Applications of Artificial Intelligence

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Applications of artificial intelligence (AI) are a convergence of cutting edge research in computer science and robotics. The goal is to create smart machines, that can perform complex tasks on their own. The applications of the field exist in every field, where intelligent analysis, precision, and automation is necessary.

It's Jeopardy, My Dear Watson.

Watson, IBM's cognitive system defeated two legendary players, Ken Jennings and Brad Rutter in the Jeopardy Challenge, using its natural language processing and machine learning abilities. To answer the tricky questions posed in this game, the computer had to understand complex nuances of natural language and analyze huge chunks of data. And no, it wasn't connected with the Internet.

How can an organic mass of mere three pounds question the origin of the universe, learn to communicate, build stuff, create works of art, figure out the physical laws that govern the universe, harness them, and transcend the limitations of a planet to travel beyond? Yes, we are talking about the human brain, a complex network of more than 200 billion neurons, with more than 125 trillion synaptic connections between them, that somehow manages to be self aware. Intelligence is an emergent phenomenon that arises out of this complex charged neural network. It is the ability to think, imagine, create, understand, recognize patterns, make choices, adapt to change, and learn from experience. The goal of modern artificial intelligence research is to create a non-organic machine-based entity, that has all the above abilities of a natural organic intelligence. At least, that's the goal of Strong AI proponents.

It is the ultimate challenge for an intelligence, to create an equal, another intelligent being. It is the ultimate form of art, where the artist's creation, not only inherits the impressions of his thoughts, but also his ability to think.

Initial hopes of computer scientists of creating a self-aware entity, were dashed hopelessly as they realized how much they had underrated the human mind's capabilities. How do you teach a machine to imagine? They realized that what makes natural intelligence, the human mind possible, should be first understood. Only then could they move towards their goal.

The Turing Test provides a methodology for identifying an artificial intelligence. It essentially says that if you question a human and an artificially intelligent being and if by their answers, you can't distinguish between the two, you have succeeded in creating an artificial intelligence. However, modern though differs considerably, as Peter Norvig and Stuart Russell say in their text on the subject (Artificial Intelligence: A Modern Approach),

Yet Al researchers have devoted little effort to passing the Turing Test, believing that it is more important to study the underlying principles of intelligence than to duplicate an exemplar. The quest for "artificial flight" succeeded when the Wright brothers and others stopped imitating birds and started using wind tunnels and learning about aerodynamics. Aeronautical engineering texts do not define the goal of their field as making "machines that fly so exactly like pigeons that they can fool even other pigeons".

Approaches to AI

Initially, researchers thought that creating an AI would be simply writing programs for each and every function, that an intelligence performs. As they went on with this task, they realized that this approach was too shallow. Even simple functions like face recognition, spatial sense, pattern recognition, and language comprehension were beyond their programming skills.

They understood that to create an AI, they must delve deeper into natural intelligence first. They tried to understand how cognition, comprehension, decision-making happen in the human mind. They had to understand what understanding really means. Some went into the study of the brain and tried to understand how the network of neurons creates the mind.

Researchers branched into different approaches, but they had the same goal of creating intelligent machines. Let us introduce ourselves to some of the main approaches to artificial intelligence. They are divided into two main lines of thought, the bottom-up and the top-down approach.

Neural Networks

This is the bottom up approach. It basically aims at mimicking the structure and functioning of the human brain, to create intelligent behavior. Researchers are attempting to build a silicon-based electronic network that is modeled on the working and form of the human brain. Our brain is a network of billions of neurons, each connected with the other.

At an individual level, a neuron has very little intelligence, in the sense that it operates by a simple set of rules, conducting electric signals through its network. However, the combined network of all these neurons creates intelligent behavior that is unrivaled and unsurpassed. So these researchers created a network of electronic analogs of a neuron, based on Boolean logic. Memory was recognized to be an electronic signal pattern in a closed neural network.

The human brain works by recognizing patterns and remembering them. Similarly, neural networks have the ability to learn patterns and remember. This approach has its limitations due to the scale and complexity of developing a replica of a human brain, as the neurons number in billions. Currently, through simulation techniques, people create virtual neural networks. This approach has not been able to achieve the ultimate goal but there is very positive progress in the field. The progress in the development of parallel computing will aid it in the future.

Expert Systems

This is the top-down approach. Instead of starting at the base level of neurons, by taking advantage of the phenomenal computational power of the modern computers, followers of the expert systems approach are designing intelligent machines that solve problems by deductive logic. It is like the dialectic approach in philosophy.

This is an intensive approach as opposed to the extensive approach in neural networks. As the name expert systems suggests, these are machines devoted to solving problems in very specific niche areas. They have total expertise in a specific domain of human thought. Their tools are like those of a detective or sleuth. They are programmed to use statistical analysis and data mining to solve problems. They arrive at a decision through a logical flow developed by answering yes-no questions.

Chess computers like Fritz and its successors that beat chess grandmaster Kasparov are examples of expert systems. Chess is known as the drosophila or experimental specimen of artificial intelligence.

The Agent Approach

Modern AI researchers have taken a different approach, largely modeled on the concept of a rational agent. An agent receives percepts from the environment and performs actions accordingly, to maximize its chances of success in achieving an objective. Most modern AI applications are built upon this central idea. The agents receive percepts (information about their environment through sensors) and perform an appropriate action through their installed actuators. They are programmed with a set of possible permutations and combinations of percepts that they might receive, along with the set of possible actions that will be executed in response to them. The task of the designer is to think about all possible environmental stimuli that could be received by the agent and a corresponding set of responses that could maximize its chances of achieving a predefined objective.

Machine Learning

Field of study that gives computers the ability to learn without being explicitly programmed.
- Arthur Samuel

One of the prime approaches, with the widest range of applicability, is machine learning, whereby a program learns to recognize patterns out of data, through a process dubbed as 'learning', which may be supervised, unsupervised, reinforcement type, or developmental. This pattern detection provides the program with predictive power to extrapolate future behavior patterns of any system. More specialized branches of this field like 'Deep Learning' are finding increasingly greater applications in scientific and technological endeavors.

Applications of AI

Artificial Intelligence has applications in every field of human endeavor. It combines precision and computational power with pure logic, to solve problems and reduce error in operation. Already, robot expert systems are taking over many jobs in industries that are dangerous for or beyond human ability.

Self-Driving Cars

Autonomous self-driving cars are already a reality. Run by the on-board Google Chauffeur software program, 'Stanley', an autonomous robotic vehicle created by a Google team led by Sebastian Thrun, won the USD 2 million 2005 DARPA Grand Challenge. Today, the US states of Nevada, Florida, and California have a small fleet of licensed Google driverless cars running on their roads. Fitted with laser radars and advanced equipment, the car's inbuilt software analyzes its environment through a 3D map of all objects in its vicinity. By identifying each object in real time, it can plan an appropriate course of action while driving, by controlling the acceleration, steering, as well as braking. By April 2014, the self-driving car fleet has logged in 1.1 million km of accident-free driving.

The Robotic Music Maestro

Programs like OrchExtra and Melomics, Omax, and Emi have been created that can compose music or provide automated accompaniment during performances. Software like StarPlayIt and SmartMusic provide interactive music learning.

Machine Translation

Automated machine translation systems have been deployed widely on the Internet, that use statistical and learning algorithms to translate between any two pair of languages, whose sizable data sets are available for analysis. Over time, they have gotten better at providing translations with higher accuracy. The Google translate feature uses the same statistical technique to identify the best translated versions from one language to the other.

Fighting Email Spam

Learning algorithms have been deployed to fight the spam that invades inboxes all over the world. Today, these programs reportedly block about 80% to 90% of spam that would have otherwise entered into your mailbox, potentially creating a security threat for your computer. The algorithms are designed to learn with time, to recognize and understand every type of new spam mail, to keep evolving as better spam fighters. Every time you mark an email as spam, the software learns a new sample for identification, that makes it sharper in separating spam from important mails.

Algorithmic Trading

Software programs which can predict trends in the stock market have been created, that have been known to beat humans in terms of predictive power. Algorithmic trading is widely used by investment banks, institutional investors, and large firms to carry out rapid buying and selling activity, to capitalize on lucrative opportunities that arise in the global markets. Not

only are the software programs predicting trends, but they are also making decisions, based on pre-programmed rules. The machine learning software can detect patterns which humans may not see. Heaps of data from decades of world stock market history are fed to these algorithms to find patterns that can offer an insight into making future predictions. Banks use intelligent software applications to screen and analyze financial data.

IBM's Watson

IBM has developed an advanced computing system called Watson, named after the company's legendary founder, that has natural language processing, hypothesis generation, and dynamic learning abilities. Besides defeating two former Jeopardy champions, it is now being utilized in creating a cluster of cognitive apps that can be used to solve real world problems, through an application programming interface (API), provided by IBM. Watson is powered by 2,880 POWER7 (3.5 GHz) processor cores, with 16 Terabytes of RAM. In terms of performance, this supercomputer stands at 80 TeraFLOPs. The company's goal is to unleash Watson's abilities to analyze unstructured data on a global level, providing intelligent decision-making ability in all types of fields, including medical diagnosis. Currently, IBM is offering Watson Solutions as a service for customer engagement, healthcare, finance, and accelerated data research.

Intelligent Personal Assistants: Google Now and Siri

Artificial intelligence has reached our smartphones and mobile devices today, through personal assistants like Siri and Google Now, that can learn your usage pattern, requirements, and preferences and provide you with intelligent recommendation, reminders, and knowledge navigation. These services offered by Apple and Google respectively, have natural language processing abilities that let them understand your voice commands or questions and provide immediate actions or replies based on available data, from web services and apps.

Speech Recognition

Neural networks, natural language processing, and machine learning algorithms are used in improving speech recognition, for use in various devices. Google has improved the speech recognition used in its various applications including Google Voice and Google Now, using machine learning techniques.

AI in Heavy Industries and Space

Robotics and cybernetics have taken a leap, combined with expert systems. An entire process is now totally automated, controlled, and maintained by a computer system in car manufacturing, machine tool production, computer chip production, and almost every high-tech process. They carry out dangerous tasks like handling hazardous radioactive materials. Robotic pilots carry out complex maneuvering techniques of unmanned spacecrafts sent in space. Japan is the leading country in the world in terms of robotics research and use. All the rovers that landed on Mars had an in-built operating system that could control, plan, and strategize their movements, as well as deploy on-board equipment, without help or intervention from Earth.

Spin-Offs From Computer Science

Researchers in quest of artificial intelligence have created spin-offs like dynamic programming, object oriented programming, symbolic programming, intelligent storage management systems, and many more such tools. The primary goal of creating AI still remains a distant dream but people are getting an idea of the ultimate path which could lead to it.

Autopilot Mode in Aviation

Airlines use expert systems in planes to monitor atmospheric conditions and system status. The plane can be put on auto pilot, once a course is set for the destination.

Weather Forecasting

Neural networks are used for predicting weather conditions. Previous data is fed to a neural network which learns the pattern and uses that knowledge to predict weather patterns.

Computer Vision

One of the most vibrant areas of research, computer vision, that involves the building of algorithms that can help automate recognition of objects and environment by machines, is one of the foremost applications. Automated intelligent visual recognition software can be used in industrial as well as information technology sectors. Google recently developed an algorithm that could correctly recognize the faces of cats from the billions of images strewn on the Internet.

Swarm Intelligence

This is an approach to, as well as application of AI, similar to a neural network. Here, programmers study how intelligence emerges in natural systems like swarms of bees even though on an individual level, a bee just follows simple rules. They study relationships in nature like the prey-predator relationships that give an insight into how intelligence emerges in a swarm or collection from simple rules at an individual level. They develop intelligent systems by creating agent programs that mimic the behavior of these natural systems.

Most of the applications discussed above are focused on automating tasks through machine learning and the brute force of computing power. Machines are still not close to actually understanding the meaning behind the data or making analogous connections between different types of information, which is the first step towards real intelligence.

Is artificial Intelligence really possible? Can an intelligence like a human mind surpass itself and create its own image? The depth and the powers of the human mind are just being tapped. Who knows, it might be possible, only time can tell. Even if such an intelligence is created, will it share our sense of morals and justice, will it share our idiosyncrasies? This will be the next step in the evolution of intelligence. Hope I have succeeded in conveying to you, the excitement and possibilities this subject holds.