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JSOU Quick Look

Artificial Intelligence (AI) Factsheet

AI is not a new phenomenon. It has been present in some way, shape, or form throughout our lifetimes. Due to advances in computing processing power and data availability, AI is exploding in interest and application.

AI TIMELINE

1943
Drawing parallels between the brain and computing machines, Warren McCulloch and Walter Pitts establish foundations of neural networks.

1949
"Manchester Mark 1," the first sorted program computer, is invented.

1950
Alan Turing publishes "Can Machines Think?" (Turing test).

1955
The first AI program, "Logic Theorists," is invented.

1956
At the Dartmouth Summer Research Project on AI, the term "Artificial Intelligence" is coined.

1963
Defense Advanced Research Projects Agency (DARPA) funds AI at the Massachusetts Institute of Technology.

1980
Edward Feigenbaum introduces expert systems.

TIMELINE CONTINUED ON PG. 2

What is AI?

AI is a specific field within computer science that explores how automated computing functions can resemble those of humans.[1] Subfields (see figure 1) such as machine learning (ML), machine vision (MV) e.g. Project Maven, and speech-to-text are all ways in which AI can be applied.

According to existing research, AI is typically grouped into the following three categories:[2]

1. Artificial Narrow Intelligence (ANI): AI that can execute one particular decision type, such as capably play chess. ANI is also described as Weak AI.

2. Artificial General Intelligence (AGI): AI that can execute multiple functions, such as capably play both chess and checkers. AGI is also known as Strong AI.

3. Artificial Super Intelligence (ASI): AI that surpasses human intelligence, such as discovers unexplainable ways to play both chess and checkers. ASI is also categorized as Strong AI.

While scientists have arguably mastered category 1, the development of category 2 is only beginning. Category 3 may be a lifetime away, if ever.

What are Some AI Subfields?[3]

ML: This branch focuses on teaching computer programs through an iterative process, and how to interpret data and learn from it. Depending on the problem that you want solved, ML is further subdivided into three non-mutually exclusive categories: supervised learning, unsupervised learning, and reinforcement learning. With supervised learning, the algorithm is provided labeled data and is tasked with predicting whether the label is correct or not. In unsupervised learning, the program is not fed labeled data but rather is asked to group similar data. Once similar data is grouped, anomalies can be detected in the data. Finally, reinforcement learning does not tell the program how to act but rather allows it to explore and learn based upon the choices it makes. Based upon the correct decisions made, the program will continue to make those choices in the future, but will not make the same choices based upon incorrect choices. Thus, it is a consequence-driven program that attempts to maximize its outcomes.

Deep Learning (DL): This branch is similar to ML, but rather than using algorithms to classify data, DL attempts to imitate the human brain's neurons and synapses. The neural net consists of thousands, sometimes millions, of interconnected nodes with data processed through various layers. While processing through the layers, neurons fire to the next layer if the data was received.

TIMELINE CONTINUED FROM PG. 1

1997
IBM's Deep Blue defeats Gary Kasparov in chess.

2005
A Stanford autonomous vehicle wins the DARPA grand challenge, driving 131 miles across the desert.

2011
IBM's Watson wins Jeopardy! beating two former champions.

2011
Personal assistants, like Siri, become commercially available and use speech recognition to answer questions and perform simple tasks.

2012
A Google Brain computer cluster trains itself to recognize a cat after watching millions of unlabeled images in YouTube videos.

2014
Chatbot Eugene Goostman is said to have passed the Turing test, launching controversy.

2016
AlphaGo beats professional Go Grandmaster, Lee Sedal.

2017
Several different AI programs teach themselves how to write basic code.

2017
The Department of Defense (DOD) partners with Google to create Project Maven, which uses machine vision to distinguish objects in drone videos.

This process is repeated many times, each time weighting the connections to better convey signals through the multiple layers to achieve the desired conceptual output.

Natural Language Processing (NLP): This branch attempts to use algorithms on unstructured human language data to make sense of its meaning and syntax. Thus, the algorithm uses existing grammatical rules, including the structure of sentences and meaning of words, to develop meaning-based user inputs.

Expert Systems (ES): This branch capitalizes on things that are known and can be expressed as an algorithmic ontology. Thus, it takes facts and judgmental knowledge on a particular subject and organizes that knowledge by way of Bayesian probability so that the algorithm can generate probabilistic inferences. An example of ES in practice can be found in the medical field where it assists doctors in laboratory analysis.

MV: This branch attempts to emulate a human's visual sense and judgement capabilities using sensors to capture, recognize, and evaluate images. Broken out into processes, the platform sensors capture still or moving images and then send them to a processing system that recognizes the objects and processes them for further human review. Object recognition occurs by training the system with labeled or unlabeled data.

What are Some AI Strengths?[4]

AI can quickly and effectively provide reliable data analysis to empower decision-making. In doing so, it analyzes and assesses, and ultimately can recommend, potential decisions. As a result, AI can relieve workers of mundane tasks, resulting in cost-savings and allowing them more time to engage in deeper thinking.

In doing so, AI—drawing from large, historical data sources—can also model decision-making options and outcomes to highlight the scope of possibilities that are at one's disposal.

What are Some AI Pitfalls?[5]

To be reliable, AI requires sufficient data on which to base future predictions and decisions. Knowing this, an adversary can "data poison" information, leading to false outcomes and potential risk.

Added to this, some organizations that choose to employ AI are simply adapting it due to the newness of the technology, which admittedly is exciting. However, for AI technologies to be successful, organizations first have to identify the problem their organization wants to solve and then determine whether AI is the best means to achieve the desired ends.

Finally, analysts may take intellectual shortcuts with AI, seeing it as directive versus a recommendation on the scope of possible outcomes.

How Have Special Operations Forces (SOF) Employed AI technologies?

The United States Special Operations Command, in conjunction with the Joint Artificial Intelligence Center (JAIC), has already employed AI technologies in the battlefield. Some examples include utilizing MV to distinguish people and objects in drone videos, a wide-area surveillance sensor system, and predictive maintenance applications. Using MV—an effort that combines both ML and DL—the drone program was able to flag images by category for human review. These objects were classified using SOF data gathered from forward deployed locations. Although the technology was initially only employed in certain areas of responsibility, it has now expanded out to other geographic combatant commands.

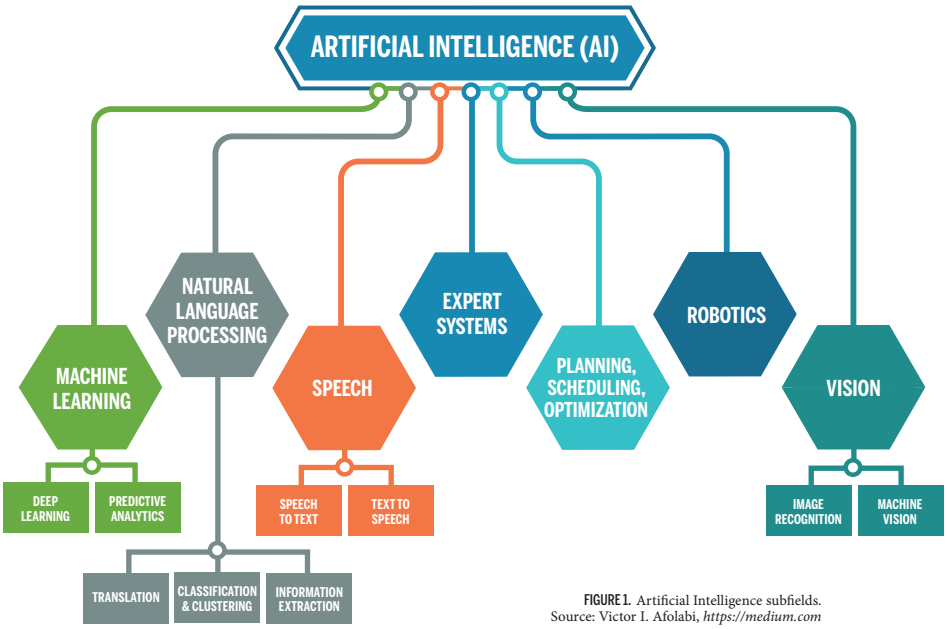

FIGURE 1. Artificial Intelligence subfields.
Source: Victor I. Afolabi, *https://medium.com*

Expanding on the initial successes of AI technologies in the battlefield, the DOD employed Reapers providing an all-seeing eye in the sky that collected a large volume of data. Due to the large volume of this data, analysts could not skillfully and efficiently comb through this data while the intelligence was still relevant. As a consequence, the DOD employed ML technologies to view objects in the videos and flag analysts if anything deemed suspicious appears. Using a large video data set, ML has been able to train the sensor system to drastically reduce the number of false positives.

Predictive maintenance is a final example of SOF employing AI, again working with the JAIC and Carnegie Mellon University. SOF aviators figured out they could conduct predictive maintenance on Night Stalkers for the 160th Special Operations Aviation Regiment. The predictive maintenance saved SOF resources since they knew when to repair the helicopters based off historical data and sensors collecting current data. ■

AI/Big Data Reading List

Endnotes

1. Pedro Domingos, *The Master Algorithm* (New York: Basic Books, 2015), 7.
2. Max Tegmark, *Life 3.0* (New York: Random House, 2013), 39.
3. David Ellis and Mark Grzegorzewski, *Big Data for Generals* (Tampa: JSOU Press, anticipated publication date 2021).
4. Judea Pearl and Dana MacKenzie, *The Book of Why* (New York: Basic Books, 2018), 16-19.
5. Nate Silver, *The Signal and the Noise* (London: Penguin Books, 2015).

Additional References

- Nick Bostrom, *Superintelligence* (Oxford: Oxford University Press, 2014).
- Vishal Maini and Samer Sabri, *Machine Learning for Humans* (self-pub., 2017).
- Peter W. Singer and August Cole. *Burn-In: A Novel of the Real Robotic Revolution* (Boston: Houghton Mifflin Harcourt, 2020).

Where Can I Learn More About AI?

Free Online AI Education

- "Elements of AI," Reaktor and the University of Helsinki, *https://www.elementsofai.com/*
- "Google AI," Google Education, *https://ai.google/education/*
- "Machine Learning University," Amazon, *https://www.aws.training/*
- "How to Create a Mind: Ray Kurzweil at TEDxSiliconAlley," *https://www.youtube.com/watch?v=RIkxVci-R4k*
- "AI with AI," Center for Naval Analysis (CNA), *https://www.cna.org/news/AI-Podcast*

Other AI Resources

- Center for Autonomy and Artificial Intelligence at CNA, *https://www.cna.org/caai/*
- Technology Policy Program at Center for Strategic and International Studies, *https://www.csis.org/programs/technology-policy-program/technology-and-innovation/artificial-intelligence*
- Artificial Intelligence and Global Security at Center for New American Security, *https://www.cnas.org/artificial-intelligence-and-global-security*
- Cybersecurity Initiative at New America, *https://www.newamerica.org/cybersecurity-initiative/*
- Artificial Intelligence at RAND, *https://www.rand.org/topics/artificial-intelligence.html*
- Artificial Intelligence at Mckinsey & Company, *https://www.mckinsey.com/featured-insights/artificial-intelligence*

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