Extend 2D Convolution for Convolutional Neural Networks CNN

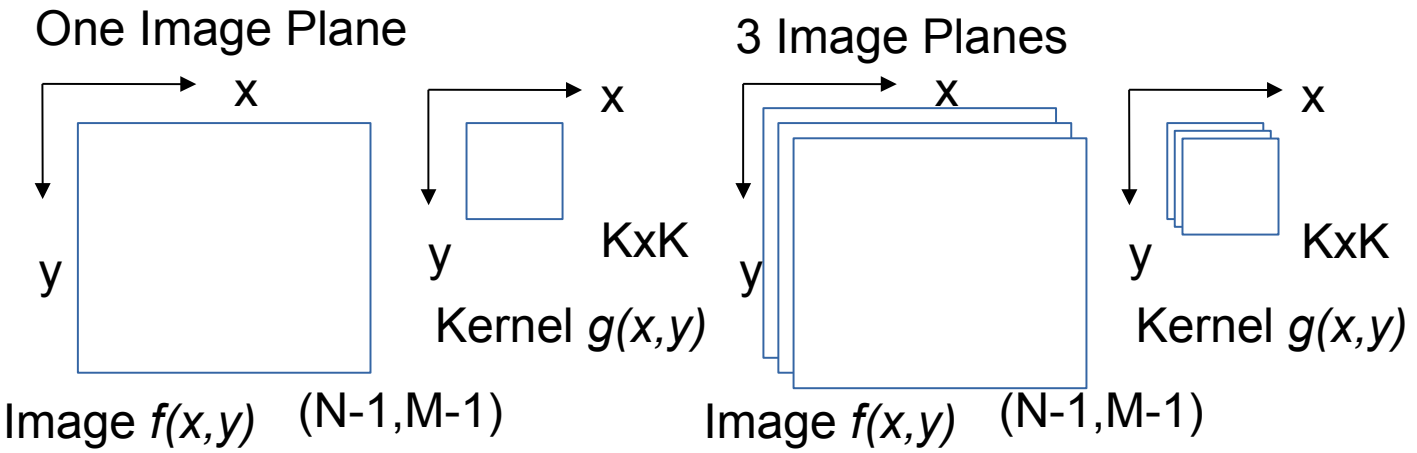
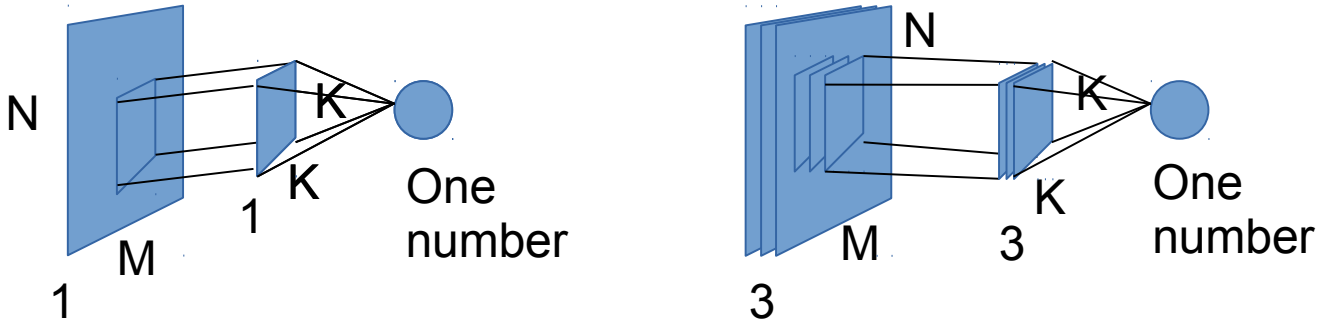


Fig. 1. Representation in Computer Vision

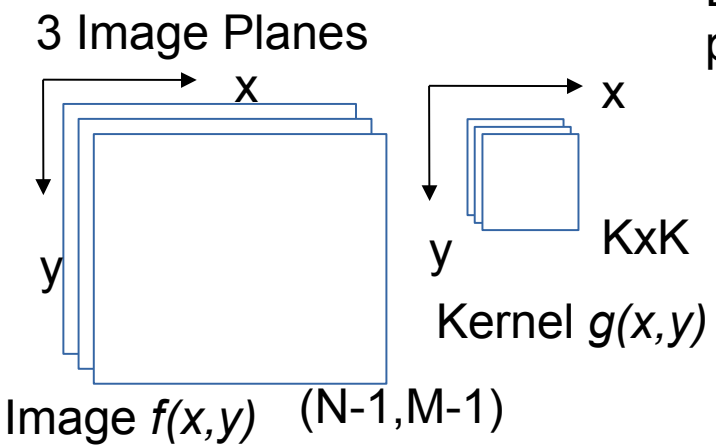


Depth of the image: 1
Resolution: N x M

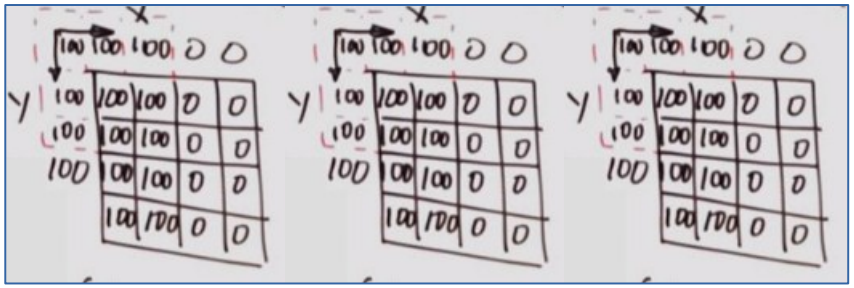
Depth of the image: 1
Resolution: N x M

Fig 2. The same convolution but representation in CNN

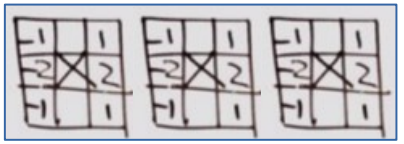
Extend 2D Convolution Example

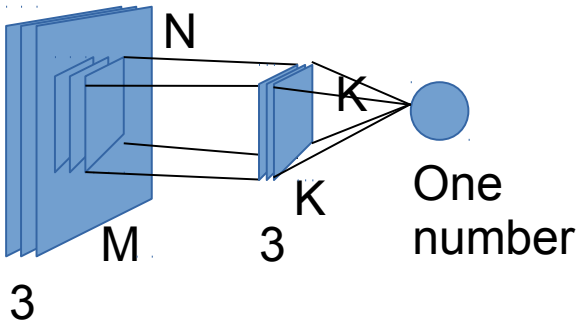


Example: 3 image planes (we can use one image from the previous example and duplicate to 3 for simplicity)



1 kernel with depth = 3, we choose the one to duplicate it to 3 for simplicity, just like what we did for the images

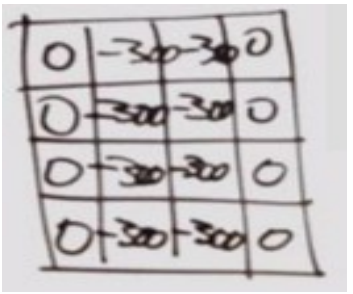




Depth of the image: 1
Resolution: N x M

So the result is the 3 times the previous 1 image plane convoles with the kernel (depth = 1)

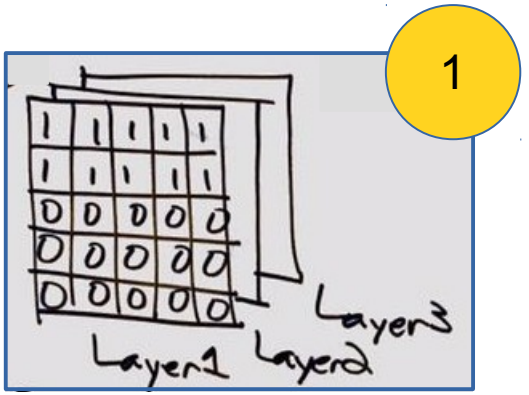
3 x



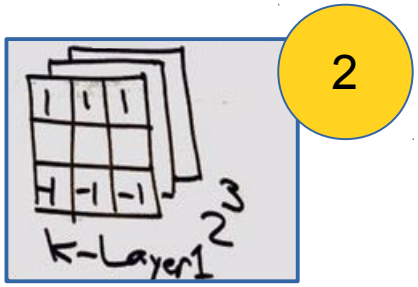
Extend 2D Convolution Example (2)

Example: Compute Convolution Layer, with given image I(x,y), depth = 3, resolution: 5x5

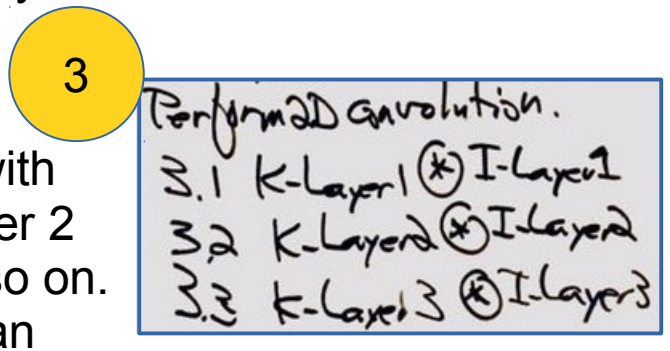
Step 1, image I(x,y), with depth = 3



Step 2. The kernel k(x,y) with depth = 3, and kernel size K = 3

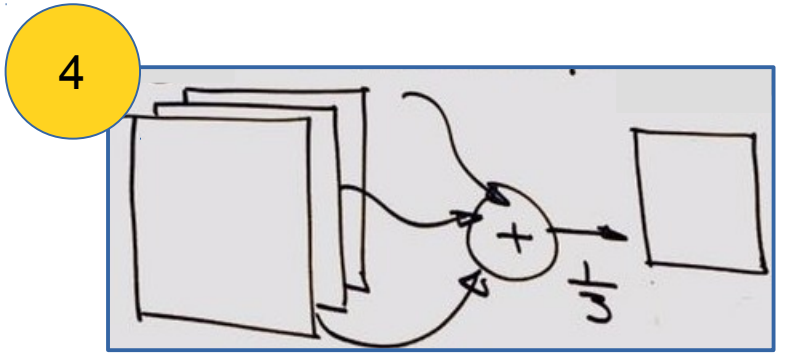


Step 3. Perform 2D convolution 1 image plane with 1 kernel layer at time

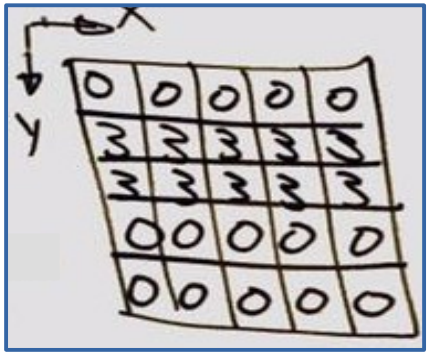


Kernel layer 1 convolve with image plane 1, kernel layer 2 with image plane 2, and so on. So we have 3 layers, as an intermediate convolution layer

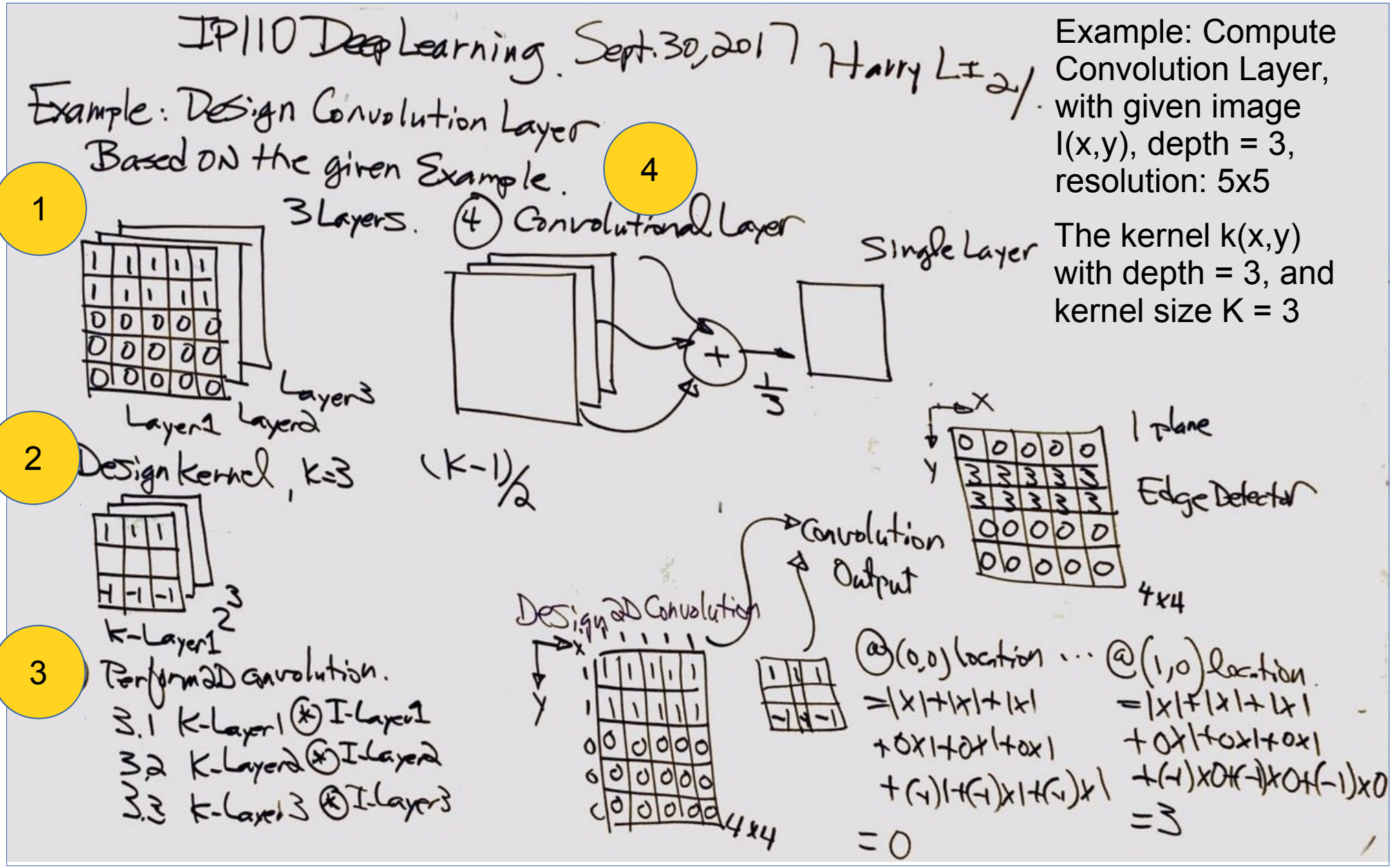
Step 4. Assemble the intermediate convolution layers by adding them up to become one single layer output



Hence, the final result is



Extend 2D Convolution Example (3)



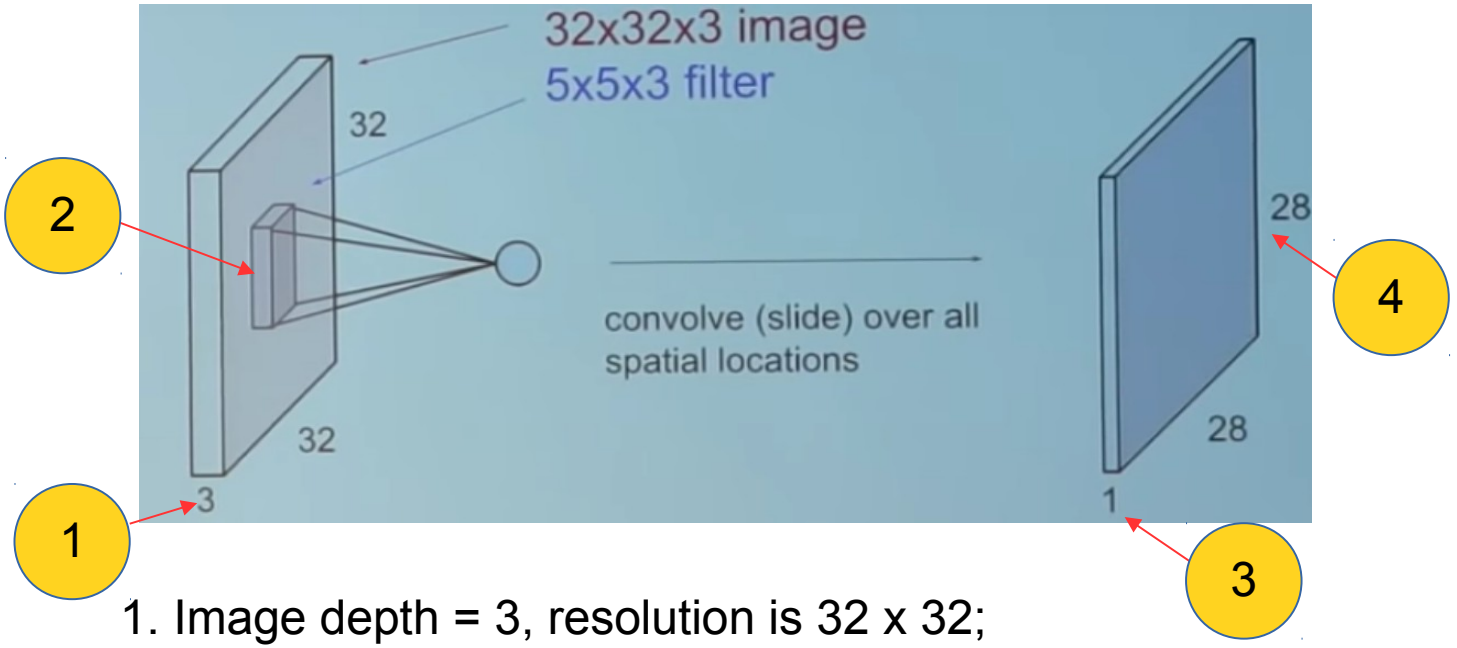
Example: Compute Convolution Layer, with given image I(x,y), depth = 3, resolution: 5x5

The kernel k(x,y) with depth = 3, and kernel size K = 3

Extend 2D Convolution Example (2)

https://medium.com/technologymadeeasy/the-best-explanation-of-convolutional-neural-networks-on-the-internet-fbb8b1ad5df8

Example:

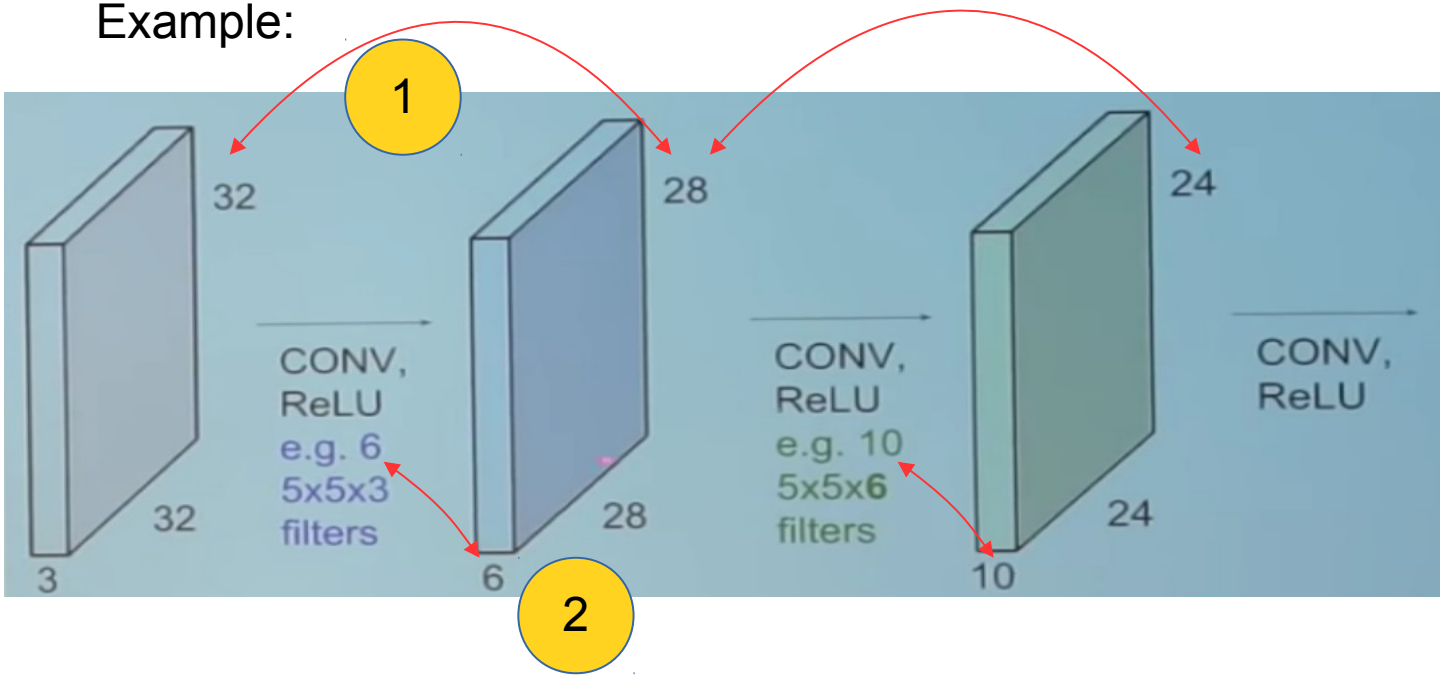


1. Image depth = 3, resolution is 32 x 32;
2. Kernel depth = 3, (the same as the image depth), size: 5 x5 ;
3. Result image depth = 1;
4. Result image resolution is 28 x 28, because of the boundary conditions, kernel size is 5x5, so one each side of the image, if not duplicating the boundary pixels, we will have to place the kernel to avoid outside the image, so result in reduction of the (k-1)/2 rows top and button, and same reductions of the columns left and right.

Convolution Layers Example

https://medium.com/technologymadeeasy/the-best-explanation-of-convolutional-neural-networks-on-the-internet-fbb8b1ad5df8

Example:



Note:

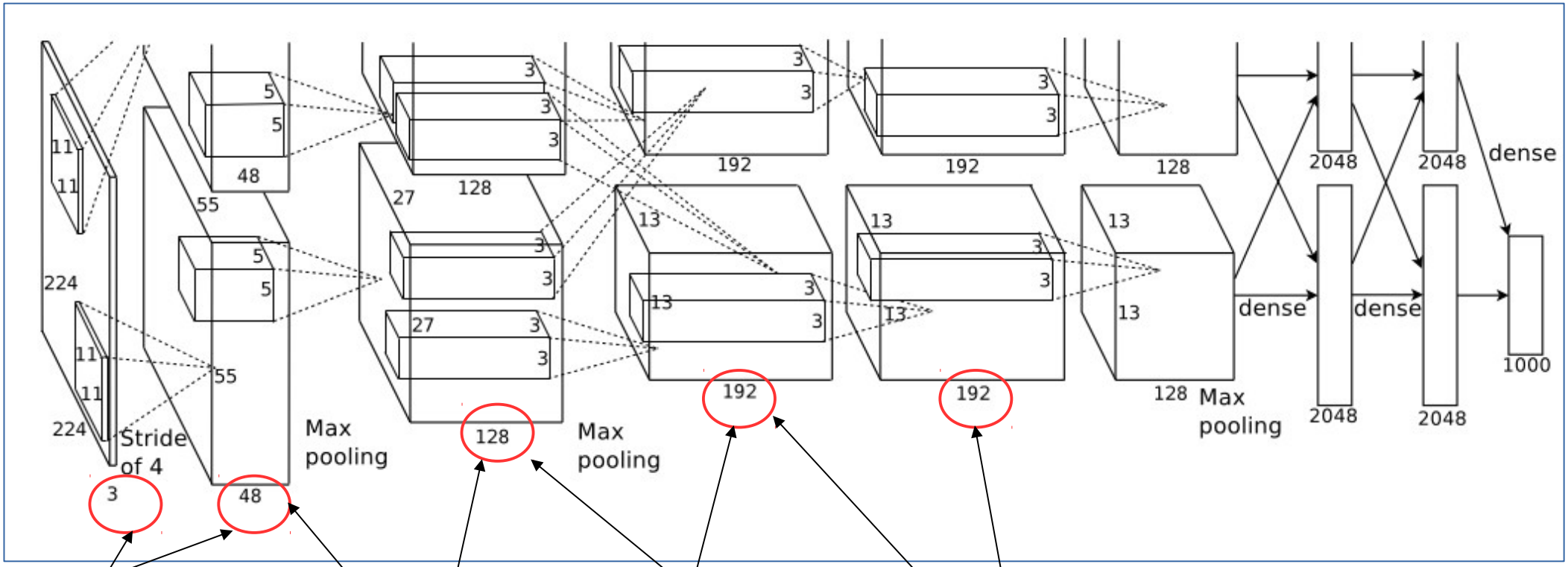
1. Due to the boundary conditions, the resolution of the convolution layer changed.
2. The depth of the convolution layer is equal to the number of kernels, as the direct result of convolution of each kernel produces 1 depth layer.

Alex Net Convolution Layers

https://adeshpande3.github.io/adeshpande3.github.io/The-9-Deep-Learning-Papers-You-Need-To-Know-About.html

Reference: The 9 Deep Learning Papers You Need To Know About (Understanding CNNs Part 3)

Kernel By Learning



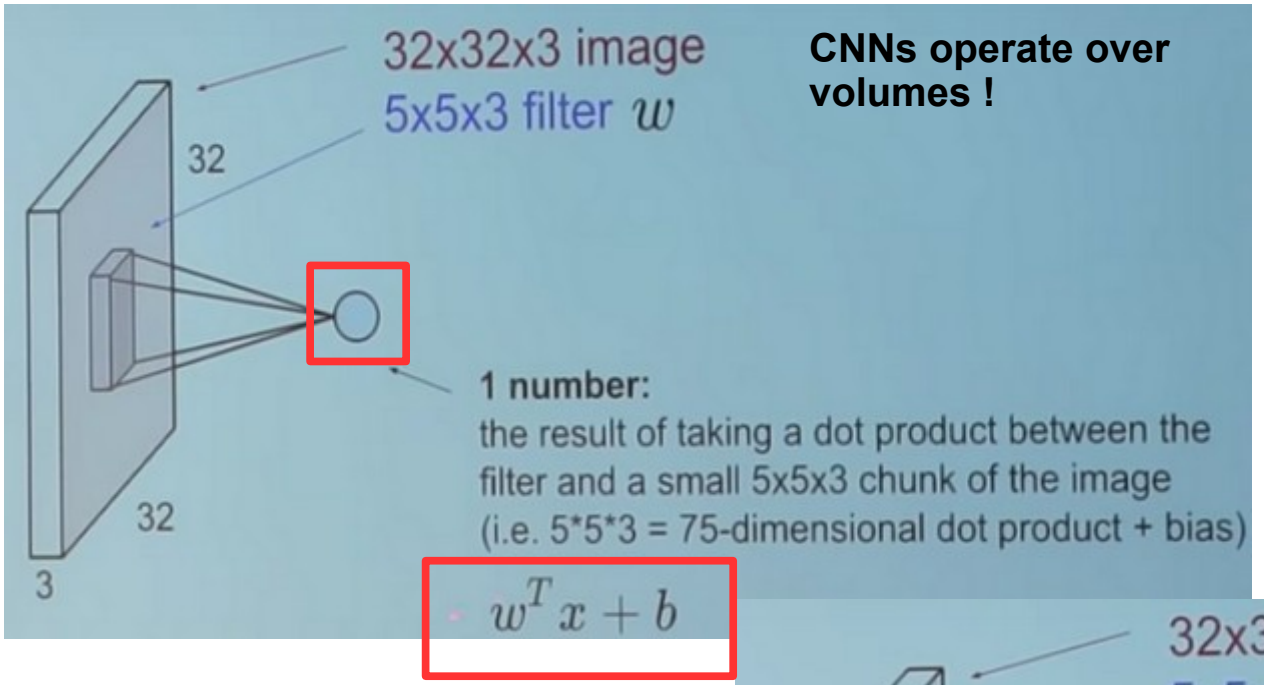
Example 1: 48 kernels, the depth of the kernel is 3

Example 2: 128 kernels, the depth of the kernel is 48

Example 3: 192 kernels, the depth of the kernel is 128

Example 4: 192 kernels, the depth of the kernel is 192

Convolution for
Convolutional Neural Netwoks

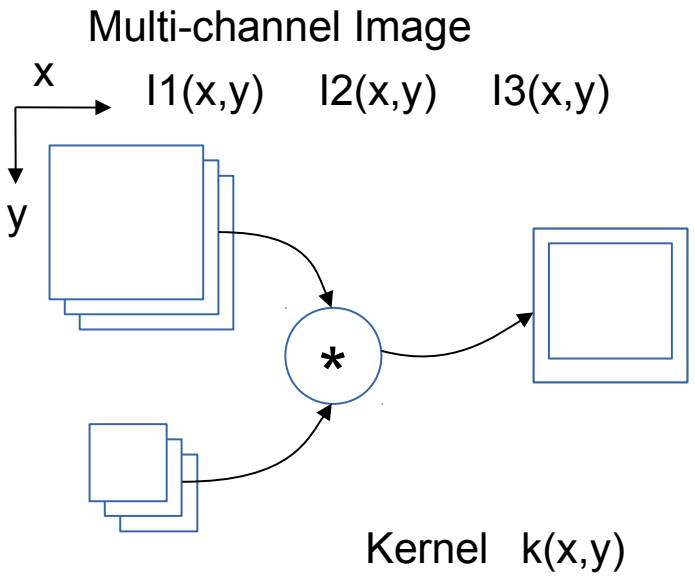


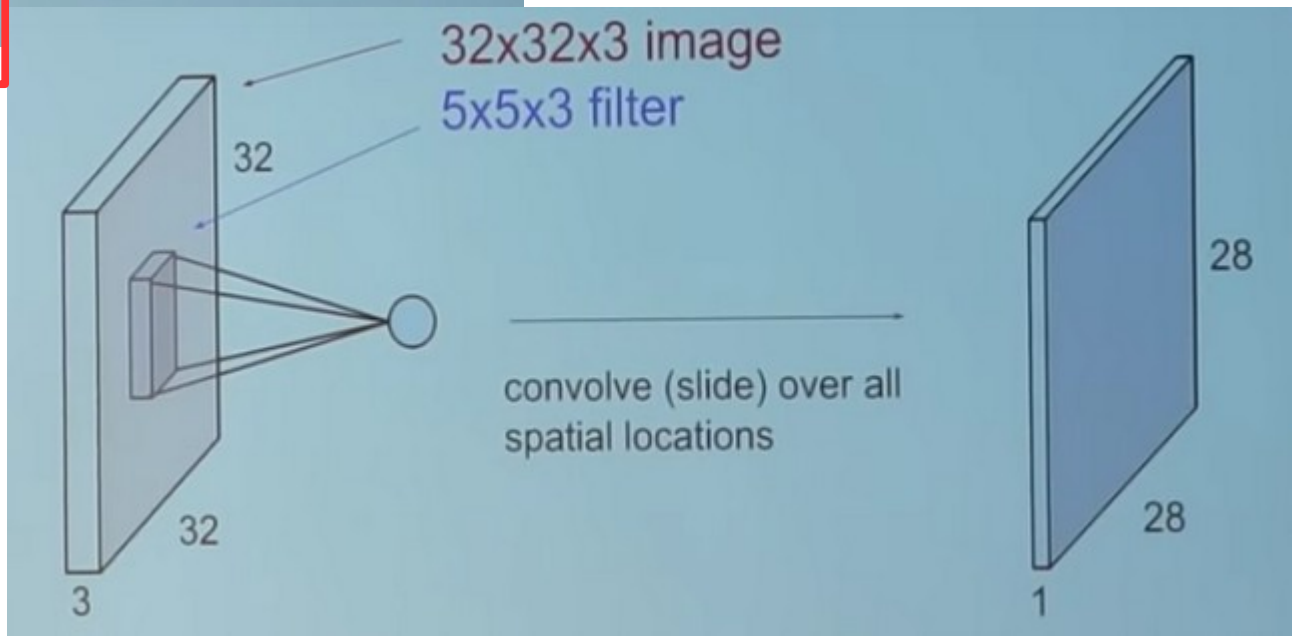
https://medium.com/technologymadeeasy/the-best-explanation-of-convolutional-neural-networks-on-the-internet-fbb8b1ad5df8

Unlike neural networks, where the input is a vector, here the input is a multi-channeled image (3 channeled in this case).

Step 1. Convolution

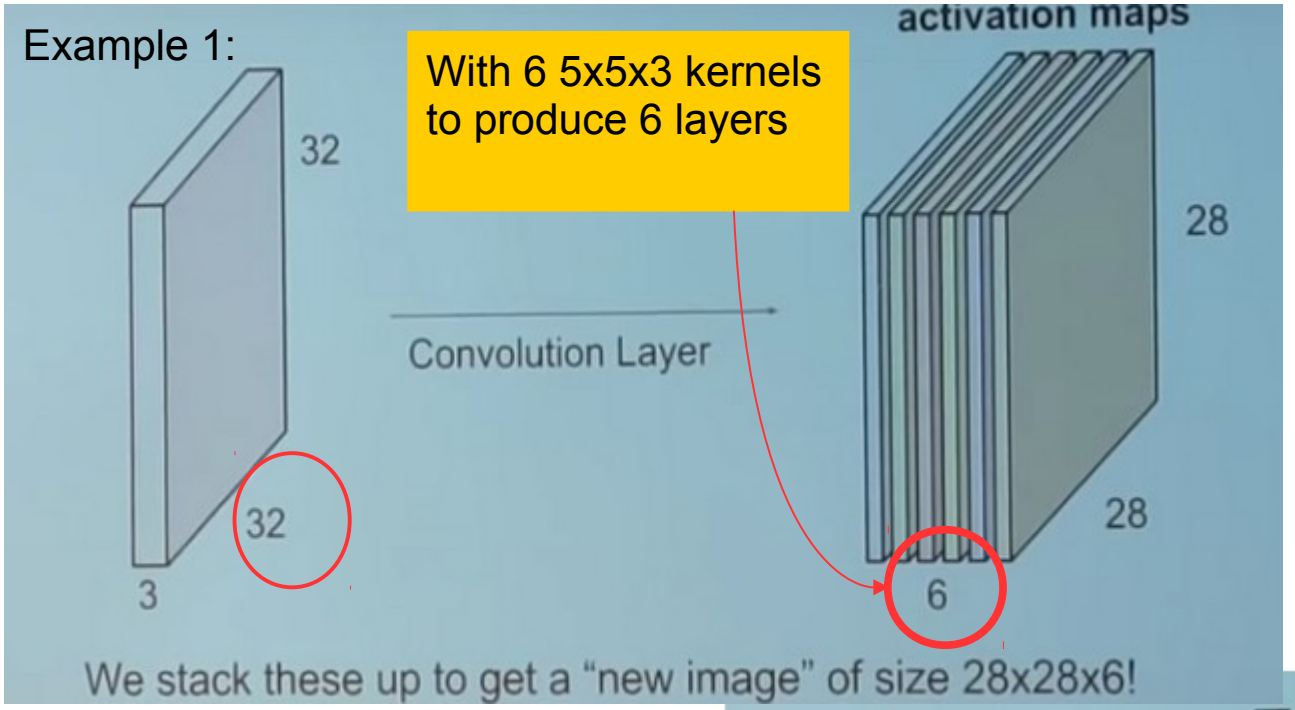
Due to boundary condition, output reduced Size





Convolution Layers Matching to Number of Kernels

The convolution layer is the main building block of a convolutional neural network.



Observation:

1. The output layers equal to the number of kernels; 2. the depth of the kernel is equal to the number of input layers

The convolution layer comprises of a set of independent filters (6 in the example shown). Each filter is independently convolved with the image and we end up with 6 feature maps of shape 28*28*1.