LeNet

What is LeNet ?

LeNet is a convolutional neural network that Yann LeCun introduced in 1989. LeNet is a common term for **LeNet-5**, a simple convolutional neural network.

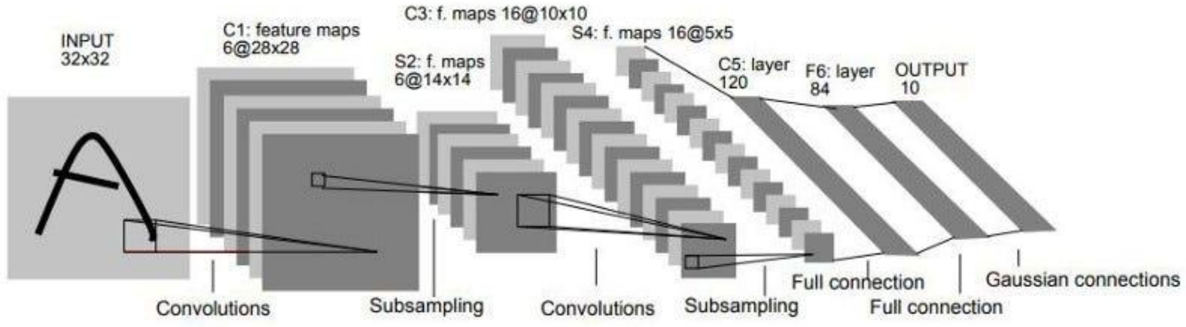
The LeNet-5 signifies CNN's emergence and outlines its core components. However, it was not popular at the time due to a lack of hardware, especially GPU (Graphics Process Unit, a specialised electronic circuit designed to change memory to accelerate the creation of images during a buffer intended for output to a show device) and alternative algorithms, like SVM, which could perform effects similar to or even better than those of the LeNet.

Features of LeNet-5

- Every convolutional layer includes three parts: convolution, pooling, and nonlinear activation functions
- Using convolution to extract spatial features (Convolution was called receptive fields originally)
- **The average pooling layer** is used for subsampling.
- '**tanh**' is used as the activation function
- Using **Multi-Layered Perceptron** or **Fully Connected Layers** as the last classifier
- The sparse connection between layers reduces the complexity of computation

Architecture

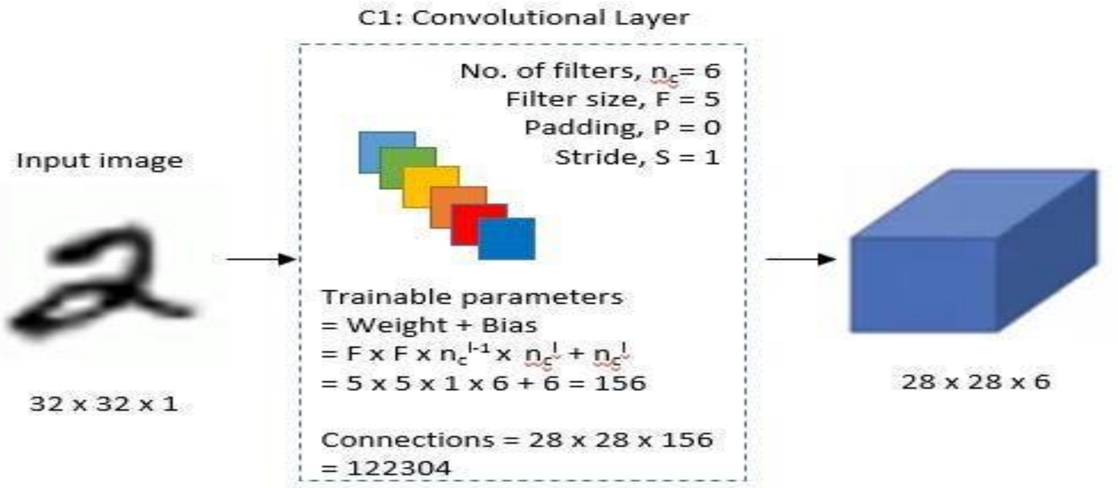
The LeNet-5 CNN architecture has seven layers. Three convolutional layers, two subsampling layers, and two fully linked layers make up the layer composition.



LeNet-5 Architecture

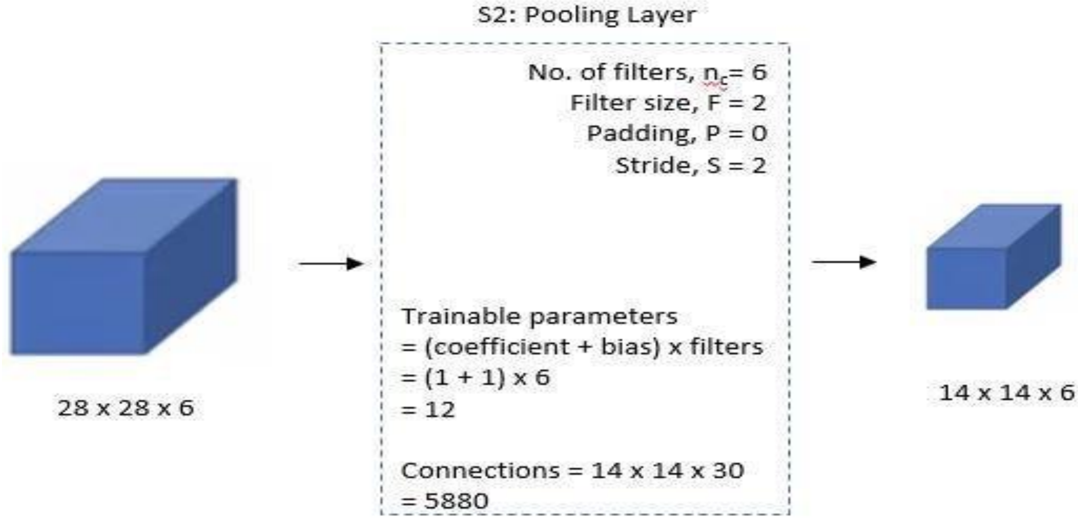
First Layer

A 32x32 grayscale image serves as the input for LeNet-5 and is processed by the first convolutional layer comprising six feature maps or filters with a stride of one. From 32x32x1 to 28x28x6, the image's dimensions shift.



Second Layer

Then, using a filter size of 22 and a stride of 2, the LeNet-5 adds an average pooling layer or sub-sampling layer. 14x14x6 will be the final image's reduced size.



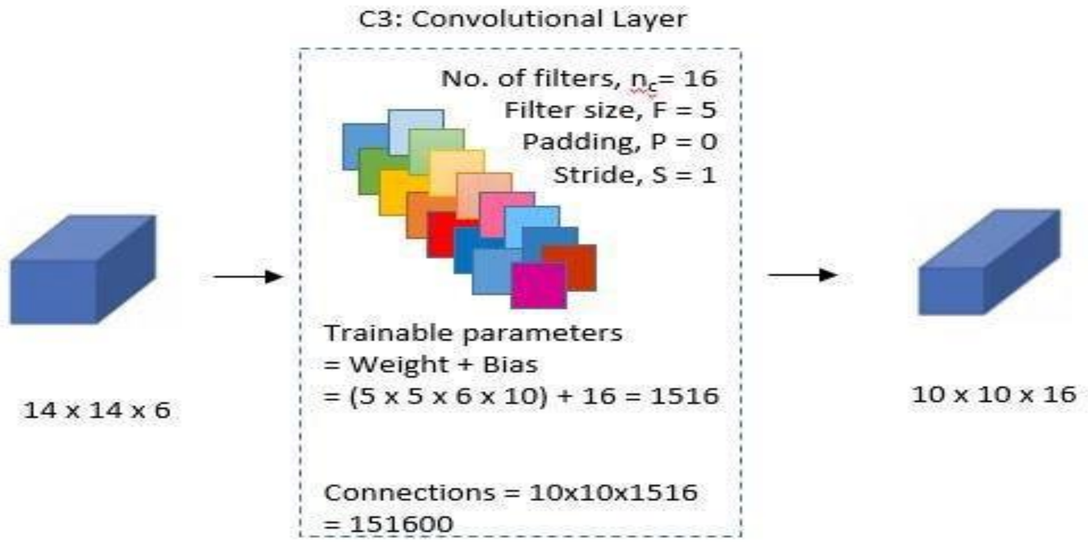
Third Layer

A second convolutional layer with 16 feature maps of size 55 and a stride of 1 is then present. Only 10 of the 16 feature maps in this layer are linked to the six feature maps in the layer below, as can be seen in the illustration below.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	X				X	X	X			X	X	X	X		X	X
1	X	X				X	X	X			X	X	X	X		X
2	X	X	X				X	X	X			X		X	X	X
3		X	X	X			X	X	X	X			X		X	X
4			X	X	X			X	X	X	X		X	X		X
5				X	X	X			X	X	X	X		X	X	X

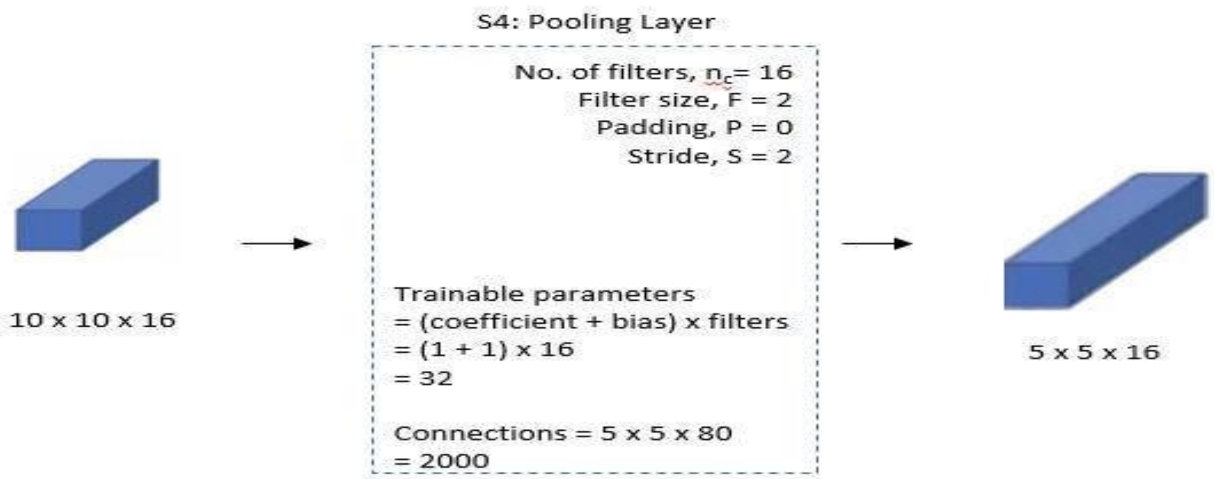
TABLE I
EACH COLUMN INDICATES WHICH FEATURE MAP IN S2 ARE COMBINED BY THE UNITS IN A PARTICULAR FEATURE MAP OF C3.

The primary goal is to disrupt the network's symmetry while maintaining a manageable number of connections. Because of this, there are 1516 training parameters instead of 2400 in these layers, and similarly, there are 151600 connections instead of 240000.



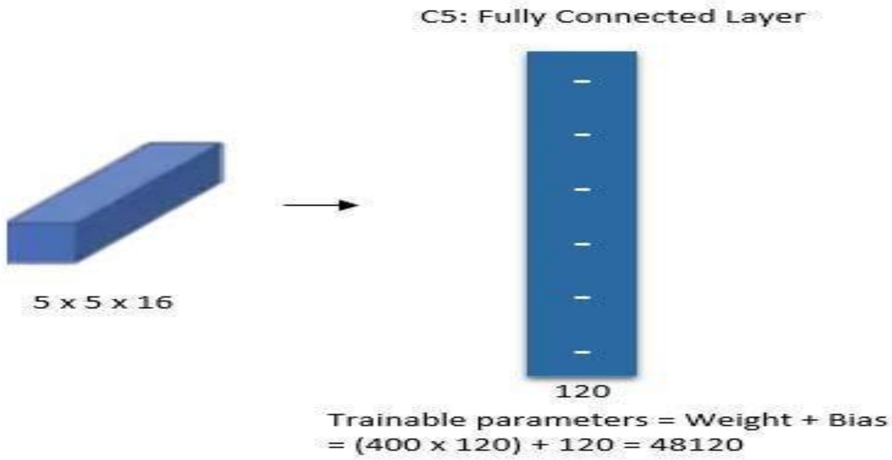
Fourth Layer

With a filter size of 22 and a stride of 2, the fourth layer (S4) is once more an average pooling layer. The output will be decreased to 5x5x16 because this layer is identical to the second layer (S2) but has 16 feature maps.



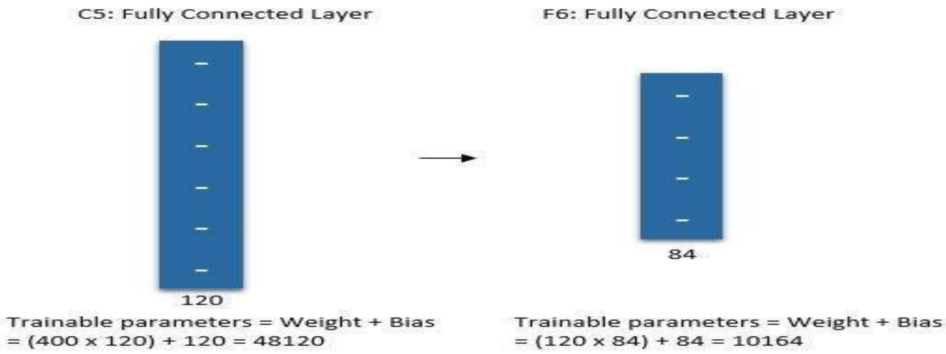
Fifth Layer

With 120 feature maps, each measuring 1 x 1, the fifth layer (C5) is a fully connected convolutional layer. All 400 nodes (5x5x16) in layer four, S4, are connected to each of the 120 units in C5’s 120 units.



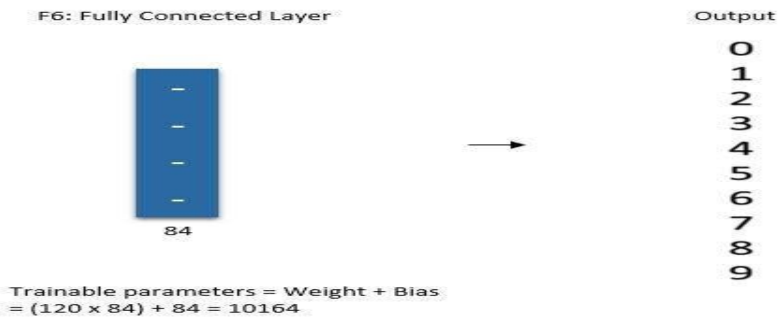
Sixth Layer

A fully connected layer (F6) with 84 units makes up the sixth layer.



Output Layer

The SoftMax output layer, which has 10 potential values and corresponds to the digits 0 to 9, is the last layer.



Summary of LeNet-5 Architecture

Layer		Feature Map	Size	Kernel Size	Stride	Activation
Input	Image	1	32x32	-	-	-
1	Convolution	6	28x28	5x5	1	tanh
2	Average Pooling	6	14x14	2x2	2	tanh
3	Convolution	16	10x10	5x5	1	tanh
4	Average Pooling	16	5x5	2x2	2	tanh
5	Convolution	120	1x1	5x5	1	tanh
6	FC	-	84	-	-	tanh
Output	FC	-	10	-	-	softmax

Summarized table for LeNet 5 Architecture