



Extend 2D Convolution for Convolutional Neural Networks CNN

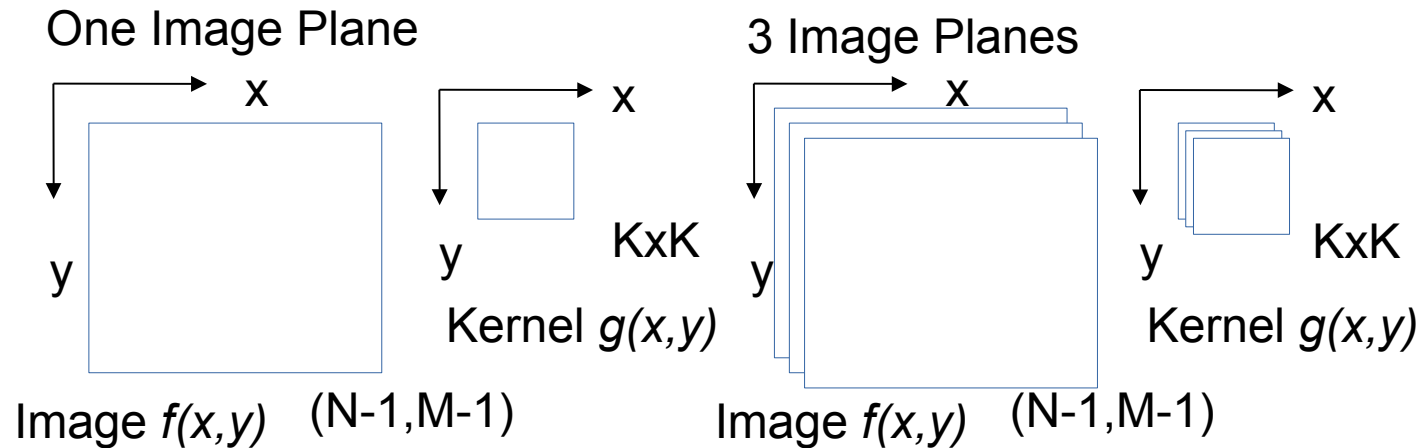


Fig. 1. Representation in Computer Vision

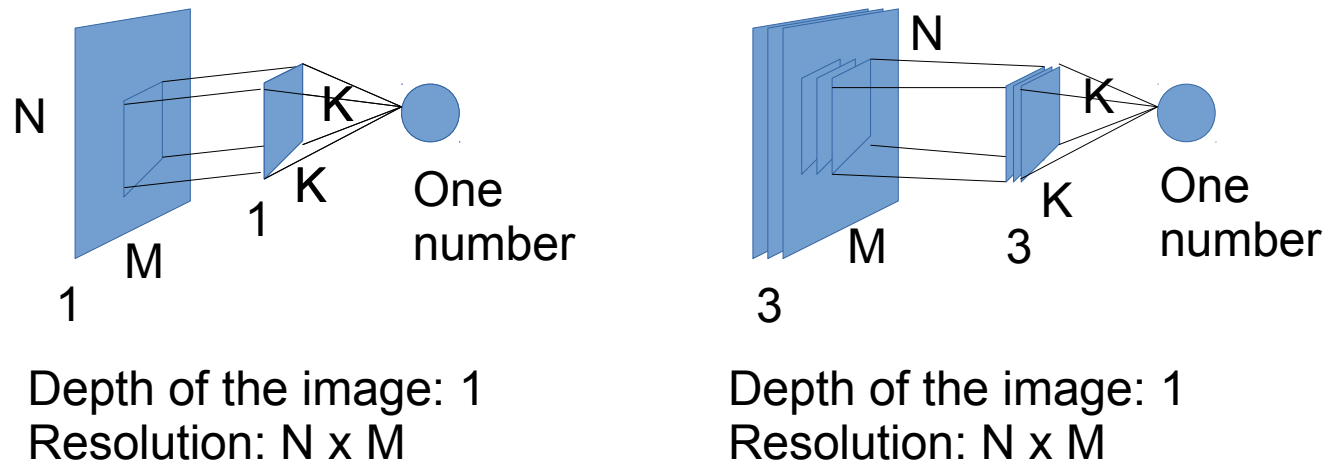
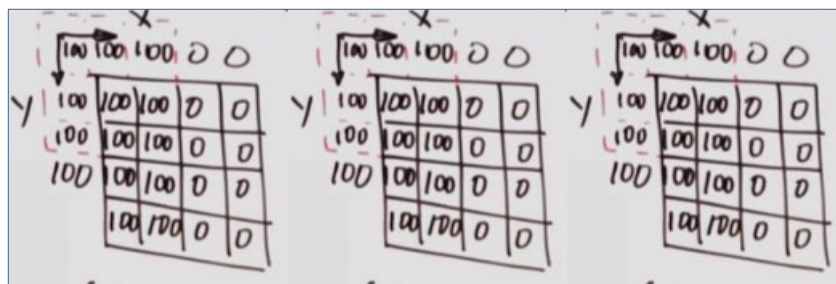
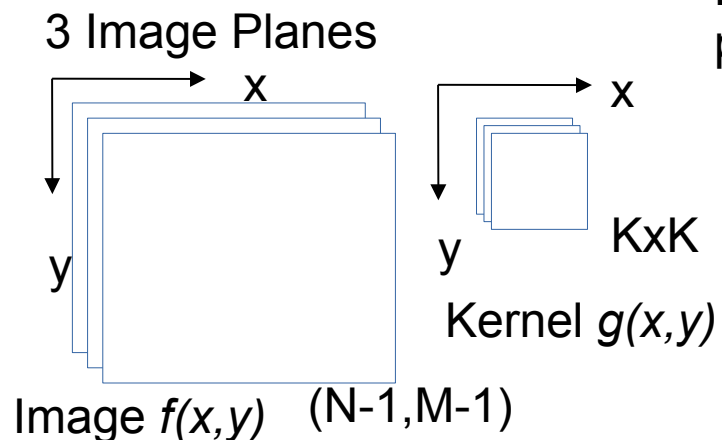


Fig 2. The same convolution but representation in CNN

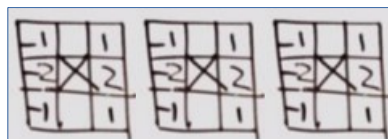
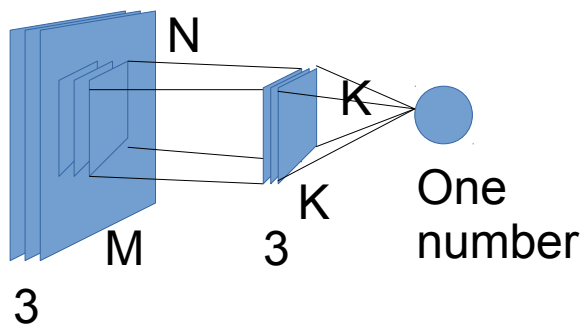


Extend 2D Convolution Example

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

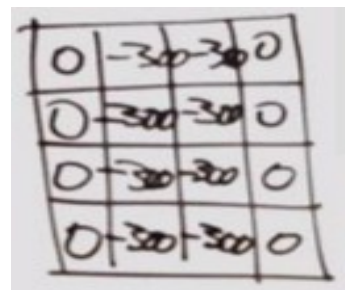


1 kernel with depth = 3, we choose the one to duplicate it to 3 for simplicity, just like what we did for the images



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

3 x

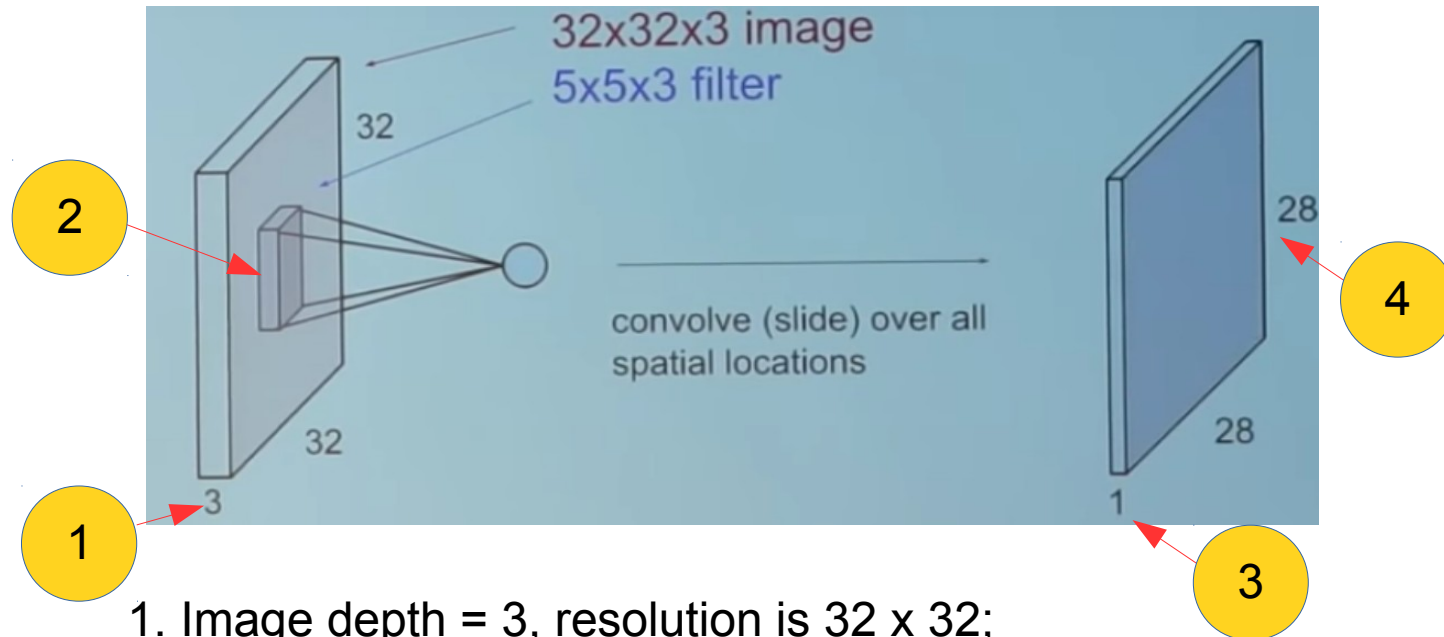




Extend 2D Convolution Example (2)

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

Example:



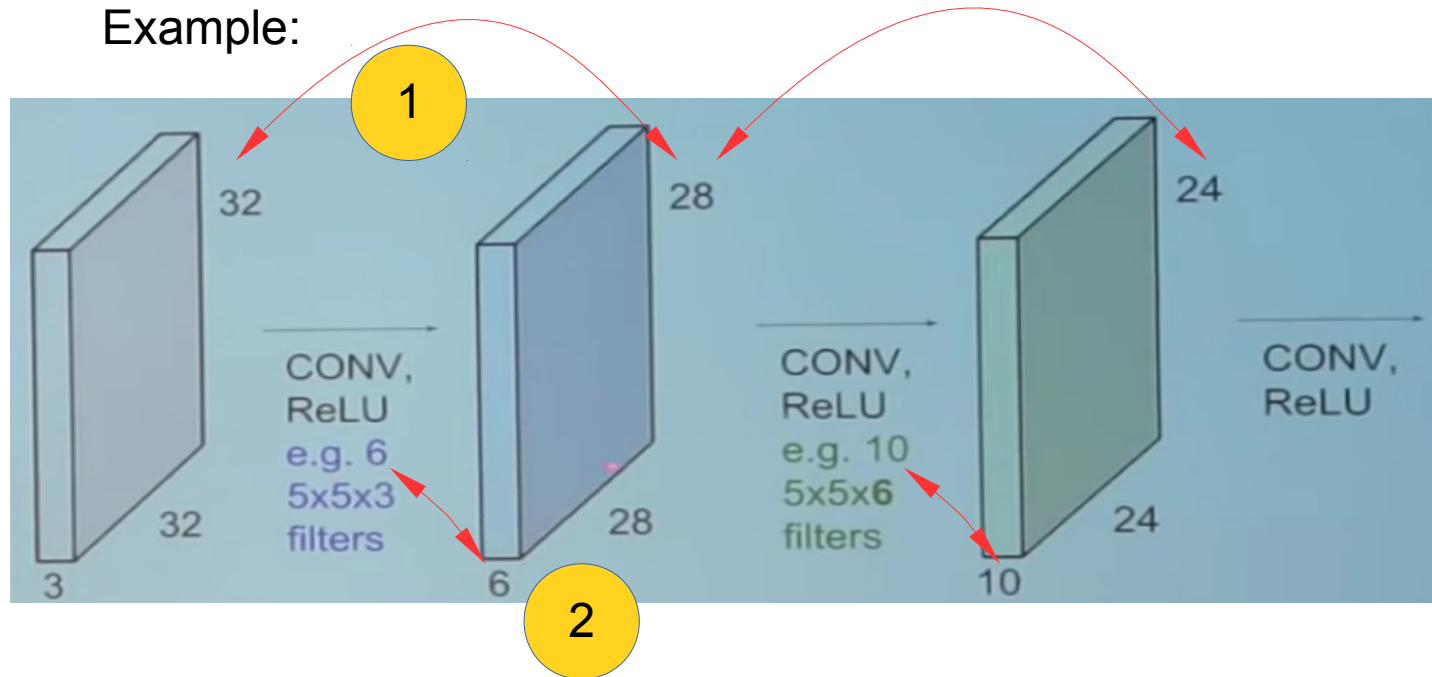
1. Image depth = 3, resolution is 32 x 32;
2. Kernel depth = 3, (the same as the image depth), size: 5 x 5 ;
3. Result image depth = 1;
4. Result image resolution is 28 x 28, because of the boundary conditions, kernel size is 5x5, so one each side of the image, if not duplicating the boundary pixels,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

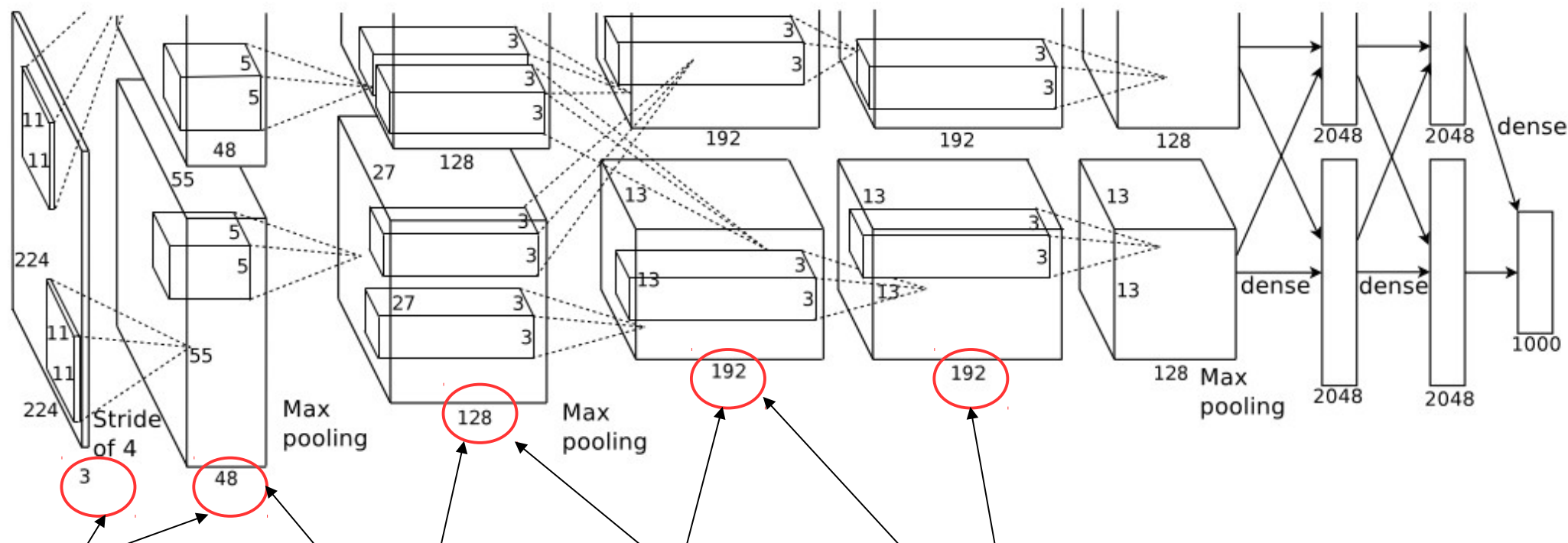


Alex Net Convolution Layers

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

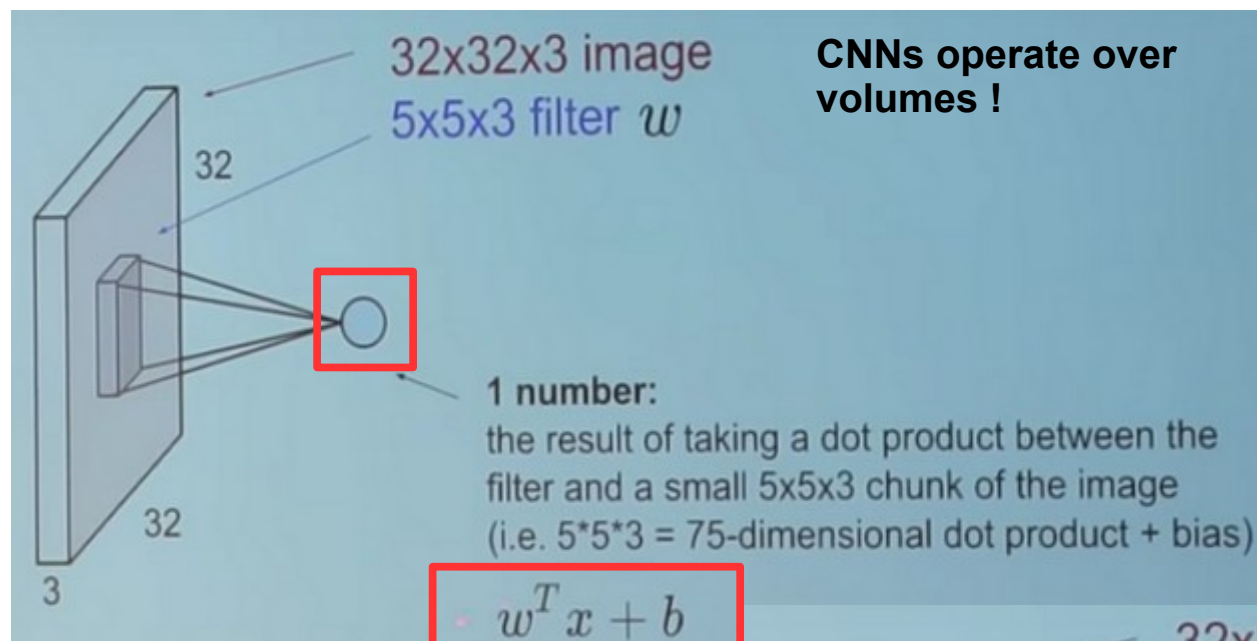
Reference: The 9 Deep Learning Papers You Need To Know About (Understanding CNNs Part 3)

Kernel By Learning





Convolution for Convolutional Neural Networks

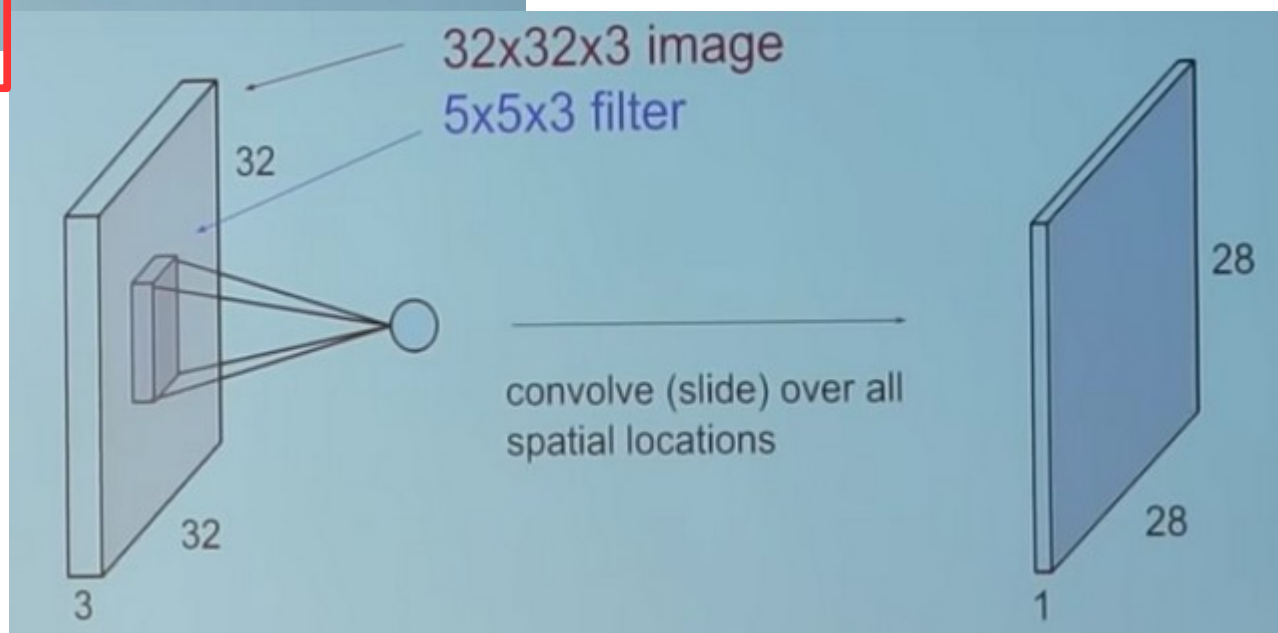
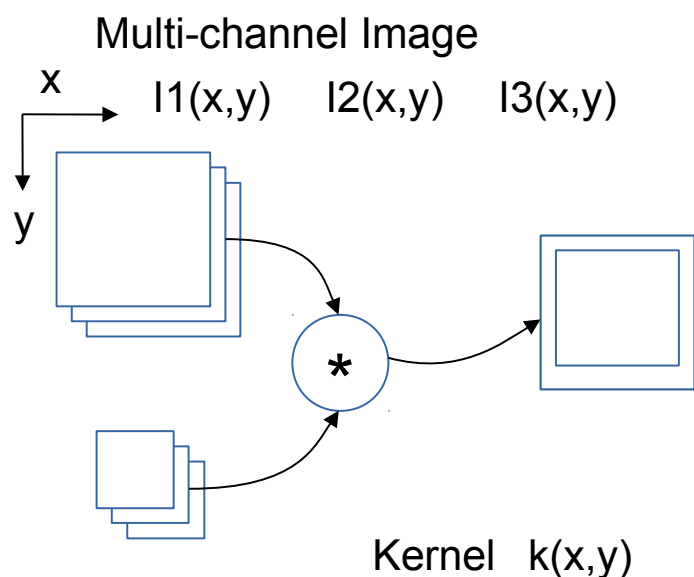


<https://medium.com/technologymadeeasy/the-best-explanation-of-convolutional-neural-networks-on-the-internet-fbb8b1ad5df8>

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

Step 1. Convolution

Due to boundary condition, output reduced Size

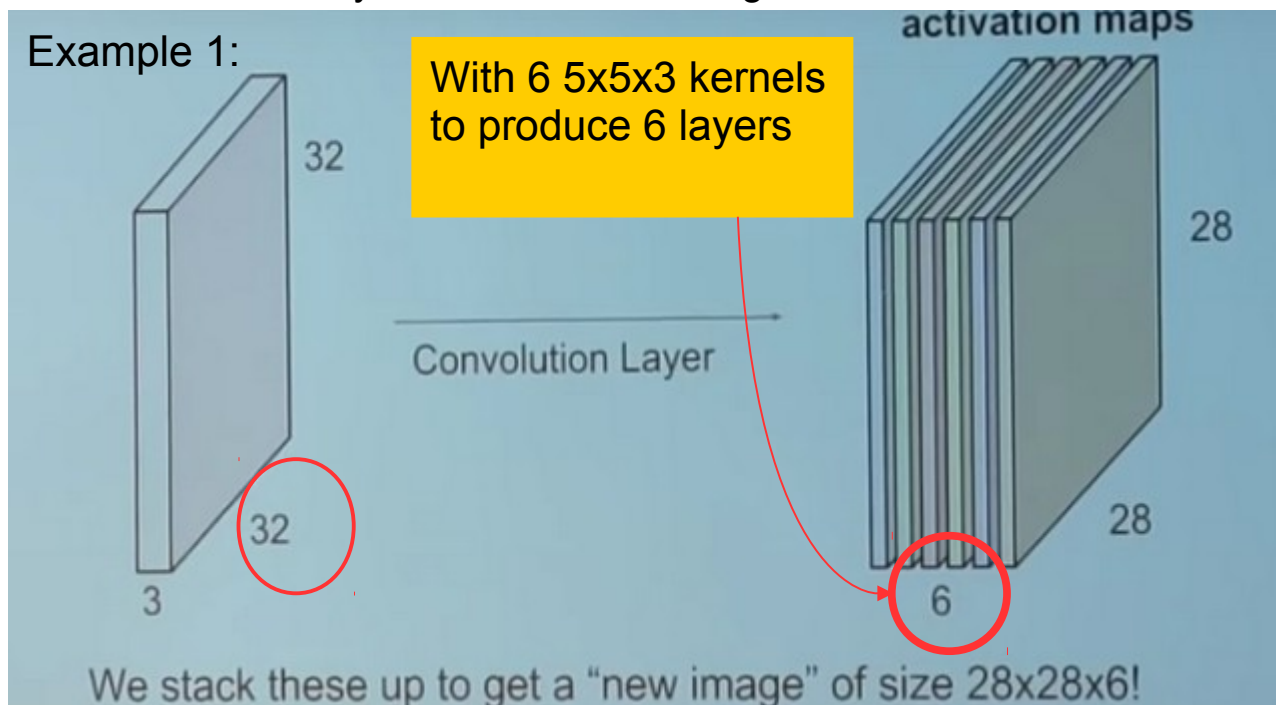




Convolution Layers Matching to Number of Kernels

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

Example 1:



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.

