Convolutional neural networks are distinguished from other neural networks by their superior performance with image, speech or audio signal inputs. They have three main types of layers, which are:

- Convolutional layer
- Pooling layer
- Fully-connected (FC) layer

The convolutional layer is the first layer of a convolutional network. While convolutional layers can be followed by additional convolutional layers or pooling layers, the fully-connected layer is the final layer. With each layer, the CNN increases in its complexity, identifying greater portions of the image. Earlier layers focus on simple features, such as colors and edges. As the image data progresses through the layers of the CNN, it starts to recognize larger elements or shapes of the object until it finally identifies the intended object.

A convolutional layer, a core component of Convolutional Neural Networks (CNNs), performs feature extraction by applying a convolution operation, using "filters" or "kernels" that slide across the input data to detect patterns and create feature maps.
Here's a more detailed explanation:
Key Concepts:

- **Convolution Operation:**

This involves sliding a small matrix (the kernel) over the input data (e.g., an image), performing element-wise multiplication and summing the results to produce a new value.

- **Kernels/Filters:**

These are learned parameters that identify specific features in the input data, such as edges, textures, or shapes.

- **Feature Maps:**

The output of a convolutional layer, representing the presence and location of detected features in the input.

- **Receptive Field:**

The area of the input that a particular neuron in the convolutional layer "sees" or is influenced by.

- **Strides and Padding:**

These parameters control how the kernel moves across the input and how the output size is maintained.

- **CNN architecture:**

Convolutional layers are typically followed by pooling layers and fully connected layers, forming the architecture of a CNN.

How it Works:

1. **1. Input:**

The convolutional layer receives input data, such as an image or a volume of data.

2. **2. Convolution:**

The kernel (filter) slides across the input, performing the convolution operation at each position.

3. **3. Feature Map Generation:**

The results of the convolution operations are combined to create a feature map, highlighting the presence and location of detected features.

4. **4. Activation Function:**

An activation function (e.g., ReLU) is applied to the feature map to introduce non-linearity.

5. **5. Output:**

The processed feature map is then passed to the next layer in the CNN.

Applications:

- **Image Recognition:**

CNNs, with their convolutional layers, are widely used for tasks like image classification, object detection, and image segmentation.

- **Natural Language Processing:**

Convolutional layers can also be used in NLP for tasks like text classification and sentiment analysis.

- **Signal Processing:**

Convolutional layers are used in signal processing for tasks like noise reduction and feature extraction.