An Introduction to Convolutional Neural Network

Neural Networks and Learning Systems - 1

Indian Institute of Science

Motivation

Computer Vision: Image Classification

Suppose we had a set of classes : cat, truck, boat.

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Computer Vision: Image Classification

Suppose we had a set of classes : cat, truck, boat.

→ Cat

Problem: The semantic gap

Images are represented as 3D arrays of numbers, with integers between [0,255].

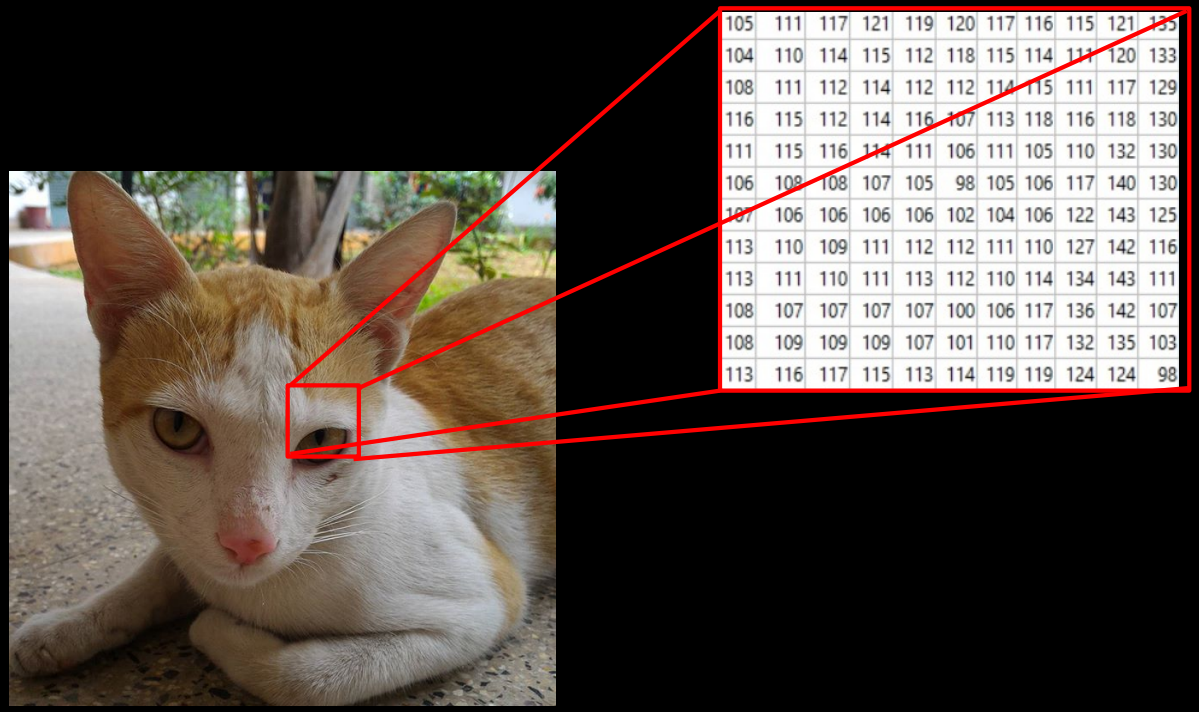
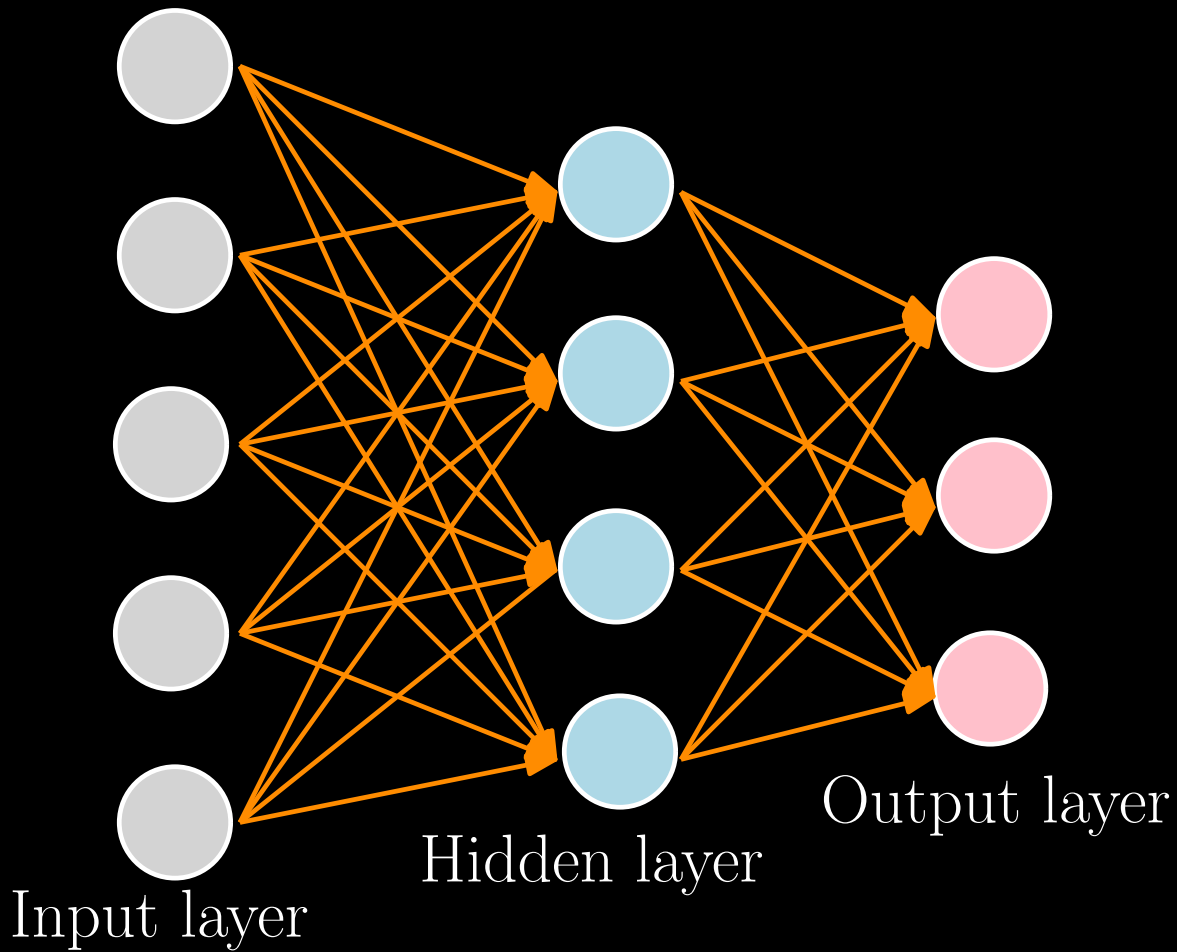


Image classifier

CIFAR-10 dataset

- **10** classes
- **50,000** training images
- **10,000** testing images
- **32** $\times$ **32** image size

Multilayer Perceptron

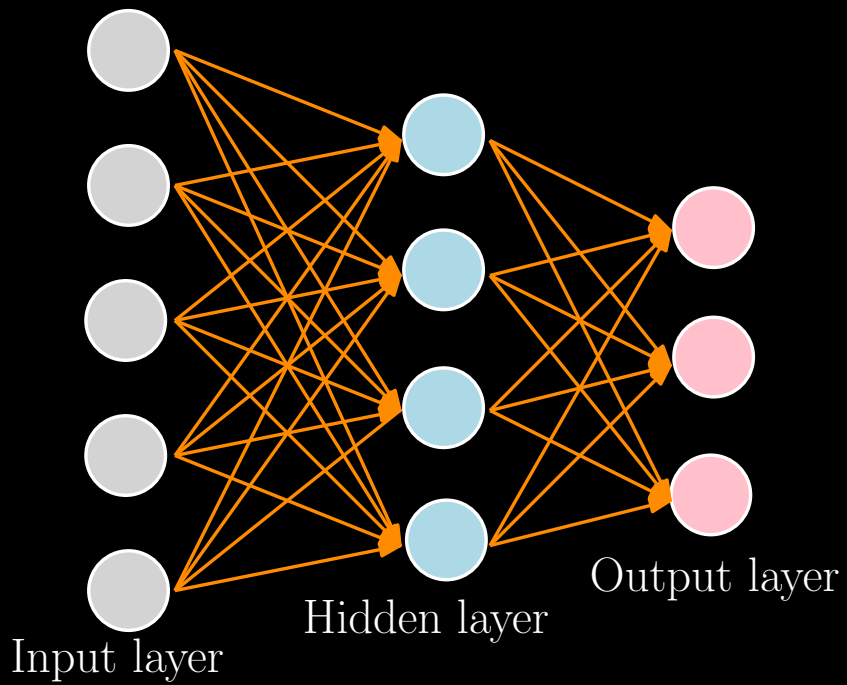


Multilayer Perceptron

Steps in training a neural network:

1. Forward propagation: Feed image and obtain loss function.
2. Back propagation : Calculate the gradients with respect to loss.
3. Update parameters: Update using the gradient.

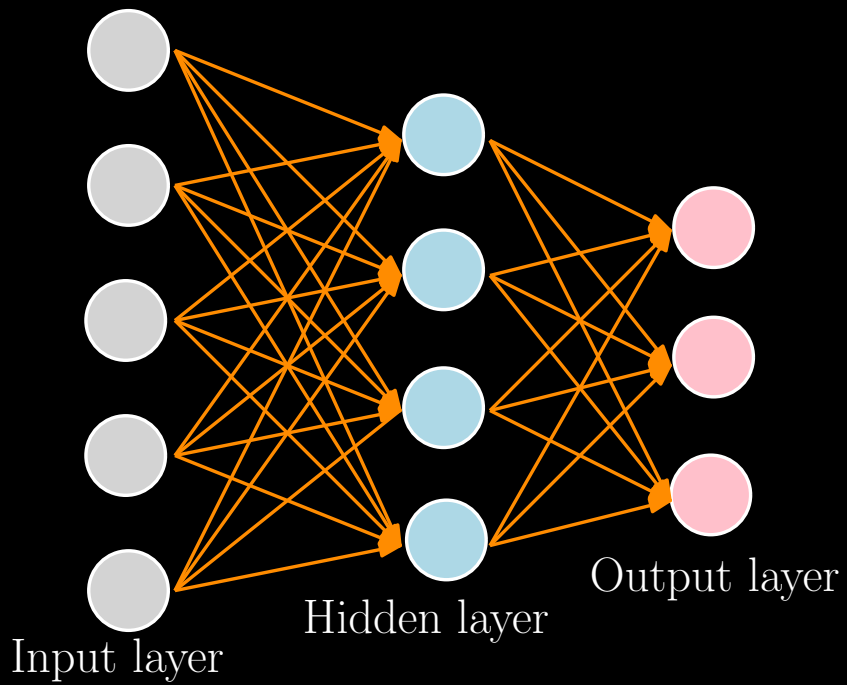
Neural Network



Say 100 hidden neurons.

- Size of image $= 32 \times 32 \times 3 = 3072$.
  Number of parameters $= 3,07,200$.

Neural Network

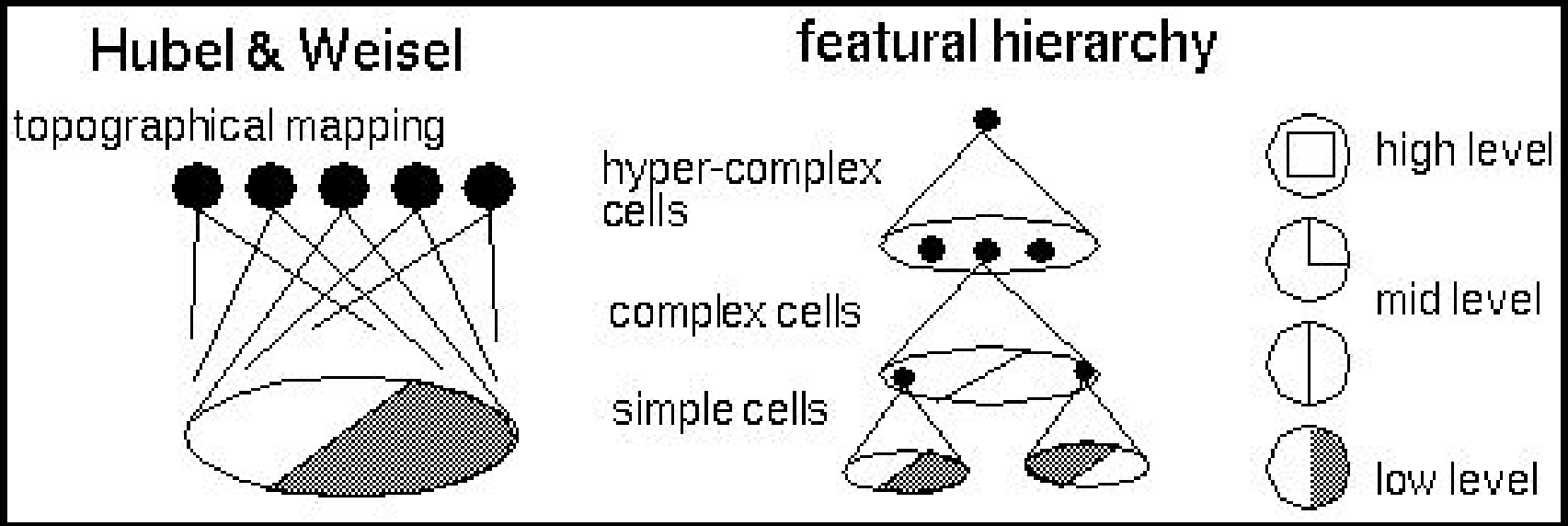


Say 100 hidden neurons.

- Size of image $= 32 \times 32 \times 3 = 3072$.
  Number of parameters $= 3,07,200$.
- Size of image $= 960 \times 720 \times 3 = 20,73,600$.
  Number of parameters $= 20,73,60,000$.

Visual Cortex

Hubel and Weisel: Feature identification using low, mid and high level features.[1]

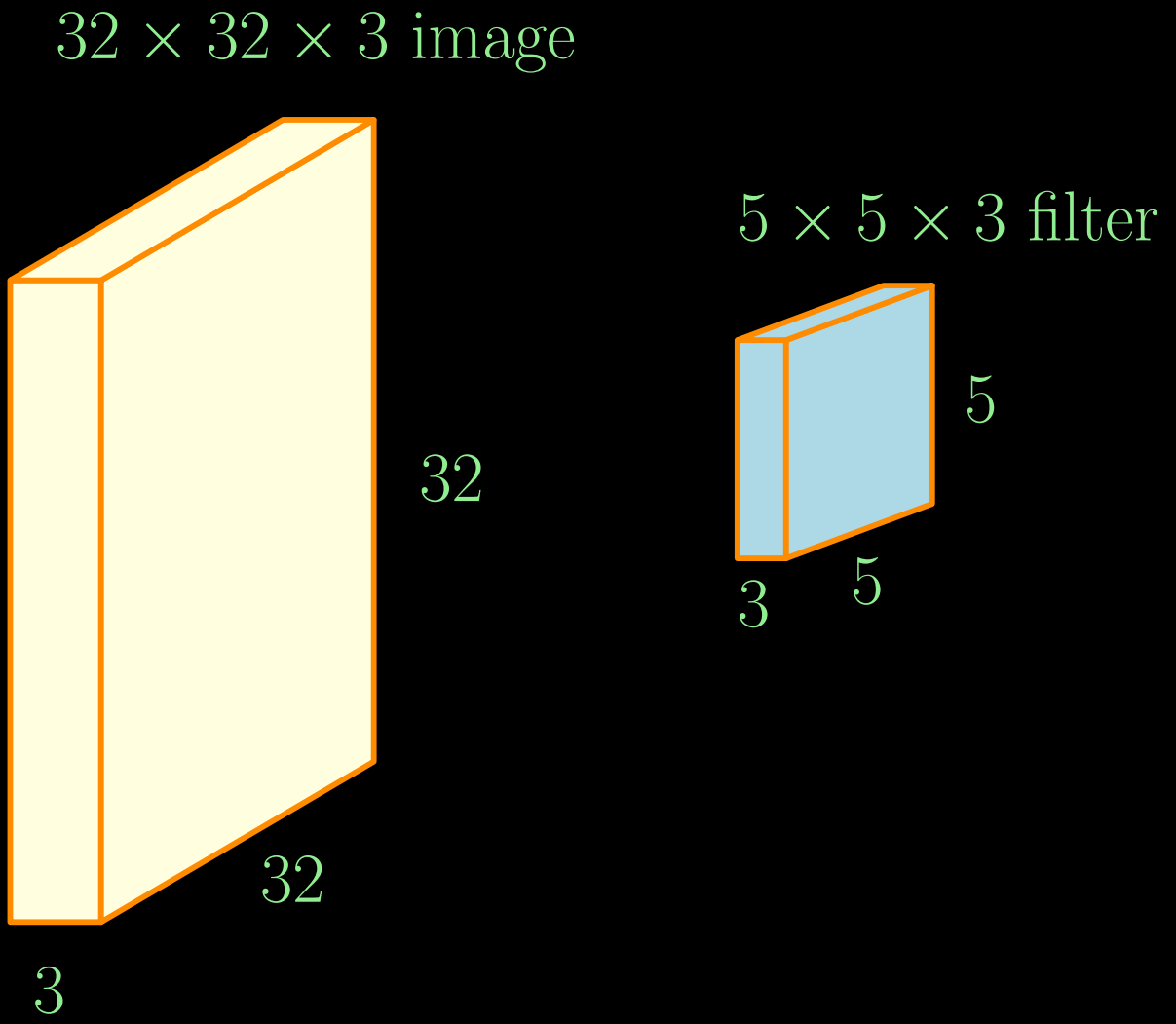


[1] Hubel, David H., and Torsten N. Wiesel. "Receptive fields, binocular interaction and functional architecture in the cat's visual cortex." The Journal of physiology 160.1 (1962): 106-154.

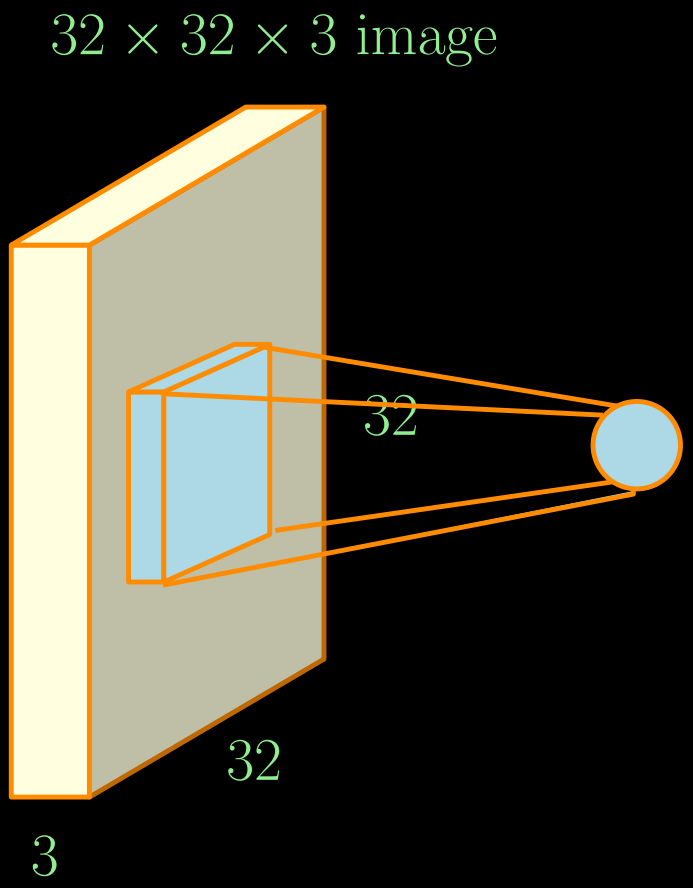
Convolution Neural Network

- Identifying features : **Convolution**
- Bringing invariance : **Pooling**

Convolution Neural Network

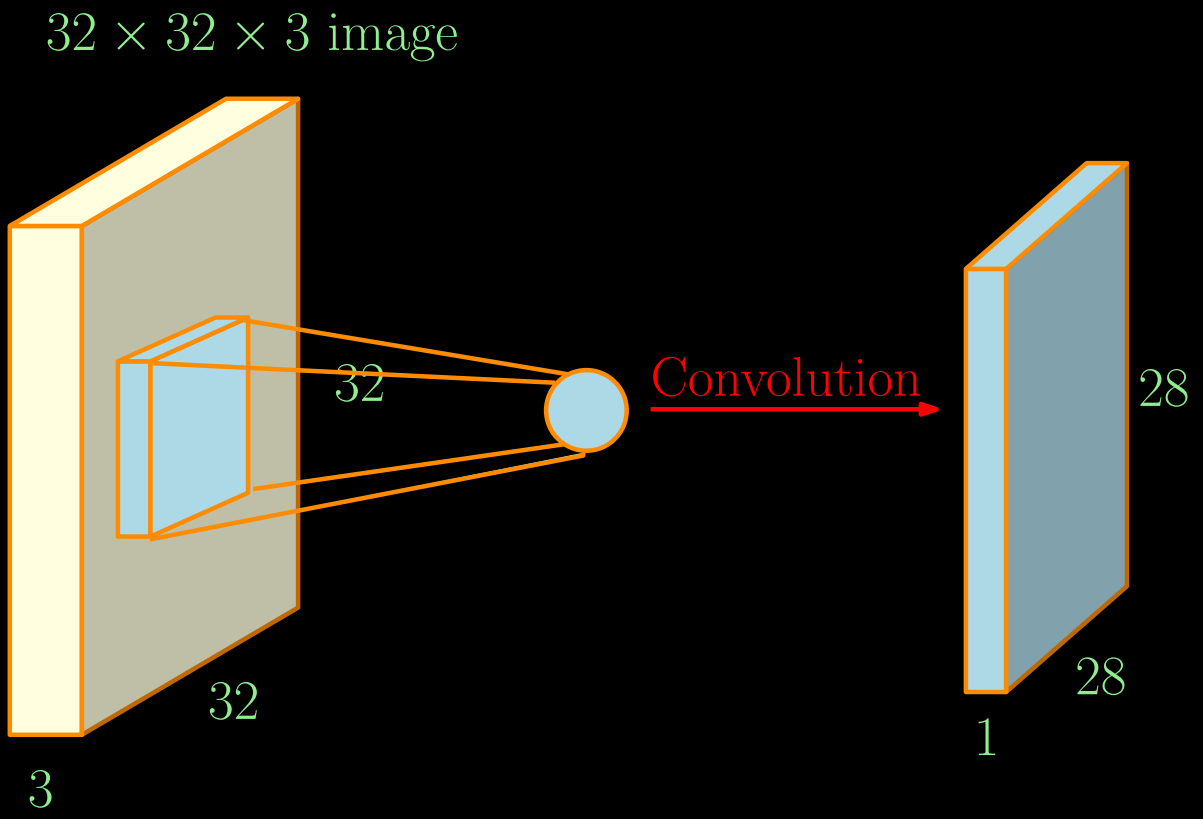


Convolution Neural Network



A single value is obtained by taking the dot product of filter and a $5 \times 5 \times 3$ portion of image.

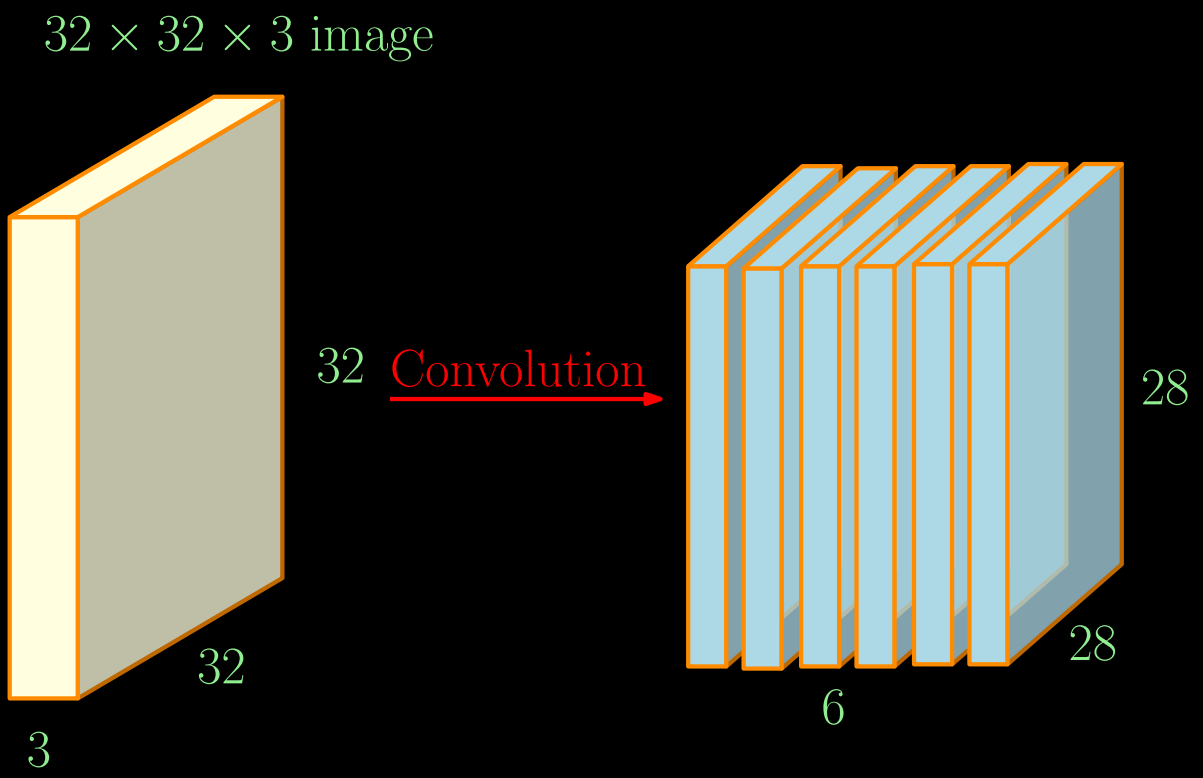
Convolution Neural Network



Convolving the filter over the image, we obtain a map of size $28 \times 28 \times 1$.

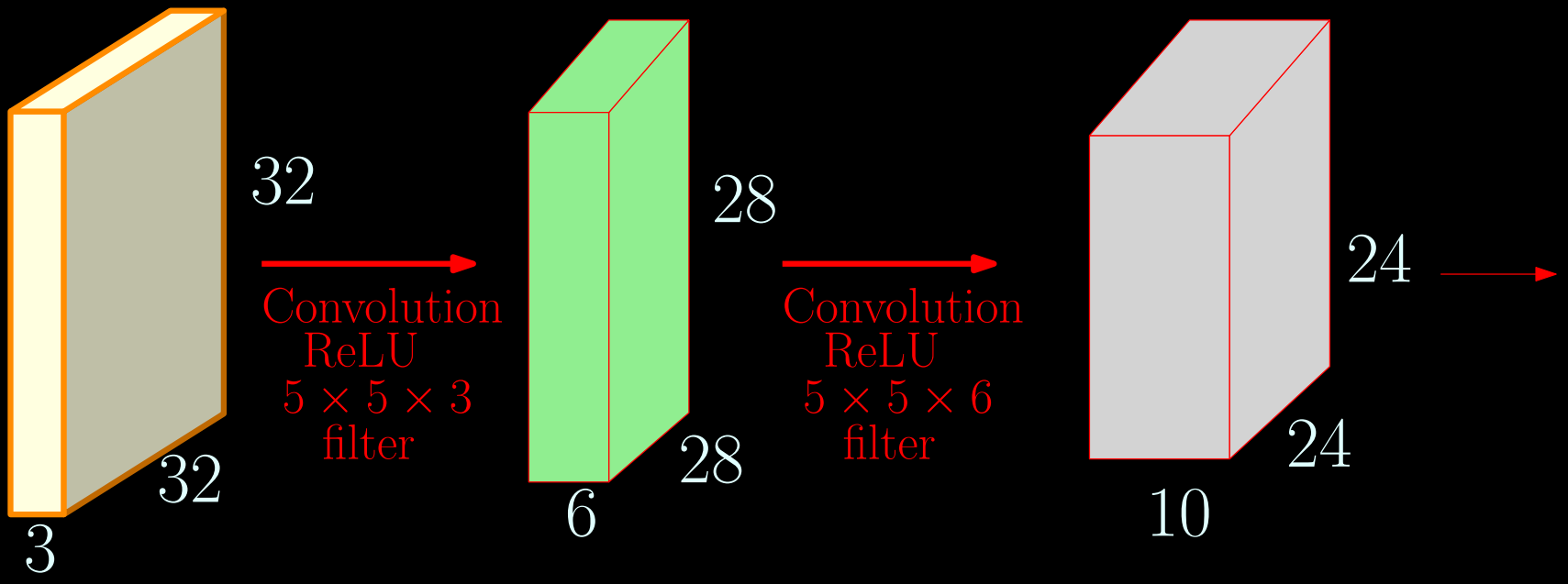
Convolution Neural Network

If we have six 5×5 filters, we will get 6 maps.



This forms the new input of size $28 \times 28 \times 6$.

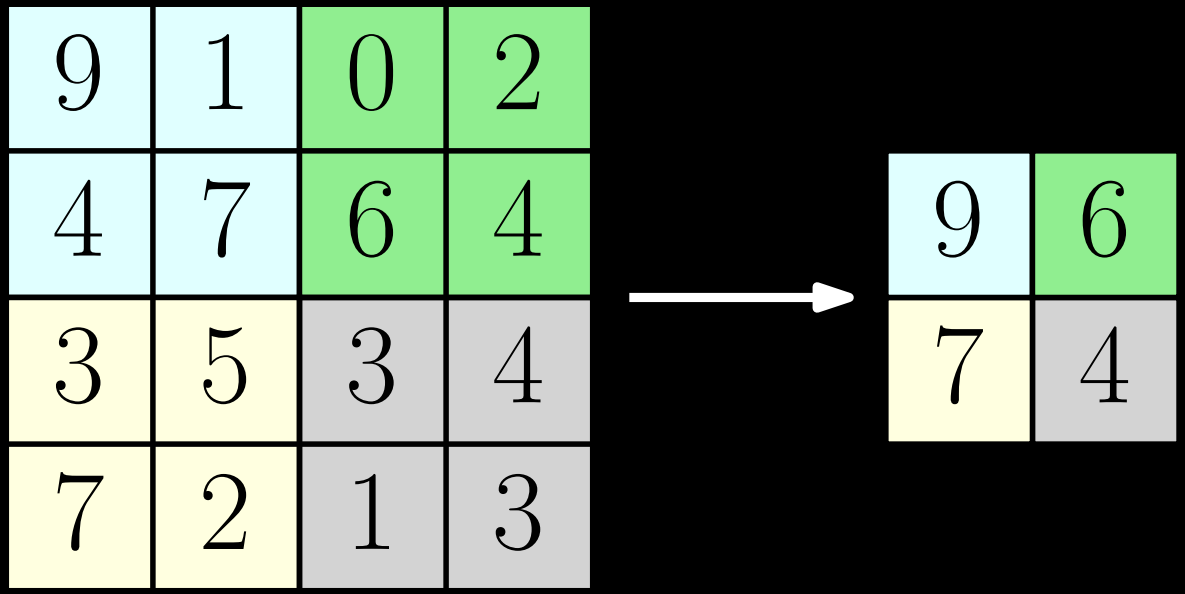
Convolution Neural Network



Depth of filters increases as the layers increase.

Pooling

MAX POOLING - Downsamples the input by 2 along the width and height by performing pooling over 2×2 with a stride of 2. Discards 75% of the activations.



Convolution Neural Network