Artificial Intelligence and the Federal Government: A 70-Year-Old Love Story Still Going Strong

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Agenda

- Common images of AI in society
- What does it mean to be Artificially Intelligent?
- How much have we spent on AI? For how long?
- What is Weak AI? Strong AI?
- Some conclusions

1

1

Common Images of Artificial Intelligence

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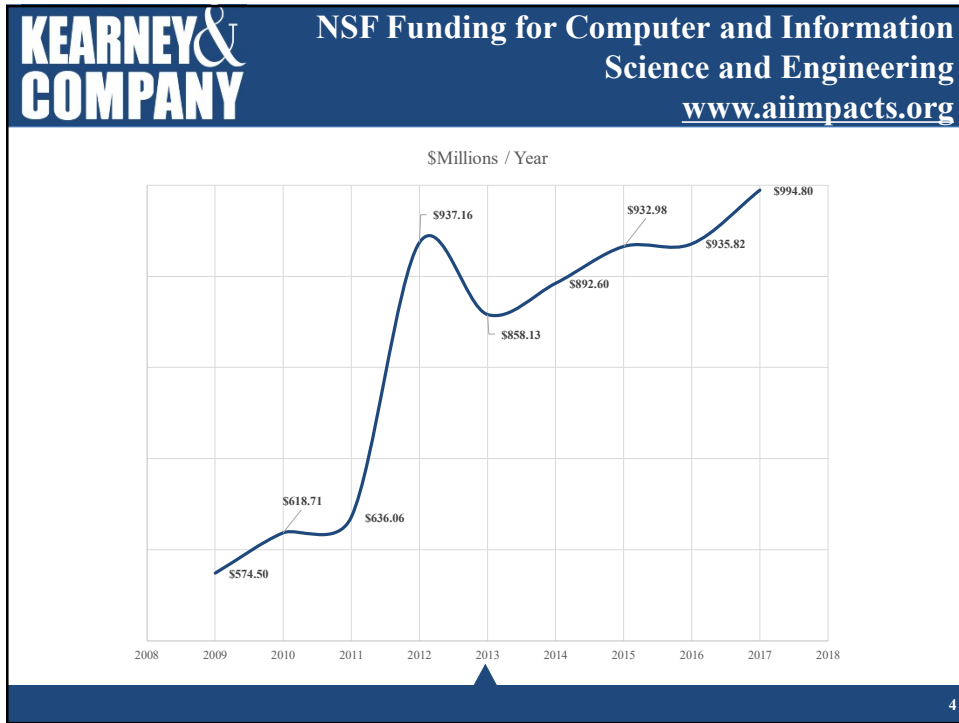COMPANY

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Common Images of AI

What if I told you the one of the biggest investors in productive AI over the last 70 years has been…
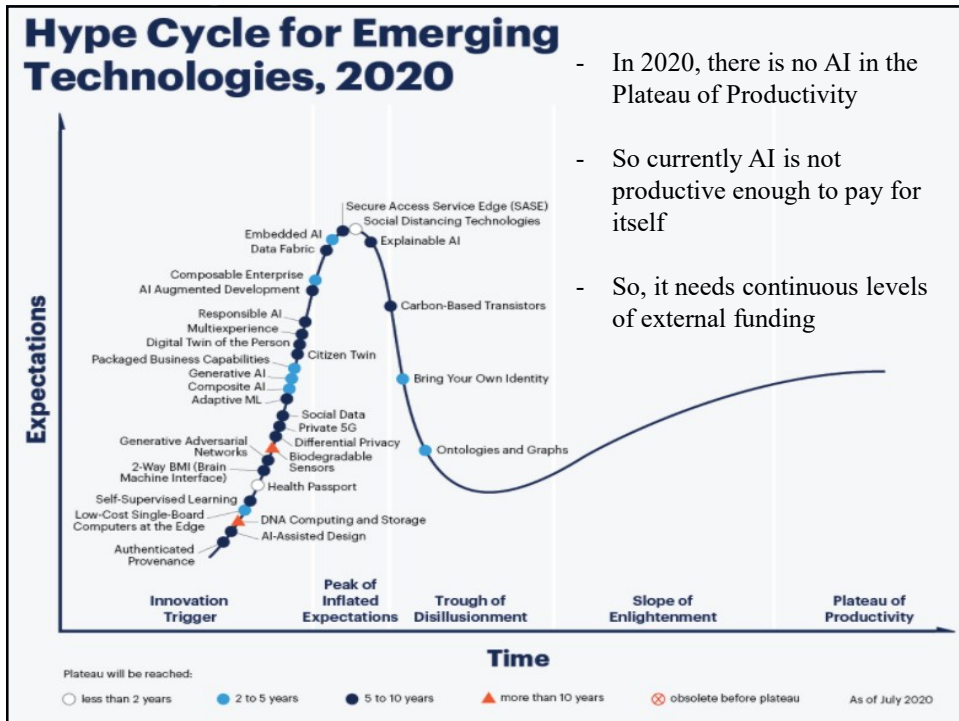
…the United States Federal Government.

Would you believe me?

3

3

NSF Funding for Computer and Information Science and Engineering
www.aiimpacts.org

$Millions / Year

- $574.50
- $618.71
- $636.06
- $937.16
- $858.13
- $892.60
- $932.98
- $935.82
- $994.80

2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

4

4

Hype Cycle for Emerging Technologies, 2020

- In 2020, there is no AI in the Plateau of Productivity

- So currently AI is not productive enough to pay for itself

- So, it needs continuous levels of external funding

5

Common Images of AI

We know AI isn't yet productive…but we keep funding it.

What is it we are looking for in AI?

Let's start with our common images of it…

6

Robocop
Not Artificial Intelligence
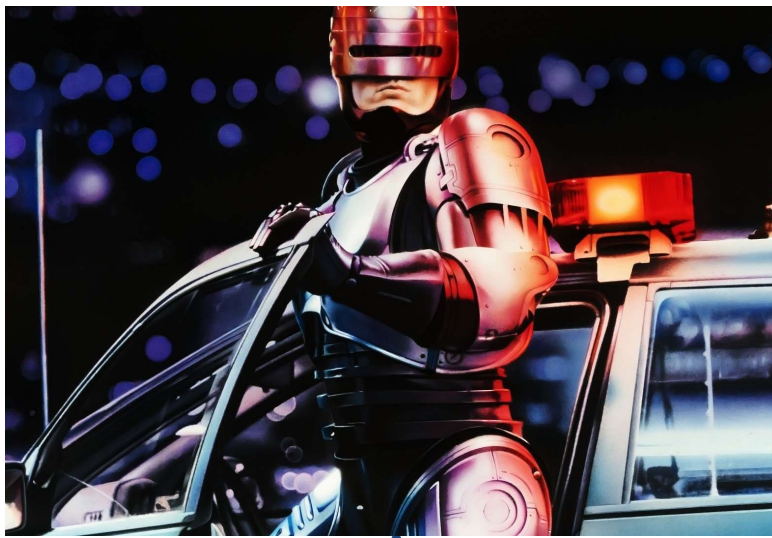
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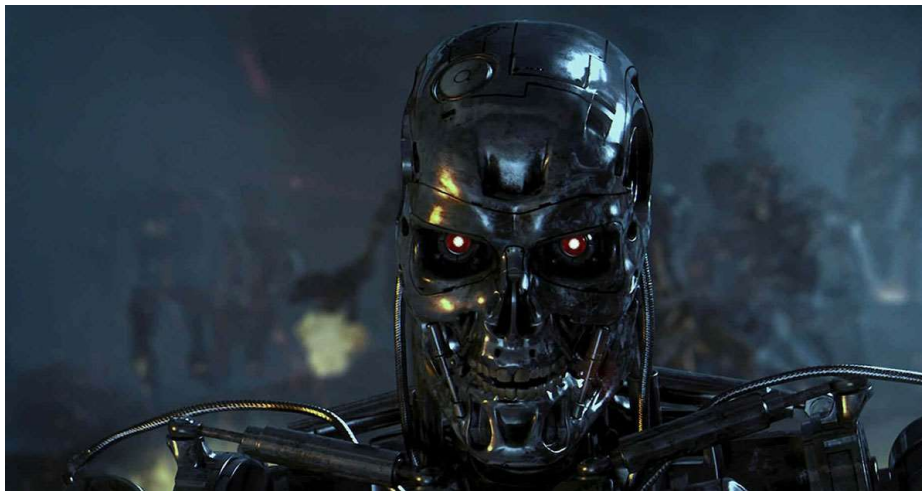
**Big Hero 6
AI as Childhood Friend**

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**The Terminator
AI as Human Destroyer**

9

9

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**The Matrix
AI as Human Escape Room**

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**Transcendence
AI as Savior of the Planet**

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11

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**Outside the Wire
AI as Warfighter**
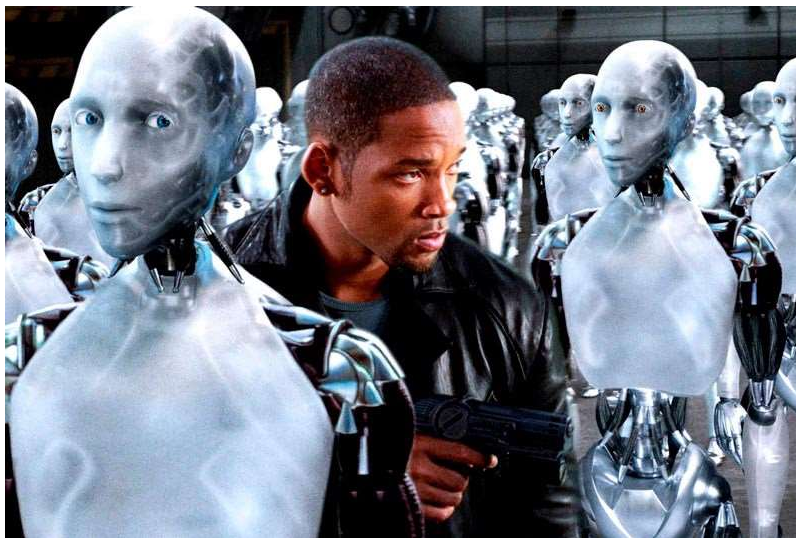

12

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**I Robot
AI as Savior of the Human Race**

13

13

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Human Intelligence and Artificial Intelligence

"Why do you give them faces? Try to friendly them all up, make them look all human? I guess if you did then we wouldn't trust them. Not me. These things are just lights and clockwork."

- Detective Spooner (I Robot)

What are we looking for when we fund AI? AI that is more and more human? Do we need a hero? A warrior? Is it our Savior of the Planet? Our Greatest enemy? Trustworthiness? Productivity?

14

14

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Polling Question #1

Which movie on AI describes what your expectations of AI once it becomes productive?

- ***Big Hero 6*** *– Friend for our children?*
- ***Terminator*** *– Enemy that tries to destroy us?*
- ***The Matrix*** *– Controlling every facet of our reality?*
- ***Transcendence*** *– A way humans can preserve themselves? Savior for our planet?*
- ***Outside the Wire*** *– Warfighter?*
- ***I Robot*** *– A high powered friend who shares our values and will help us*

15

15

What does it mean to be Artificially Intelligent?

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16

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What is AI?

Great question…

What if I told you, we are not quite sure…

17

17

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Definition

AI – Artificial Intelligence

"The capacity of computers or other machines to exhibit or *simulate intelligent behavior*; the field of study concerned with this."

- Oxford English Dictionary

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Definition

AI – Artificial Intelligence

"The ability of a digital computer or computer-controlled robot to *perform tasks* commonly associated with intelligent beings."

- Chethan.Kumar@IndianMoney.com

19

19

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Definition

The Turing Test. What is it?

- The Turing test, originally called the *Imitation Game* by Alan Turing in 1950, is a test of a machine's *ability to exhibit intelligent behavior equivalent to, or indistinguishable from, that of a human.*

- The Imitation Game is a simple party game involving three players.
  - Player A is a man
  - Player B is a woman
  - Player C - the interrogator - either gender

20

20

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The Imitation Game

- In the imitation game, player C can't see either A or B.
- Players use only written notes to communicate.
- C questions A & B in order to determine their gender.

- Player A's role is to trick C into making the wrong decision
- Player B's role is to help C to make the right one.

Now, let's consider what happens if Player A is an AI.

If Player C cannot determine that Player A is an AI, then the AI has passed the Turing Test. *Player A has sufficiently simulated human behavior enough for Player C not to be able to determine that Player A is not a human being.*

21

21

KEARNEY& COMPANY — What to we learn from The Imitation Game

C's intelligence is human
A's intelligence is machine

General Intelligence   ✗→ C ≡ A

? C ≢ A → 👍

General Intelligence

22

22

KEARNEY& COMPANY — The Imitation Game

A Turing Test-passing, AI would arguably need to be *generally intelligent*, that is, capable of learning quickly and following subtle verbal cues in a conversation the same way as a human. And of course somehow be competent in the skills of deception.

A Turing Test-passing AI does not have to exhibit every aspect of human intelligence to achieve general intelligence. Such an AI would should be able to, theoretically, fill in for humans in certain situations.

To date, no AI has ever passed the Turing Test.

And so are born two categories: *Weak AI* – AI that does not pass the Turing Test, and *General AI* – which the world has not yet seen, but we continue to search for.

23

23

Polling Question #2

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What is an important attribute in the definition of Artificial Intelligence? Artificial Intelligence should be able to…

- Beat human beings at board games

- Exhibit intelligent behavior

- Memorize every word in the dictionary

- Speak in every kind of language

24

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How much have we spent on AI? For how long?

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When will AI finally get here?

100 years from now…

10 years from now…

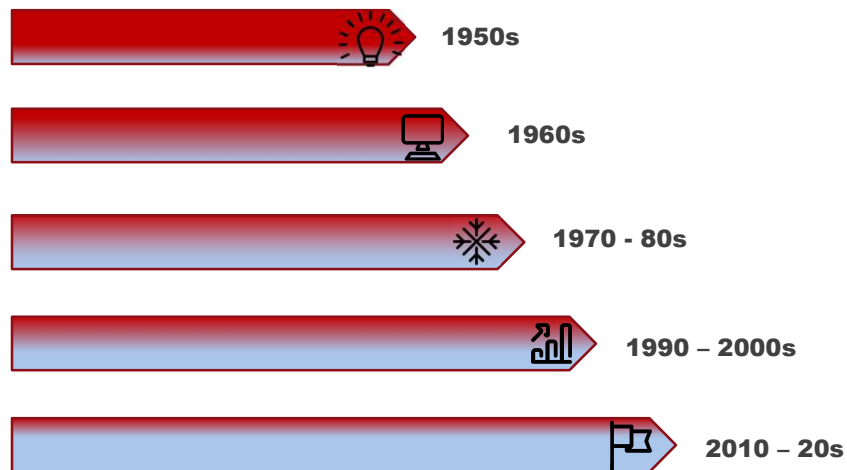We will never get there…

It's already been here for a long time….

It's just been hiding…

There is no such thing as A..I…

26

26

AI and the Federal Government
A 70-year Love Story!

1950s

1960s

1970 - 80s

1990 – 2000s

2010 – 20s

27

27

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### 1950s – Genesis
First Awards for Research

- 1950s Alan Turing proposed the Turing Test as a measure of machine intelligence

- 1956 Marvin Minsky built the *first electric neural net* at the Dartmouth College Summer AI Conference (In Our Own Image) sponsored by him and John McCarthy officially giving birth to the research field of Artificial Intelligence or "thinking machines".

- *1959, the U.S. Federal Government followed up with a $2.2 million award to develop machine aided cognition to Minsky and McCarthy lab, newly established as the AI Lab at MIT.*

28

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1950s
The Minsky Neural Net

Neural networks are a set of algorithms, modeled loosely after the human brain, that are designed to recognize patterns. Part of the initial research into how human brains work.
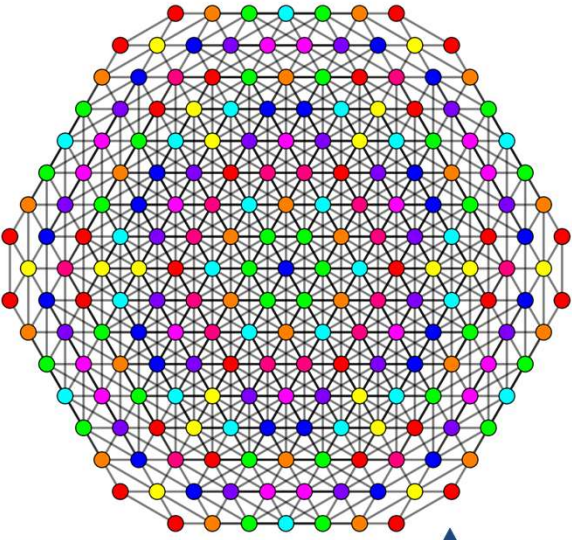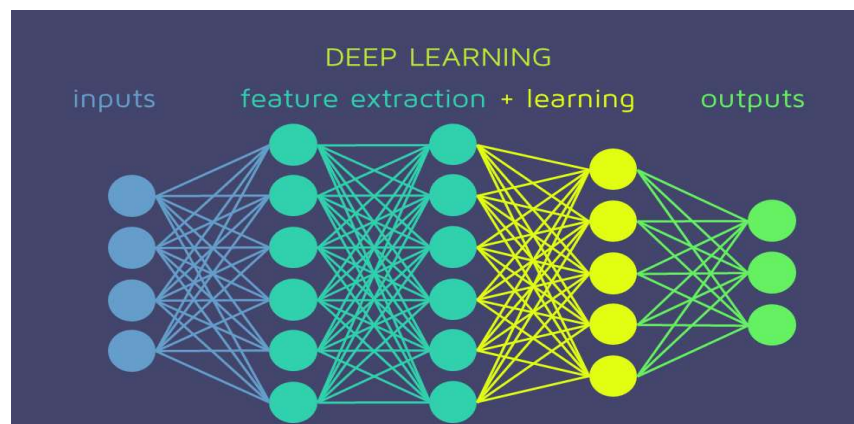

29

29

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1950s
The Minsky Neural Net

The neural network like a human brain has layers and surface area creating a three-dimensional network across which signals can be relayed – unfortunately this only provides a signal input, transfers and output theory…intelligence is far greater than this

30

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1950s
The Minsky Neural Net

The human brain is not the goal – but rather intelligence…intelligence is far different than a network transferring signals into, across and out of the net…but it was the starting place in 1950…

31

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1960s – Development
The Rise of Expert Systems

- In the 1960s, U.S. investment into research into the subject matter focuses on the development of *expert systems*
- 1961 UNIMATE – first industrial robot working at GM
- 1964 ELIZA – first chatbot developed by Joseph Weizenbaum at MIT
- 1966 SHAKEY – general purpose mobile robot that reasons about its own actions
- Computer systems that emulates the decision-making ability of a human expert. Expert systems are designed to solve complex problems by reasoning through bodies of knowledge, represented mainly as if–then rules rather than through conventional procedural code.
- Systems such as Dendral, MYCIN, and INTERNIST rise to focus on specific activities such as identify unknown organic molecules, identify bacteria causing severe infections, and diagnose multiple diseases in internal medicine by modelling the behavior of clinicians .
- *DARPA provided much of the funding through it's Heuristic Programming Project as well as the National Institute of Health.   On the way, the internet is discovered, computer workstations proliferate across the world, and computing power climbs.*

32

32

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1970s – 1980s: Winter
Two Decades Lack of Funding

- 1970 Abandonment of connectionism.

Connectionism – use of developed neural net models to approximate processing in the human brain

- 1971 DARPA's frustration with the Speech Understanding Research program at Carnegie Mellon University. Harpy in the 1970s could only understand about 1000 words. Same as a 3-year-old.

- 1973 Large decrease in AI research in the United Kingdom in response to the Lighthill report. A report published by James Lighthill, a British applied mathematician, stating many of the promised solutions had not been delivered by AI

- 1974 DARPA's cutbacks to academic AI research in general
- 1987 Collapse of the LISP machine market (personal computers that ran LISP code)
- *1988 Cancellation of new spending on AI by the U.S. Strategic Computing Initiative*

33

33

KEARNEY & COMPANY — 1990s – 2000s: Renaissance

- The 1990s and 2000s saw a major explosion in commercial and Government funded research and achievements in machine learning, case-based reasoning, uncertain reasoning, machine sight, natural language processing and visual reality.

- 1991 Lockheed develops the DART, the Dynamic Analysis and Re-planning Tool
- 1997 Deep Blue defeats Gary Kasparov at chess
- 2004 DARPA funds a $1million prize contest to create a self-driving car
- 2005 Development on IBM Watson begins
- 2009 Google develops a self-driving car that can navigate modern traffic

34

34

KEARNEY & COMPANY — DART: Dynamic Analysis Re-Planning Tool

- DARPA funded the MITRE Corporation and Carnegie Mellon University to analyze the feasibility of several intelligent planning systems.

- In November 1989, a demonstration named *The Proud Eagle Exercise* indicated many inadequacies and bottlenecks within military support systems.

- In July, DART was previewed to the military by BBN Systems and Technologies and the ISX Corporation (now part of Lockheed Martin Advanced Technology Laboratories) in conjunction with the United States Air Force Rome Laboratory.

- It was proposed in November 1990, with the military immediately demanding that a prototype be developed for testing. Eight weeks later, in 1991, DART was introduced to the USTRANSCOM at the beginning of Operation Desert Storm during the Gulf War.

- By 1995, the cost recovery on DART *repaid all funding investment DARPA had made in AI since 1960.*

35

35

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2010 – 2020s: Moving Forward!

- 2011 IBM Watson wins Jeopardy
- 2011 Apple launches SIRI
- 2014 Google buys AI startup Deep Mind for $650M
- 2016 Salesforce acquires MetaMind an AI deep-learning startup
- 2018 – Department of Defense establishes the JAIC – Joint Artificial Intelligence Center
- 2018 – DARPA announces a $2 billion campaign to develop the next wave of AI
- 2019 - President Trump announces the U.S. Government's commitment, not just to funding research but to creating a highly positive climate for AI researchers going forward. He issued executive order Exec. Order No. 13,859, 84 Fed. Reg. 3967 (February 14, 2019), focused on establishing America's place as the global leader in artificial intelligence technology and marking the launch of the **American AI Initiative**
- 2020 Google's BERT system accelerates advanced Natural Language Processing (NLP) techniques. NLP describes the problem of the interaction of humans and AI and human speech recognition by machines.

36

36

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2021 and beyond: the Future

- 2021 – Google's Deep Mind defeats the best AlphaGo player in the world
- 2021 – the Department of Defense appoints the first ever CDAIO – Chief Digital and Artificial Intelligence Officer.

- 2021 - **The National Artificial Intelligence Initiative (NAII)** was established by the National Artificial Intelligence Initiative Act of 2020 (NAIIA) (DIVISION E, SEC. 5001) – bipartisan legislation enacted on January 1, 2021. The main purposes of the initiative are to ensure continued US leadership in AI R&D; lead the world in the development and use of trustworthy AI systems in public and private sectors; prepare the present and future US workforce for the integration of artificial intelligence systems across all sectors of the economy and society; and coordinate ongoing AI activities across all Federal agencies, to ensure that each informs the work of the others. www.ai.gov

37

37

Polling Question #3

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Which Agency has contributed significantly to the funding of AI since 1950?

- DARPA - Defense Advanced Research Projects Agency

- NCUA – National Credit Union Administration

- USDA – United States Department of Agriculture

- SOCOM – United States Special Operations Command

38

38

What is Weak AI? Strong AI?

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39

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Two Types of AI

40

40

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Weak AI

- **Weak artificial intelligence (AI)**—also called narrow AI—is a type of artificial intelligence that is limited to a specific or narrow area.

- Weak AI simulates *the effect of* human cognition. It has the potential to benefit society by automating time-consuming tasks and by analyzing data in ways that humans sometimes can't. Weak AI systems do not have general intelligence, they have specific intelligence.

- To further explain - An AI that is an expert at telling you how to drive from point A to point B is usually incapable of challenging you to a game of chess. In the same way, a form of AI that can pretend to speak Chinese with you probably cannot sweep your floors.

41

41

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Weak AI

- *Why is weak AI important?*

- It will reach the productive stage of the hype cycle far faster than any other AI.

- This is one of the things we are looking for … **productivity!**

- For instance, feed a deep learning algorithm with enough pictures of skin cancer, and it will become better than experienced doctors in spotting skin cancer. This doesn't mean that deep learning will replace doctors.

- You need *intuition, abstract thinking, empathy* and a lot more skills to be able to decide what's best for a patient. But the deep learning algorithms will surely help doctors perform their jobs better, faster and tend to more patients in a shorter amount of time. It will also cut down the time it takes to educate and train professionals in the health care industry.

42

42

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Weak AI

Since the early 2010s – funding for narrow AI is rapidly shifting towards the marketplace

The graph to the left from Statista.com represents – **Funding of AI startup companies worldwide from 2014 to 2021(in billion U.S. dollars)**

© Statista 2022

Additional Information   Show source
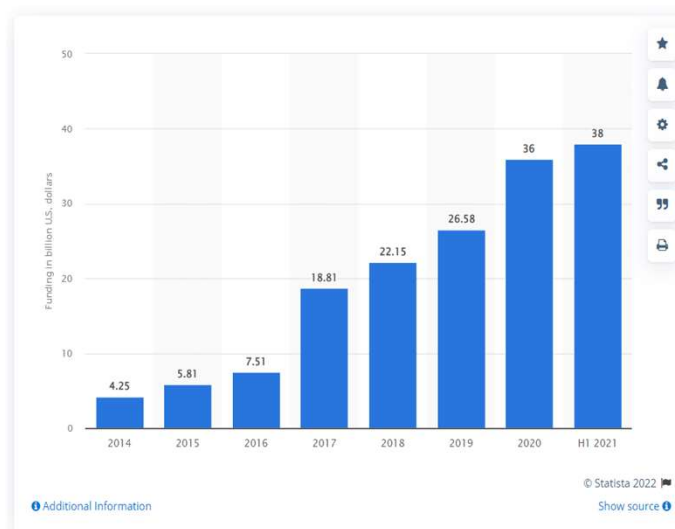
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43

Weak AI

Growth in the AI market from 2020 to 2021 to 2022

The chart to the left from Gartner.com represents –
AI Software Market Forecast by Use Case (Millions of U.S. Dollars), $51BN to $62BN

Table 1. AI Software Market Forecast by Use Case, 2021-2022, Worldwide (Millions of U.S. Dollars)

Segment	2021 Revenue	2021 Growth (%)	2022 Revenue	2022 Growth (%)
Knowledge Management	5,466	17.6	7,189	31.5
Virtual Assistants	6,210	12.0	7,123	14.7
Autonomous Vehicles	5,703	13.7	6,849	20.1
Digital Workplace	3,593	13.7	4,309	20.0
Crowdsourced Data	3,483	13.6	4,171	19.8
Others	27,049	14.1	32,827	21.4
Total	**51,503**	**14.1**	**62,468**	**21.3**

Source: Gartner (November 2021)

44

Weak AI

- Funding for Weak AI systems is faster coming from the private marketplace, now that Weak AI is quickly becoming productive!

- Examples of Weak AI productivity

  - Alexa / Siri Digital voice assistants
  - Netflix recommendation engines
  - Google search engine
  - Website chatbots
  - Waze traffic navigation
  - Tesla Autonomous Vehicles
  - Amazon predictive analytics
  - Military Drones

- *With Weak AI, we are just beginning to achieve productivity!*

45

Weak AI in the Federal Government

- **Multiplying Force Capability** - The US Air Force recently spoke at our Spark + AI Conference on how they are using AI to predict part failures across their fleet of jets. They examine wear patterns and data sets from flight travel to identify when they might have a part failure.

- **Customer Service** - In 2015, the US Citizenship and Immigration Services (USCIS) announced the launch of a chatbot named Emma. Emma can reportedly answer questions on immigration and take visitors to the right page of the USCIS website. The USCIS was receiving a high volume of customer queries, with over 14 million calls on immigration issues each year.

- **Energy Research** - The Energy Department's National Renewable Energy Laboratory, or NREL, is set to gain a powerful new supercomputer that will support huge, data-intensive workloads and necessary research and development to help the nation prepare for future clean energy-aligned needs. Anticipated to operate at approximately 44 petaflops, that fresh machine—named Kestrel—will boast more than five times greater performance potential than NREL's existing system.

46

46

Where are we on Strong AI

- And Strong AI?

- Honestly, we can't even agree on a definition…

- So, no one is actually sure when we would even achieve it…

- Some characteristics we are looking for

  - Generalized knowledge
  - Planning for the future
  - Ability to reason
  - Common Sense
  - Consciousness
  - Discerning emotional needs

- Broadly speaking, right now, most people expect strong AI should be able to do everything human intelligence can do…including create music….but as for now, strong AI is hypothetical…

47

47

Polling Question #4

Which statements below are true?

- Weak AI will never be achieved

- Weak AI has achieved consciousness

- We don't even know how to define Strong AI

- Weak AI is all around us and proliferating quickly!

48

48

In Conclusion

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49

In Conclusion

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So…how have we done since 1950?

So much funding…and what did we get?

Well, we spent billions!!

Maybe in the beginning we were looking for an AI that was very similar to a human generally…*but now we are more focused on AI with focused competencies that can be quickly productive!*

Where do we go from here?

50

50

Ethics and Trustworthiness!

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AI like any other tools reflects the values of those using it! *Yes, weak AI in the hands conflicted objectives or negligent ones, can create all kinds of ethical conundrums.*

In 2020, the DoD, as part of it's AI Strategy, adopted and Ethical Framework for the Use of AI - *Responsibility, Equity, Traceable, Reliable, and Governable.*

In 2022, the National Institute of Standards and Technology (NIST) has announced their *AI Risk Management Framework* to better manage risks to individuals, organizations, and society associated with artificial intelligence (AI). The NIST Artificial Intelligence Risk Management Framework (AI RMF or Framework) is intended for voluntary use and to improve the ability to incorporate *trustworthiness* considerations into the design, development, use, and evaluation of AI products, services, and systems.

51

51

52