

Artificial General Intelligence

"I'm sorry Dave, I'm afraid I can't do that" – HAL 9000

This is a famous line from Stanley Kubrick's 2001: A Space Odyssey. This film released to critical acclaim in 1968 at a time when interest in artificial intelligence was at an all-time high. The field of research was new and exciting. In 1956, American computer and political Scientist Herbert A. Simon predicted "machines will be capable, within twenty years, of doing any work a man can do". However, as we know this was not the case. In fact, research in the field, which had mainly been funded by the American Department of Defence, was brought to a standstill as progress wasn't being made towards a true artificial intelligence. This period is now referred to as the "AI Winter".

Artificial Intelligence Today

But now over 50 years later the Boom is back and research into machine learning and artificial general intelligence is steadily increasing year on year with more and more huge corporations devoting increased time and funding into these technologies. The increased computational power of today's computers and the huge amounts of data that is collected daily around the globe also lends itself to a resurgence in the field of AI research.

Terms like machine learning and artificial neural networks have become buzz words in recent years but that doesn't mean they aren't legitimate paths to achieving a general intelligence. Machine Learning is a field of AI research that uses statistical techniques to give a computer system the ability to "learn". This means an algorithm can be trained to solve a problem without it having to be explicitly coded. The systems learn by progressively improving their performance at a task. For example, an image classifier, let's say an algorithm that can determine whether a picture contains a cat or a dog. The algorithm or "model" will be fed a large data set of labelled images of cats and dogs. The model will make predictions on what it thinks the image contains, given as a percentage of certainty, and then it will readjust its parameters (known as weights and biases) to try and get a better result on subsequent predictions.

Before today the computational power to drive machine learning algorithms wasn't at a stage yet where it could perform all the calculations required for training these machine learning models in a reasonable time, in addition to this access to huge amounts of data from the internet etc. provide the perfect data sets to training model for solving real world problems e.g. self-driving cars recognising road signs.

OpenAI

OpenAI is a non-profit artificial intelligence research company. Their goal is to further AI research in a way that will benefit mankind in its entirety. Because OpenAI is a non-profit organisation it is free from the need to generate a financial return meaning they can direct their research towards an overall positive impact on society.

As OpenAI state themselves, that the field of artificial intelligence research has always been a surprising one. In the early days, it was thought that the ability to solve certain complex problems like playing chess would lead to a human level artificial intelligence. However, the algorithms written to solve these types of problems turned out to be far less general than researchers had hoped. Essentially these algorithms just involved calculating the best outcome of vast amounts of move in the case of chess.

Modern day research, as I stated earlier, involves deep learning where instead of hand coding solutions you can set out an architecture (an artificial neural network) which can readjust itself based on the data that you input. This is the machine learning and training of models I referred to above.

In recent years these new deep learning techniques have produced amazing results in areas such as image classification, machine translation and speech recognition.

OpenAI Founders

Ilya Sutskever is the research director and co-founder of OpenAI. Ilya, obtained his Bachelors, Masters and PhD in computer science from the University of Toronto under the supervision of Geoffrey Hinton, who was the world's previous leading researcher in the field of artificial intelligence. Sutskever has also written many papers on artificial intelligence, specifically in the areas of deep learning techniques and the future of artificial intelligence. He is widely considered one of the worlds experts in machine learning.

After year of research in Stanford and again with Hinton back in Toronto, Ilya was hired by Google's artificial intelligence research team "Google Brain". Here he worked with a team to create the sequence to sequence learning algorithm, which is a fundamental part of machine learning algorithms, specifically in for machine translations.

The Future of OpenAI

Modern AI systems have hugely impressive capabilities but thus far the range of problems they can solve is quite limited. The team at OpenAI are working relentlessly to keep expanding the realms of possibilities for artificial intelligence solutions, until they hopefully achieve a general artificial intelligence which could be a hugely beneficial tool for society. The team at OpenAI is also very concerned about the possibility of a human-level artificial intelligence being built incorrectly or used for the benefit of a small group of people to the detriment of society as a whole.

OpenAI Projects

Dota

The first OpenAI project that caught my attention, was the team's foray into professional gaming. In August 2017 OpenAI pitted a system they had trained using deep learning techniques against the Dota 2 world champion in a 1 v 1. Dota is a version of a real-time strategy game which requires a huge amount of skill and a high level of strategic thinking. For more information on the game and how it's played [see here](#).

This project bears many similarities to training an AI to play chess competitively, or the AlphaGo project by the DeepMind research team which made headlines in 2015. However, Dota is a far more complex game to master because of the number of move and different characters (heroes) a player can choose from, this means there is an incredible number of permutations of situations any player could find themselves in. Which is a huge leap forward from teaching an AI to play chess as there are far less possible moves to make.

The fact that the game is played in real-time also presents a challenge because the AI no longer has a turn to make its decision on what to do next. Speed is an essential part of the game; the AI must make all its decisions in a matter of milliseconds. The AI won the matches convincingly against all human opponents. The system was able to master the game so quickly by using a learning technique called self-play where the system will train against itself, across multiple games concurrently to accrue a wealth of experience and knowledge in a short space of time. The OpenAI system was able to play hundreds of years' worth of games in a matter of weeks giving it the upper hand against expert human players who had been training for years.

OpenAI Five

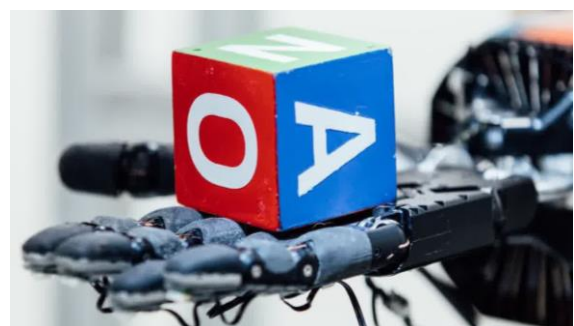
A little under a year later the team was prepared for another bout of Dota 2 but this time they competed in a 5 v 5 match which creates an almost incalculable amount of possibilities per game. OpenAI's team of five managed to defeat a pro team of human players in just over 14 minutes (an evenly matched game of Dota takes about 45 mins).

The AI also mastered another extremely difficult part of the game which is the character draft, at the beginning of each games pick from a large roster of character which have a wide variety of strengths and weaknesses, the system was able to effectively identify which would work well in a team together and at the same time would be effective counters to the character choices of the opposing human players.

While these are still extremely niche problems in terms of a general artificial intelligence solution they show a huge leap forward in the capabilities of AI to become extremely effective at a task without the need for a hand coded algorithm i.e. using machine learning to develop algorithms that are almost impossible for a software engineer to code themselves.

Learning Dexterity

The team at OpenAI is also working to create solutions real-world problems. In this project the team trained a robotic hand with human-like anatomy to preform fine object manipulation. The hand received information from three RGB cameras and the coordinates of the fingertips of the hand. This was to mimic our own sight and touch senses.



The AI system was given an object in the palm of its robot hand and was required to reorient the object in a specific way. The system learned to solve this problem in a simulated environment without any human input. These trained models were then put to the test in the real world. Training AI systems in a simulated environment allows for far faster learning, as simulations can be run much faster, concurrently and the ability to tweak parameters and conditions such as friction constants and object colours. Again, allowing the AI to gain years' worth of learning experience in a matter of hours. On the other hand, the it is extremely difficult to produce an accurate simulation of real-world physics.

Through its training the AI develops “Emergent Behaviours” without any explicit instructions or incentives from humans aside from the “reward” system of reaching the desired goal. Some of these strategies are often used by humans in object manipulation as well such as, pivoting the object around the fingers and sliding the object along the palm of the hand.

This project effectively solves a major difficulty in robotics, emulating the bio-mechanics of the human body to allow robots to manipulate a wide variety of objects. To make decision on where to move the hands fingers to reorient the object the AI using two independent neural networks, one for the computer vision (identifying the current orientation of the object) and one to estimate the next pose the hand needs to move the object towards the desired orientation.

OpenAI's Impact

Founded in 2015 OpenAI has already made huge progress in the field of artificial intelligence. I believe their mission to develop a general artificial intelligence, in a democratized and open source environment will be the key to providing a safe AI that can benefit society as a whole. Many people suspect that once a powerful enough AI is created the rate of improvement will be exponential which could pose problems on a global scale if used maliciously.

Because of this OpenAI's is committed to developing a software that is safe in the long term, so not only are they making progress on developing AI technology a large part of their research is dedicated to making sure any general artificial intelligence developed by themselves or otherwise is going to be safe and that the wider community of AI research teams also adopts these practices.

References

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