Era of Advancing Artificial Intelligence (AI): History and Discovery of Future Artificial Intelligence Scenarios

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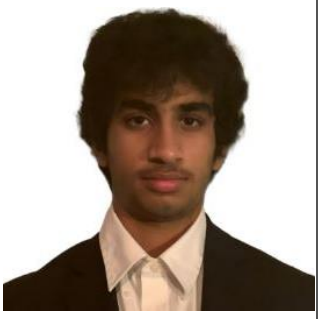
Abstract:

Since its founding in the 1955 Dartmouth Conference, AI has experienced significant changes to become what it is today. As computers have gotten stronger, and as people have become more knowledgeable on the capabilities of AI, the power and use of AI has increased heavily, and continues to do so. AI has also improved and developed some core features, including NLP, clinical uses, and nonclinical uses. AI is already making a big impact on the world today, as it is helping complete simple tasks, which has had negative impacts, like taking people's jobs and being used unethically, but it has also had positive impacts, like helping employees and companies work more efficiently by letting AI complete small tasks. Certain features of AI like deep learning allow AI to have as big of an impact as it does, and as its capabilities will only continue to increase, AI will have a significant impact in the future world.

Introduction:

Artificial intelligence's (AI) role has significantly increased since its birth. Since its beginnings in the 1900's, AI has experienced numerous advancements to expand its abilities. AI has abilities ranging from analyzing data to make predictions to performing human activities more efficiently. However, it was not always like this, as AI's capabilities were limited until the recent decade. The term "Artificial intelligence" was first coined by John



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McCarthy in 1956 in a conference in Dartmouth (Skinner 2012). However, he was not the only contributor to the origin of AI. In the same conference, Allen Newell, Herbert Simon, and John Shaw all contributed to the first ever AI program, the Logic Theorist. This program did things like prove mathematical theorems and mimic the brains of mathematicians. After the Logic Theorists, Newell and Simon continued to make new AI programs with new capabilities throughout the mid to late 1900's.

Artificial intelligence has numerous different meanings, as it is a broad term that has many uses and impacts. In a 2004 paper (revised in 2007), John McCarthy defined AI as "the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable" (McCarthy 2007). Although the first real AI technologies have only been made in the last century, the thought of it has been around for long before that. Numerous technologies where the machine does most of

the work compared to the human started to be created well before the 1900's. For example, the first calculator was made in 1642, and machines like the cotton gin were introduced in the late 1700's and early 1800's. Although these machines aren't a direct example of AI, the introduction of them shows how philosophies were changing during this time, which eventually led to the invention of direct representations of AI like the AI programs we see today.

How AI Has Progressed:

Among the first AI devices was the "Logic Theorist," made by Allen Newell, J.C. Shaw, and Herbert A. Simon in 1955. Designed to emulate human problem-solving and prove mathematical theorems, it marked the beginning of AI exploration. Then, in the late 1950s and early 1960s, researchers introduced other early AI programs, like Frank Rosenblatt's "Perceptron," a neural network-oriented device for image recognition (Khan *et. al* 2021). As the 1960s and 1970s unfolded, AI research progressed with systems such as Dendral and MYCIN, dedicated to chemical analysis and medical diagnosis. These rule-based systems relied on specific knowledge for decision-making. These early AI devices were task-specific, and they lacked the versatility of modern systems. The 21st century experienced significant advancements in machine learning, particularly deep learning. Fueled by neural networks with numerous layers, deep learning transformed AI, enabling systems to learn from extensive data and independently extract features from the data. This was a significant advancement, as early AI devices were only able to use a specific set of data to perform their tasks. Today's AI devices, including virtual assistants, image recognition systems, and intricate natural language processing models, evolve from the foundation of devices like the "Logic Theorist", utilizing advanced algorithms and computing power for impressive abilities.

One early AI self-learning programs was the Samuel Checkers-playing Program (shown first in 1956), which was a program that could play checkers against someone else by itself (Khan *et. all* 2021). This program worked by calculating the win probability based on the position and determined that next move based on that. Furthermore, the application also remembered positions that it faced earlier (using rote learning, which allows AI to remember things), allowing it to become more efficient in determining the next best move. These techniques helped the program become a good checkers player, which showed when it played a publicized match against one of the best checkers players at the time, Robert Nealey, and won. Techniques like rote learning and using statistics paved the way for numerous other AI inventions that used similar methods.

When AI was in its beginning, the thought of the high capabilities of it spread quickly. The government quickly became interested, and the optimism of how strong AI could become increased heavily. Additionally, the possibilities of AI's functions increased as computers became more powerful and more accessible, and the first language translator marked a big step for AI's usefulness in the real world. However, during this time, there were still many obstacles that AI had to overcome. Although computers became more powerful in the late 1900's, they still weren't powerful enough to do anything big. So, AI's capabilities were limited at the time because computers were too weak to allow AI to maximize its potential. Now, with computers being more powerful than ever, and more and more of AI's features are being discovered, AI is stronger than it has ever been.

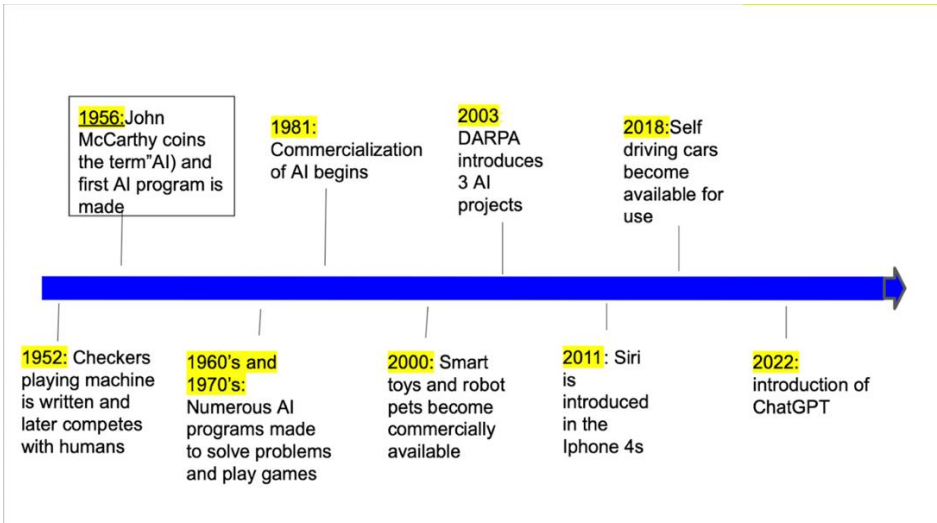

Figure 1: A timeline of some milestone events relating to Artificial Intelligence

Recently, AI has become a big part of human life. For example, Chat GPT, an AI program, can do many things like function as a search engine, generate ideas for humans, provide solutions to problems, and many more. AI has had an impact on almost every field in the world today, and its impact is projected to only become bigger in the future. Because AI is and will continue to be an important aspect of people's lives, it is important to know how it started and how it has changed. With this, people can make predictions and suggestions on how to improve AI and how to adapt to improved AI, so they can get ready for and succeed in the new digital world.

Modern AI's function is widespread, as more than 80% of people use an AI powered technology. However, near its beginning, AI's function was a lot more limited. It still had some capabilities, like playing games and translating languages, but the big breakthroughs of AI took place in the late 2000's and early 2010's. Data science, a new field related to AI, became popular during this time. The use of data science activities helps extract information and knowledge from data (Provost *et. all* 2013*)*. This new field, which consisted of advanced analytics in computer science, opened a whole world of new possibilities for AI. Furthermore, in 2012, AlexNet, an AI tool that could classify images, won a competition by receiving a 10.8% lower error rate than others, as it achieved a low error percentage of about 15% (Krizhevsky *et. all* 2012). This was considered one of the biggest events in the advent of modern AI, as it showed AI's capabilities. AlexNet's use of GPU was a building block for future modern AI, as the GPU helps AI use high speed computing power. Since then, AI has become stronger and more efficient. Now, AI includes numerous different technologies that have many different functions. For example, some are used for communication (language translators), some for reasoning, and some for finding information (ChatGPT).

Neural Networks and Deep Learning:

The main thing that has allowed AI to make the significant advancements that it has is machine learning. Machine learning helps AI learn, and it does this by creating algorithms to represent data sets (Allen 2020). Machine learning can be categorized into 4 categories: supervised, unsupervised, semi-supervised, and reinforcement learning.

Supervised learning involves machines using patterns from a data set to make predictions on what future data sets will look like. They base these sets on a target from a feature (for example, the price of a product could be a target) that shows them what the pattern is from the data set. Unsupervised learning happens when machines aren't given a target to show the patterns, so the algorithm created must determine if there is a pattern and what the pattern is by itself. Semi-supervised learning is like a mix of the other two, and it is most effective when part of a data set has features with a target, and the other part just has features. Lastly, reinforcement learning is used to make an algorithm help find an optimal answer to a problem (Li 2018). There is no clear answer to the problem, but there is an overall objective, and reinforcement learning helps find the best way to reach this objective. For example, in a shooting game like Call of Duty, a task could be to kill all enemies. However, there is no one specific way to kill all of them, as the player decides that. This would be an example of where reinforcement learning is needed.

Within machine learning, there are two key concepts that AI uses. The first is artificial neural networks (ANN). Artificial neural networks, somewhat based on biological neural networks, is a network of a group of processors/nodes. The processors are connected through the network, and these connections allow an input to be processed to create an output. There are many different types of artificial neural networks. One common one is feedforward networks, where the network takes an input, and then this data flows in only one direction throughout the network until it is processed and produces an output from an output node. A common use of this is in speech recognition applications. Another type is convolutional networks, which is mainly used in image processing. Instead of a 2D arrangement of the nodes, there is a 3D arrangement, and the third dimension is called the convolutional layer. The network converts parts of the image and processes it, and it does this for each part of the image. A last common type is recurrent neural networks. A key difference in this type is that the network processes the input to help predict the outcome (so it might not make the right prediction at first). This type is mainly used for things like text to speech translation. These are three common types of artificial neural networks, but there are many more types. Artificial neural networks use mostly supervised learning when making algorithms and processing data.

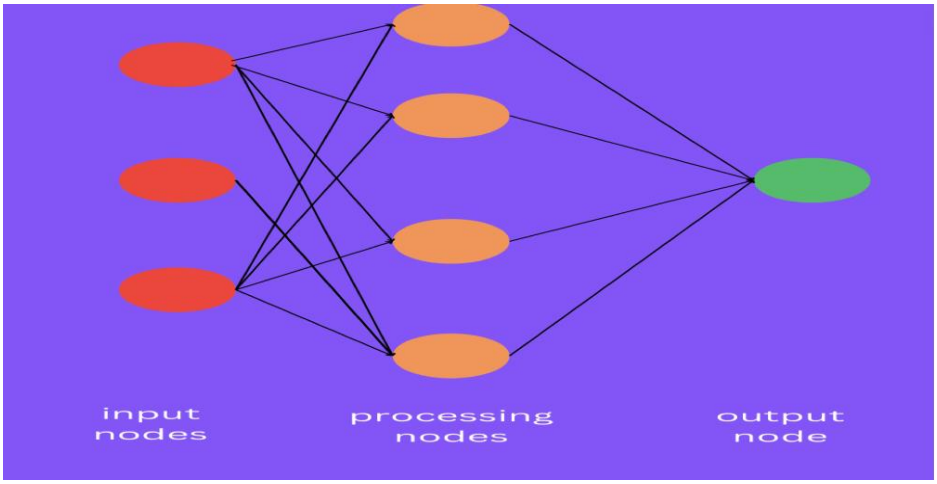

Figure 2: showing a basic representation of how a neural network works

The other concept is deep learning. Deep learning is the use of multiple artificial neural networks (so multiple layers of networks) to have more accuracy in the networks (Allen 2020). Since the networks are layered, each network produces an intermediate output, and it flows through all the layers until the last one produces an accurate output. Because the data has to go through many networks, each more specific layer produces a more accurate output, until the final layer produces the most accurate one. So, deep learning requires things like more computing power, but it provides more accurate outputs. Because it is multi-layered, deep learning can use different types of machine learning, including unsupervised, semi-supervised, and reinforcement learning.

NLP: A Core Power of AI

Natural Language Processing (NLP) has experienced significant advancements with the development of AI. NLP is a process where AI represents and processes different human languages. Until 1990, it was hard to make much progress on developing and advancing NLP because computers were limited in terms of power. However, with new computers and AI advancements, many improvements to NLP have been made, including speech recognition, dialogue systems, and language processing.

NLP is one core feature of machine learning in AI. NLP is what allows computers to translate languages, so it is a core part of features like voice to speech translation. To translate languages, NLP uses a method called tokenization. Tokenization is defined as converting text into smaller parts (tokens). This allows machines to use and process these smaller sized tokens so that they can efficiently translate it.

There are multiple different types of tokenization. Word tokenization is the most common, and it involves splitting text into single words. So, for example, if the text says, “hello my good friend”, the machine may cut this into 4 parts, “hello”, “my”, “good”, and “friend”, and will translate each one of these instead of translating the whole thing together. This may cause some errors in how the text is spoken or written, so the machines use statistical data to minimize these errors.

Another type of tokenization is character tokenization. This splits the text into very small characters. If the text says “Hello”, the characters will be “H”, “e”, “l”, “l”, and “o”. This tokenization helps with some of the errors produced in word tokenization, but because the characters are usually very small, the length of the inputs and outputs increases tremendously with an increased text size, so this tokenization can be very inefficient at times.

The last type of tokenization is subword tokenization. This type of tokenization is like a mix of the first two types. Subword tokenization splits text into subwords, so that big words are split into multiple parts. Subword tokenization doesn’t split common words into subwords, but it does split rare words into subwords. For example, the word “hello” would be split as “hello”, but the word “chairs” would likely be split into “chair” and “s”. Subword tokenization attempts to minimize the errors brought by word tokenization and character tokenization.

Figure 3: showing different types of tokenization

Additionally, to cater to how languages are used in the real world rather than how they are supposed to be used, computational NLP uses statistics based on large amounts of data based on human conversation. Because NLP works by cutting the text into smaller parts, the meaning of the full sentence may be lost when translating each part by itself, because it may not translate the same when taken as separate words rather than a full sentence.

Clinical and Non-Clinical Uses:

AI can play a big part in the healthcare industry, and its part in this industry is referred to with clinical terms. Clinical terms in the context of AI refers to how AI is applied in the healthcare field. There are many applications for this, as many new technological devices used in the industry are related to AI. For example, AI is used to manage patients' data, help interpret medical images (X-rays, MRIs, etc.), and provide information that can help professionals make decisions. However, AI is not only used in the industry. Nonclinical terms refer to the application of AI outside of the medical field. AI is used in many ways outside of the healthcare industry. For example, many AI devices have been made to make tasks easier for humans, with uses like analyzing business data, managing and assessing financial data, self-driving technology, smart-home technology, and NLP. Furthermore, AI is also used for entertainment, as it is used for video games, virtual reality, and movies (AI can help enhance special effects). Although they are two separate things, the clinical and nonclinical applications of AI have had a profound impact on the world today. As more research and advancements are made on AI, these applications will only become larger.

Ethical and Social Implications of AI:

There are many features and uses of AI that have societal and ethical impacts on the population. For example, with AI learning to perform more and more tasks, people can start using this for their own work. Many people are now able to perform writing tasks by simply putting something into an AI application, and AI's features have expanded to things like creating art as well. This could have a big impact on the arts and literature field because of AI's increased capabilities. People could, ethically or unethically, use AI to make their art or writing. AI's capability of doing this could lead to improved efficiency for companies and others when working, but people can also use it unethically to exploit or cheat their work.

AI also has other unethical implications that could cause big problems in the future. For example, AI can make spreading fake news easier. With the heavy increase in social media use, more and more people are getting their information from social media. People can use AI to mimic real informative posts, but the information itself can be false. Spreading misinformation can be used for things like scams, and AI just makes this easier. Additionally, AI can allow people to plagiarize more without getting caught. Writers can directly copy other peoples' work and paste it into AI to rephrase it. This is just another of the many ways AI can be used unethically.

AI can also have big social implications where the ethical use of it can be questioned. Artificial intelligence programs can make big implications on the internet and social media. These programs can make it easier for users to see others' private accounts, which can lead to harmful consequences. Furthermore, people can use AI to help create fake personas on the internet. These can be used on social media

in attempts to scam, or on apps like chatting or dating apps by pretending to be someone else, which can also have dangerous implications. So, AI has many potential dangerous ethical implications on society.

Figure 4: Showing some unethical and ethical uses of ChatGPT and other OpenAI sites

How AI has helped some key industries:

AI has made significant impacts to various industries all around the world. However, two major industries that AI has impacted are the medical and pharmaceutical industry, and it has mainly done this in two ways. The first way is that it has helped collect, manage, and analyze large amounts of clinical trials. Instead of humans managing and analyzing heaps of trials, which takes a very long time, AI can do this much quicker. AI can go through thousands of trials in mere seconds, and it can do things like extract information or recognize patterns, depending on what is wanted. Additionally, AI can also minimize the effect of human error when collecting and tallying/extracting data. Humans may glance over certain data or misread some information, but AI will fix these problems.

AI also affects these two industries by helping with supply chain management. AI can use some of its properties mentioned before like machine learning and artificial neural networks to make predictions for the supply chain (Dash *et. all* 2019). For example, AI can estimate demands for certain products and thus provide an estimate of how many of these products should be produced These estimates can account for overproduction or underproduction, which disrupts the supply chain and has a negative impact economically. In addition to keeping the supply chain stable, AI can also help with the safety of the supply chain in the pharmaceutical industry AI can manage the regulation processes with more accuracy and a faster rate, which will help safe drugs reach the market quicker and better prevent harmful ones from reaching it. To find harmful drugs, AI can use machine learning algorithms to predict possible negative effects of drugs, and it can inspect the drug's properties to check for any potential flaws in its structure, which can vastly improve the safety of drugs on the market (Dave 2024).

Basic Future Outlook for AI:

In the future, AI will have a plethora of opportunities to change the world in new ways. As AI becomes more proficient in things like completing basic tasks, it can start performing jobs as well as humans do, causing some people to lose jobs. AI will be able to perform tasks like taking orders and reporting them, helping in customer service, etc. However, although some people may lose jobs to this, AI also creates many jobs. AI is predicted to a significant number of jobs in the future, and many businesses are starting to hire workers for AI-related positions, like software engineers and data analysts (REABCIUC *et. all* 2023). So, AI will most likely be something that people will see more frequently in the future. Furthermore, AI will likely play a bigger role in healthcare. It will become more efficient in areas like analyzing data from patients and detecting possible diseases and/or illnesses to improve healthcare. As ongoing research in AI algorithms continues, predictive analysis's capabilities will be further extended, which can be applied to numerous different fields. Overall, AI's capabilities will only continue to get stronger, which will make it an even bigger, more prominent part of the world.

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Conclusion:

All in all, AI has made significant advancements since its founding to become as powerful as it has today. Some of its biggest features include NLP, artificial neural networks, and deep learning, all of which have become significant parts of everyday lives. It has had and continues to have major impacts in many industries, namely the healthcare industry and its sub-fields. It has also transformed lives socially, although sometimes the uses of AI in certain situations can be ethically questioned. Lastly, in the future AI looks to have a major role in everyday living, and this brings many positive effects, however, there are some threatening negative effects as well. This increased role also brings problems because sometimes AI can be exploited and used unethically, and its unethical use also only increases as well. Lastly, with the use of features like neural networks and deep learning, has made and continues to make major impacts in various industries, including the medical and pharmaceutical industries. AI, which was once small and just looking to break through, now has broken through and plays a major part of human life, and its power will only continue to emerge as more advancements are made.

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