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CSC 448: Artificial Intelligence

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What is Artificial Intelligence and Why is it Important?

Abstract:

The idea behind making intelligent machines may have been a fever dream of the past, but with the introduction of the technologies such as machine learning, natural processing, and neural networks that dream is now a reality. Artificial Intelligence is the science of creating smart computer programs in a way that attempts to replicate human intelligence. AI is already present in many of our industries of today and will continue to expand and become an even more integral part of human lives. With this in mind it is important to understand the features of AI, some definitions and terms that are being used as well.

Introduction:

The definition of Artificial Intelligence (AI) is that it is a branch of computer science which deals with intelligence of machines and an intelligent system is defined as one that is able to take actions that maximizes its success. To first understand the idea behind Artificial Intelligence we must understand that unlike computers, humans possess what is called natural intelligence. Natural or human intelligence is largely influenced by what the human has experienced in the past based on different situations and environment. Some of the things that can be considered to be a strength of human intelligence are that humans have the creativity, intuition and emotional intelligence that artificial intelligence severely lacks, the ability to adapt to unexpected situations, which

cannot be said is completely true for Artificial Intelligence. Another possible strength of human intelligence is the ability to consider the ramifications of actions when it comes to decision making. That being said however, human intelligence is definitely not without its weaknesses. Some weaknesses of human intelligence are that humans are severely limited by their own physical and mental capabilities, and are often prone to biases which may lead to poor decision making and mistakes. Finally, one of if not the biggest weakness of human intelligence is that humans require rest, and the consequence of that is that it slows down the process of learning which is a weakness that Artificial Intelligence does not suffer from.

Strengths of AI:

Artificial Intelligence has strengths that make up for the weaknesses found in human intelligence such as the ability to process extremely large amounts of data at a rate that is significantly faster than what humans are capable of, while also able to perform tasks that are too dangerous for a human to attempt. One significant strength of AI is that it does not require the rest that humans need in order to function. This strength alone has allowed the technology associated with AI to see significant advances albeit with a shorter time frame. Despite the extremely powerful strengths AI has as a tool, it also has its limitations that at this moment in time cannot be completely compensated for without the usage of human/natural intelligence. While humans make decisions based on past experiences and which by extension is technically a form of data, there are many other components that are factored into making these decisions. It is different with AI because AI makes decisions solely on the data that it has access to, which makes the decisions that AI makes purely objective. It might seem like a strength at

first, but it should be noted that an AI can only make decisions as good as the data it has been given. Because of this if the data that an AI is trained upon is not good or biased in any way, the decisions that the AI makes will reflect that.

Weaknesses of AI:

However even with some of the weaknesses that inherently has, it is still a very powerful tool that can be leveraged to increase productivity and solve specific problems. AI can generally be grouped into two categories which are called “Strong AI” and “Weak AI”. Like with human and artificial intelligence, strong and weak AI have their own strengths and weaknesses as well. Some of the advantages that can be seen with strong AI is that strong AI has the potential to perform any intellectual task that a human can, strong AI also has the ability to work WITHOUT the guidance of humans, and may possibly develop creative solutions to more complex problems. Strong AI is still very much in the developmental and research stages, and there are moral and ethical concerns and risks associated with the development of this type of AI.

Weak AI on the other hand is still classified as Artificial Intelligence, and is already a widely used technology in the world. Weak AI is very good at performing specific tasks that they are programmed for in a way that is much faster and more efficient that humans can. These types of AI can handle large amounts of data and have the ability to work without requiring rest. These weak AI’s still have the ability to improve with the usage of AI technologies such as machine learning and neural networks. The weakness however is that these AI’s are not really able to perform tasks outside of their specific programmed domain. This weakness however is propelling the desire to create

what is known as a “General Purpose AI” whose goal would then be to be able to handle tasks from many domains or industries.

Applications of AI:

Some of these areas in which AI is already present and being utilized are the finance, healthcare, marketing, entertainment, customer service and education industries. Tasks that would have in the past required human supervision can now be offloaded to AI to allow for humans to focus on more important matters. For example, fraud detection in the finance industry can now be automated based on trends and data from users to predict the probability of fraudulent transactions and prevent identity theft. Within the healthcare industry, AI can utilize given data to predict the likelihood of a disease or possibly diagnose a patient with an efficiency that most doctors may not necessarily be able to do. Within the marketing and entertainment industries, data about customers may be utilized in such a way that content such as advertisements and other recommendations seem personalized.

Technologies employed in AI:

Artificial Intelligence at this point may seem like a very powerful tool and may possibly be applied to almost anything but it would be naive to have this train of thought. Artificial Intelligence is definitely not without its limitations due to its heavy reliance on data and technologies employed when it is being developed. Some of the technologies that are used to develop such AI have their own inherent limitations. Some of these such technologies include machine learning, natural language processing (NLP), neural networks, machine vision and knowledge based systems.

Machine Learning:

Machine Learning is a term that you might hear very often when the topic of AI comes up, and that is partly due to it being what people may associate the phrase “Artificial Intelligence” with. Machine learning is an application of AI where a machine is not programmed directly with instruction on how to do a task, rather as the name of the technology suggests, these machines “learn” and improve themselves based on the experience. How these machines are able to understand how to improve is through the usage of algorithms such as Supervised Learning, Unsupervised Learning, and Reinforcement Learning. With supervised learning, a machine uses labeled datasets to be able to classify data and predict outcomes whereas in unsupervised learning a machine is given unlabeled datasets which it then it uses patterns or similarities and differences in the data and then categorizes the data without the need for human intervention. Reinforcement learning is similar to supervised learning but the machine is not trained using sample/labeled data but instead goes through trial and error. Positive outcomes will then reinforce the ability of the machine to come up with the best solution for a given problem.

Natural Language Processing (NLP):

Natural Language Processing or often referred to as NLP generally refers to the interactions between computers and human language where computers are programmed to process natural human languages. Human languages are often hard for computers or machines because they have trouble understanding the underlying context of the sentences that are formed when humans are talking to each other. NLP aims to tackle this problem through using algorithms to process the human language into a format that computers can understand and work with. Examples of these can be

seen in Google Translate or other online customer service chat bots where variations in typing styles may pose a challenge for machines to understand fully. Using technologies like transformer models allow for AI models to be created which utilize different components of the transformer technology such as Encoder only models that typically excel in sentence classification or entity recognition. Decoder only models utilize the decoder part of the transformer model and are often called auto-regressive technologies including OpenAI's ChatGPT or Google's Bard. Technologies that utilize both the encoder and decoder components of the transformer model are called sequence to sequence models and are generally best suited for tasks that involve summarization, translation or generative question answering because with the usage of both components the the model is able to access parts of the context that is further away from the source.

Neural Networks:

Neural Networks are another form of technology that was inspired by the human brain. Within neural networks are nodes that represent the neurons in the human brain. These nodes are then connected to other nodes within the brain just like in the brain with other neurons. Neural networks are somewhat of a black box because after they have been trained with a learning algorithm, a neural network will take inputs and give outputs. Because of this, neural networks almost seem magical. A neural network however is usually organized into multiple aforementioned nodes within layers that are the input layer, hidden layers and output layers. With each node is a predefined activation function that decides whether the node’s input should be important in the prediction process of the network itself. Some examples of activation functions are the

Sigmoid activation function, ReLU (Rectified Linear Unit) activation function, and the SoftPlus activation function. Between each node is a weight that is determined through the processes, one of which is called backpropagation.

Artificial Intelligence is definitely a powerful tool that may seemingly be able to solve a lot of if not all of our problems in the industry. AI is a very versatile tool that when employed properly may increase productivity significantly. AI is definitely one of the crowning achievements of humanity but as humans we must understand just how AI can benefit us we must understand the underlying technologies that are being employed underneath the hood. AI is not the answer to every single problem because while there are strengths with the technology there are some glaring weaknesses and issues regarding ethics. As humanity continues to employ AI technology and as the technology continues to evolve, understanding the fundamentals, ideas and concepts are integral to stay competitive within the workforce.

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