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	Group members name	ID No
1.	EPHREM ALEMNEW	GUR 01167/12
2.	ABENEZER FEKADU	GUR 01301/12
3.	ASRAT ENDALE	GUR 01937/12
4.	AMARE GATIE	GUR 00391/12
5.	GETASIL GETINET	GUR 00068/12
6.	SELAMAWIT ALEMU	GUR 01081/12

Submitted to: Mulualem Bitew(MSc)

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INTRODUCTION

Today's world is heavily reliant on technology. Tech tools significantly affect all aspect of our life, from communication and time management to manufacturing and healthcare. And the one that comes on top of most people minds when asked about what tech has to offer, they will probably answer AI. AI is the idea of building intelligent machines which have the ability to think, reason and learn and AI consist of machine learning. Machine learning is subset of artificial intelligence that facilitates the development of AI-driven applications. And within machine learning we find deep learning. Deep learning is a subset of Machine learning, which is simply a neural network with three or more layers these neural networks try to replicate how the human brain functions. The additional layers can help to tune and refine for accuracy even if a neural network with only one layer can still make approximation predictions. Deep learning a very important data science element that channels its modeling based on data-driven techniques under predictive modeling and statistics**.**

WHAT IS DEEP LEARNING?

Deep learning is a machine learning method that teaches computers to perform tasks that humans accomplish easily without even thinking about it. Neurons, or nerve cells, make up the human brain and transmit and analyze the data gathered from our senses. Our brain has a network of nerves made up of many of these nerve cells. These nerves connect one neuron to another by sending electrical impulses, and this is what programmers try to mimic in their code to develop a machine or system that can analyze data that it perceives from its sensors (cameras or audio devices) on its own and respond to that action with another rational action through actuators. A computer model learns to carry out categorization tasks directly from images, text, or sound using deep learning. Sometimes the accuracy of the response can even outperform human-level performance.

Deep learning took off around 2010 but it has been around since 1960s. Alexey Ivakhnenko and Lapa issued the first multilayer general, working learning algorithm in 1967. The reason that deep learning become more and more useful in recent years is because back in 20th century there wasn't enormous quantities of data that also required labels and also Deep learning needs a lot of computing or processing power. This why One of the most significant developments in machine learning in the most recent generation is deep learning, due to breakthroughs in tech industries .The only expense we now face as a result of technological innovation is the cost of the hardware and software needed to practice deep learning.

HOW DEEP LEARNING IS WORK?

Deep learning models are sometimes referred to as deep neural networks because the majority of deep learning techniques use neural network topologies. The number of hidden layers in the neural network is typically indicated by the term "deep." While deep networks can have as many as 150 hidden layers, traditional neural networks typically have two or three. Large collections of labeled data and neural network topologies that automatically learn characteristics from the data are used to train deep learning models.

The potential of machine learning is always expanding. Deep learning, a variation that models its programs after the very anatomy of the brain, is the subject of intriguing experiments now being conducted by researchers. Programs for deep learning are made up of layers of algorithms built on top of one another. An input is sent from one layer to the next, where it is further processed by each succeeding layer. With this intricate framework, deep learning is able to perform incredibly

sophisticated operations that are higher level than anything we've seen so far from conventional machine learning systems.

Deep Learning is inspired by how the human brain function and it tries to mimic that. To understand deep learning in simpler terms, imagine a baby who is like 2 or 3 years old who is developing his speaking skill and let's just say he come in contact with a cat. The toddler learns what a cat is and is not by pointing to objects and saying the word *cat*. The parent says, "Yes, that is a cat," or, "No, that is not a cat." As the toddler continues to point to objects, he becomes more aware of the features that all cats possess. That is what deep learning do it's not something that happen in a day or so the machine is feed with loads of data which will make him develop and stand on its own.

To take a look at how deep learning algorithms work let's see how one of algorithm for example Convolutional neural networks aka (CNN or ConvNet) are among the most often used varieties of deep neural networks. You do not need to know the features that are utilized to classify images because CNNs conduct the manual feature extraction for you. Direct feature extraction from photos is how CNN operates. The pertinent features are not pertained; instead, they are discovered as the network is trained on a set of images. Deep learning models are extremely accurate for computer vision applications like object categorization thanks to this automated feature extraction. Using tens or hundreds of hidden layers, CNNs can learn to recognize many aspects in an image. Every hidden layer makes the learnt picture features more complex. For instance, the first hidden layer might learn how to recognize edges, while the final one might learn how to recognize more intricate shapes tailored to the geometry of the object we're trying to identify.

DEEP LEARNING ALGORITHMS

An algorithm is a set of step-by-step procedures, or a set of rules to follow, for completing a specific task or solving a particular problem. Neural networks are nothing more than a collection of decision-making networks that have been pre-trained to do a task, and deep learning algorithms are dynamically constructed to run over numerous layers of neural networks. There are a lots of deep learning algorithms but to name a few they are as follows:

1. Convolutional Neural Networks (CNNs)

We have mentioned CNN before in this essay when discussed about how deep learning works but know it will more detailed. ConvNets, aka CNNs, are primarily made up of numerous layers and are used mainly for object detection and image processing. It was first known as LeNet and was created by Yann LeCun in 1998. It was created back then to detect numerals and zip code characters. CNNs are widely used in anomaly detection, series forecasting, medical image processing, and satellite image identification.

In order to do convolutional operations, CNNs process the data by putting it through several layers and extracting features. Rectified Linear Units (ReLUs), which are part of the convolutional layer, are used to correct the feature map. These feature maps are corrected for the following feed using the pooling layer. Pooling is often a down-sampled sampling procedure that decreases the dimensionality of the feature map. Later, the output is produced as 2-D arrays made up of a single, long, continuous, and linear vector that has been flattened in the map.

2. Long Short Term Memory Networks (LSTMs)

LSTMs which are known as recurrent neural networks (RNNs) with long-term dependent learning and adaptation capabilities. It can remember and recall information from the past for a longer time, and by default, this is its only behavior. Because LSTMs can hold onto memories or prior inputs, they are frequently utilized in time series predictions because they are built to retain information across time. This comparison is made due to their chain-like structure, which consists of four interconnected layers that communicate with one another in various ways. Along with time series prediction applications, they can be used to build voice recognizers, advance medicinal research, and create musical loops. The LSTM operate on a series of events. First of all, they have a tendency to forget redundant information acquired in the preceding condition. They then selectively update a subset of the cell-state values before generating a subset of the cell-state as output.

3. Recurrent Neural Networks (RNNs)

Recurrent neural networks, also known as RNNs, are made up of a cycle of directed connections that enable the current phase of RNNs to utilize the input from the LSTMs. Because these inputs are so deeply ingrained, the LSTMs' capacity for memorization allows them to be temporarily stored in the

internal memory. As a result, RNNs rely on the inputs that LSTMs preserve and operate in accordance with the synchronization phenomena of LSTMs. RNNs are mostly used for data translation to machines, time series analysis, handwritten data recognition, and captioning of images.

4. Generative Adversarial Networks (GANs)

GANs are deep learning algorithms that produce new instances of data that closely resemble the training data. In a GAN, there are typically two parts: a generator that learns to produce fake data and a discriminator that adjusts by taking lessons from this false data. Since they are widely employed to sharpen astronomical images and simulate lensing the gravitational dark matter, GANs have grown significantly in popularity over time. Additionally, by replicating 2D textures in a higher quality, such as 4K, video games can boost the visual appeal of their 2D textures.

They are also employed in the production of lifelike cartoon characters, as well as the representation of human faces and 3D objects. GANs simulate by creating and processing both fictitious and real data. The discriminator quickly learns to adapt and recognize it as false data throughout the training to grasp these data, while the generator produces various types of phony data. These results are then sent for update by GANs.

5. Radial Basis Function Networks (RBFNs)

RBFNs use Radial functions as activation functions. RBFNs are subset of neural networks that employs a feed-forward methodology. Input, hidden, and output layers make up their three layers, which are mostly utilized for time-series prediction, regression analysis, and classification. By analyzing the similarities found in the training data set, RBFNs do these tasks. Typically, they contain an input vector that sends these data into the input layer, validating the identification and disseminating results by comparing prior data sets.

The input layer's neurons are specifically sensitive to certain data, and the layer's nodes are effective at classifying the data class. Although they cooperate closely with the input layer, neurons are initially found in the hidden layer. The output's distance from the center of the neuron is inversely proportional to the Gaussian transfer functions in the hidden layer. The neuron's output layer contains linear combinations of radial-based data that are passed through Gaussian functions.

6. Multilayer Perceptrons (MLPs)

We can say that the foundation of deep learning technology is MLPs. It belongs to a group of feed-forward neural networks that have several perceptron-filled layers. These perceptrons each have a different activation function. Input and output layers in MLPs are also connected and have the same number of layers. Between these two strata, there is another layer that is still undiscovered. MLPs are primarily used to create voice and picture recognition software, as well as various kinds of translation software.

Data is fed into the input layer to begin the operation of MLPs. The layer's neurons come together to create a graph that creates a link that only goes in one direction. It is discovered that there is weight for this input data between the hidden layer and the input layer. Which nodes are prepared to fire is determined by MLPs using activation functions. The tanh function, sigmoid, and ReLUs are some of these activation mechanisms. In order to produce the required output from the given input set, MLPs are mostly utilized to train the models and determine what kind of co-relation the layers are serving.

7. Self-Organizing Maps (SOMs)

SOMs were created by **Teuvo Kohenen** in order to see data and comprehend its aspects using artificial, self-organizing neural networks. In order to solve problems, attempts are made to visualize data that is mostly impossible for people to see. Because these data are typically multidimensional, there are fewer opportunities for human error and involvement.

SOMs aid in data visualization by choosing random vectors from the provided training data after initializing the weights of various nodes. So that dependencies may be understood, they look at each node to determine the respective weights. The best matching unit is used to choose the winning node (BMU). These winning nodes are later found by SOMs, but they gradually disappear from the sample vector. Therefore, there is a greater likelihood of identifying the weight and doing additional tasks the closer the node is to BMU.

8. Deep Belief Networks (DBNs)

Because DBNs comprise multiple layers of latent and stochastic variables, they are also known as generative models. Because the latent variable has binary values, it is referred to as a hidden unit.

Because the RGM layers are piled on top of one another to establish communication between earlier and later layers, DBNs are also known as Boltzmann Machines. Applications like video and image identification as well as the capture of moving objects use DBNs. The most typical method DBNs operate is by leaning through a top-down strategy to create weights in layers. On the top hidden two-layer, DBNs employ a step-by-step Gibbs sampling method. Then, using a model that adheres to the ancestral sampling approach, these steps take a sample from the discernible units. Following the bottom-up pass strategy, DBNs learn from the values that are contained in the latent value from each layer.

9. Restricted Boltzmann Machines (RBMs)

RBMs are stochastic neural networks that learn from the probability distribution in the supplied input set. They were created by Geoffrey Hinton. This algorithm is mostly employed in the areas of topic modeling, regression, and classification, as well as in the reduction of dimension. The visible layer and the secret layer are the two layers that make up RBIs. Both of these layers have bias units attached to nodes that produce the output and are connected via hidden units.

RBMs typically consist of two phases: forward pass and backward pass. By taking inputs and converting them to numbers, RBMs carry out their duty of encoding inputs in the forward pass. Every input is weighted by RBMs, and the backward pass takes these weights and further transforms them into reconstructed inputs. Both of these translated inputs are afterwards mixed with their respective weights. These inputs are subsequently sent to the visible layer, where activation takes place and output that is simple to reconstruct is produced.

10. Autoencoders

A unique kind of neural network called an autoencoder finds inputs and outputs that are typically identical. It was created largely to address issues with unsupervised learning. Highly trained neural networks called autoencoders reproduce the data. The input and output are typically the same because of it. They are employed to do out tasks including population prediction, image processing, and drug discovery. The encoder, the code, and the decoder are the three parts that make up an autoencoder.

The encoder compresses the input into a latent space representation that can later be reconstructed to obtain the original input. Code - The compressed portion (latent space representation) obtained after encoding. And The decoder attempts to restore the code to its original form. The obtained reconstruction output may not be as accurate as the original and may contain some loss.

The design of autoencoders allows them to take in inputs and convert them into a variety of representations. Reconstructing the original input is a more accurate method of copying it. They accomplish this by reducing the size and encoding the image or input. If the image is not clearly visible, it is sent to the neural network for explanation. The image that has been made clearer is then referred to as a reconstruction image, and it is equally accurate as the original image.

APPLICATION OF DEEP LEARNING

Deep learning applications are used in industries from the hand held smart phone self-driving automated cars. It's basically hard to find something that deep learning cannot be involved in from medicine to military it's only a matter of time till the whole world become deep learning consumer. To mention few of deep learning applications:-

Medicine

Deep learning is used in medicine to analyzing large amounts of data, it employs artificial intelligence to deduce the fundamentals and physiological underpinnings of human diseases. This knowledge is then used to predict diseases, make clinical diagnoses, and deliver medical services. Algorithms that are mentioned above are used to do varies tasks on their own in medical field to help identify diseases and cure patients. For example, in drug discovery and testing a significant portion of potential medications are rejected by regulatory agencies, these failures are brought about by undesirable interactions (off-target effects), insufficient efficacy (on-target effects), or unexpected harmful effects.

The application of deep learning to forecast bio molecular targets, off-targets, and harmful consequences of environmental chemicals in foods, home goods, and medications has been studied in depth. Atom Net is a deep learning system for rationally designing drugs based on structure. And also, in bioinformatics an autoencoder ANN was used to predict gene ontology annotations and gene-function relationships.

When we come to medical image analysis in medical applications like cancer cell classification, lesion identification, organ segmentation, and picture enhancement, deep learning has been shown to deliver competitive outcomes. Modern deep learning algorithms show excellent disease detection accuracy and the value of their application by medical professionals to increase diagnosis effectiveness.

Image processing

In Image recognition Deep learning-based image recognition has become "superhuman", producing more accurate results than human contestants. Deep learning-trained automobiles can now understand 360-degree camera footage by recognizing human faces. Facial Dysmorphology Novel Analysis (FDNA), which examines human malformation cases linked to a sizable database of hereditary diseases, is another illustration. We can also apply deep learning to inverse issues like denoising, super-resolution, inpainting, and film colorization to restore images. Applications like "Shrinkage Fields for Effective Image Restoration," which trains on an image dataset, and "Deep Image Prior," which trains on the image that needs restoration, are examples of learning techniques used in these applications.

And also Art can be created with an AI picture generator. It produces artwork and photos using a sophisticated AI in response to straightforward directions and text messages. And this Stable Diffusion model which is aided by deep learning, gained popularity this year 2022. Deep learning is also involved in image reconstruction several works showed the better and superior performance of the deep learning methods compared to analytical methods for various applications

Automatic speech recognition

We can this is the most widely known deep learning application, the likes of Siri, Sophia, Cortana and Alexa are using this application of deep learning to function properly and to make our life easier. LSTM and RNNs are capable of learning "Very Deep Learning" tasks that need speech events to be separated by thousands of discrete time steps, each of which lasts for around ten milliseconds. These algorithms are used to recognize speech and convert to machine language so that it can give rational response.

Military

Deep learning is being incorporated into weapons and other systems employed on terrestrial, marine, aerial, and space platforms by defense forces from various nations across the world. Deep learning have allowed for the creation of effective warfare systems that rely less on human input. Additionally, it has made military systems more effective and synergistic while requiring less maintenance. AI is also anticipated to equip independent and fast-moving weapons to conduct

coordinated attacks. Cyber-attacks frequently target military systems, which can result in the loss of sensitive data and damage to those system

However, AI-enabled systems are capable of automatically defending networks, computers, software, and data against all forms of illegal access. We are witnessing an astonishing and terrifying paradigm shift in contemporary warfare as a result of the widespread adoption of AI in military technology, both hardware and software. The fact that the biggest militaries in the world are concentrating more on this technology than anything else should come as no surprise, and whomever prevails in the technology race will probably have greater worldwide influence than the US did after inventing the atom bomb.

News Aggregation and News Fraud Detection

There is now a way to remove all of the negative and offensive news from news feed. The extensive use of deep learning in news aggregation is bolstering efforts to tailor news to individual readers. While this may not appear to be novel, newer levels of sophistication in defining reader personas are being met in order to filter out news based on geographical, social, and economic parameters, as well as the individual preferences of a reader. In today's world, where the internet has become the primary source of all genuine and fake information, fraud news detection is a valuable asset. As bots replicate fake news across channels, it becomes increasingly difficult to distinguish it. Deep Learning aids in the development of classifiers that can detect fake or biased news and remove it from your feed while also alerting you to potential privacy breaches. It is extremely difficult to train and validate a deep learning neural network for news detection because the data is riddled with opinions and no one party can ever decide whether the news is neutral or biased.

Detecting Fraud

Another domain that benefits from Deep Learning is the banking and financial sector, which is plagued with the task of fraud detection as money transactions become digital. Autoencoders in Keras and Tensorflow are being developed to detect credit card fraud, potentially saving financial institutions billions of dollars in recovery and insurance costs. Fraud prevention and detection are based on identifying patterns in customer transactions and credit scores, as well as identifying anomalous behavior and outliers

SUMMARY

Deep learning is a machine learning method that teaches computers to perform tasks that humans accomplish easily without even thinking about it. Deep learning took off around 2010 but it has been around since 1960s. Alexey Ivakhnenko and Lapa issued the first multilayer general, working learning algorithm in 1967.

Deep learning models are sometimes referred to as deep neural networks because the majority of deep learning techniques use neural network topologies. Deep learning, a variation that models its programs after the very anatomy of the brain, is the subject of intriguing experiments now being conducted by researchers. Deep learning models are extremely accurate for computer vision applications like object categorization thanks to this automated feature extraction. Using tens or hundreds of hidden layers, CNNs can learn to recognize many aspects in an image.

There are a lots of deep learning algorithms Some of them are: Convolutional Neural Networks (CNNs), Long Short Term Memory Networks (LSTMs), Recurrent Neural Networks (RNNs), Generative Adversarial Networks (GANs), Radial Basis Function Networks (RBFNs), Multilayer Perceptrons (MLPs), Self-Organizing Maps (SOMs), Deep Belief Networks (DBNs), Restricted Boltzmann Machines (RBMs), Autoencoder and etc.

Deep learning is used in medicine to analyzing large amounts of data, it employs artificial intelligence to deduce the fundamentals and physiological underpinnings of human diseases. This knowledge is then used to predict diseases, make clinical diagnoses, and deliver medical services. In Image recognition Deep learning-based image recognition has become "superhuman", producing more accurate results than human contestants. Deep learning-trained automobiles can now understand 360-degree camera footage by recognizing human faces. Deep learning in Automatic speech recognition algorithms are used to recognize speech and convert to machine language so that it can give rational response. Deep learning is being incorporated into weapons and other systems employed on terrestrial, marine, aerial, and space platforms by defense forces from various nations across the world.

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