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Deep Learning Tutorial

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Deep Learning Tutorial

Deep learning is one of the methods of machine learning that extracts features straight from data. Learn comprehensively in this deep learning tutorial that helps you understand the core and advanced concepts.

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Introduction to Deep Learning

Machine learning algorithms become less effective as data volume increases, but deep learning provides superior performance, such as accuracy. We cover the following in this deep learning tutorial:

- Overview of Deep Learning
- Basic Neural Network: ANN & BNN
- Convolutional Neural Network
- Recurrent Neural Network

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- Generative Adversarial Network
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Overview of Deep Learning

Artificial neural networks are used in deep learning, a branch of machine learning, to learn from large amounts of data without the need for explicit programming.

- These networks, which take their cues from the human brain, are capable of processing language, comprehending voice, and identifying images.
- Deep learning networks come in a variety of forms, including feedforward, convolutional, and recurrent neural networks.
- While deep learning can produce excellent results in many applications, it requires large amounts of labeled data and powerful computers to function well.

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Application of Deep Learning

Here are the applications of deep learning:

- Natural Language Processing
- Virtual assistants,
- Chatbots and robotics
- Automatic Image Caption Generation
- Self-driving cars
- Automatic Machine Translation

Basic Neural Network: ANN & BNN

ANNs and BNNs are basic components.

- ANNs are more straightforward systems with preset connections that are intended to carry out particular tasks; the network architecture is left up to the creator.
- BNNs are extremely advanced and adaptive systems that can process data in parallel. They



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can also learn and change over time.

ANN: Artificial Neural Network

One kind of neural network that uses a feed-forward technique is called an artificial neural network (ANN). This is because data is continuously passed through the nodes until it reaches the output node. This kind of neural network is sometimes referred to as the most basic kind.

ANN has the following advantages:

- The capacity to learn regardless of the kind of input (non-linear or linear).
- Because of its extreme volatility, ANN works well for financial time series forecasting.

Limitations of ANN:

- The network's behavior is hard to explain by its simple architecture.
- Hardware is a must for this network.

BNN: Biological Neural Network

The components of a biological neural network (BNN) are axons, dendrites, cell bodies, and synapses. Neurons in this neural network are responsible for processing.

Other neurons provide signals to dendrites, which then total up the signals and send them to the axon, which sends them to other cells.

BNN has the following advantages:

- The input processing component is the synapses.
- It can handle a lot of complicated inputs simultaneously.

Limitations of BNN:

- There's no system in place to regulate it.
- Because of its complexity, processing is done slowly.

Differences between ANN and BNN

While the fundamental building blocks of Artificial Neural Networks (ANNs) and Biological Neural Networks (BNNs) are similar, they differ in a few ways.

Neurons: The fundamental building elements that process and transmit information in both BNNs and ANNs are neurons.

- But compared to ANNs, BNN neurons are more varied and complicated.
- In contrast to ANNs, which typically have a single output, BNNs feature multiple dendrites that take input from many sources and axons that transfer messages to other neurons.

Synapses: The places of connection between neurons where information is transferred are known as synapses in both BNNs and ANNs.

- In BNNs, the connections between neurons are more flexible and the strength of the connections can be altered by a variety of factors.
- It includes learning and experience, whereas in ANNs, the connections between neurons are typically fixed and the strength of the connections is determined by a set of weights.

Neural Pathways: The connections between neurons in BNNs and ANNs that permit information to be sent across the network are known as neural pathways.

- Neural pathways in BNNs, on the other hand, are extremely varied and complicated, and experience and learning can change the connections between neurons.
- Neural routes in ANNs are typically

predetermined by the network architecture and thus simpler.

Convolutional Neural Network

One kind of deep learning neural network design that is frequently utilized in computer vision is the convolutional neural network (CNN).

“Computer vision” is the area of artificial intelligence that allows computers to interpret and process images and other visual data.

Three different sorts of layers are present in a typical neural network:

- **Input Layers:** This is the layer where we provide our model with input. The entire number of features in our data is equivalent to the number of neurons in this layer.
- **Hidden Layer:** The hidden layer receives the input that was previously given into the input layer. Several hidden layers may exist, contingent on the amount of the data and our model.
- **Output Layer:** The probability score for each class is obtained by feeding the output of the hidden layer into a logistic function such as the sigmoid or softmax.

CNN Architecture

The input layer, convolutional layer, pooling layer, and fully connected layers are the various layers that make up a CNN architecture, or convolutional neural network. Gradient descent and backpropagation are used by the network to find the optimal filters.

- The input image is processed by the convolutional layer to extract features
- The pooling layer reduces computation by downsampling the image.
- The fully connected layer generates the final prediction.

Advantages of Convolutional Neural Networks:

- Adept at finding characteristics and patterns in audio, video, and picture signals.
- Robust to scaling invariance, rotation, and translation.
- Complete training without requiring manual feature extraction.
- Able to process vast volumes of data with great accuracy.

Disadvantages of Convolutional Neural Networks:

- costly to train computationally and memory-intensive.
- may be prone to overfitting in the absence of sufficient data or appropriate regularization.
- needs a significant quantity of tagged data.
- Limited interpretability makes it challenging to comprehend the network's learnings.

[Deep Learning Engineer Salary](#)

Recurrent Neural Network

An example of a neural network type is a recurrent neural network (RNN), which takes as its input the output of the previous stage. All of the inputs and outputs of conventional neural networks are independent of one another.

How is a feedforward neural network different from an RNN?

Feedforward neural networks are artificial neural networks without looping nodes. This type of neural network is also known as a multi-layer neural network since all input is simply passed along.

Types of RNN

Depending on how many inputs and outputs the network has, there are four different types of RNNs.

One to One: This kind of RNN, also called a Vanilla Neural Network, functions similarly to any other

basic neural network. This neural network has a single input and a single output.

One to Many: This type of RNN has several related outputs and a single input. One common use of this network is image captioning, where we utilize a picture to anticipate a sentence with many words.

Many to One: With this kind of network, numerous inputs are supplied into the system at various points in time, producing a single output. This kind of network is applied to issues such as sentiment analysis.

Many to Many: This kind of neural network has several outputs that correlate to different problems as well as multiple inputs. Translation between languages will be one example of this issue.

Advantages of Recurrent Neural Networks:

- Over time, an RNN retains every single bit of information. Only because it has the ability to recall past inputs is it helpful for time series prediction.
- Even with convolutional layers, recurrent neural networks are utilized to increase the effective pixel neighborhood.

Disadvantages of Recurrent Neural Networks:

- Problems with gradients vanishing and exploding.
- An RNN's training is an extremely challenging process.
- It cannot parse long sequences when relu or tanh is utilized as the activation function.

Variation of Recurrent Neural Network (RNN)

Many new, more sophisticated RNNs have been developed to address issues such as disappearing gradients and explosive gradient descent. Some of these include:

Bidirectional Neural Network (BiNN): An example of a BiNN is a Recurrent Neural Network variant where data enters the network in both directions and the outputs are combined to generate the input.

When the context of the input is more crucial, like in NLP jobs and time-series analysis difficulties, BiNN is helpful.

Long Short-Term Memory (LSTM): According to the read-write-and-forget principle, a network that receives input information reads and writes the most pertinent information while discarding information that is not crucial for forecasting the final result.

Three more gates are added to the RNN to do this. In this manner, the network only transmits the data that has been chosen.

Generative Adversarial Network

Generative Adversarial Network is a state-of-the-art method for generative modeling in deep learning that frequently makes use of convolutional neural network architectures.

Finding patterns in input data on its own is the aim of generative modeling, which allows the model to generate new examples that reasonably mirror the original dataset.

The three components of Generative Adversarial Networks (GANs) are as follows:

Generative: Learning a generative model that explains the process of generating data in terms of a probabilistic model is generative.

Adversarial: Use the word adversarial to set one item up against another. This indicates that the generative result is compared with the real images in the data set while using GANs.

A discriminator mechanism is employed to apply a

model that differentiates between authentic and counterfeit photographs.

Networks: For training purposes, use deep neural networks as artificial intelligence (AI) algorithms.

Deep Learning Training

Types of GANs

The following are the various types of GAN:

Vanilla GAN: The most basic kind of GAN is called a vanilla GAN.

- In this case, the generator and the discriminator are simple multi-layer perceptrons.
- Stochastic gradient descent is the method used by a vanilla GAN's basic algorithm to optimize the mathematical issue.

GAN with conditions (CGAN): You may think of CGAN as a deep learning technique with some conditional parameters applied.

- To generate the same data in CGAN, the generator receives an extra parameter called "y."
- For the discriminator to assist in differentiating between the real data and the phony generated data, labels are additionally added to the input.

Deep Convolutional GAN (DCGAN): This is one of the most widely used and well-performing GAN implementations. ConvNets are used in its composition rather than multi-layer perceptrons.

- Convolutional stride is used in place of max pooling when implementing the ConvNets.
- The layers are not entirely connected, either.

Laplacian Pyramid GAN (LAPGAN): An octave-separated set of band-pass pictures plus a low-

frequency residual comprise the Laplacian pyramid, a linear invertible image representation.

- This method makes use of several generator and discriminator networks as well as several Laplacian pyramid levels.
- The primary reason for using this method is that it yields extremely high-quality photos.
- In a backward pass, the image is first down-sampled at each pyramid layer, then up-scaled at each layer once more.
- During this process, the image picks up some noise from the conditional GAN at each layer until it reaches its original size.

Super Resolution GAN (SRGAN): SRGAN, as the name implies, is a GAN design technique that generates higher-resolution images by combining an adversarial network with a deep neural network.

When it comes to enhancing the details of original low-resolution photos while decreasing errors, this kind of GAN is really helpful.

Reinforcement Learning

Reinforcement learning is a subset of machine learning paradigms where a feedback loop is used to train a learning algorithm instead of pre-existing data. Since they do away with the need to pay for data collection and cleaning, these algorithms are hailed as the wave of the future for machine learning.

For every time step, there is one fixed activation function unit in the recurrent neural network. Every unit possesses an internal state known as the unit's hidden state.

The recurrence relation listed below is used to update the concealed state:

$$h_{\{t\}} = f_{\{W\}}(x_{\{t\}}, h_{\{t-1\}})$$

Advantages of Recurrent Neural Networks (RNNs):

- **Capacity to Analyze Sequential Data:** RNNs are valuable in applications like time series analysis, speech recognition, and natural language processing because they can analyze sequential data of different durations.
- **Memory:** By utilizing hidden states, RNNs can remember details about the preceding inputs in the sequence. This makes it possible for RNNs to carry out tasks like stock price forecasting and word prediction in sentences.
- **Versatility:** Sequence-to-sequence mapping, regression, and classification are just a few of the many applications for RNNs.
- **Flexibility:** To construct hybrid models for particular tasks, RNNs can be merged with other neural network architectures, such as feedforward neural networks or convolutional neural networks (CNNs).

Limitations of RNN:

Here are the disadvantages of RNN:

- **Vanishing Gradient Problem:** RNNs are susceptible to this issue, which makes it challenging to learn long-term dependencies. This is especially true for RNNs with several layers or lengthy sequences.
- **Computationally Expensive:** RNNs can be computationally expensive, especially when utilizing complicated topologies or analyzing lengthy sequences.
- **Lack of Interpretability:** RNNs can be challenging to understand, especially when it comes to figuring out how the network decides or makes predictions.

RNNs are a powerful tool for many machine learning applications because of their capacity to handle sequential data and preserve recollection of prior inputs, despite significant drawbacks.

Conclusion

We hope this deep learning tutorial will be helpful

for beginners and professionals with an understanding of various deep learning fundamentals. If you want to elevate your skills, join our **[deep learning training in Chennai](#)**.

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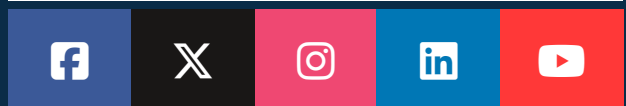
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