# Parameter Counts in CNNs

We explore what makes Convolution Neural Networks well suited for images
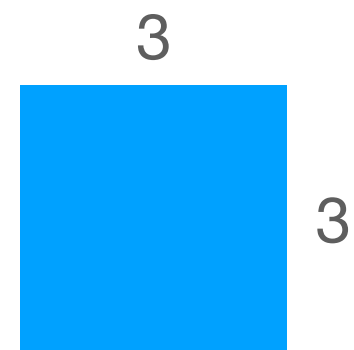
Parameters

What are Parameters or weights?

- They are the variables that need to be learnt when training a Model

- Often called learnable parameters or weights

- Our hidden layers like the Convolution or Fully Connected Layers have weights

Calculating Learnable Parameters in a Conv Filter

Input Image

Feature Map Output
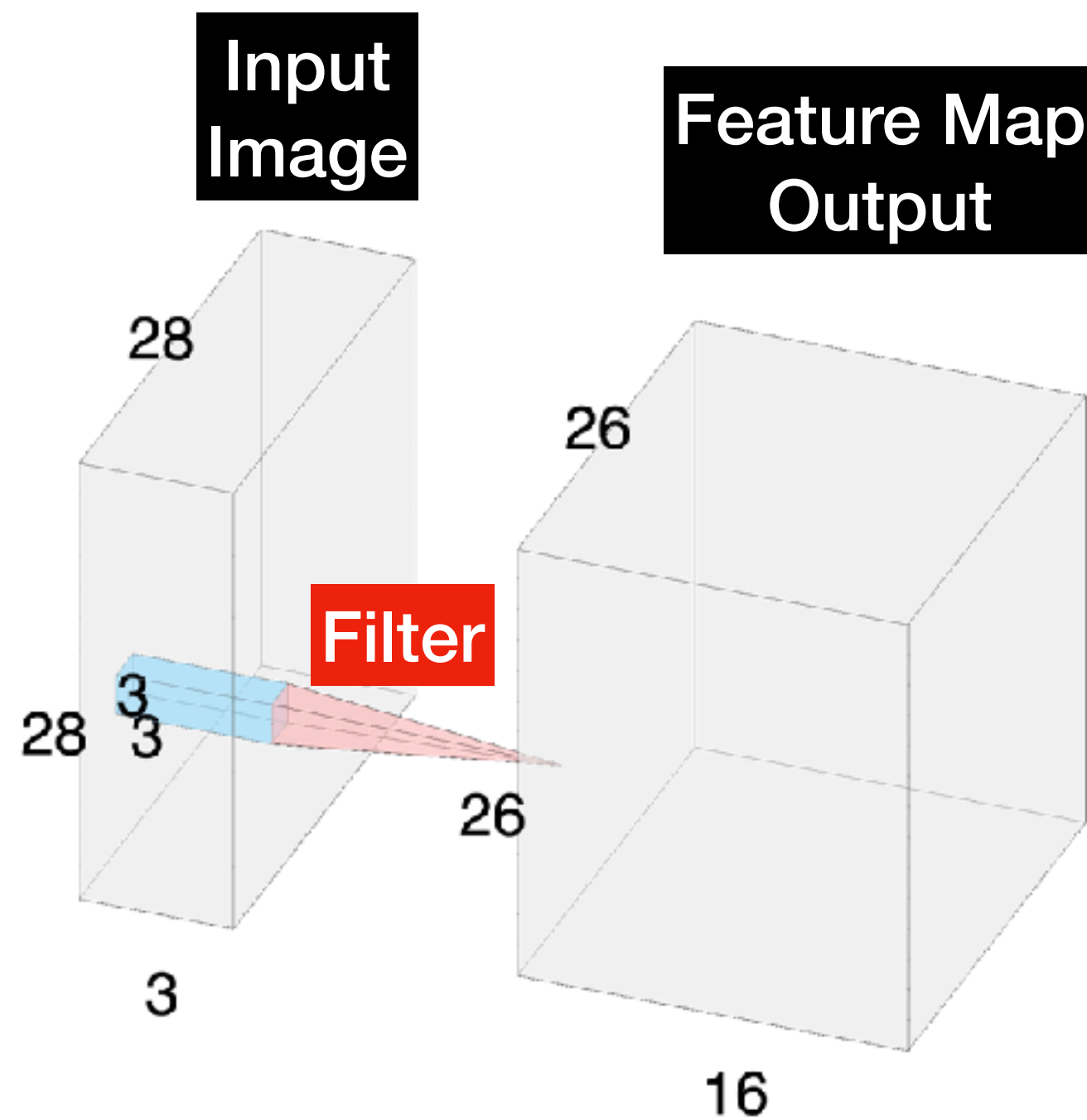
- How many parameters are in 16 Convolution Filters with 3x3 kernels?

- Does the input image dimension matter? No, only it's depth

- All that matters is that we have 16 Conv Filters of 3x3 kernel size

Parameters for One Filter

$(Height \times Width \times Depth) + bias$

$(3 \times 3 \times 1) + 1 = $ **10**
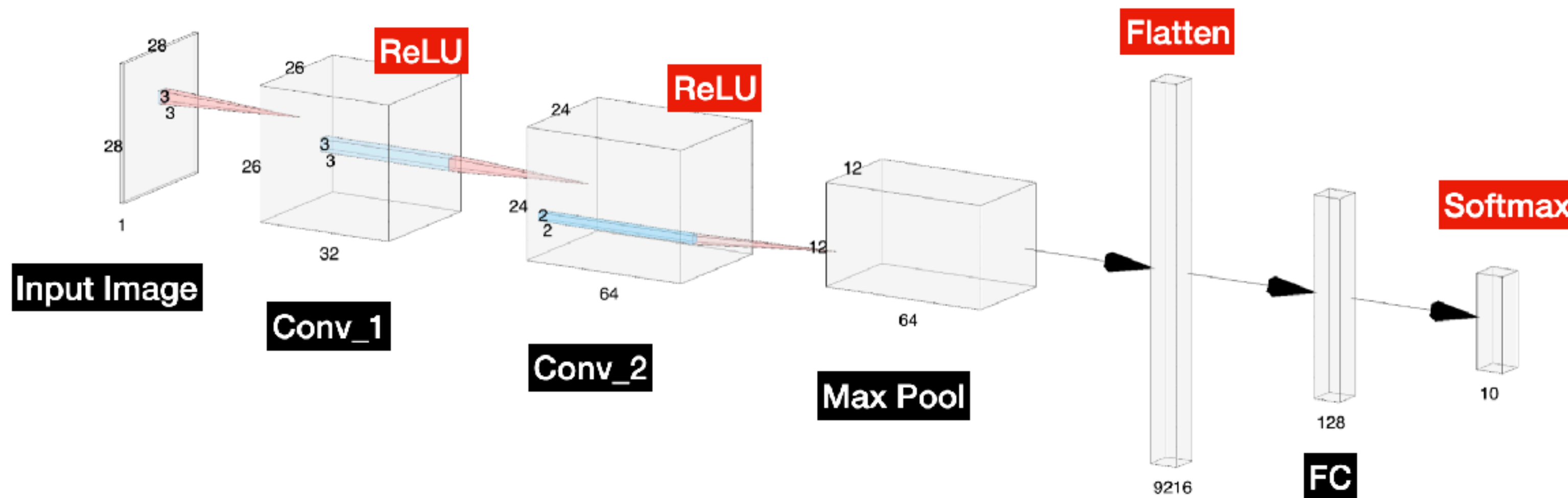
Parameters for 16 Filters

$((Height \times Width \times Depth) + bias) \times 16$

$((3 \times 3 \times 1) + 1) \times 16 = $ **160**

Biases

- Biases allow us to shift our activation function (left or right) by adding a constant value

- Biases are per '**neuron**', so per **filter** in our case (shared in the case with colour RGB images as the input)

- These shared biases per 'neuron' allow the filter to detect the same feature

- They are a learnable parameter

Let's Calculate the Number of Parameters in Our Simple CNN

Layer	Parameters
Conv_1 + ReLU	320
Conv_2 + ReLU	18494
Max Pool	0
Flatten	0
FC_1	1,179,776
FC_2 (Output)	1,290
Total	1,199,882

Conv_1

$$((Height \times Width \times Depth) + bias) \times N_f$$

$$((3 \times 3 \times 1) + 1) \times 32 = 320$$

Conv_2

$$((Height \times Width \times Depth) + bias) \times N_f$$

$$((3 \times 3 \times 32) + 1) \times 64 = 18,494$$

No Trainable Parameters

- Max Pool
- Flatten
- ReLU

Fully Connected/Dense

$$(Length + bias) \times N_{nodes}$$

$$(9216 + 1) \times 128 = 1,179,776$$

Final Output (FC/Dense)

$$(Length + bias) \times N_{nodes}$$

$$(128 + 1) \times 10 = 1,290$$

Modern Computer Vision
BY RAJEEV RATAN

Next...

Why CNNs work so well for Images