Convolutional Neural Network(CNN)

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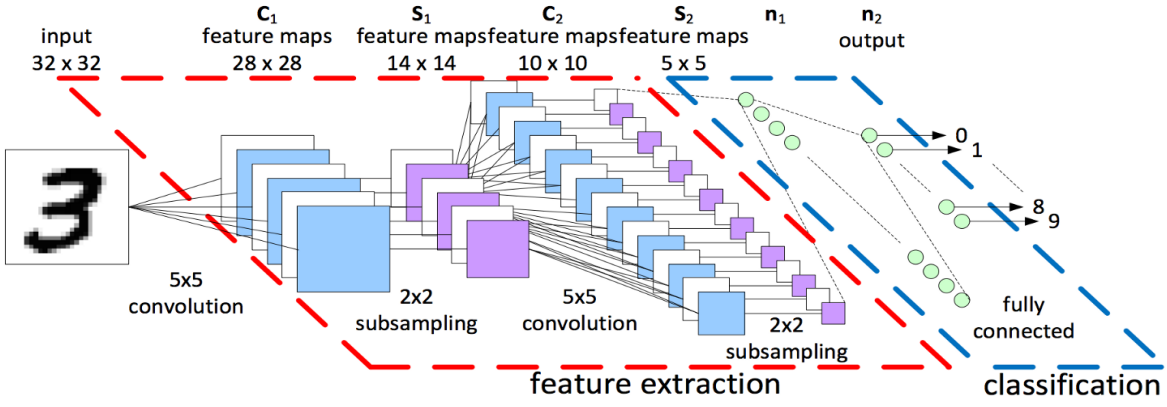
Introduction: Yann LeCun, director of facebook's AI Research Group. He built the first convolutional neural network called LeNet in 1988. LeNet was used for character recognition tasks like reading zip codes and digits.

About CNN: Convolutional Neural Networks have a different architecture than regular Neural Networks. Regular Neural Networks transform an input by putting it through a series of hidden layers.

Convolutional Neural Networks are a bit different. First of all, the layers are organised in 3 dimensions: width, height and depth. the neurons in one layer do not connect to all the neurons in the next layer but only to a small region of it. Lastly, the final output will be reduced to a single vector of probability scores, organized along the depth dimension.

CNN is composed of two major parts:

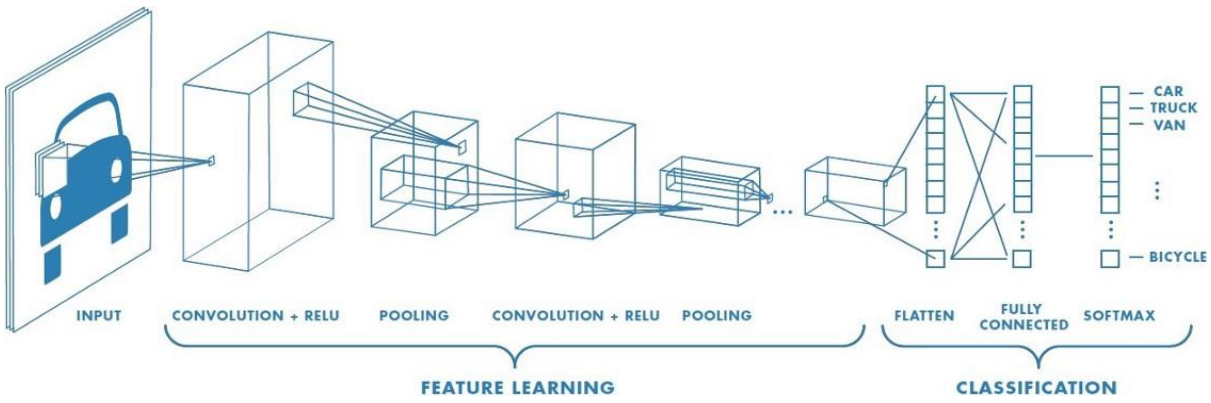
- **Feature Extraction:** In this part, the network will perform a series of convolutions and pooling operations during which the features are detected. If you had a picture of a zebra, this is the part where the network would recognize its stripes, two ears, and four legs.
- **Classification:** Here, the fully connected layers will serve as a classifier on top of these extracted features. They will assign a probability for the object on the image being what the algorithm predicts it is.



Source: https://miro.medium.com/max/653/1*EPpYI-llkbtwHgfprtTJzw.jpeg

Major parts of CNN

Architecture of CNN: Convolutional Neural Network (also called ConvNet) leverage spatial information and are therefore very well suited for image classification. A CNN mainly comprised of three layers namely convolutional layer, pooling layer and fully connected layer. These three layers can be repeatedly used to form a deep CNN architecture.



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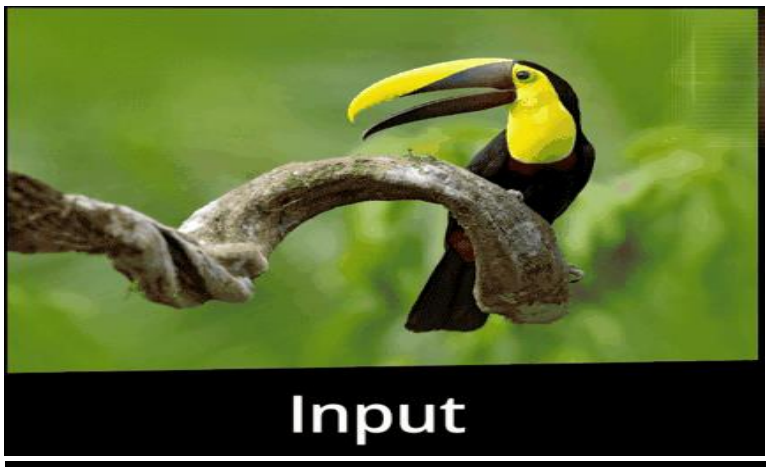
Architecture of CNN

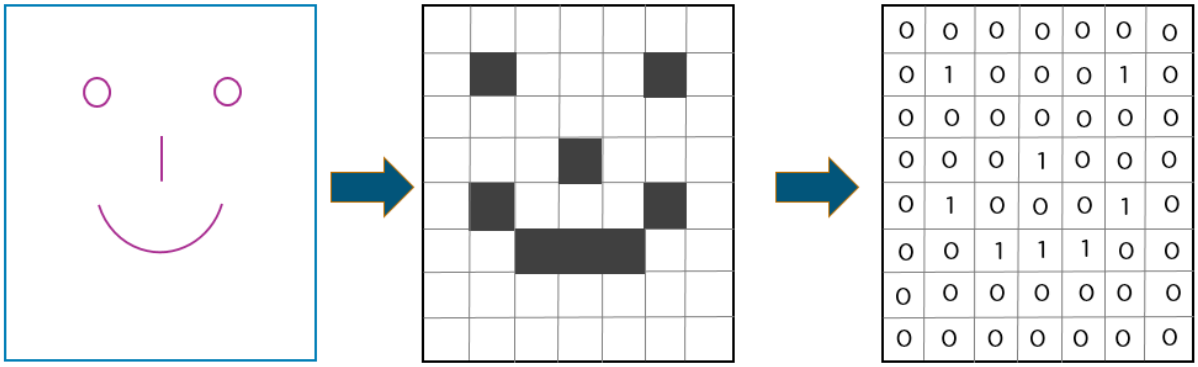
Layers in CNN: A convolution neural network has multiple hidden layers that help in extracting information from an image.

- **Input layer:** The first layer in every CNN is input layer .It retains the image's raw pixel value. Input image can be fed to the input layer of the CNN by applying pre-processing technique in order to achieve better accuracy.



Source: https://www.simplilearn.com/ice9/free_resources_article_thumb/Input_feature_map.gif

- **Convolution layer:** This is the first step in the process of extracting valuable features from an image. A convolution layer has several filters that perform the convolution operation. Every image is considered as a matrix of pixel values.



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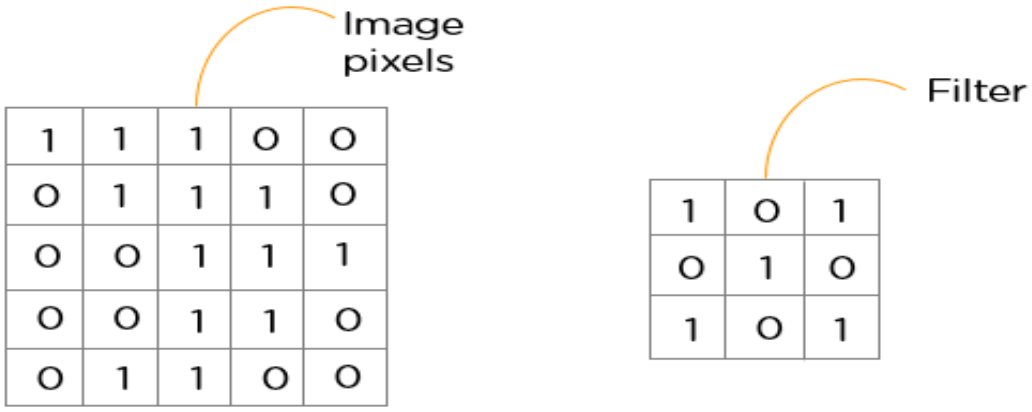
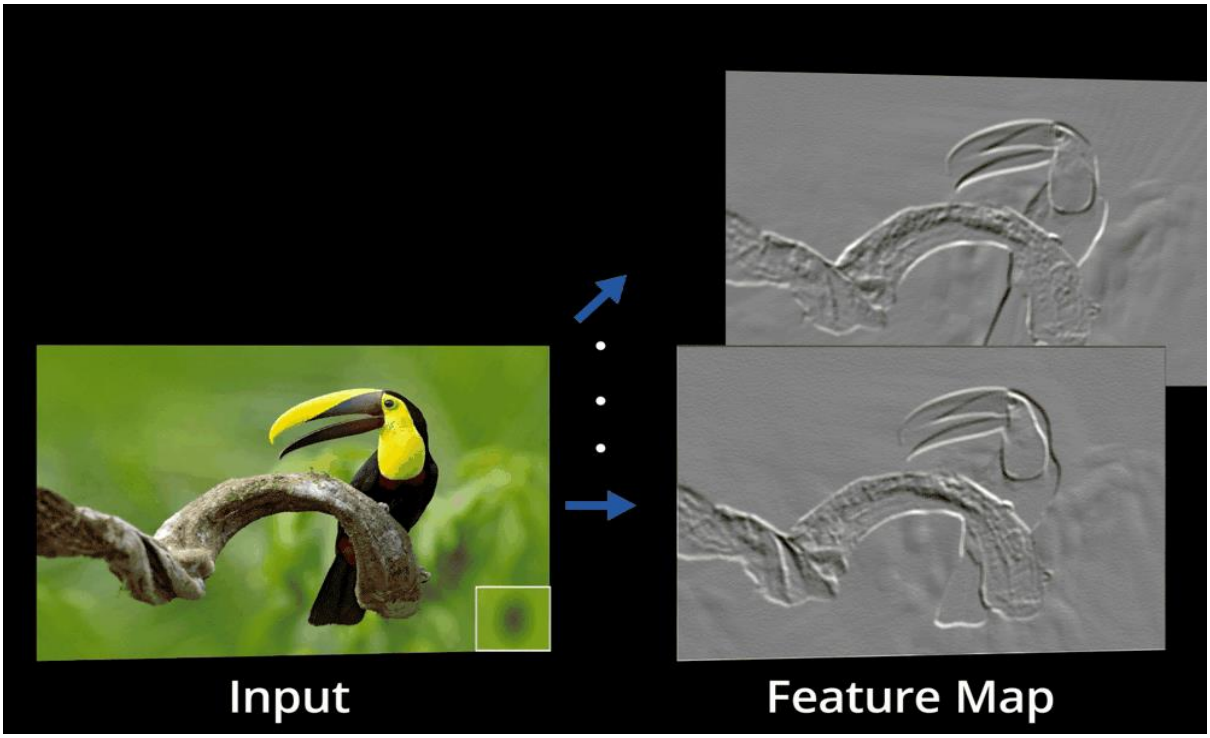
Consider the following 5x5 image whose pixel values are either 0 or 1. There's also a filter matrix with a dimension of 3x3. Slide the filter matrix over the image and compute the dot product to get the convolved feature matrix.



Source: https://www.simplilearn.com/ice9/free_resources_article_thumb/filter_matrix.png4

We will get different feature maps by applying different kernels/Filter. The typical activation functions are sigmoid, tanh, eLU and ReLU . Several features can be extracted at each location by applying different feature maps within the same convolutional layer.



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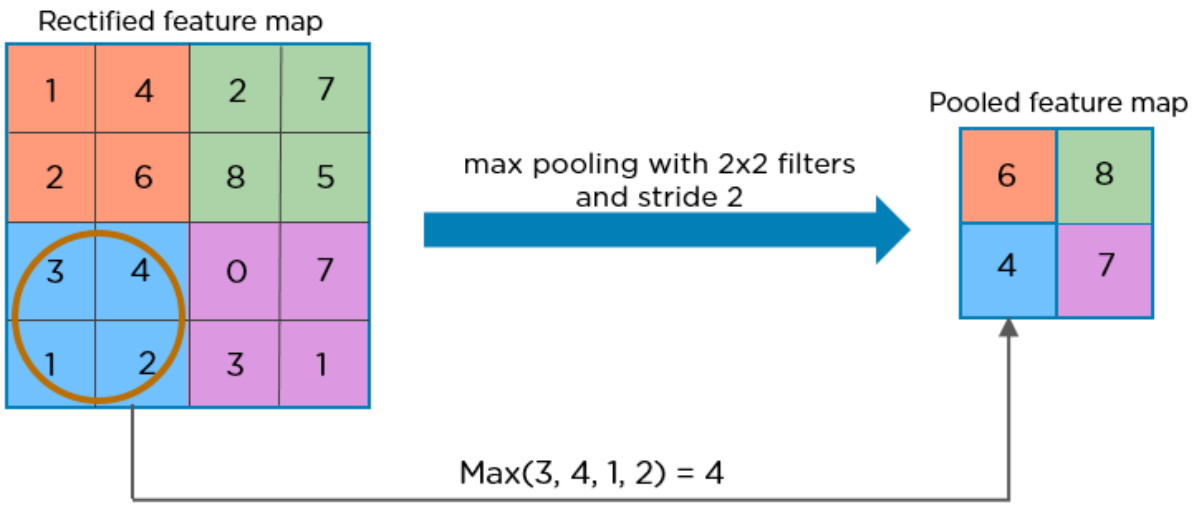
- **Pooling layer:** Pooling is a down-sampling operation that reduces the dimensionality of the feature map. The rectified feature map now goes through a pooling layer to generate a pooled feature map.



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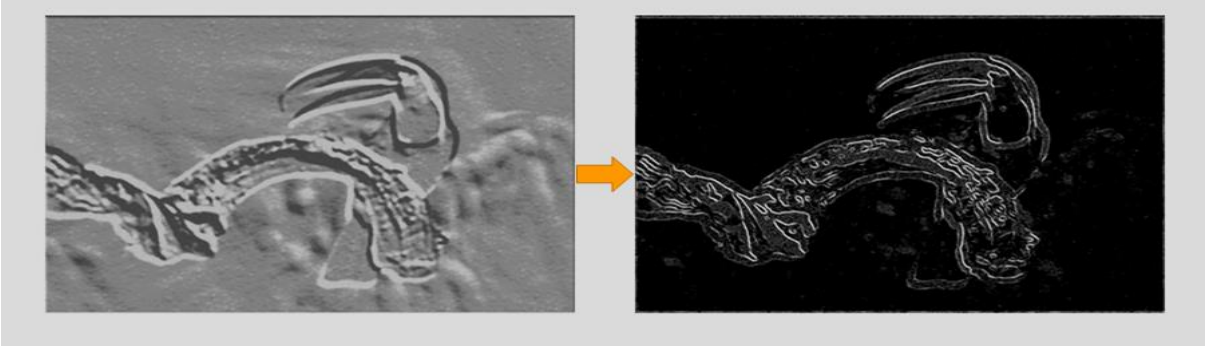
The pooling layer uses various filters to identify different parts of the image like edges, corners, body, eyes, and beak.



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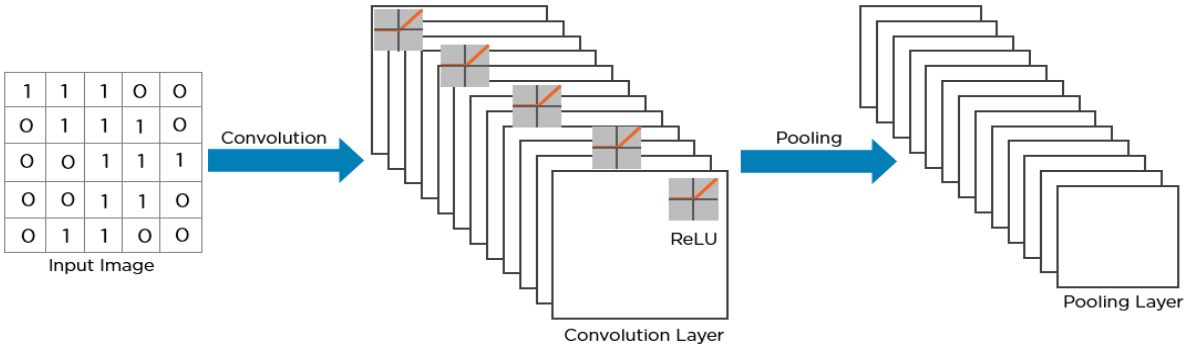
Here's how the structure of the convolution neural network looks so far:



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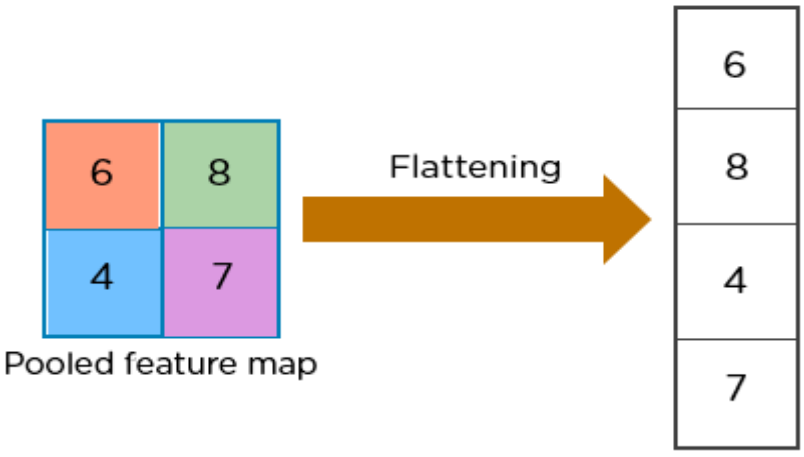
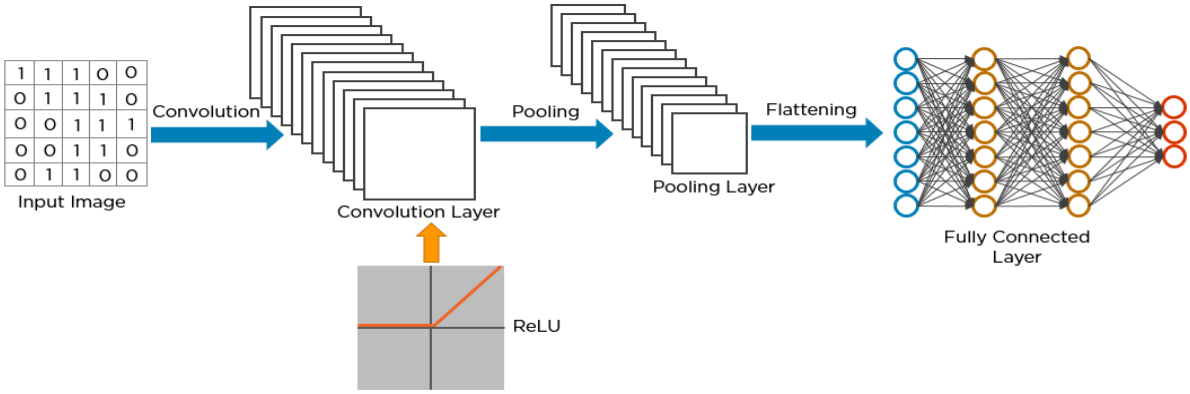
- **Fully connected layer:** In a fully connected layer each neuron is connected to every neuron in the previous layer, and each connection has its own weight. This layer flattens the input feature representation into a feature vector and performs the function of high level reasoning.



Source: https://www.simplilearn.com/ice9/free_resources_article_thumb/flattening.png

The flattened matrix is fed as input to the fully connected layer to classify the image.



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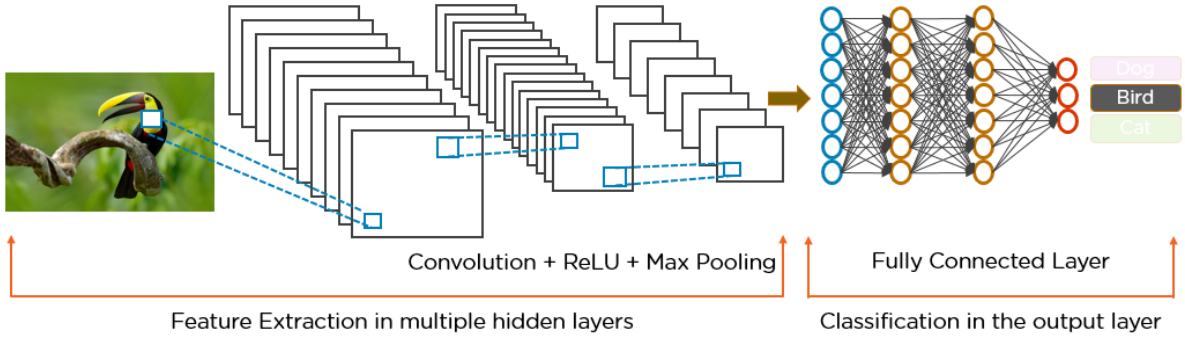
- **Output layer:** CNN recognizes a bird…



Source: https://www.simplilearn.com/ice9/free_resources_article_thumb/CNN_recognizes_a_bird1.png

Over all steps :-

- The pixels from the image are fed to the convolutional layer that performs the convolution operation.
- It results in a convolved map.
- The convolved map is applied to a ReLU function to generate a rectified feature map.
- The image is processed with multiple convolutions and ReLU layers for locating the features.
- Different pooling layers with various filters are used to identify specific parts of the image.
- The pooled feature map is flattened and fed to a fully connected layer to get the final output.

Use CNN:

- Convolutional Neural Network Implementation For Car Classification.
- Facial expression recognition using convolutional neural networks.
- Real-time video object recognition using convolutional neural network.
- Face Recognition using Convolutional Neural Networks.

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