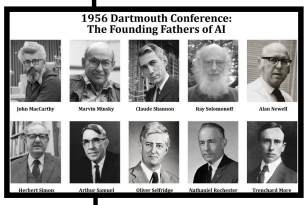
Accurate and Fast
but Unpredictable

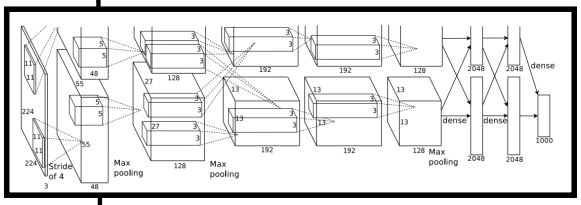
Third wave AI: Explainable

"Combine first and second wave AI to generate explanations"

Accurate and Fast and Accountable

and Ethical, Fair, Adaptable,
and Climate Sustainable





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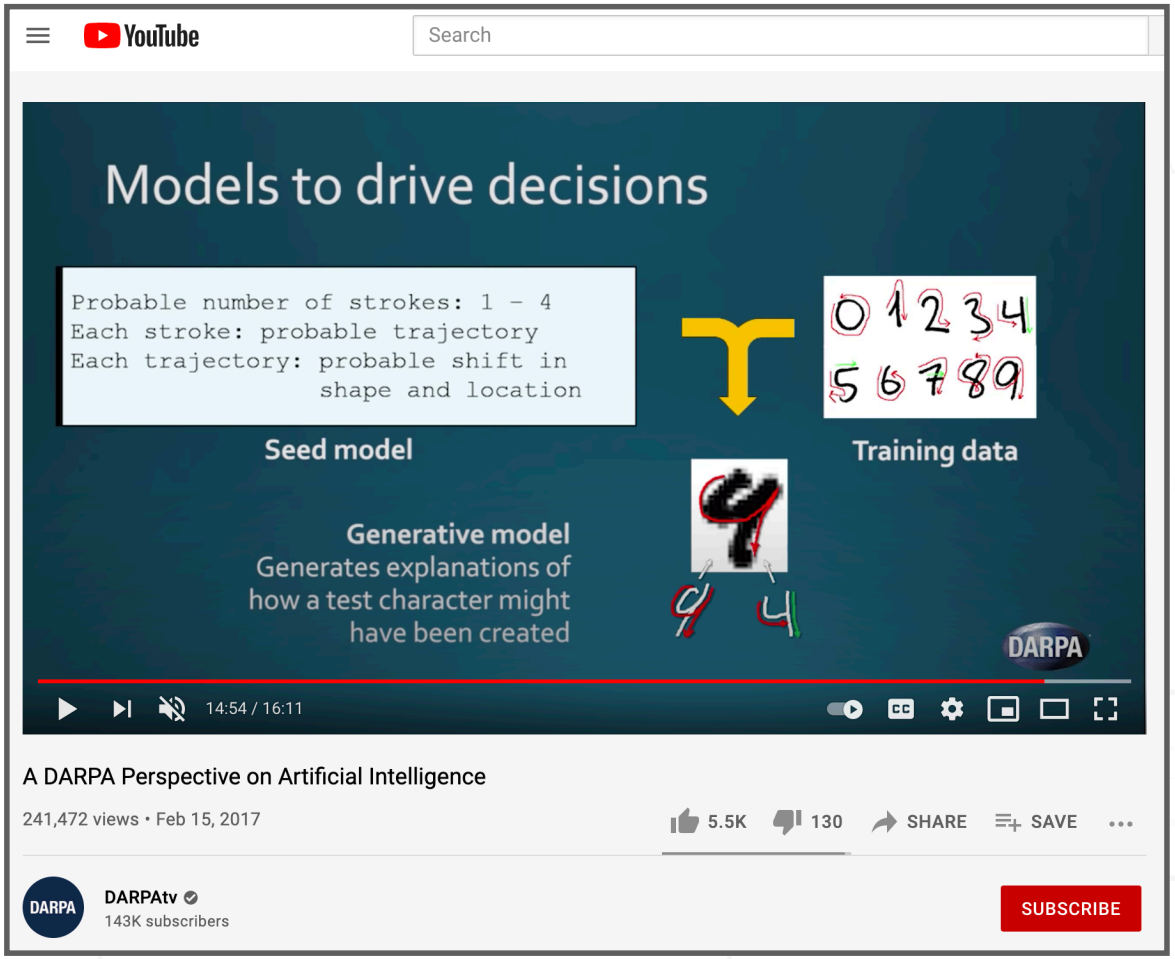
1956

2011

20??

Time



Third wave AI: Explainable

"Combine first and second wave AI to generate explanations"

Accurate and Fast and Accountable

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??

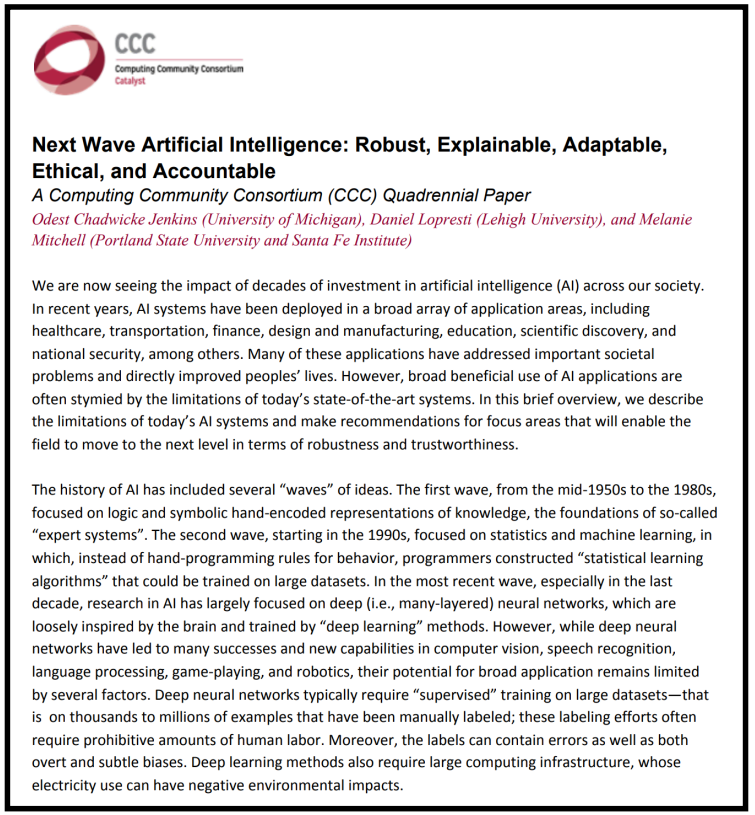
20??

Time

The Next Wave of AI

How to get ahead

- **Federal investment critical for success**
  - Was true before (since WWI), still true now
- **Global competition**: If we do not lead, others will
- **Education**: the classroom of today builds the AI leaders for tomorrow
- **Diversity**: the next breakthrough could come from anywhere



CCC
Computing Community Consortium
Catalyst

Next Wave Artificial Intelligence: Robust, Explainable, Adaptable, Ethical, and Accountable

A Computing Community Consortium (CCC) Quadrennial Paper

Odest Chadwicke Jenkins (University of Michigan), Daniel Lopresti (Lehigh University), and Melanie Mitchell (Portland State University and Santa Fe Institute)

We are now seeing the impact of decades of investment in artificial intelligence (AI) across our society. In recent years, AI systems have been deployed in a broad array of application areas, including healthcare, transportation, finance, design and manufacturing, education, scientific discovery, and national security, among others. Many of these applications have addressed important societal problems and directly improved peoples' lives. However, broad beneficial use of AI applications are often stymied by the limitations of today's state-of-the-art systems. In this brief overview, we describe the limitations of today's AI systems and make recommendations for focus areas that will enable the field to move to the next level in terms of robustness and trustworthiness.

The history of AI has included several "waves" of ideas. The first wave, from the mid-1950s to the 1980s, focused on logic and symbolic hand-encoded representations of knowledge, the foundations of so-called "expert systems". The second wave, starting in the 1990s, focused on statistics and machine learning, in which, instead of hand-programming rules for behavior, programmers constructed "statistical learning algorithms" that could be trained on large datasets. In the most recent wave, especially in the last decade, research in AI has largely focused on deep (i.e., many-layered) neural networks, which are loosely inspired by the brain and trained by "deep learning" methods. However, while deep neural networks have led to many successes and new capabilities in computer vision, speech recognition, language processing, game-playing, and robotics, their potential for broad application remains limited by several factors. Deep neural networks typically require "supervised" training on large datasets—that is on thousands to millions of examples that have been manually labeled; these labeling efforts often require prohibitive amounts of human labor. Moreover, the labels can contain errors as well as both overt and subtle biases. Deep learning methods also require large computing infrastructure, whose electricity use can have negative environmental impacts.