Deep Learning

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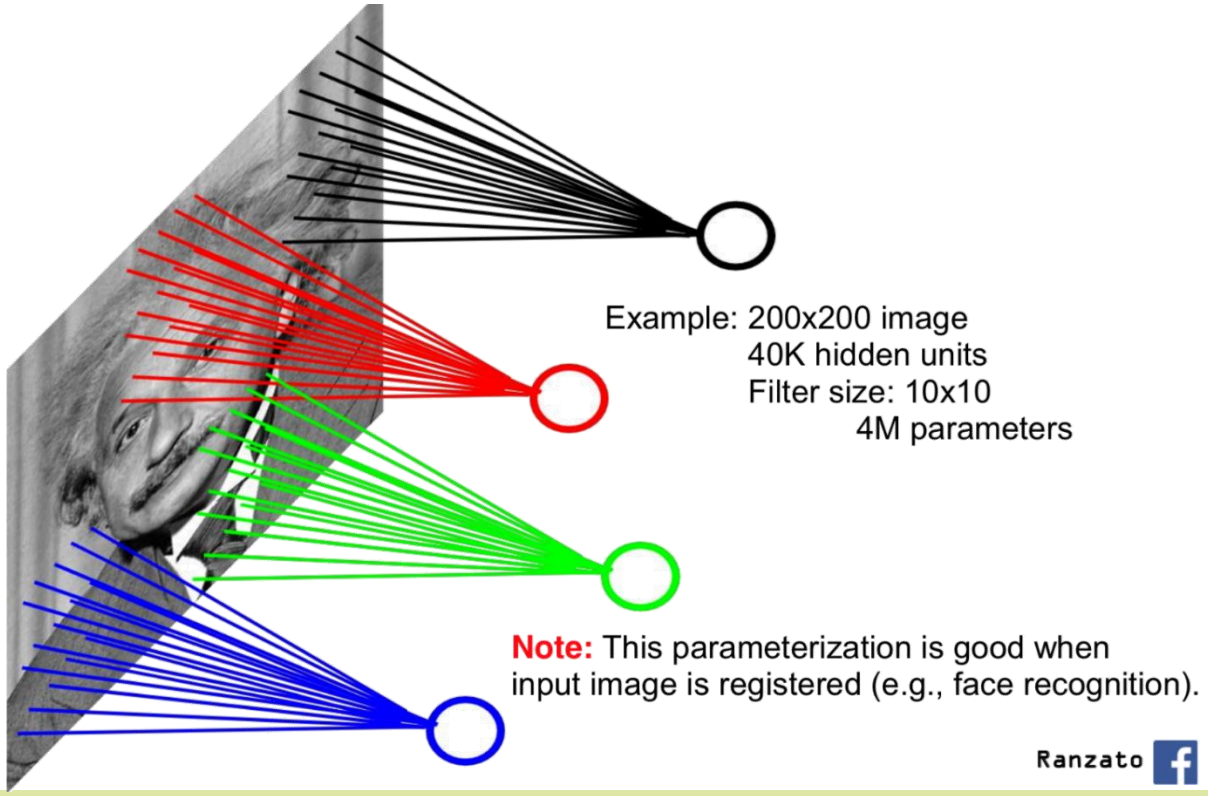
Convolution

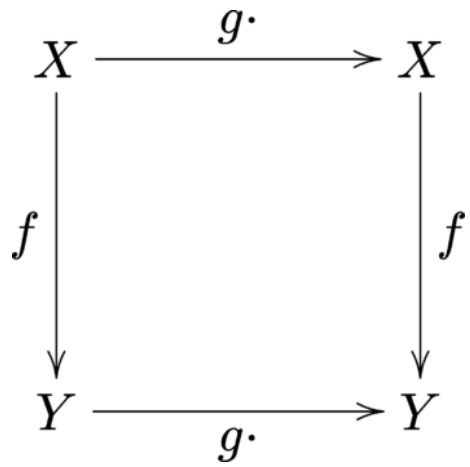
- Sparse interactions
- Parameter sharing
- Equivariant representations
- Working with inputs of variable size



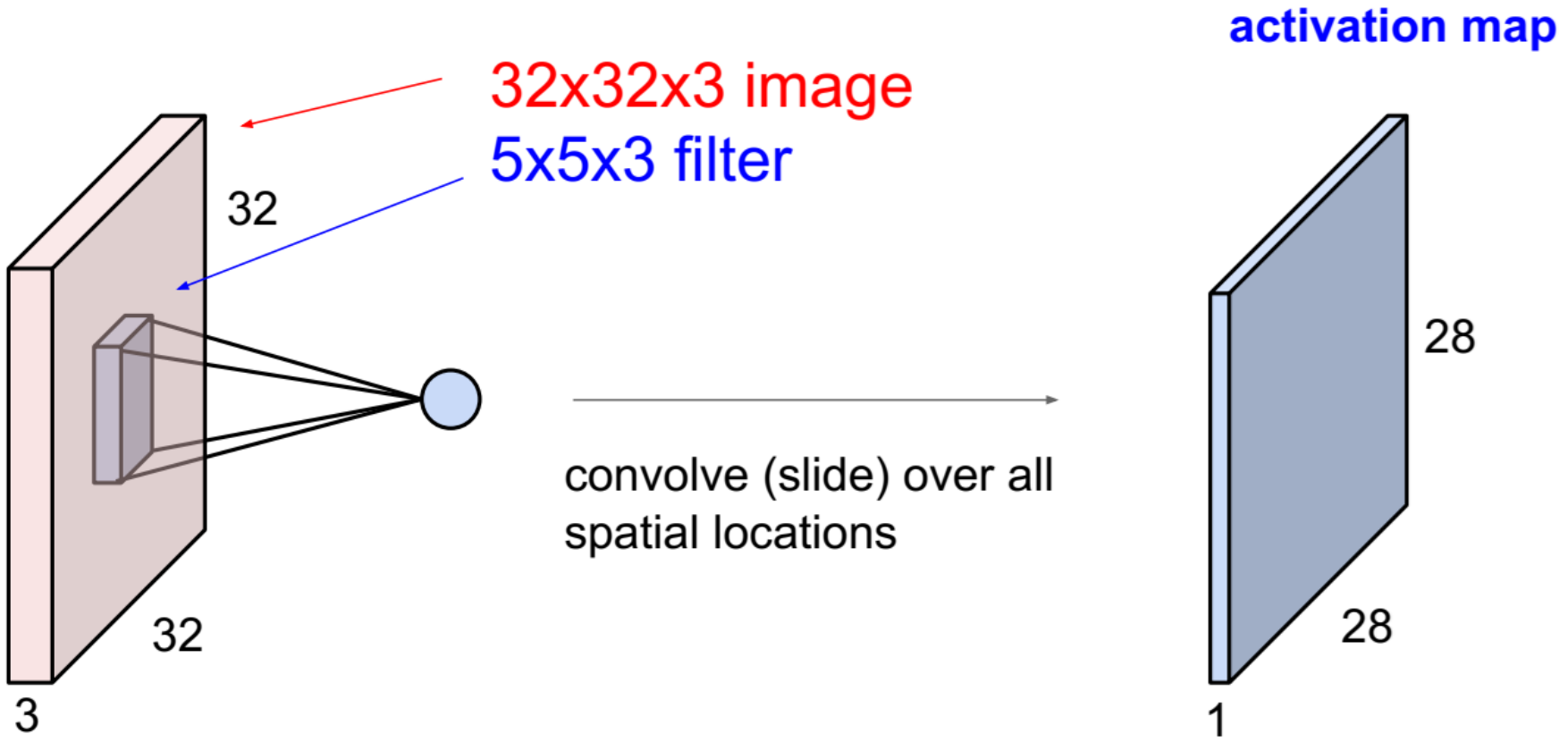
Equivariant representations

- To say a function is equivariant means that if the input changes, the output changes in the same way
- In the case of convolution, the particular form of parameter sharing causes the layer to be equivariant to translation
- Convolution is not naturally equivariant to some other transformations, such as changes in the scale or rotation of an image
- In some cases, we may not wish to share parameters!

$$f(g(\boldsymbol{x})) = g(f(\boldsymbol{x}))$$

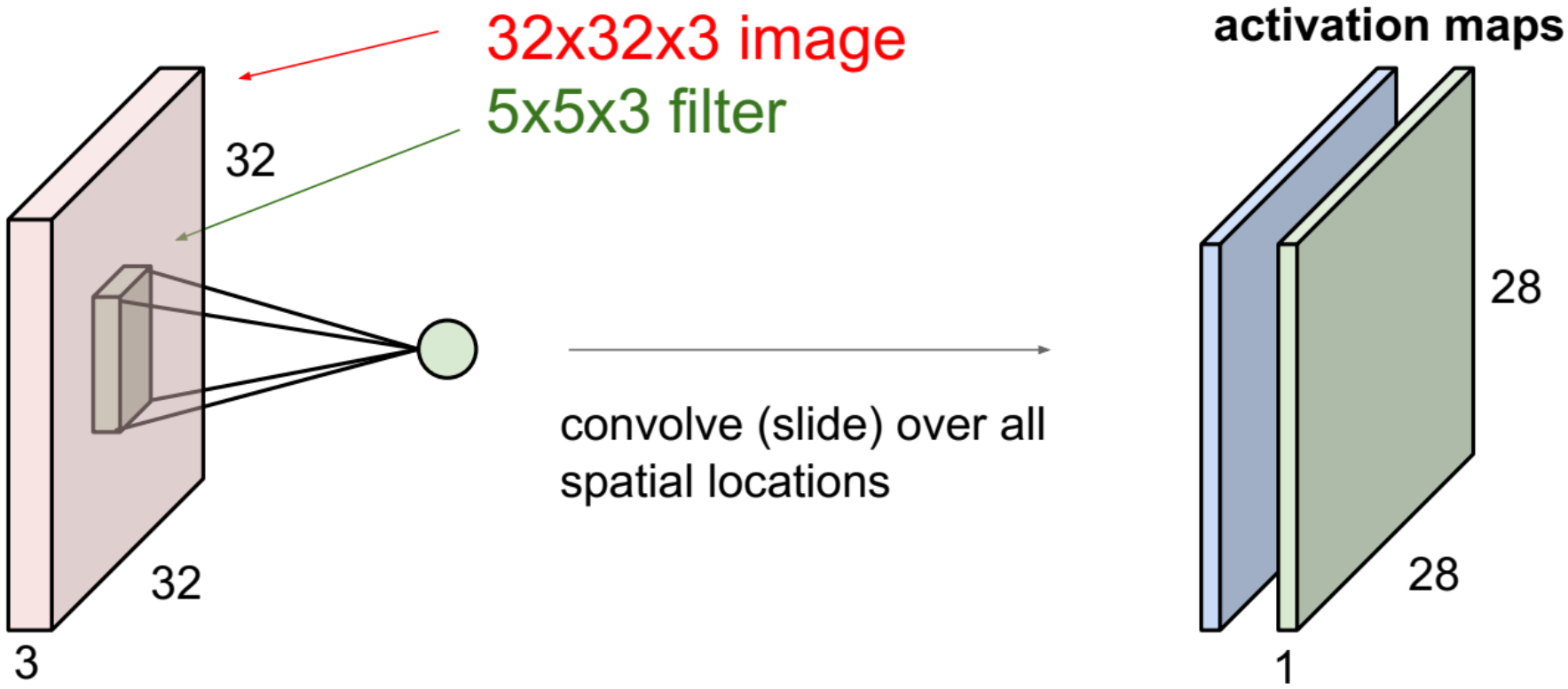


Convolution layer



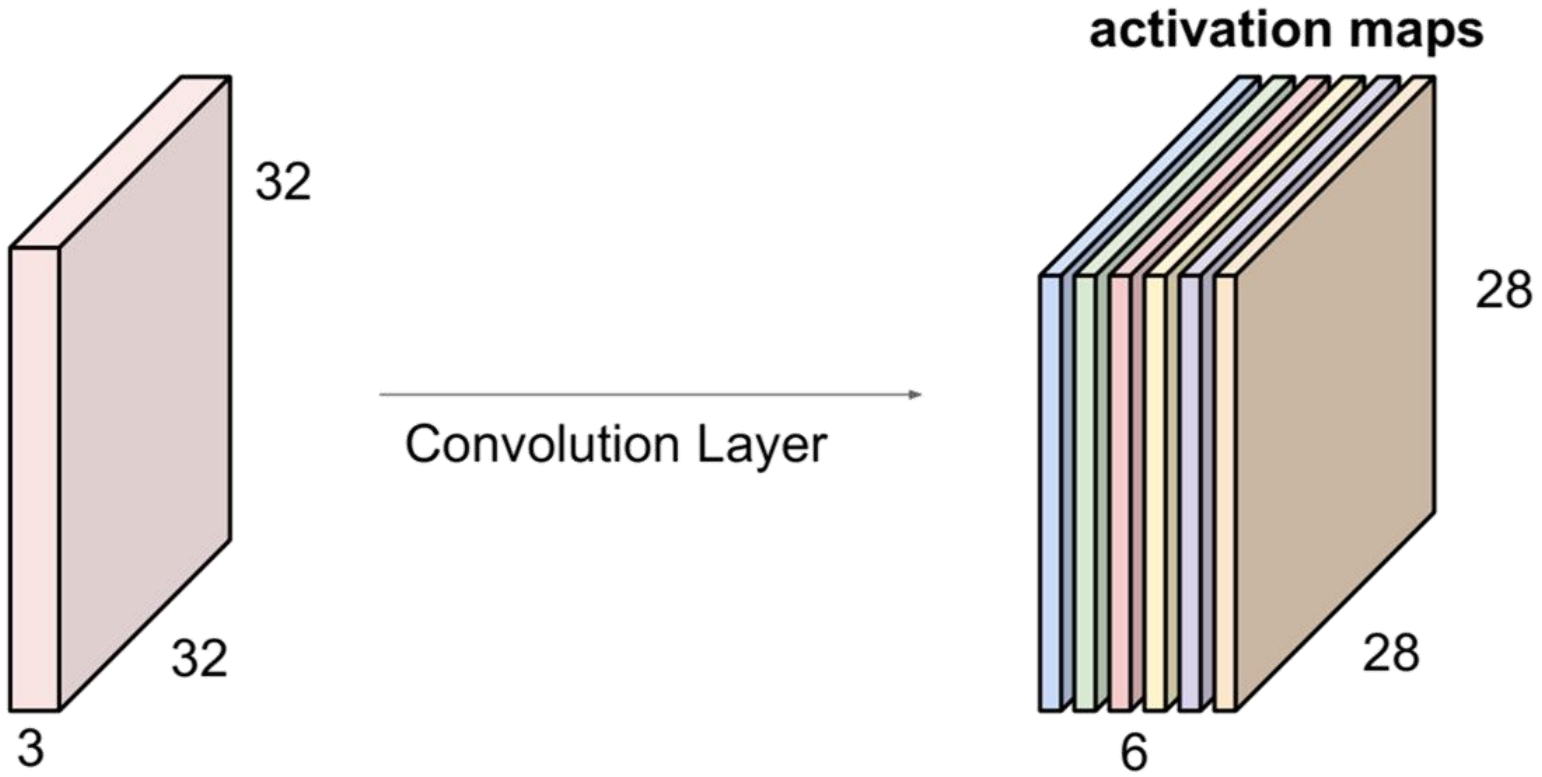
Convolution layer

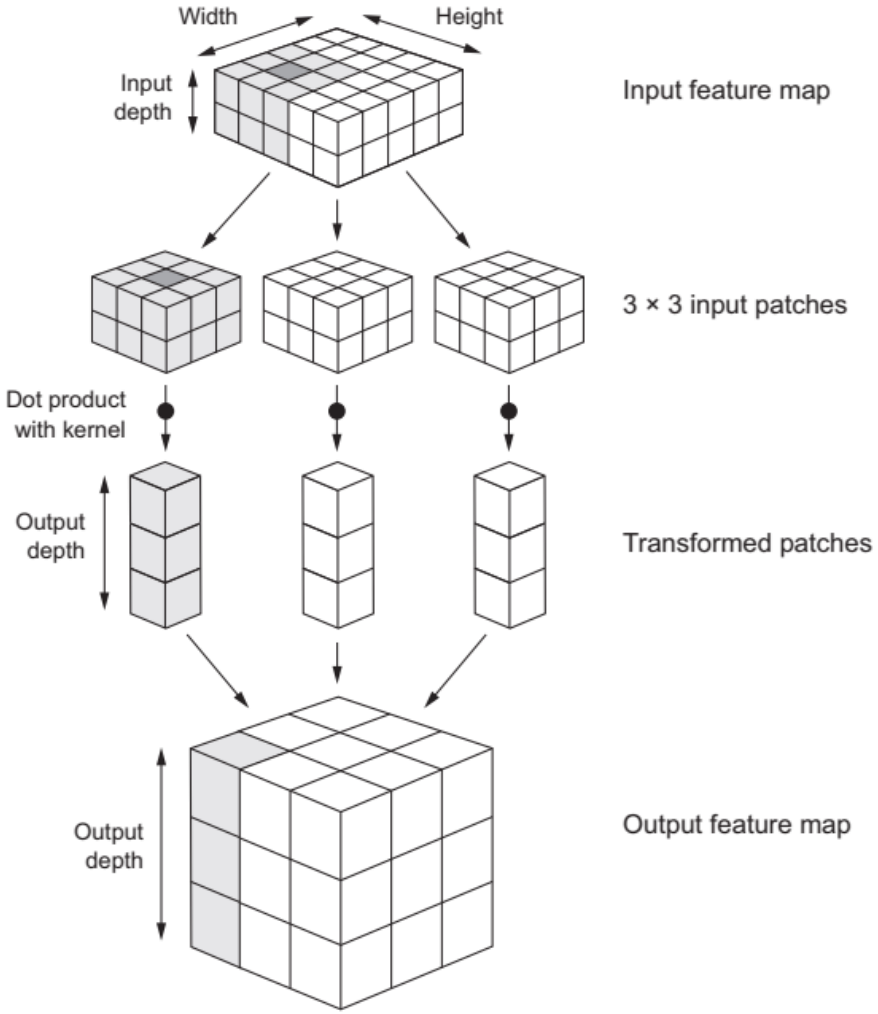
- Consider a second, green filter



Convolution layer

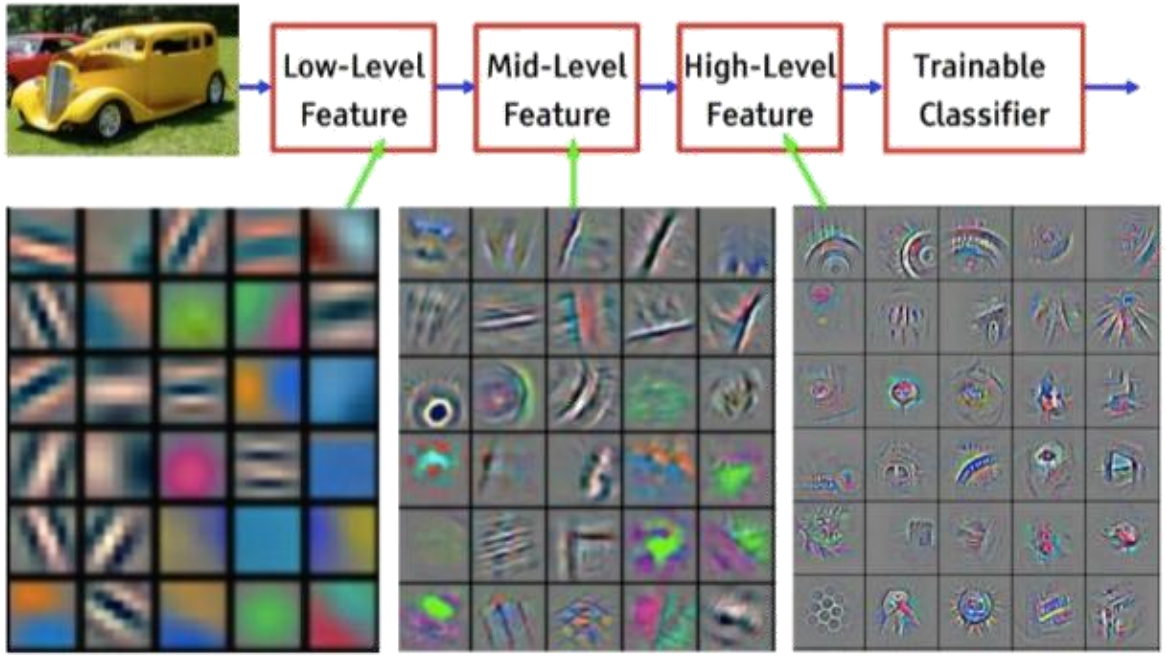
- In a convolution layer, we use some separate filters



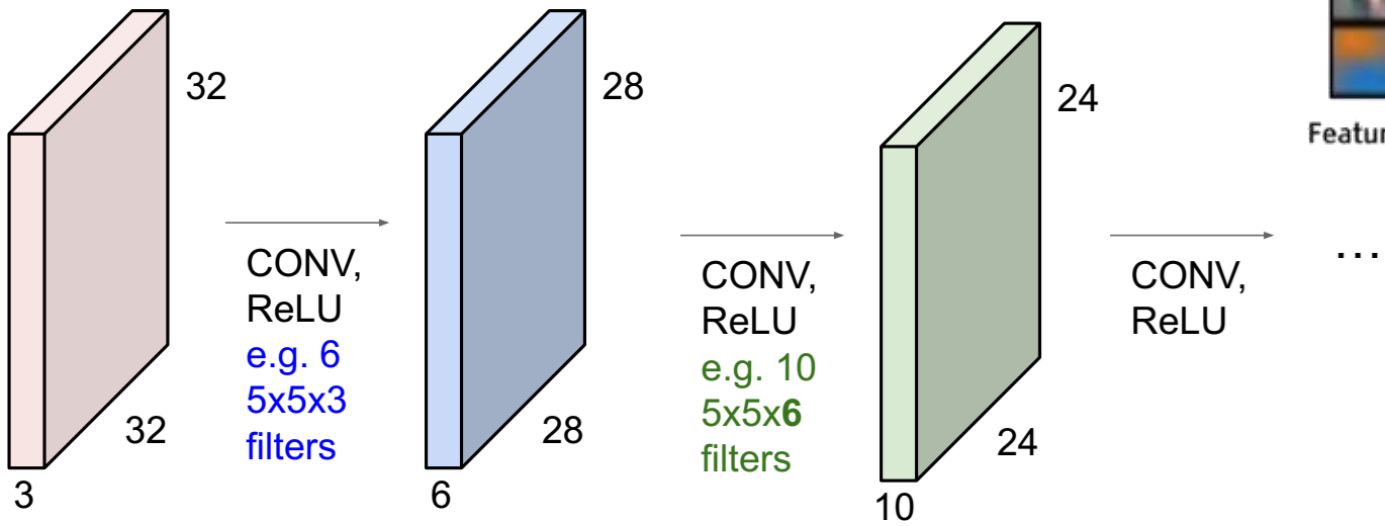


ConvNet

- ConvNet is a sequence of convolution layers, interspersed with activation functions



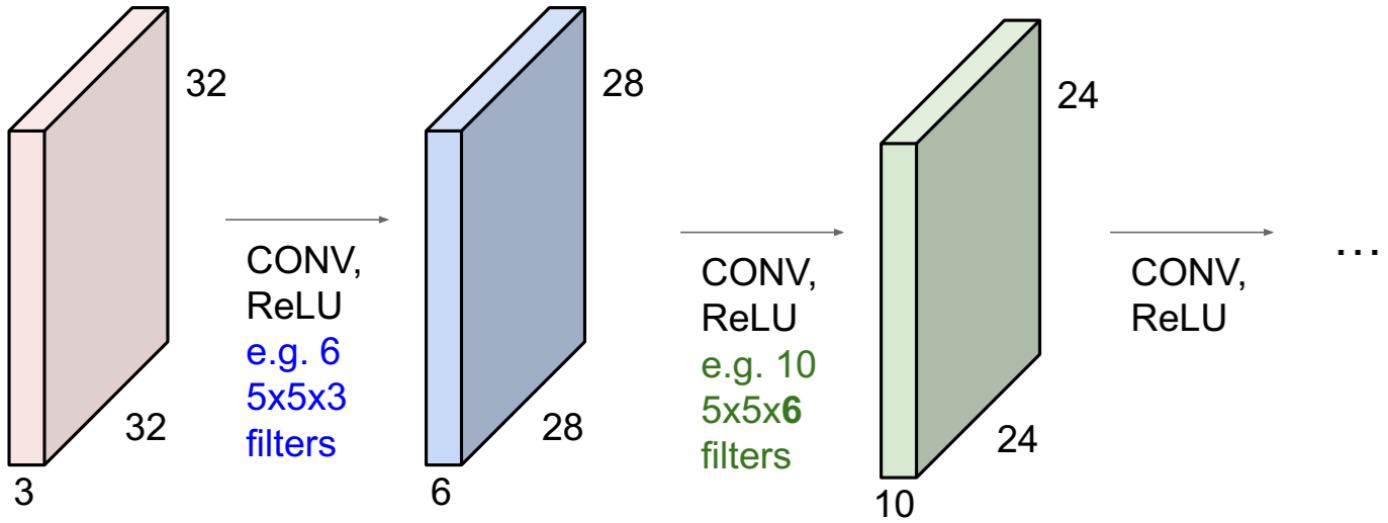
Feature visualization of convolutional net trained on ImageNet from [Zeiler & Fergus 2013]

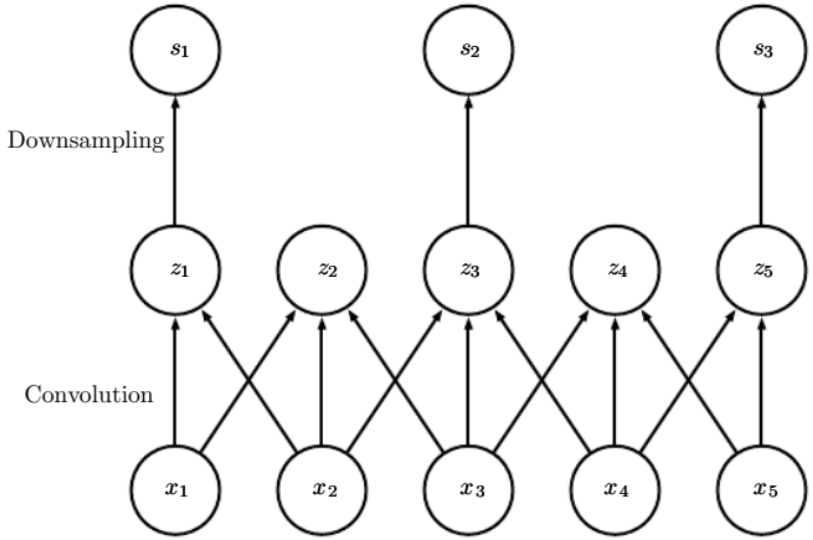


https://colab.research.google.com/drive/15UbFTQnh_wEcnqUPZ8k04u4ZW59c36_u?usp=sharing

Stride

- We may want to skip over some positions of the kernel in order to reduce the computational cost
  - at the expense of not extracting our features as finely
  - we can think of this as downsampling





Stride

- We may want to skip over some positions of the kernel in order to reduce the computational cost
  - at the expense of not extracting our features as finely
  - we can think of this as downsampling
  - this increases the receptive field