



Artificial Intelligence, Machine Learning, and Deep Learning: Are They All the Same?

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Artificial Intelligence (AI) is a field of computer science and computer systems that emphasizes frameworks to perform tasks that conventionally are perceived as requiring human cognition and intelligence. It is an industry that has been progressing and integrating into our daily lives through the technologies we use. With recent scientific developments, Machine Learning (ML) and Deep Learning (DL) have been prominent names associated with AI. While there is an overlap among all of them, they are not the same.

WHAT IS ARTIFICIAL INTELLIGENCE?

As the name implies, the goal of Artificial Intelligence is to create machines that emulate human intelligence “artificially.” To be able to understand what this means, we must first learn what constitutes intelligence within a human. Capabilities that we often take for granted, including our reasoning abilities, linguistic competence, problem solving, visual and auditory perceptions, and how we learn, are broad categorizations that constitute our intelligence. These in fact are quite difficult to simulate in artificial systems owing to their complex computational nature and limitations in transferability.

There are many areas of research within AI that have had practical applications for the general public. Natural Language Processing (NLP) is a subset of AI that builds computational tools for analysis and modeling of human text, such as [machine translation, summarization, and question-answering](#). NLP is prominent within our [daily utilities, including email filters, search results, and predictive text](#). Machine Vision is another subset of AI that aims to simulate the visual perception component of human intelligence. Through a combination of hardware and software tools, machine vision aims to analyze images and provide predictive insights for human guidance. A popular application of machine vision is for autonomous vehicles: self-driving cars use [multiple cameras, lidar, radar, and ultrasonic sensors](#) to process the visual field around the car in order to make decisions on driving. Another major application of machine vision is in healthcare. From biomedical image analysis to surgical guidance, machine vision enables healthcare providers to detect illness earlier and create preventative measures for optimizing health outcomes. A subset of AI that sees overlap with machine vision is robotics. Although we perceive the field of robotics as encompassing humanoid robots like Sophia, there are many other subfields within robotics. For

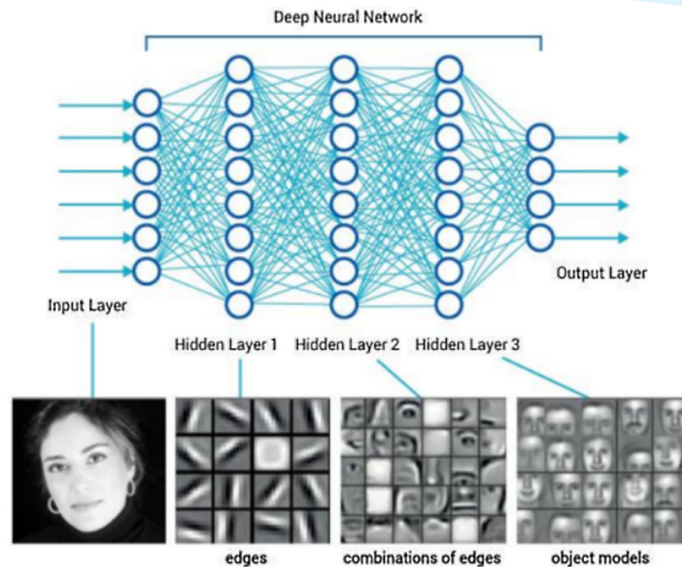
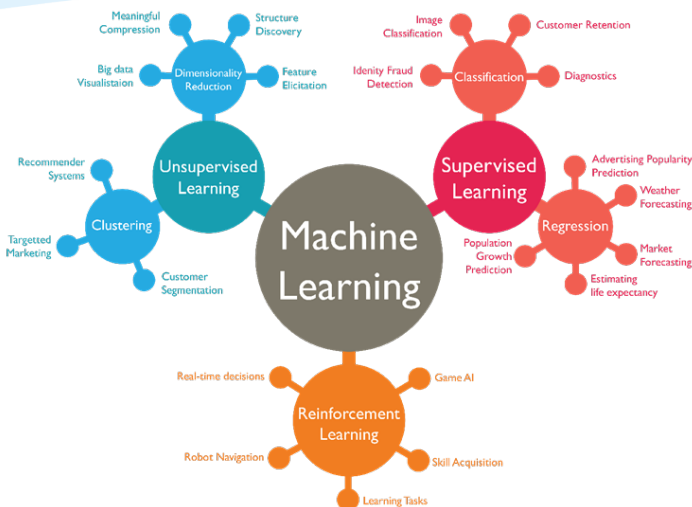


example, there are [autonomous robots](#) that function independently from human intervention like the iRobot vacuum cleaners and there are [augmented robots](#) that enhance human capabilities like robotic prosthetic limbs.

WHAT IS MACHINE LEARNING?

Like the subsets of AI discussed above, Machine Learning (ML) is just another subset of AI. Thus, all of ML can be considered AI, but not all AI can be considered ML. Put simply, Machine Learning uses statistical algorithms to understand large quantities of data and finds patterns that we can use to gain insight on the data as a whole. Any digital information can constitute as data and therefore can be run through a machine learning algorithm to obtain these insights. Many of the products we use today have some form of machine learning pipeline implemented into their workflow, including [Netflix, YouTube, Spotify, Facebooks, and even voice assistants like Siri and Alexa](#). The unique aspect of ML is our ability to teach the machine how to learn without explicit, programmed instructions. The data is what the machine learns from.

Data is important for learning; thus, the quality and quantity of data both play an integral role in the predictive insights that can be extracted. We can train the algorithm by using a subset of our data, which we will call the “training set”. Once the algorithm goes through a set number of iterations through the training set, we can use the rest of the data not shown to the machine as a “testing set.” This is analogous to a student in a classroom learning a new subject. The teacher teaches them, the student absorbs the information and tries making connections as the material is presented to them, and then they are tested on their comprehension of the sub-



ject through an exam. Likewise, the algorithm going through the training set is like that student learning the material in class and the testing set is like the exam.

The main types of ML that we will go through are Supervised Learning, Unsupervised Learning and Reinforcement Learning. In [Supervised Learning](#), the data is labeled to tell the machine the exact patterns it needs to look out for. Suppose you have a classification problem. There is a dataset with images of apples labeled as “apples” and oranges labeled as “oranges” and the task of the algorithm is to classify the image associated with apples and oranges correctly. This is a Supervised Learning example because the training data already consists of input vectors and their corresponding targets. In Unsupervised Learning, there are no labels on the data and the algorithm must draw insights without this added crutch. Suppose now the data contains images of apples, oranges, and bananas without any labels on them. This would likely be a clustering problem where the algorithm parses the data and finds patterns among the images with different fruits and subsequently groups them together. [Reinforcement Learning](#) is based on the maximization of reward as the algorithm learns what to do and how to map situations to actions. In this form of learning, the machine learns through trial and error. The agent is subsequently rewarded or penalized based on the answer. Thus, as the model gains more reward points, it trains itself in the correct path to follow. [AlphaGo](#), a program created to compete against players in the game Go, used reinforcement learning to beat the best human competitors.

WHAT IS DEEP LEARNING?

Deep Learning (DL) is a subset of Machine Learning. It is a method that relies heavily on data representations in contrast to task-specific algorithms. As a result, the [computers learn from experience and understand the world in terms of a hierarchy of concepts](#). Inspired by the human brain, deep learning mainly utilizes artificial neural networks (though

there are multiple different methods within deep learning) to extract features from the data shown to it. The above section discussed that in machine learning, we have to tell the machine the specific features in which various parts of the data can be separated. The neural network, on the hand, runs through the data and automatically extracts the features that best represent the data. The beauty in deep learning is that as we advance as a civilization and have more access to data, the performance of deep learning models also increases. Traditional Machine Learning usually plateaus after a certain quantity of data and its performance flattens. This has been a major reason for why Deep Learning has become popular in recent times, where technology has driven improvements in the data we acquire and store.

An application of Deep Learning is Speech Recognition, something that is out of the scope for ML. Additionally, DL has played an integral role in Self-Driving Cars. In addition to using ML principles, as these cars obtain more data and tracking measures about driving behavior on the road, they improve and become more efficient as autonomous agents. For that reason, the reason for software updates for Tesla vehicles is so that the model gets trained with the extra data collected from Teslas driving on the road to improve overall performance.

IMPLICATIONS AND NEXT STEPS

As [Dong et al. 2020](#) writes in their Review of Human Intelligence and AI, “AI, which simulates human operational intelligence, is far superior to human beings in computing speed, capacity, and accuracy” which will allow AI to “help humans in more fields and more profoundly.” Although AI, ML, and DL are still in their budding stages of conception, there are many advancements owing to progress within these fields that have helped humans lead better lives. Enabling more people to understand the conceptual frameworks around



these principles will allow diverse perspectives to approach the field and thus become better utilized by more people. My hopes in this lecture series are to at least introduce or make the concepts within AI less daunting and more approachable.

REFERENCES

<https://qualitastech.com/difference-between-ai-ml-dl/>

<https://towardsdatascience.com/machine-learning-algorithms-in-laymans-terms-part-1-d0368d769a7b>

<https://iq.opengenus.org/hidden-layers/>