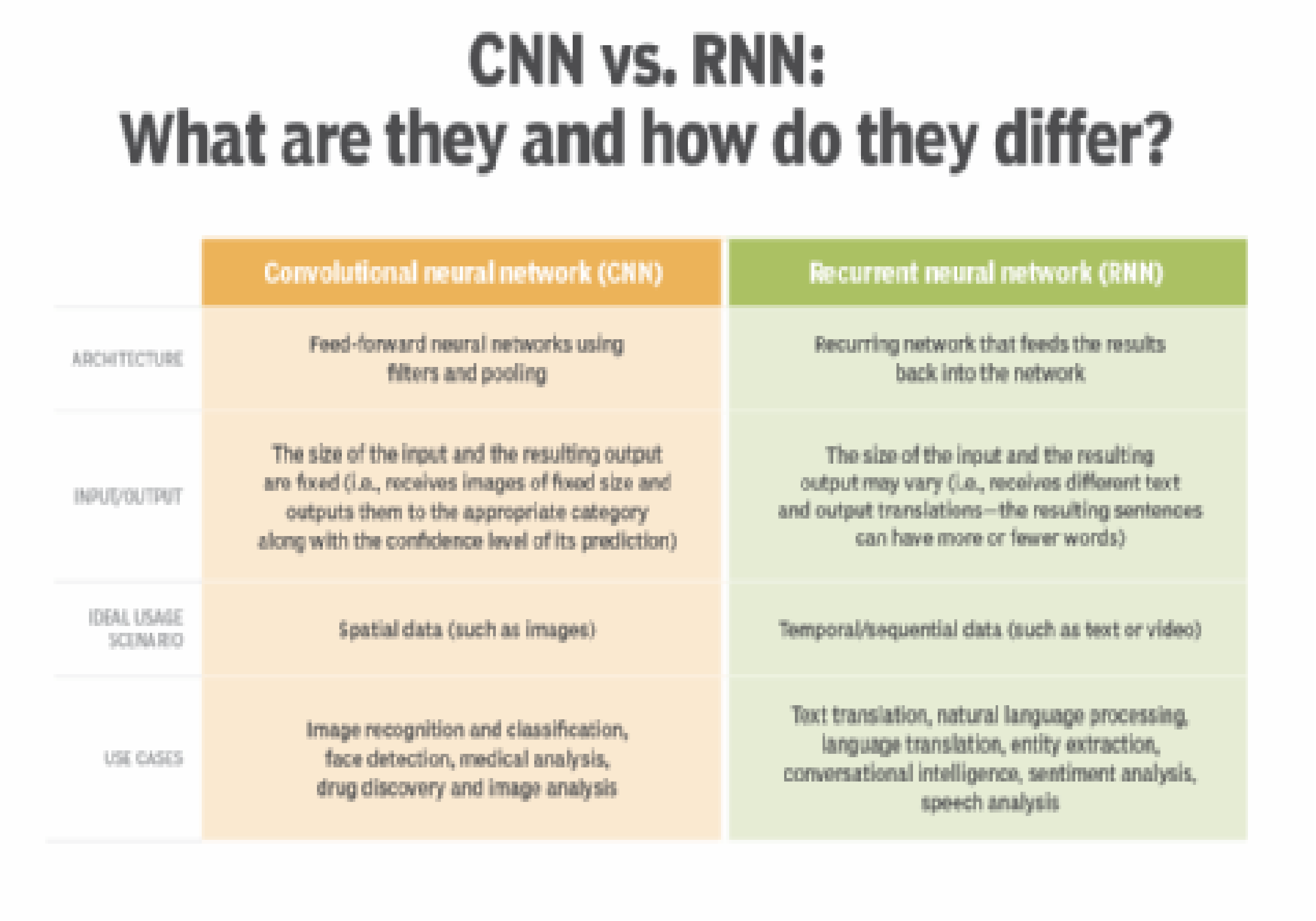
UNIT V- DEEP LEARNING

Difference between CNN and RNN



CNN vs. RNN:
What are they and how do they differ?

	Convolutional neural network (CNN)	Recurrent neural network (RNN)
ARCHITECTURE	Feed-forward neural networks using filters and pooling	Recurring network that feeds the results back into the network
INPUT/OUTPUT	The size of the input and the resulting output are fixed (i.e., receives images of fixed size and outputs them to the appropriate category along with the confidence level of its prediction)	The size of the input and the resulting output may vary (i.e., receives different text and output translations—the resulting sentences can have more or fewer words)
IDEAL USAGE SCENARIO	Spatial data (such as images)	Temporal/sequential data (such as text or video)
USE CASES	Image recognition and classification, face detection, medical analysis, drug discovery and image analysis	Text translation, natural language processing, language translation, entity extraction, conversational intelligence, sentiment analysis, speech analysis

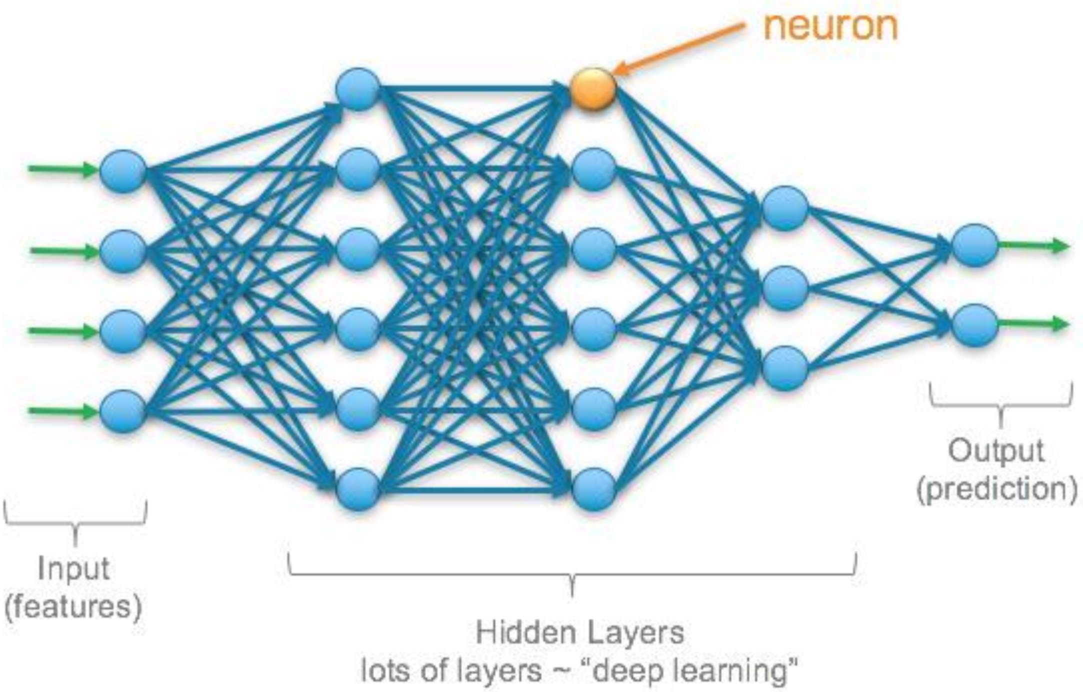
Advantages and Disadvantages of recursive neural network

The advantage of Recursive neural network is that they can be very powerful in learning hierarchical, tree-like structure. The disadvantages are, firstly, that the tree structure of every input sample must be known at training time.

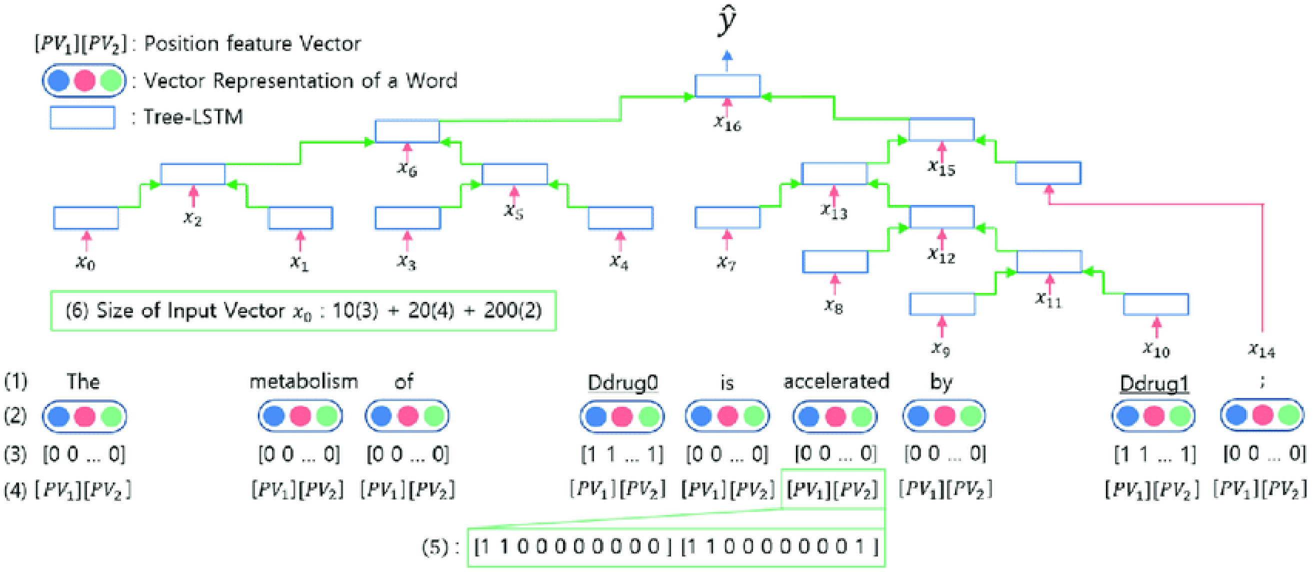
Recursive Neural Network

A Recursive Neural Network is a type of deep neural network. So, with this, you can expect & get a structured prediction by applying the same number of sets of weights on structured inputs. With this type of processing, you get a typical deep neural network known as a recursive neural network. These networks are non-linear in nature.

The recursive networks are adaptive models that are capable of learning deep structured erudition. Therefore, you may say that the Recursive Neural Networks are among complex inherent chains. Let's discuss its connection with deep learning concepts.



Recursive Neural Network

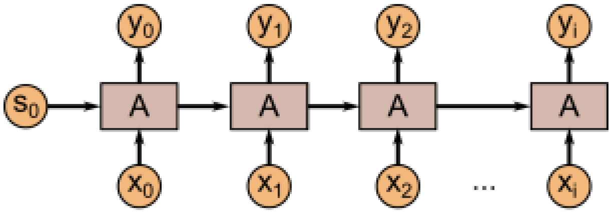


In simple words, if we say that a Recursive neural network is a family person of a deep neural network, we can validate it. So, if the same set of weights are recursively applied on a structured input, then the Recursive neural network will take birth. So, it will keep happening for all the nodes, as explained above. Recursive neural networks are made of architectural class, which is majorly operational on structured inputs. The RNN's are particularly directed on acyclic graphs. It's a deep tree structure. For conditions like there are needs to parse the complete sentence, there recursive neural networks are used. It has a topology similar to tree-like. The RNN's allow the branching of connections & structures with hierarchies.

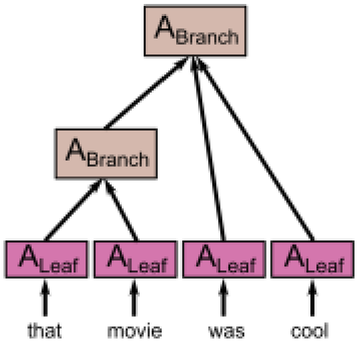
They mainly use recursive neural networks for the prediction of structured outputs. It is done over variable-sized input structures. Also, it traverses a given structure that too in topological order. They also do it for scalar predictions. But here point to note is that the Recursive neural network just does not respond to structured inputs, but it also works in contexts.

Each time series is processed separately. A very interesting point to ponder is that the first introduction of RNN happened when a need arose to learn distributed data representations of various structural networks. For instance, logical terms.

Recurrent Neural Network vs. Recursive Neural Networks



Recurrent Neural Net



Recursive Neural Net

Recurrent neural network is a recursive neural network. Both the neural networks are denoted by the same acronym – RNN. If neural networks are recurring over a period of time or say it is a recursive networking chain type, it is a recurrent neural network. To generalize, it belongs to the recursive network.

The above image depicts the recursive neural network. Here, if you see, you will find that each of the parent nodes, its children are a node quite similar to the parent node. Therefore, it's evident that the recurrent neural network is more similar to a hierarchical network type. You can see clearly that there is no concept of structured input & output processing here. It is just performed in a tree-like hierarchical manner where there are no time specifications & dependencies associated.

Hence, the major difference between the recursive neural network and recurrent neural networks is clearly not very well defined. It is seen that the efficiency of any recursive neural network is far better compared to a feed-forward network. Recurrent neural networks are created in a chain-like structure. There are no branching methods, but the recurrent neural networks are created in the form of a deep tree structure.

Recursive Neural Networks | Principle defined

So, to generalize here, the Recurrent networks do not differ from Recursive neural networks. But in fact, it is a Recursive neural network. There is a fact related to that recursive networks are inherently complex and, therefore, not accepted on a broader platform. These RNN's are even more expensive at all computational learning stages & phases.

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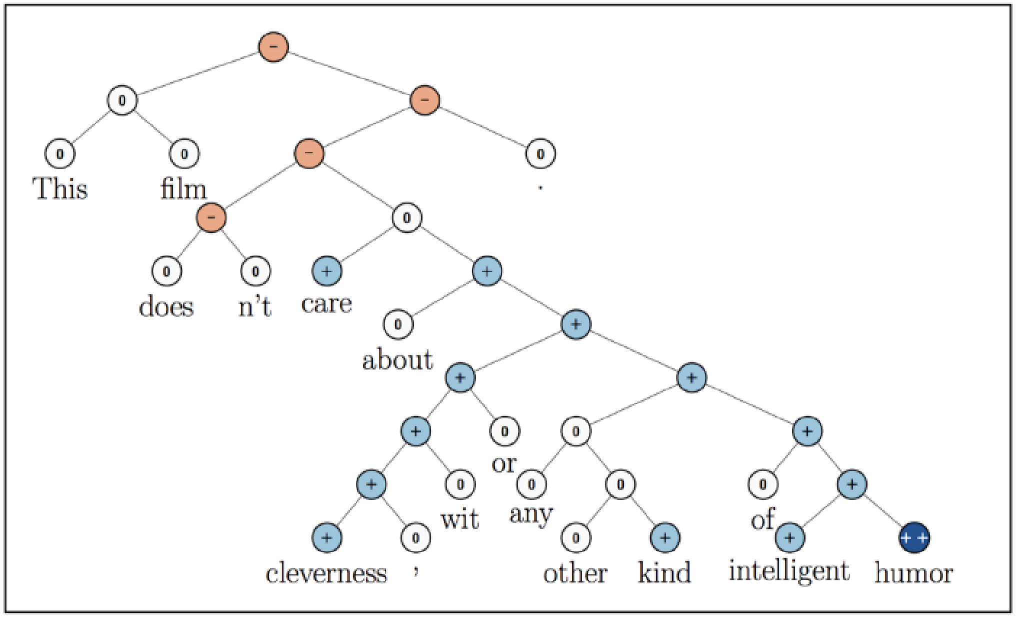
Recursive Neural Network Implementation

We use a Recursive Neural Network for sentiment analysis in sentences. Sentiment analysis of sentences is among the major tasks of NLP (Natural Language Processing), that can identify writers writing tone & sentiments in any specific sentences. When a writer expresses any sentiments, basic labels around the tone of writing are identified. For instance, whether the meaning is a constructive form of writing or negative word choices.

For instance, in the undermentioned case of the variable dataset, it expresses every emotion in distinctive classes.



So, if you see the above image for the Sentiment analysis, it is completely implemented with the help of Recursive Neural Networks algorithms. The RNN is a form of a recursive neural net that has a tree structure.

https://www.upgrad.com/blog/introduction-to-recursive-neural-network/

https://en.wikipedia.org/wiki/Recursive_neural_network

Convolutional neural network

Neural networks reflect the behavior of the human brain, allowing computer programs to recognize patterns and solve common problems in the fields of AI, machine learning, and deep learning.

Perceptron is a type of Neural Network which is the most basic in form. It is a simple feed-forward artificial neural network with only one hidden layer. In the Perceptron network, each neuron is connected to every other neuron in the forward direction.

The connections between these neurons are weighted because of which the information that is transferred between the two neurons is strengthened or attenuated by these weights. In the training process of the Neural Networks, it is these weights that are adjusted to get the correct value.

The Perceptron makes use of a binary classifier function in which is maps a vector of variables that are binary in nature to a single binary output. This can also be used in Supervised Learning.

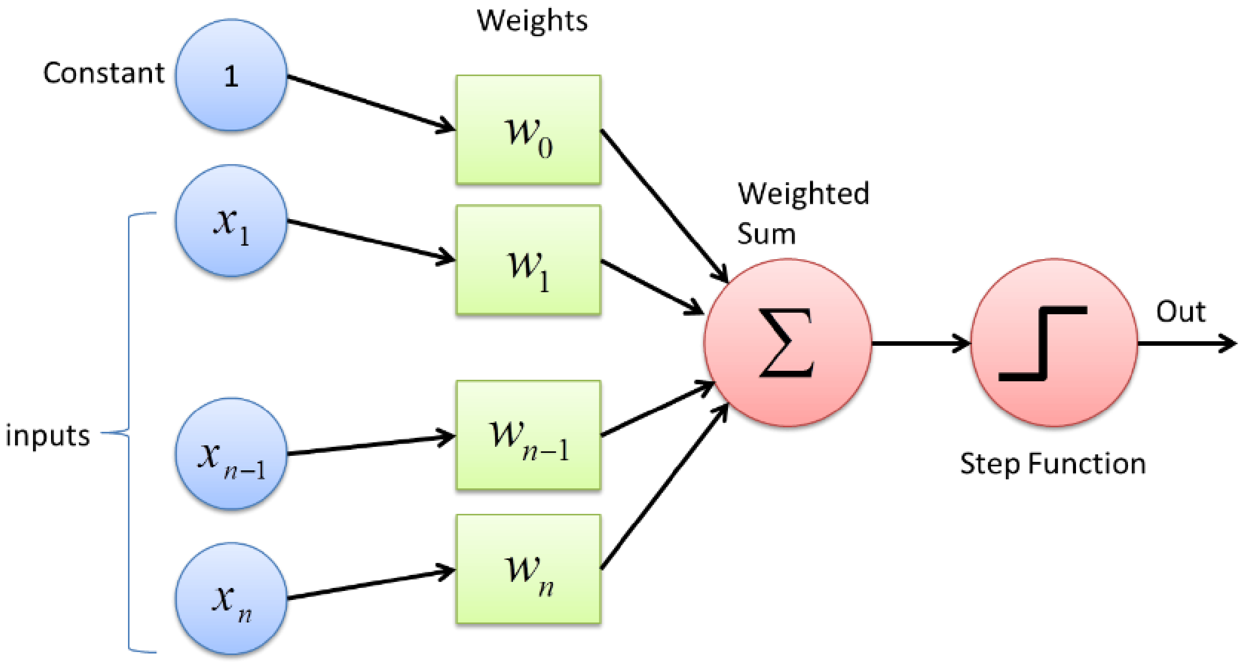
The steps in the Perceptron Learning Algorithm are –

1. Multiply all the inputs with their weights w, where w are real numbers that can be initially fixed or randomized.
2. Add the product together to obtain the weighted sum, $\sum wj\ xj$
3. Once the weighted sum of inputs is obtained, the Activation Function is applied to determine whether the weighted sum is greater than a particular threshold value or not depending upon the activation function applied. The output is assigned as 1 or 0 depending upon the threshold condition. Here the value "-threshold" also refers to the term bias, b.

In this way, the Perceptron Learning algorithm can be used to fire up (value =1) the neurons present in the Neural Networks that are designed and developed today. Another representation of the Perceptron Learning Algorithm is –

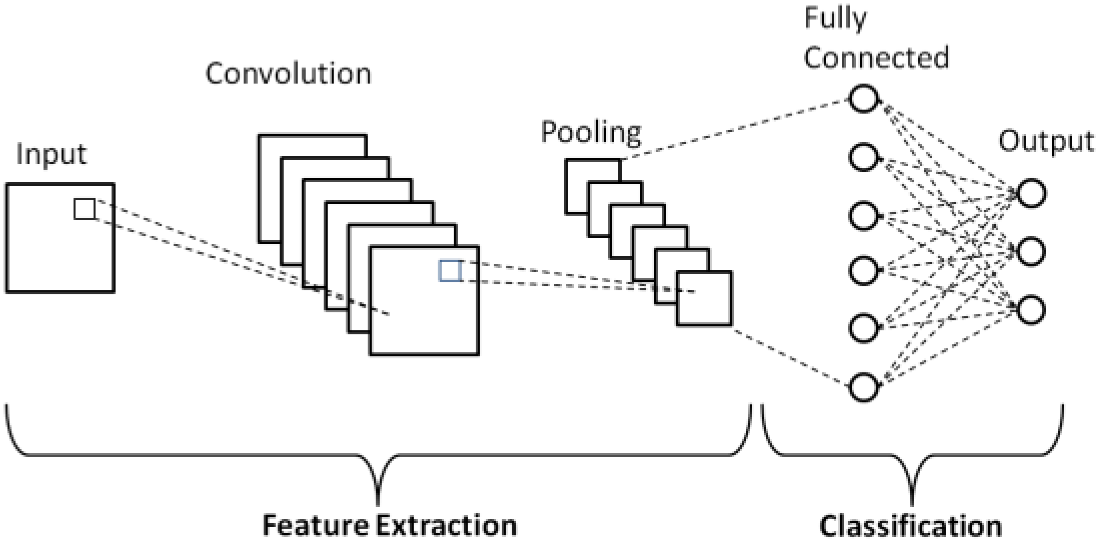
$f(x) = 1$, if $\sum wj\ xj + b \geq 0$
0, if $\sum wj\ xj + b < 0$

Though the Perceptrons are not widely used nowadays, it still remains as one of the core concepts in Neural Networks. On further research, it was understood that small changes in either the weights or bias in even one perceptron could vastly change the output from 1 to 0 or vice versa. This was one major disadvantage of the Perceptron. Hence, more complex activation functions such as the ReLU, Sigmoid functions were developed which introduces only moderate changes in the weights and bias of the artificial neurons.



Convolutional Neural Networks

A Convolutional Neural Network is a Deep Learning Algorithm that takes an image as an input, assigns various weights and biases to various parts of the image such that they are differentiable from each other. Once they become differentiable, using various activation functions the Convolutional Neural Network Model can perform several tasks in the Image Processing domain including Image Recognition, Image Classification, Object and Face Detection, etc.
The fundamental of a Convolutional Neural Network Model is that it receives an input image. The input image can be either labelled (such as cat, dog, lion, etc.) or unlabelled. Depending upon this, the Deep Learning algorithms are classified into two types namely the Supervised Algorithms where the images are labelled and the Unsupervised Algorithms where the images are not given any particular label.
To the computer machine, the input image is seen as an array of pixels, more often in the form of a matrix. Images are mostly of the form h x w x d (Where h = Height, w = Width, d = Dimension). For example, an image of size 16 x 16 x 3 matrix array denotes an RGB Image (3 stands for the RGB values). On the other hand, an image of 14 x 14 x 1 matrix array represents a grayscale image.



Layers of Convolutional Neural Network

As shown in the above basic Architecture of a Convolutional Neural Network, a CNN Model consists of several layers through which the input images undergo pre-processing to get the output. Basically, these layers are differentiated into two parts –

- The first three layers including the Input Layer, Convolution Layer and the Pooling layer which acts as the feature extraction tool to derive the base level features from the images fed into the model.
- The final Fully Connected Layer and the Output Layer makes use of the output of the feature extraction layers and predicts a class for the image depending upon the features extracted.

The first layer is the **Input Layer** where the image is fed into the Convolutional Neural Network Model in the form of an array of matrix i.e., 32 x 32 x 3, where 3 denotes that the image is an RGB image with an equal height and width of 32 pixels. Then, these input images pass through the **Convolutional Layer** where the mathematical operation of Convolution is performed.

The input image is convolved with another square matrix known as the kernel or filter. By sliding the kernel one by one over the pixels of the input image, we obtain the output image known as the feature map which provides information about the base level features of the image such as edges and lines.

Convolutional Layer is followed by the **Pooling layer** whose aim is to reduce the size of the feature map to reduce computational cost. This is done by several types of pooling such as Max Pooling, Average Pooling and Sum Pooling.

The **Fully Connected** (FC) Layer is the penultimate layer of the Convolutional Neural Network Model where the layers are flattened and fed to the FC layer. Here, by using activation functions such as the Sigmoid, ReLU and tanH functions, the label prediction takes place and is given out in the final **Output Layer**.

Where the CNNs Fall Short

With so many useful applications of the Convolutional Neural Network in visual image data, the CNNs have a small disadvantage in that they do not work well with a sequence of images (videos) and fail in interpreting the temporal information & blocks of text.

In order to deal with temporal or sequential data such as the sentences, we require algorithms that learn from the past data and also the future data in the sequence. Luckily, the Recurrent Neural Networks do just that.

https://www.upgrad.com/blog/cnn-vs-rnn/