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A Review of Deep Learning

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ABSTRACT: Deep Learning is simply a kind of Machine Learning, inspired by the structure of a person's brain. Deep learning algorithms plan to draw similar conclusions as humans would by continually analyzing data with a given logical structure. To realize this, deep learning uses a multi-layered structure of algorithms called neural networks. Next, we review several specific application areas that deep learning has been wont to solve. While one goal of deep learning is to style algorithms that are capable of solving a broad sort of tasks, thus far a point of specialization is required.

Historical Trends in Deep Learning

It is easiest to know deep learning with some historical context. Instead of providing an in depth history of deep learning, we identify a couple of key trends:

- Deep learning has had an extended and rich history, but has gone many names reflecting different philosophical viewpoints, and has waxed and waned in popularity.
- Deep learning has become more useful because the amount of obtainable training data has increased.
- Deep learning has improved to grown in size over time as computer infrastructure (both hardware and software) for
- Deep learning has solved more complicated applications with increasing accuracy over time.

What is deep learning?

Deep learning may be a subset of machine learning, which is actually a neural network with three or more layers. These neural networks plan to simulate the behavior of the human brain—albeit faraway from matching its ability allowing it to “learn” from large amounts of knowledge. While a neural network with one layer can make approximate predictions, and extra hidden layers can help to optimize and refine for accuracy.

Nowadays, Deep learning provides many AI (AI) applications and services that improve automation, performing analytical and physical tasks without human interference. Deep learning technology lies behind in our everyday products and services such as digital assistants, voice-enabled TV remotes, and MasterCard fraud detection and also as emerging technologies such as self-driving cars.

Deep learning allows machines to unravel complex problems even when employing a knowledge set that's very diverse, unstructured and inter-connected. The more deep learning algorithms learn, the higher they perform.

Why Are Deep Learning Models

Deep learning techniques are so powerful because they learn the simplest thanks to represent the matter while learning the way to solve the matter. This is often called representation learning.

Representation learning is probably the most important differentiation between deep learning models and classical machine learning algorithms.

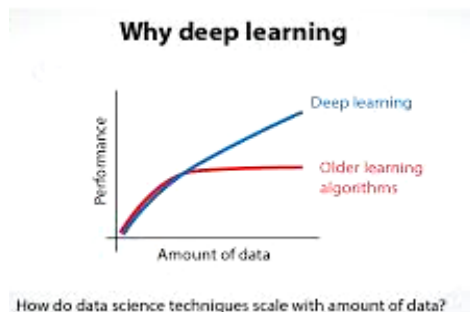


Figure 1: Why Are Deep Learning Models

It is the facility of representation learning that's spurring such great creativity within the way the techniques are getting used. For example:

- Deep learning models are getting used for very difficult problems and making progress, like colorizing image and videos supported the context within the scene.
- Deep learning models are getting used in bold new ways, like cutting the top off a network trained on one problem and tuning it for a totally different problem, and getting impressive results.
- Combinations of deep learning models are getting used to both identify objects in photographs then generate textual descriptions of these objects, a posh multi-media problem that was previously thought to need large AI systems.

Deep Learning vs Machine Learning

We use a machine-learning algorithm to parse data, learn from that data. And make informed decisions supported by what it's learned. Basically, deep learning is employed in layers to make a man-made "neural network". Which will learn and make its intelligent decisions?

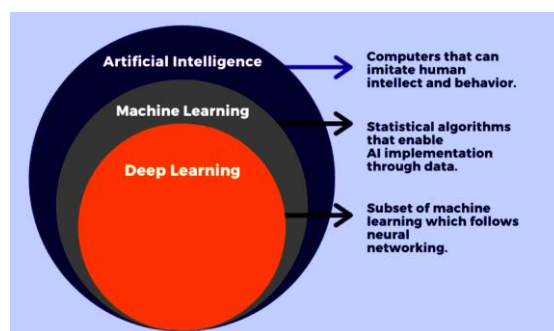


Figure 2: Deep Learning vs Machine Learning

Let's we understand the comparison of deep learning vs machine learning through their features as follows:

1. Data dependencies: Performance is that the main key difference between both algorithms. Although, when the info is little, deep learning algorithms don't perform well. this is often the sole reason Deep learning algorithms need an outsized amount of knowledge to know it perfectly.

2. Hardware dependencies: Generally, the deep learning process depends on high-end machines. While traditional learning depends on low-end machines. Thus, deep learning requirement includes GPUs. That's an integral part of its working. Also, they are doing an outsized amount of matrix operation operations.

3. Feature engineering: It's a general process. Here, domain knowledge is put into the creation of feature extractors. Also, to scale back the complexity of the information. Further, make patterns more visible to find out algorithm is working. Although, it's very difficult to process. Hence, it's time-consuming and expertise.

4. Problem Solving approach: Generally, we use traditional algorithms to unravel problems. Although, it must break a drag into different parts. Further, solve them individually. Moreover, to urge a result, combine all of them.

For Example – you've got a task of multiple object detection. Although, during this task, we've to spot what's the thing and where is it present within the image. Further, during a machine learning approach, we've to divide the matter into two steps:

- Object detection
- Object recognition

First, we use the grab cut algorithm to skim through the image and find all the possibilities of the objects. Then of all the recognized objects, you'd then use a visual perception algorithm like SVM with HOG to acknowledge relevant objects.

5. Execution time: Usually, deep learning takes longer as compared to machine learning to coach. The most reason behind its while is that numerous parameters in the deep learning algorithm. Whereas machine learning algorithms take much less time to coach, starting from a couple of seconds to a couple of hours.

6. Interpretability: we've interpretability as an element for comparison of both learning techniques. Deep learning remains thought 10 times before its use in industry.

Deep learning methods

Various methods are often wont to create strong deep learning models. These techniques include the following:

- **The learning rate:** the learning rate is that defines the system for its operation prior to the learning process that controls how much change the model experiences in response to the estimated error whenever the model weights are altered. If the Learning rates are too high then it may end in unstable training processes. If learning rates are too small then may produce a lengthy training process that has the potential to urge stuck. The learning rate decay method is additionally called learning rate annealing or adaptive learning rates -- is that the method of adapting the training rate to increase performance and reduce training time. The simplest and commonest adaptations of learning rate include the techniques to scale the training rate over time back.
- **Transfer learning:** This process involves to make perfecting a previously trained model; it requires an interface to the internals of a preexisting network. First, users feed the prevailing network new data containing previously unknown classifications. Once adjustments are made to the network then new tasks are mostly performed with more specific categorizing abilities. This method has the advantage of requiring much fewer amounts of data compared with others, thus reducing computation time to minutes or hours.
- **Training from scratch:** This method requires a developer to gather an outsized labeled data set and configure a specification that will learn the features and model. This system is particularly useful for brand spanking new applications and applications with an outsized number of output categories. However, overall, it's a less common approach, because it requires inordinate amounts of knowledge, causing training to wish days or weeks.
- **Dropout:** This method effort to unfurl the matter of over fitting in networks with large amounts of parameters by randomly dropping units and their connections from the neural network during training. It's been proven that the help of the dropout method can improve the performance of the neural networks in areas like speech recognition, document classification, and computational biology.

Limitations and challenges

The biggest limitation of deep learning models is that they learn and process through the process of observations. This suggests they only know what was within the data on which they trained. If a user features a bit of knowledge or it comes from one specific source that's not necessarily representative of the broader functional area, the models won't learn in a way that's Generalizable.

The issue of biases is additionally a serious problem for deep learning models. If a model processes the data that contains biases and then the model will reproduce those biases in its own predictions. This has been a vexing problem for deep learning programmers because of these models learn to differentiate supported subtle variations in data elements. Often, the factors it determines are important aren't made explicitly clear to the programmer. This suggests, for instance, a face recognition model might make determinations about people's characteristics supported things like race or gender without the programmer being aware.

The learning rate also can become a serious challenge to deep learning models. If the speed is just too high, then the model will converge too quickly, producing a less-than-optimal solution. If the speed is just too low, then the method may grind to a halt, and it'll be even harder to succeed in an answer.

The hardware requirements for deep learning models also can create limitations. Multi core high-performing graphics processing units (GPUs) and other similar processing units are required to make sure improved efficiency and decreased time consumption. However, these units are more expensive and use large amounts of energy. Other hardware requirements include random access memory and a tough disc drive (HDD) or RAM-based solid-state drive (SSD).

Other limitations and challenges include the following:

- Deep learning requires large amounts of knowledge. Furthermore, the most powerful and accurate models will need more parameters, and which also requires more data.
- Once it was trained, deep learning models become inflexible and can't handle multitasking. they will deliver efficient and accurate solutions but only to at least one specific problem. Even solving an identical problem would require retraining the system.
- Any of the applications that need reasoning, like programming or applying the methodology and long-term planning of an algorithm like data manipulation is totally beyond what current deep learning techniques can do, even with large data.

Applications of Deep Learning

Applications of Real-world deep learning are a neighborhood of our daily lives, but in most cases, they're so well-integrated into products and services that users are unaware of the complex processing that's happening within the background. a number of these examples include the following:

- **Virtual assistants**-Whether it's Alexa or Siri or Cortana, the virtual assistants of online service providers' use deep learning to assist understand your speech and therefore the language humans use once they interact with them.
- **Translations**-In an identical way, deep learning algorithms can automatically translate between languages. This will be powerful for travelers, business people, and people in government.
- **Vision for driverless delivery trucks, drones, and the autonomous cars**-The way an autonomous vehicle understands the realities of the road and a ball within the street or another vehicle is through deep learning algorithms. The algorithms receive more data, the higher they're ready to act human-like in their information processing—knowing a stop sign covered with snow remains a stop sign.

- **Chatbots and repair bots**-Chatbots and repair bots that provide customer service for tons of companies that are ready to respond in an intelligent way and helpful because of an increasing amount of auditory and text questions because of the deep learning.
- **Image colorization**-To transforming black-and-white images into color was formerly very difficult to done by human hands. Today, deep learning algorithms are ready to use the context and objects within the photographs to paint them into basically recreate the black-and-white image in color. The results are impressive and accurate.
- **Facial recognition**-Deep learning is getting used for face recognition not just for security purposes except for tagging people on Facebook posts and that we could be ready to buy items during a store just by using our faces within the near future. The challenge for deep-learning algorithms for face recognition knows it's an equivalent person even once they have changed hairstyles, grown or shaved off a beard or if the image taken is poor thanks to bad lighting or an obstruction.
- **Medicine and pharmaceuticals**-From disease and tumor diagnoses to personalized medicines created specifically for an individual's genome, deep learning within the medical field have the eye of many of the most important pharmaceutical and medical companies.

A working network of Deep Learning

A deep learning algorithm uses supervised and unsupervised learning algorithms to coach the outputs through the delivered inputs.

See the following image; the circles represent neurons that are interconnected. These neurons are mainly classified into three different hierarchies of layers such as Input, Hidden, and Output Layers.

- The first neuron layer i.e. input layer receives the input file and passes it to the primary hidden layer.
- The hidden layer of the neurons performs the computations on the received data. The biggest challenge under neural networks creation is to make a decision depends on the number of neurons and the variety of hidden layers.
- Finally, the output layer produces the specified output.

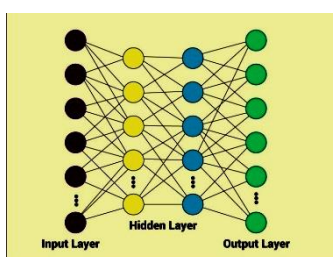


Figure 3: Working network of Deep Learning

This is the basic flow of working. Now, comes the purpose where the tactic of computation is explained.

Every connection between the neurons consists of weights; it denotes the importance of the input values. In order to standardize the outputs, and activation function is used.

There are two important measures that are considered for training the network. The first is to make an outsized data set and therefore the second is large computational power. The 'Deep' in deep learning signifies the number of hidden layers the model is using to coach the info set.

Working of Deep learning is often summed up in four final points:

- ANN asks a mixture of binary True/False queries.
- Extracting numeric values from blocks of knowledge.
- Sorting the info as per the received answers.
- A final point is marking/labeling the info.

Future Trends

Nowadays machine learning and deep learning is in trend. For many companies, demand for both is rapidly increasing. Also, their demand is, particularly for a few companies. I.e. company that desires to survive to inculcate Machine Learning in their business. Also, it's necessary to understand basic terminologies.

Deep learning is discovered and proves the simplest technique with state-of-the-art performances. Thus, deep learning is surprising us and can still do so within the near future.

Recently, many of the researchers are continuous in Machine Learning and Deep Learning. Within the past, researchers are limited to academia. But, nowadays, research in ML and DL is making its own place in both industry and academia.

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