Artificial Intelligence

Nathan K. Waskiewicz, Jennifer Alcantara

Progression in AI Machines

April 25, 2021

Project Summary

AI machines have evolved greatly over time. It's incredible, especially in such a short period of time. The world has started off with simple reactive machines that have evolved to supercomputers that can think faster than humans, even in as little as one billionth of a second.

We would like to dive in and go in depth on the details of AI's advancements overtime with demos, research, and examples.

Project Goals

- To give a detailed understanding of how Artificial Intelligence developed from the 1950's to the present-day machines we see in 2021.
- To show how AI is still developing to this day and what the future will hold for AI, including projects currently in development as well as theorized possibilities for where AI can go.
- Provide research and information from scholarly articles on how specific AI machines function, and how they came to be. Example: WABOT-1, Deep Blue, IBM Watson, Google searches, etc.
- Provide visual examples of past and recent AI with brief photos and videos.

Work Plan

- Provide in-depth research on the progression of AI systems.
- Decide which examples to provide
- Create a demo on a low-level, reactive machine example
- Create a demo for a more advanced AI system example

- Include all information and finalize presentation

Research

Artificial Intelligence has many definitions. The one that we would like to use for this work is: “machines, artificially rationally thinking as human beings, and performing human actions and/or making decisions in the same way a human would”.

- *Reactive Machines*: simplest level of robot

Before the 1960’s AI was gradually progressing. There were movies, novels, and smaller computer systems. In the 1950’s, robots were being used in an assembly lines. General Motors installed its own robotic arm to assist in the assembly line in 1961. In 1969, Stanford's engineer Victor Scheinman created the Stanford Arm, a 6-axis robot that could move and assemble parts in a continuous repeated pattern.

In the 1960’s, AI progressed rapidly. In the 1970’s the Wabot-1 came to life. It was the first anthropomorphic robot. It had three systems: a conversation system, limb-control system, and a vision system. It was created in Tokyo, at the Waseda University. It communicated to humans in Japanese and was also able to measure direction and distance using artificial eyes, ears, and mouth, and external receptors. It was able to grip and transport objects and walked with its lower limbs. It was determined that Wabot-1 had the mental capacity of a 1-and-a-half-year-old child. Wabot-1 was considered a “personal robot”.

In the 1980’s Wabot-2 was designed. Unlike Wabot-1, a “personal robot”, Wabot-2 was a “specialist robot”. Its goal was to play a keyboard instrument. This robot was able to have conversations with humans and read and play average melodies on an electrical organ. Although Wabot-1 aim was to be a “personal robot”, Wabot-2, truly accomplished this title.

- *Limited Memory:* a limited memory machine

Deep Blue was a machine created beginning in the late 1980’s by a team of computer scientists. At completion in the year 1996, the machine consisted of two towers each standing

over 6 feet tall, containing in total over 500 processors that would aide in computing the best possible move to play in a game of chess. Deep Blue was first paired in a series of matches with world chess champion Gary Kasparov in 1996. At the time, it could compute around 100 million moves every second with its processing power. The machine lost in a series of games to Kasparov, and was taken back for re-design and improvement in order to face Kasparov again in a years' time. With upgrades to its processing power and efficiency, in 1997 Deep Blue was able to process almost 200 million possible games states per second. This upgraded version of the machine was then able to defeat Kasparov the following year, winning the series over 7 matches with 2 victories, 1 loss, and 4 draws.

The extent of Deep Blue's impact would go beyond chess, however, with its AI being crucial in the creation of machines that would help in the medical field by aiding in creating new drugs, machines that could predict financial modeling, as well as perform massive calculations for other fields such as physics with the huge computational power that Deep Blue possesses. However, only 20 years later similar AI are extremely more efficient. For example, stockfish, which is available for use on both top chess websites chess.com and LiChess, can analyze 70 million moves and outcomes per second. This is without needing two 6-foot-tall towers in order to compute these moves, while also being theorized that if it were to face Deep Blue, stockfish would win 9 out of 10 games on average. In 2019, stockfish was upgraded via the use of NNUE (neural networks). The implementation of NNUE into stockfish has made it about 10 times stronger than the previous version of itself, meaning that this new NNUE stockfish would be as much stronger as the previous version of stockfish as that version was to Deep Blue. In other words, the implementation of NNUE into stockfish in one year made the same jump in computational power and chess prowess that was made in the 21 years between 1997 and 2018. With further advancements of this type on chess playing robots, many believe that chess could become "solved" in the near future, meaning that the AI would always be able to find the best possible move and with optimal play, could never lose a game.

Watson is a machine created by computer scientists at IBM in the early 2000's, with its completion coming in 2011, named after IBM's founder Thomas Watson. The machine can process human voice and use text-to-speech to translate this into data that it can process, a technology developed by IBM in 2004. This means the machine can answer questions asked of it

by humans. This is a huge step from a machine such as Deep Blue which needed to be fed input manually by a human operator before it could calculate the next move to make. Watson processes data at 80 teraflops per second, which is about equal to the processing power of a high functioning human being. Watson contains 2880 processors in comparison to Deep Blue's 500, which accommodates about 15 Terabytes of storage space.

Because of its text-to-speech nature, Watson was tested against humans in a game of Jeopardy in 2011. The machine was able to beat arguably the best Jeopardy player of all time, Ken Jennings, over the course of a week of games. Watson would need to listen to the question asked, process the text, and come up with an answer pulling from its plethora of accessible data, made up of 90 servers including 200 million pages of information. Watson was then able to respond with a human-like voice to give its answer. In 2016, Baker Hostetler, a law firm from Ohio, outsourced a project named Ross to IBM. The goal was to develop a Watson-like machine that would take speech input and give an answer in short time in order to help the firm answer complex questions in a short amount of time. Ross can min data from around 1 billion text documents in order to come up with an answer to most complex questions asked of it in about 3 seconds. Similar systems to Ross are being developed that will aide medical field in a similar way that Ross is able to aid the legal world. One such example is how Watson was implemented in treatment centers in order to recommend treatments to cancer that would best suit the patient while minimizing costs.

- *The Theory of Mind*: machines that "understand" people and humans have emotions.

Theory of Mind AI is still mostly in early development. It's the ability to predict information based on reading emotions of others. This system can interact with humans emotionally as well as provide information. Instead of asserting a generative model, the real goal is to learn autonomously using limited data. Without visiting the next agent, it will know how it's going to act and collect its data for other agents.

There are generally two broad categories in Theory of the mind, theory theory and stimulation theory. Theory theories are when an intelligent agent's understanding of another's mind is based on innate or learned rules, sometimes known as folk psychology. Stimulation theory hypothesizes that cognitive introspection utilizes the same processes as interaction with an external environment.

A loose example of Theory of Mind is self-driving cars, also known as autonomous cars. In the sense that they make decisions consciously considering human emotions (not running over people while traveling, etc.) But again, it is a work in progress.

In London, a team has created a Theory of Mind AI system. It's called ‘ToMnet’, and it can observe and learn other AI systems. Like our brain, it has three artificial neural networks, each with a different computer program. ANN 2 builds an understanding of AI beliefs. Outputs of 1 and 2 are input into ANN 3, and ANN 3 outputs data based on observation.

Once it is accomplished, this form of AI will be able to interact with humans socially and be able to interact with the environment more successfully.

Current common AI such as Siri are not Theory of Mind AI as they do not comprehend emotion in humans or are able to convey different emotions back to humans when in use.

- *Self-Awareness*: machines that have human-level consciousness and understand their existence in the world

These AI are still only works of science fiction; however, it could be possible someday.

This agent would have self-awareness of its world, surroundings, existence, it would be an independent intelligence to the humans that created them.

They would be able to think and act on their own, likely would be indistinguishable from humans in interaction, and could possibly even become smarter than the human beings that created them.

Examples of AI use

Google Maps uses AI in order to track real time traffic reports and predict the shortest possible route accounting for current traffic conditions to present to the user. The app utilizes this information and performs search over all possible routes in order to discover which route is the

optimal for the user to take. (GIF for presentation of a simple search being performed, breadth-first or uniform cost?)

Ride sharing apps such as Uber and Lyft have been utilizing machine learning algorithms in order to train the apps to suggest the best possible ride to both the driver and the user in order to maximize driver availability while keeping the cost as low as possible for the users. The AI is also used to calculate things such as optimal pickup location, estimated arrival times, etc.

Commercial airlines almost all use autopilot for flights. On average, it is estimated that there is only about 7 minutes of human input on a flight, normally just during takeoff and landing periods. Similar technology is being extended to self-driving road vehicles, which become more common every day via the likes of Tesla. However, we are still working towards developing fully autonomous vehicles and optimizing currently existing self-driving cars.

It also includes mobile check deposits, face recognition (Facebook), plagiarism checks, online shopping, Alexa/google home.

The use of AI is everywhere, and humans are extremely dependent on it. It's almost as if most humans almost don't even recognize it.

Demonstration

In the attached code, we have a simple example of a reactive artificial intelligence agent. The agent can take some input text written by a user, and output a response based on key phrases read in the text blurb. This agent can have a few short lines of dialogue with the user, giving sequential responses based on the inputs of the user and the answers the user gives to the agent as it responds.

This is considered a form of reactive artificial intelligence because the agent can only discover certain key phrases in the user input and output a previously specified response based on the words it finds. It cannot learn from prior conversations or remember prior conversations in

order to come up with new responses in the future, the main feature that distinguishes this agent from being a form of limited memory artificial intelligence.

Attached is a video explaining and demonstrating use of this AI.

Conclusion

Overall, we have discussed the four main distinct forms of artificial intelligence as well as key milestones and machines made for each one of them. The progression of machines such as the first reactive AI that could work assembly lines doing repeated motions or solve answers to questions but never remember its past interactions, to agents that repeat and remember actions millions of times to learn such as Deep Blue or who have access to millions of pieces of information, to the future of AI such as machines like ToMnet that could interact with humans on an emotional level. Over the course of just about 70 years, all of this progression took place, and we continue to march forward ever faster into the future of technology and the advancement of artificial intelligence.

References

Burns, Ed. “What Is IBM Watson Supercomputer? - Definition from WhatIs.com.” *SearchEnterpriseAI*, TechTarget, 27 June 2018, searchenterpriseai.techtarget.com/definition/IBM-Watson-supercomputer.

Davies, Aran. “A Giant Leap For Humankind: Theory Of Mind AI.” *DevTeam.Space*, 15 Mar. 2021, www.devteam.space/blog/theory-of-mind-ai/.

“Deep Blue.” *IBM100 - Deep Blue*, www.ibm.com/ibm/history/ibm100/us/en/icons/deepblue/.

Faggella, Daniel. “Everyday Examples of Artificial Intelligence and Machine Learning.” *Emerj*, Emerj, 11 Apr. 2020, emerj.com/ai-sector-overviews/everyday-examples-of-ai/.

Fonseca, Lauren. “An Introduction to Artificial Intelligence: The Four Types of AI.” *Homepage - The Difference Engine*, TheDifferenceEngine, www.thedifferenceengine.tech/blog/2019/11/an-introduction-to-artificial-intelligence-the-four-types-of-ai.

“Humanoid History -WABOT-WAseda RoBOT-.” *Humanoid History -WABOT-*, www.humanoid.waseda.ac.jp/booklet/kato_2.html.

John Scott, et al. “The History of Artificial Intelligence.” *Science in the News*, 23 Apr. 2020, sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/.

Reynoso, Rebecca. “A Complete History of Artificial Intelligence.” *Learning.g2.com*, Learning Hub, 1 Mar. 2019, learn.g2.com/history-of-artificial-intelligence.