19CST302-NEURAL NETWORKS AND DEEP LEARNING

UNIT-IV DEEP LEARNING ARCHITECTURES

QUESTIONS

Generative Adversarial Network (GAN)

A Generative Adversarial Network (GAN) is a deep learning architecture that consists of two neural networks competing against each other in a zero-sum game framework. The goal of GANs is to generate new, synthetic data that resembles some known data distribution.

Generative Adversarial Networks (GANs) are a powerful class of neural networks that are used for unsupervised learning. It was developed and introduced by Ian J. Goodfellow in 2014. GANs are basically made up of a system of two competing neural network models which compete with each other and are able to analyze, capture and copy the variations within a dataset. Why were GANs developed in the first place?

It has been noticed most of the mainstream neural nets can be easily fooled into misclassifying things by adding only a small amount of noise into the original data. Surprisingly, the model after adding noise has higher confidence in the wrong prediction than when it predicted correctly. The reason for such an adversary is that most machine learning models learn from a limited amount of data, which is a huge drawback, as it is prone to overfitting. Also, the mapping between the input and the output is almost linear. Although, it may seem that the boundaries of separation between the various classes are linear, but in reality, they are composed of linearities, and even a small change in a point in the feature space might lead to the misclassification of data. How do GANs work?

Generative Adversarial Networks (GANs) can be broken down into three parts:

Generative: To learn a generative model, which describes how data is generated in terms of a probabilistic model.

Adversarial: The training of a model is done in an adversarial setting.

Networks: Use deep neural networks as artificial intelligence (AI) algorithms for training purposes.

In GANs, there is a Generator and a Discriminator. The Generator generates fake samples of data(be it an image, audio, etc.) and tries to fool the Discriminator. The Discriminator, on the other hand, tries to distinguish between the real and fake samples. The Generator and the Discriminator are both Neural Networks and they both run in competition with each other in the training phase. The steps are repeated several times and in this, the Generator and Discriminator get better and better in their respective jobs after each repetition. The work can be visualized by the diagram given below:

Generative Adversarial Network Architecture and its Components

Here, the generative model captures the distribution of data and is trained in such a manner that it tries to maximize the probability of the Discriminator making a mistake. The Discriminator, on the other hand, is based on a model that estimates the probability that the sample that it got is received from the training data and not from the Generator. The GANs are formulated as a minimax game, where the Discriminator is trying to minimize its reward V(D, G) and the Generator is trying to minimize the Discriminator's reward or in other words, maximize its loss. It can be mathematically described by the formula below:

Loss function for a GAN Model

perceptrons. The ConvNets are implemented without max pooling, which is in fact replaced by convolutional stride. Also, the layers are not fully connected.

Laplacian Pyramid GAN (LAPGAN): The Laplacian pyramid is a linear invertible image representation consisting of a set of band-pass images, spaced an octave apart, plus a low-frequency residual. This approach uses multiple numbers of Generator and Discriminator networks and different levels of the Laplacian Pyramid. This approach is mainly used because it produces very high-quality images. The image is down-sampled at first at each layer of the pyramid and then it is again up-scaled at each layer in a backward pass where the image acquires some noise from the Conditional GAN at these layers until it reaches its original size.

Super Resolution GAN (SRGAN): SRGAN as the name suggests is a way of designing a GAN in which a deep neural network is used along with an adversarial network in order to produce

higher-resolution images. This type of GAN is particularly useful in optimally up-scaling native low-resolution images to enhance their details minimizing errors while doing so.