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A Study of Comparison between Machine Learning and Deep Learning

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ABSTRACT - This is research paper on a brief comparison and summary about the machine learning and deep learning. This comparison on these two learning techniques was done as there was lot of confusion about these two learning techniques. Nowadays these techniques are used widely in IT industry to make some projects or to solve problems or to maintain large amount of data. This paper includes the comparison of two techniques and will also tell about the future aspects of the learning techniques.

Keywords: ML, DL, AI, Neural Networks, Supervised & Unsupervised learning, Algorithms.

I.INTRODUCTION

As the technology is getting advanced day by day, now we are trying to make a machine to work like a human so that we don't have to make any effort to solve any problem or to do any heavy stuff. To make a machine work like a human, the machine need to learn how to do work, for this machine learning technique is used and deep learning is used to help a machine to solve a real-time problem. They both have algorithms which work on these issues.

With the rapid growth of this IT sector, this industry needs speed, accuracy to meet their targets. With these learning algorithms industry can meet their requirements and these new techniques will provide industry a different way to solve problems.

II. RELATED WORK

Arthur Samuel who is an American pioneer in the field of computer graphics with artificial intelligence. He managed to bring this term 'machine learning' out in the market in 1959.But at that time this technique was very new to study and explore. So later on in 1990's machine learning re-organized and made a separate field in industry. Now this is new way to solve problems and make machines work for humans. [4]

Rina Dechter who is a professor in Computer Science introduced the term 'Deep Learning' in 1989 as a sub part of machine learning. And then later on in 2000 this term was again introduced by Igor Aizenberg to Artificial Neural Networks. Deep Learning plays an important role in understanding the real problems. [7]

III. MACHINE LEARNING

As the name suggests, it's a new way through which we made machines learn how to do work, like make decisions, solve problems, solve real-time problems. Actually we see machine learning works as helping hand to artificial intelligence. It is way to apply artificial intelligence through machine learning algorithms to make an extra-ordinary machine for us. Machine learning has many algorithms and they are divided into categories. [1] Machine has three categories for these algorithms:

A. Supervised Machine Learning: The majority of practical machine learning uses supervised learning.

Supervised learning is where you have input variables (x) and an output variable (Y) and you use an algorithm to learn the mapping function from the input to the output.

$$Y = f(X)$$

The goal is to approximate the mapping function so well that when you have new input data (x) that

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you can predict the output variables (Y) for that data.

It is called supervised learning because the process of an algorithm learning from the training dataset can be thought of as a teacher supervising the learning process. We know the correct answers, the algorithm iteratively makes predictions on the training data and is corrected by the teacher. Learning stops when the algorithm achieves an acceptable level of performance.

Supervised learning problems can be further grouped into regression and classification problems.

- **Classification**: A classification problem is when the output variable is a category, such as “red” or “blue” or “disease” and “no disease”.

- **Regression**: A regression problem is when the output variable is a real value, such as “dollars” or “weight”.

Some common types of problems built on top of classification and regression include recommendation and time series prediction respectively.

Some popular examples of supervised machine learning algorithms are:

- Linear regression for regression problems.

- Random forest for classification and regression problems.

- Support vector machines for classification problems.

B. Unsupervised Machine Learning: Unsupervised learning is where you only have input data (X) and no corresponding output variables.

➢ The goal for unsupervised learning is to model the underlying structure or distribution in the data in order to learn more about the data.

➢ These are called unsupervised learning because unlike supervised learning above there are no correct answers and there is no teacher. Algorithms are left to their own devises to discover and present the interesting structure in the data.

Unsupervised learning problems can be further grouped into clustering and association problems.

- **Clustering**: A clustering problem is where you want to discover the inherent groupings in the data, such as grouping customers by purchasing behavior.

- **Association**: An association rule learning problem is where you want to discover rules that describe large portions of your data, such as people that buy X also tend to buy Y.

Some popular examples of unsupervised learning algorithms are:

- k-means for clustering problems.

- Apriori algorithm for association rule learning problems.

C. Reinforcement Machine Learning: This learning is used when we are done with deciding which type of learning should be used to solve a problem (Supervised/Unsupervised). After this decision this learning makes sure that algorithm has better strategy to deal with the problem. [13]

Here’s a list of some common machine learning algorithms which are used widely:

1. Linear Regression
2. Logistic Regression
3. Decision Tree
4. SVM
5. Naïve Bayes
6. kNN
7. K-Means

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8. Random Forest
9. Dimensionality Reduction Algorithms
10. Gradient Boosting Algorithms

IV. DEEP LEARNING

As the name suggests, this is the whole new way of focusing on how do our brain and a human nervous system works. This Deep Learning is closely observing the neural system of a human being. This helps it to understand the neural system and communication better. Through this we can get to know how a normal human brain thinks and we can use it to map a new algorithm for it so that we can solve a problem through a machine just as it has been solved by a human brain. Actually deep learning is persuaded from the biological process of nervous system to think better and solve better in a whole new way. It also focuses on how a brain recognize, process on the basis of an image. [2]

Deep Learning can also be seen as neural networks which has multi-layer architectures and very huge parameters on which it works.

Deep Learning is also defined as working of neural network which has further four categories:

- Unsupervised Pre-trained Network: This pre-training learning technique is used to extract features which make easy to use in supervised learning to train data.
- Convolutional Neural Network (CNN): CNN is special architecture of artificial neural networks (ANN) which works with the assistance of visual cortex.
- Recurrent Neural Network: This network is also a class of ANN in which extracts a sequence from a directed graph which is made by connecting each node to one another. This really helps in speech recognition.
- Recursive Neural Network: RNN is just a name for deep neural network which is made by using or applying weights recursively [5].

Some methods through which Deep Learning is implemented:

1. Back Propagation
2. Batch Normalization
3. Dropout
4. Learning Rate Decay
5. Gradient Descent
6. Max Pooling
7. Long & Short Term Memory
8. Skip-gram
9. Transfer Learning
10. Continuous Bag of Words.

While deep learning was first theorized in the 1980s, there are two main reasons it has only recently become useful:

1. Deep learning requires large amounts of labeled data. For example, driverless car development requires millions of images and thousands of hours of video.

2. Deep learning requires substantial computing power. High-performance GPUs have a parallel architecture that is efficient for deep learning. When combined with clusters or cloud computing, this enables development teams to reduce training time for a deep learning network from weeks to hours or less.

Examples of Deep Learning at Work

1. Deep learning applications are used in industries from automated driving to medical devices.

2. Automated Driving: Automotive researchers are using deep learning to automatically detect objects such as stop signs and traffic lights. In addition, deep learning is used to detect pedestrians, which helps decrease accidents.

3. Aerospace and Defense: Deep learning is used to identify objects from satellites that locate areas of interest, and identify safe or unsafe zones for troops.

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4. Medical Research: Cancer researchers are using deep learning to automatically detect cancer cells. Teams at UCLA built an advanced microscope that yields a high-dimensional data set used to train a deep learning application to accurately identify cancer cells.

5. Industrial Automation: Deep learning is helping to improve worker safety around heavy machinery by automatically detecting when people or objects are within an unsafe distance of machines.

6. Electronics: Deep learning is being used in automated hearing and speech translation. For example, home assistance devices that respond to your voice and know your preferences are powered by deep learning applications.

A. Working of Deep Learning

- Most deep learning methods use neural network architectures, which is why deep learning models are often referred to as **deep neural networks**.
- The term "deep" usually refers to the number of hidden layers in the neural network. Traditional neural networks only contain 2-3 hidden layers, while deep networks can have as many as 150.
- Deep learning models are trained by using large sets of labeled data and neural network architectures that learn features directly from the data without the need for manual feature extraction.

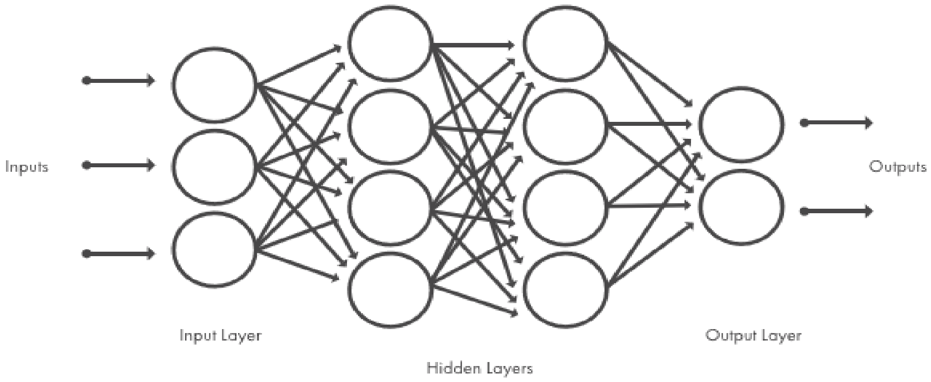

Figure 1: Neural networks, which are organized in layers consisting of a set of interconnected nodes

Networks can have tens or hundreds of hidden layers. One of the most popular types of deep neural networks is known as convolutional neural networks **(CNN** or **ConvNet)**. A CNN convolves learned features with input data, and uses 2D convolutional layers, making this architecture well suited to processing 2D data, such as images.

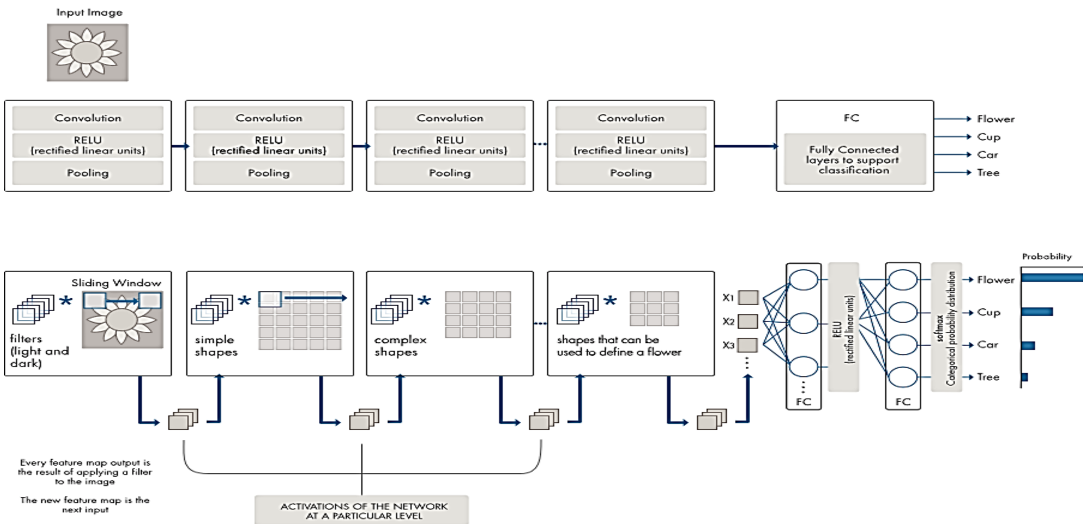

Figure 2: Example of a network with many convolutional layers

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CNNs eliminate the need for manual feature extraction, so you do not need to identify features used to classify images. The CNN works by extracting features directly from images. The relevant features are not pre-trained; they are learned while the network trains on a collection of images. This automated feature extraction makes deep learning models highly accurate for computer vision tasks such as object classification.

Filters are applied to each training image at different resolutions, and the output of each convolved image serves as the input to the next layer.

CNNs learn to detect different features of an image using tens or hundreds of hidden layers. Every hidden layer increases the complexity of the learned image features. For example, the first hidden layer could learn how to detect edges, and the last learns how to detect more complex shapes specifically catered to the shape of the object we are trying to recognize.

V. COMPARISON BETWEEN MACHINE LEARNING AND DEEP LEARNING

Deep learning is a specialized form of machine learning. A machine learning workflow starts with relevant features being manually extracted from images. The features are then used to create a model that categorizes the objects in the image. With a deep learning workflow, relevant features are automatically extracted from images. In addition, deep learning performs “end-to-end learning” – where a network is given raw data and a task to perform, such as classification, and it learns how to do this automatically.

Another key difference is deep learning algorithms scale with data, whereas shallow learning converges. Shallow learning refers to machine learning methods that plateau at a certain level of performance when you add more examples and training data to the network.

A key advantage of deep learning networks is that they often continue to improve as the size of your data increases.

Figure 3. Comparing a machine learning approach to categorizing vehicles (left) with deep learning (right)

In machine learning, you manually choose features and a classifier to sort images. With deep learning, feature extraction and modeling steps are automatic.

i) Choosing Between Machine Learning and Deep Learning

Machine learning offers a variety of techniques and models you can choose based on your application, the size of data you're processing, and the type of problem you want to solve. A successful deep learning application requires a very large amount of data (thousands of images) to train the model, as well as GPUs, or graphics processing units, to rapidly process your data.
When choosing between machine learning and deep learning, consider whether you have a high-performance GPU and lots of labeled data. If you don’t have either of those things, it may make more sense to use machine learning instead of deep learning. Deep learning is generally more complex, so you’ll need at least a few thousand images to get reliable results. Having a high-performance GPU means the model will take less time to analyze all those images.

ii) Accelerating Deep Learning Models with GPUs

Training a deep learning model can take a long time, from days to weeks. Using GPU acceleration can speed up the process significantly. Using MATLAB with a GPU reduces the time required to train a network and can cut the training time for an image classification problem from days down to hours. In training deep learning models, MATLAB uses GPUs (when available) without requiring you to understand how to program GPUs explicitly.

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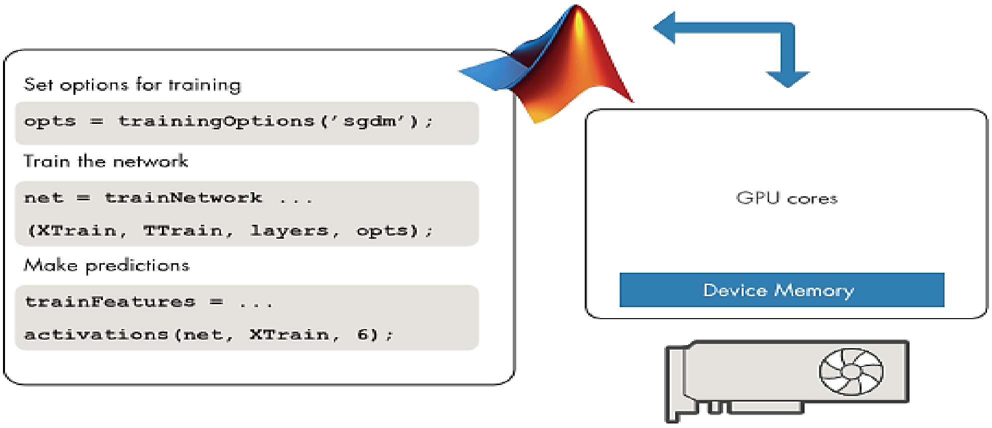

Figure 4. Deep Learning Toolbox commands for training your own CNN from scratch or using a pre-trained model for transfer learning.

VI. FUTURE ASPECTS

As Machine Learning and Deep Learning as Data Scientist are in trend in the market so every company is demanding a data scientist to hold their company at the market level. As Machine Learning and Deep Learning has proven themselves for solving problems in an amazing way so they have their future. And there are many more researchers all over the world trying to explore these two learning techniques to their very core. [6,8]

These Learning techniques will be used in future for analyzing the problem correctly and getting the result accordingly. As these techniques will give a bright future to Artificial Intelligence as well as neuroscience.

VII. CONCLUSION

We have studied working of Machine Learning and Deep Learning and also studied the difference how the two leaning techniques work. So as we conclude we get to know that both of them are equally important in implementing Artificial Intelligence. So Deep Learning is a sub-set of Machine Learning which is further a sub-set of Artificial Intelligence. This comparison provides us a clear view of Machine Learning and Deep Learning.

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