Neural Networks

Declan Groves

June 30 2016

Outline

What is a Neural Network?

Activations

Convolutional Neural Networks

1 What is a Neural Network?

2 Activations

3 Convolutional Neural Networks

Overview

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What is a Neural Network?

Activations

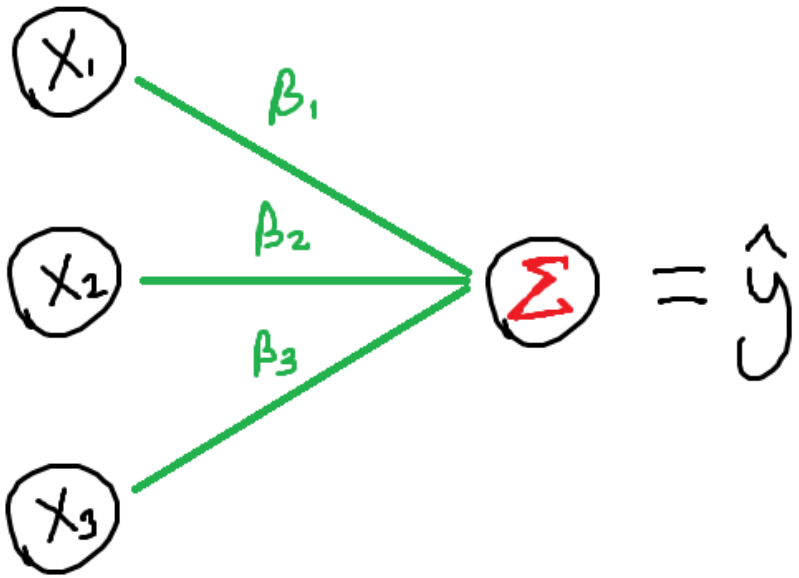
Convolutional Neural Networks

- Hypest ML
- Good at unstructured probelms
- Suboptimal at structured problems

History

- Around since the 1950s
- Resurgence in 1970s
- Resurgence in late 2000s

A graphical linear model



A graphical linear model

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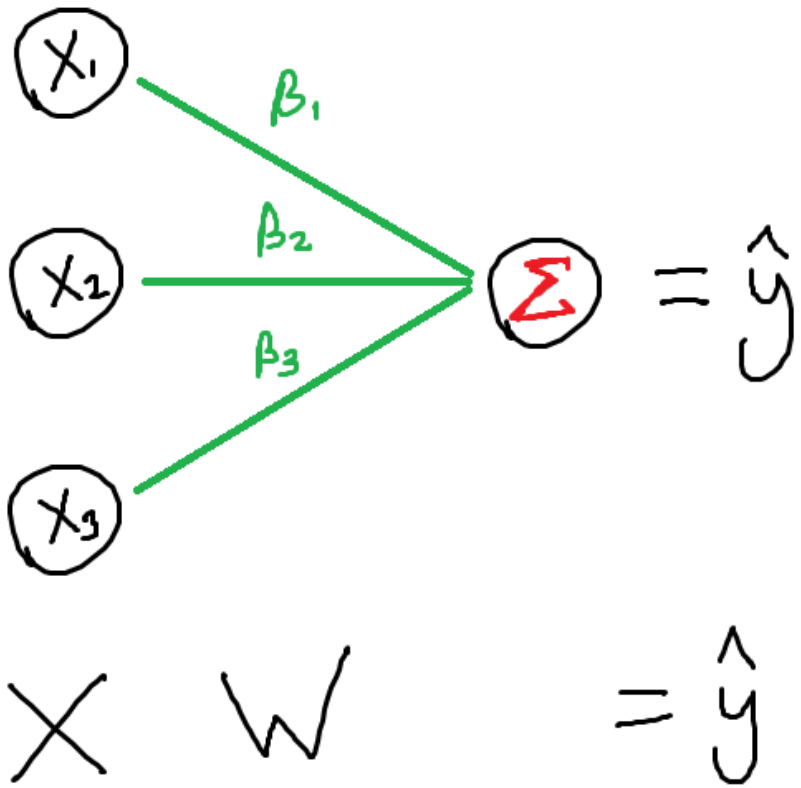
Convolutional Neural Networks



A graphical linear model

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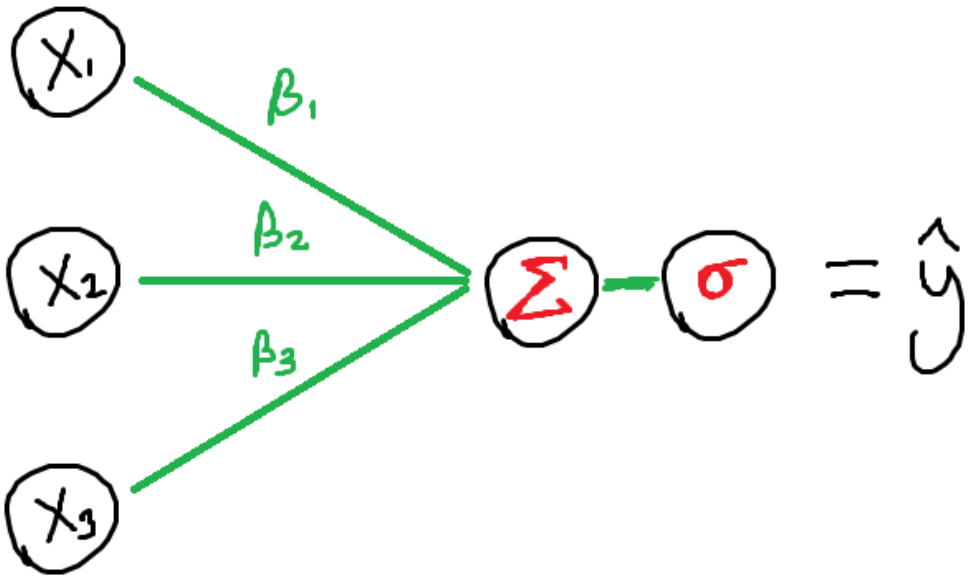

$$\sigma(X \quad W) \quad = \hat{y}$$

A graphical linear model

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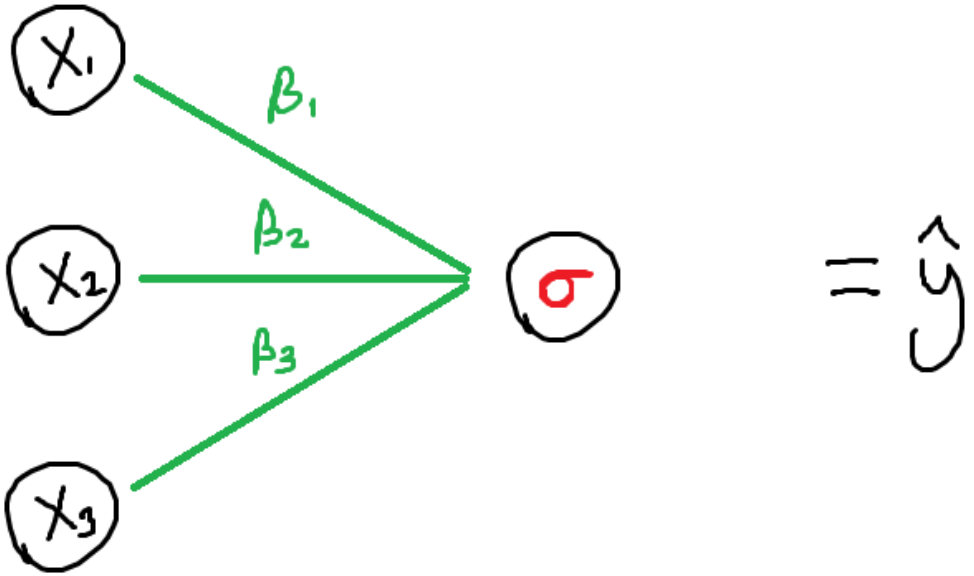

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A simple neural network

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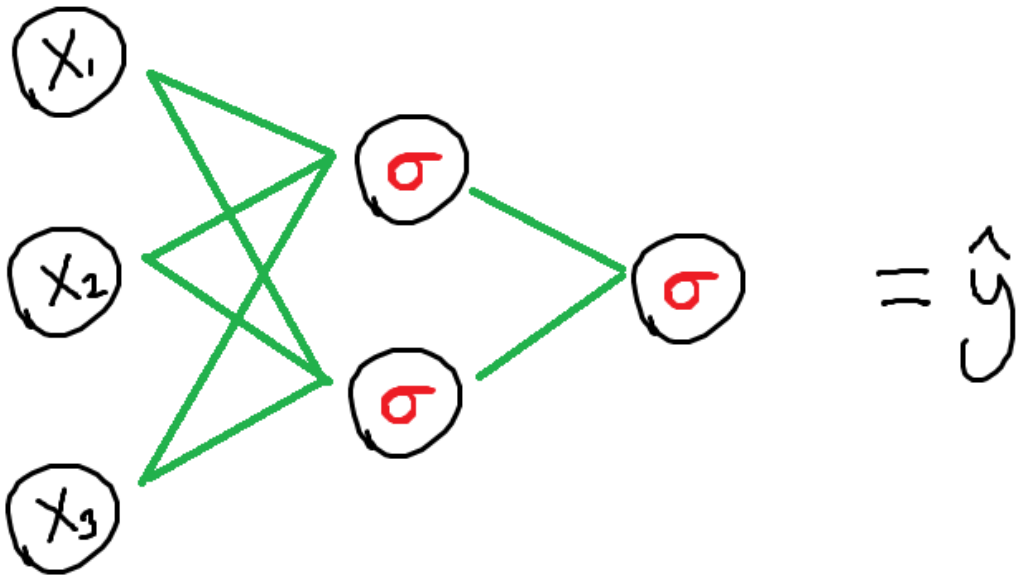

A simple neural network

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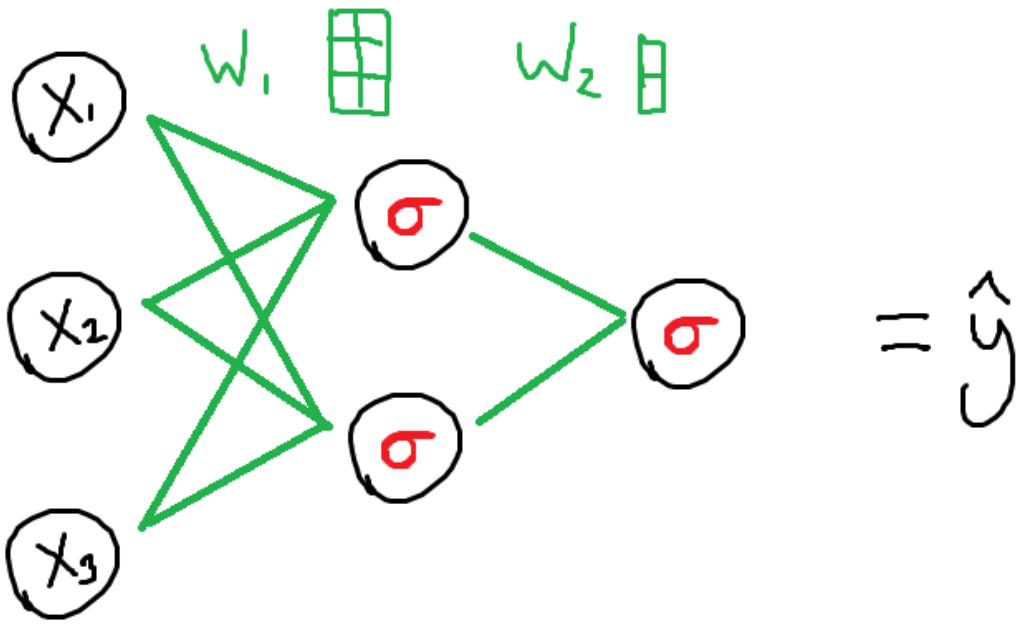

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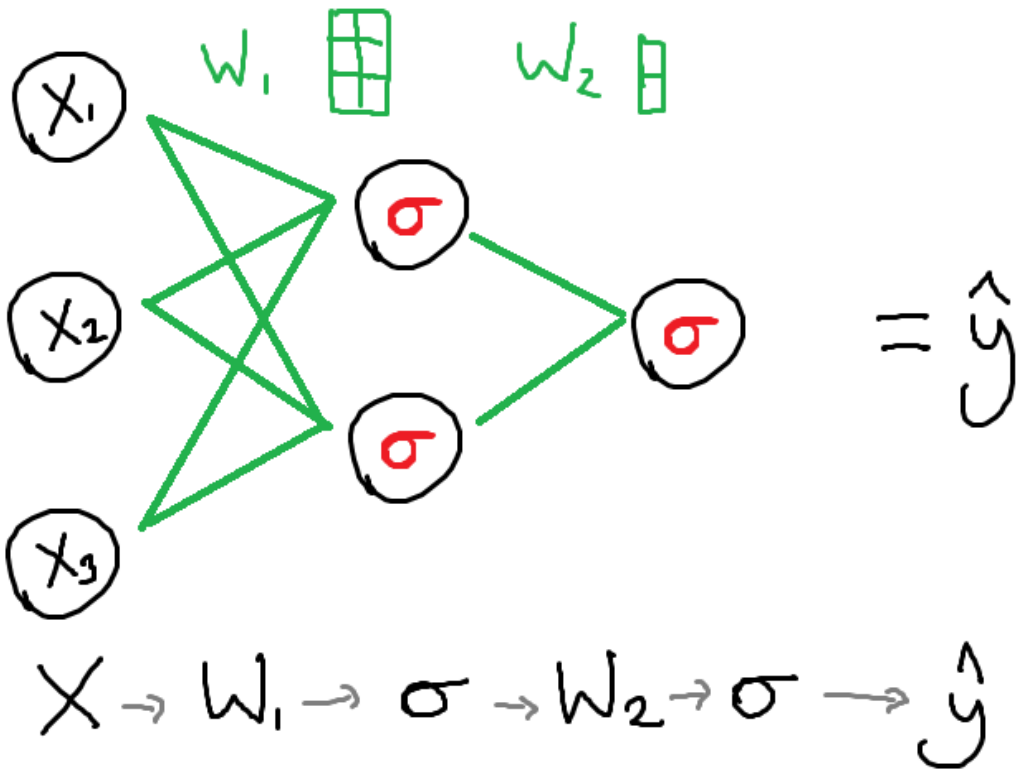

A simple neural network

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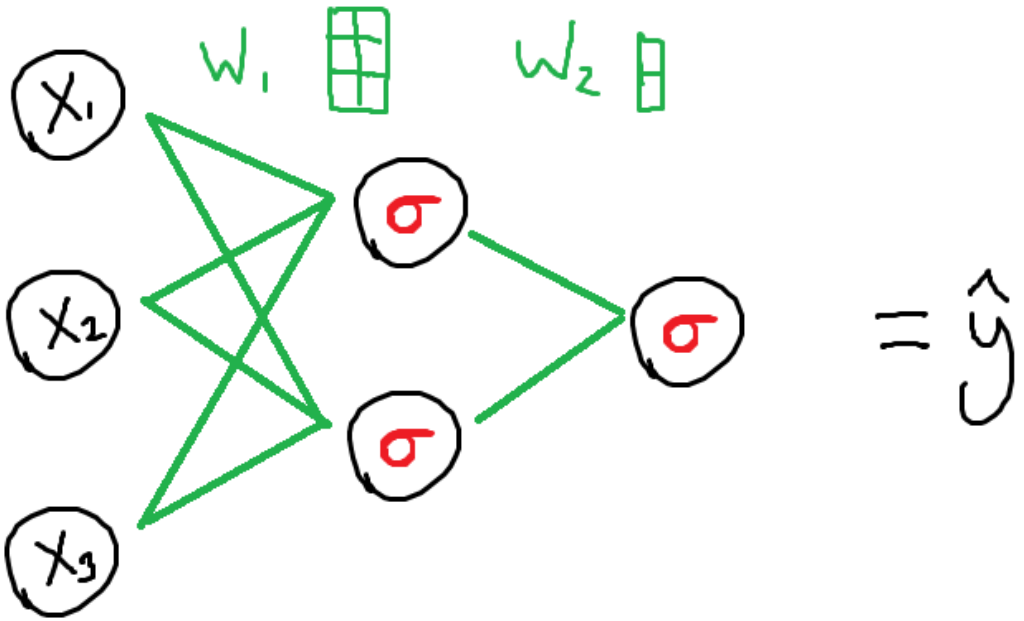

$$X \rightarrow W_1 \rightarrow \sigma \rightarrow W_2 \rightarrow \sigma \rightarrow \hat{y}$$

$$\sigma(\sigma(XW_1)W_2) = \hat{y}$$

A multilayer multinomial classifier

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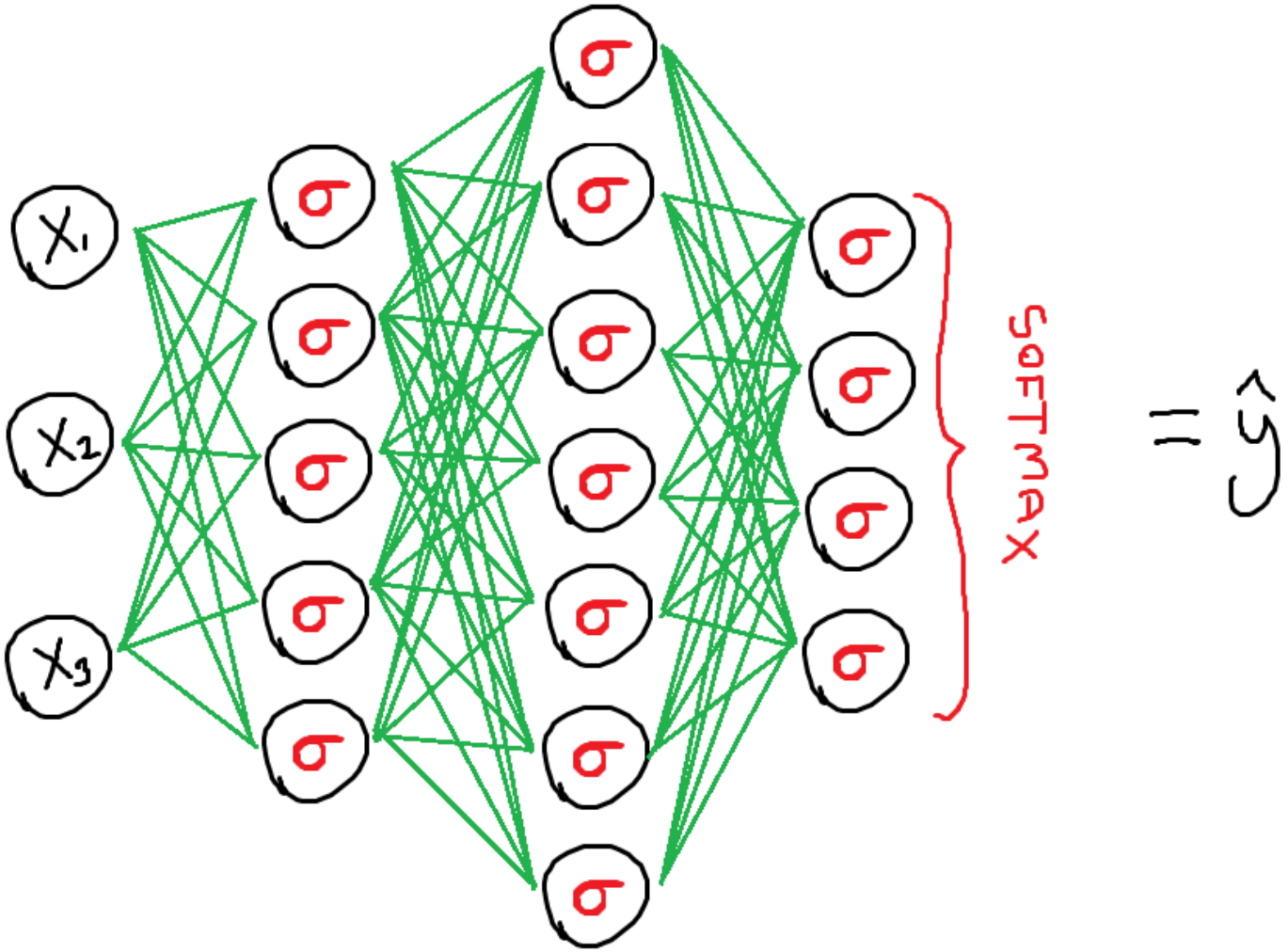
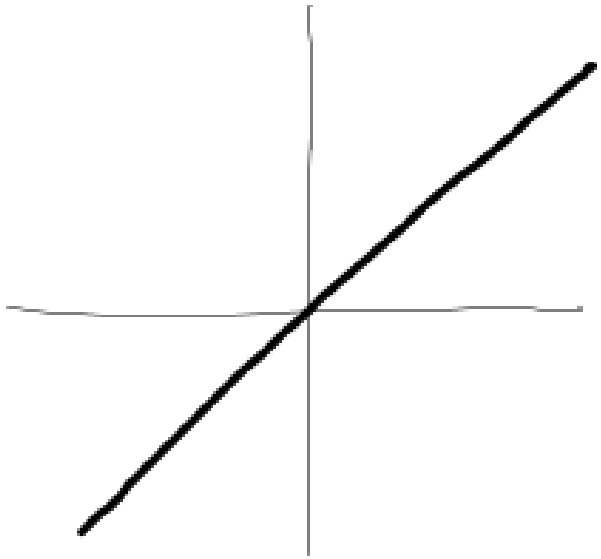


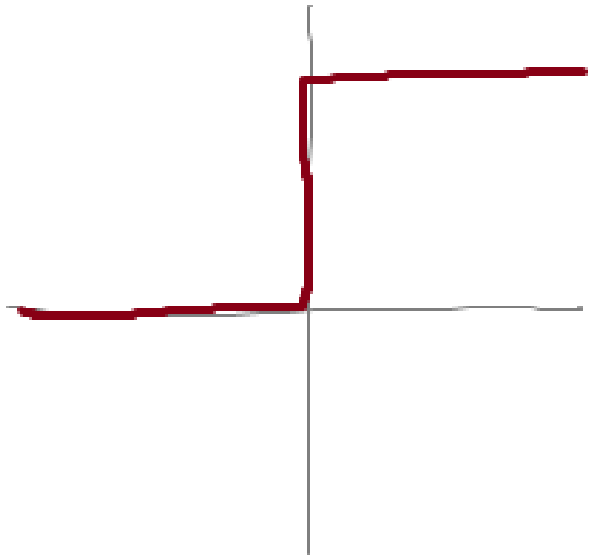
Linear

- Useless



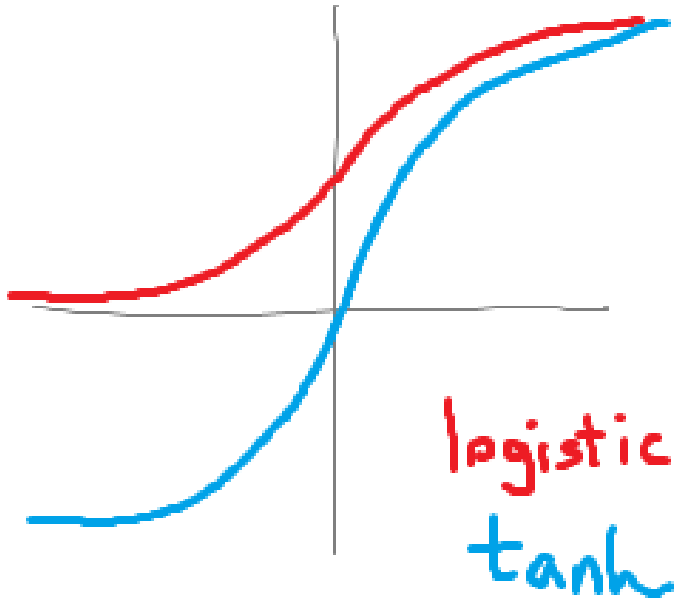
Threshold

- Similar to biological neuron
- No gradient



Sigmoid

- *tanh* preferred
- Gradients can vanish



ReLU

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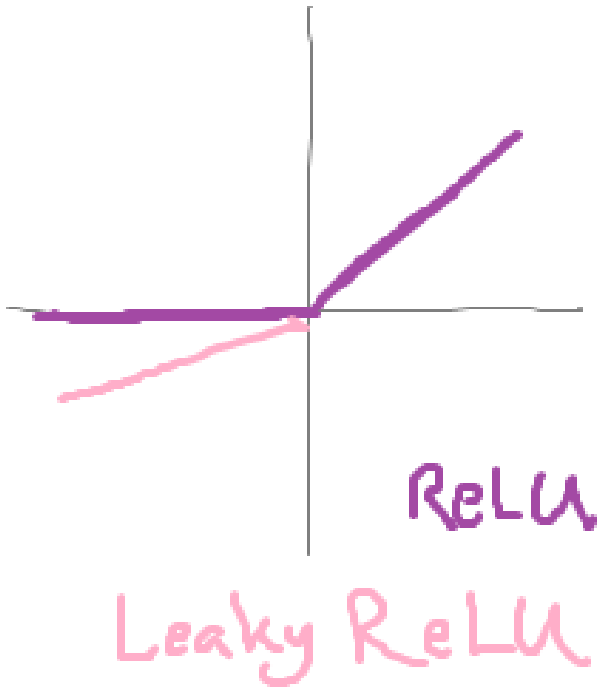
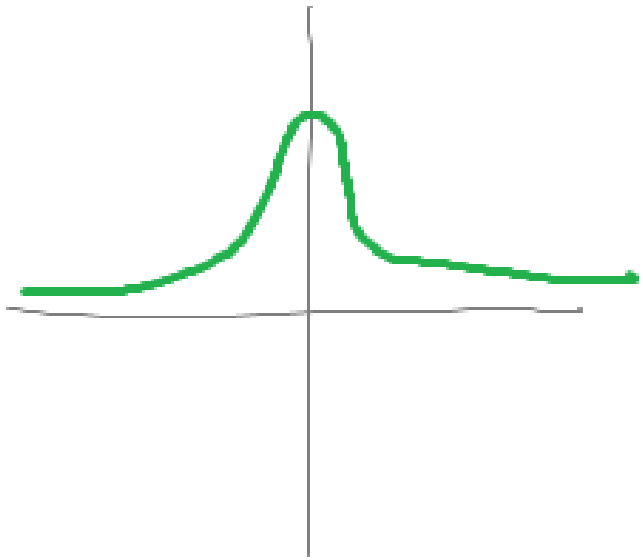
- No vanishing gradient
- Cheap to compute
- Can explode and die
- Popular with CNNs



Radial basis functions

- Gaussian + others
- Train very quickly
- Good at interpolation



Convolutional Neural Networks

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- Image recognition killer

Conceptual structure

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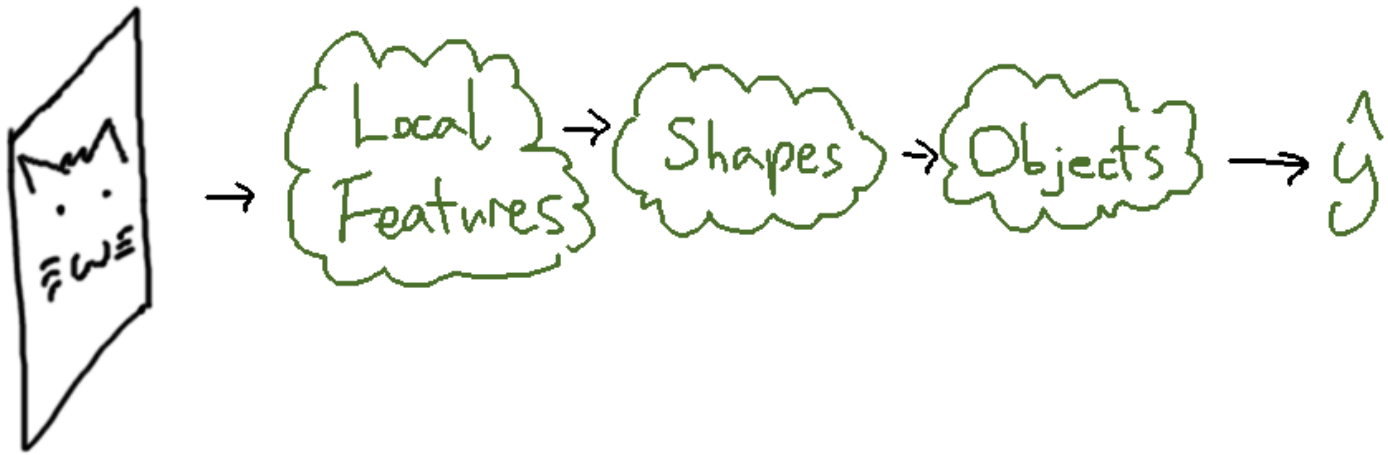

MLP $\rightarrow$ too many weights!

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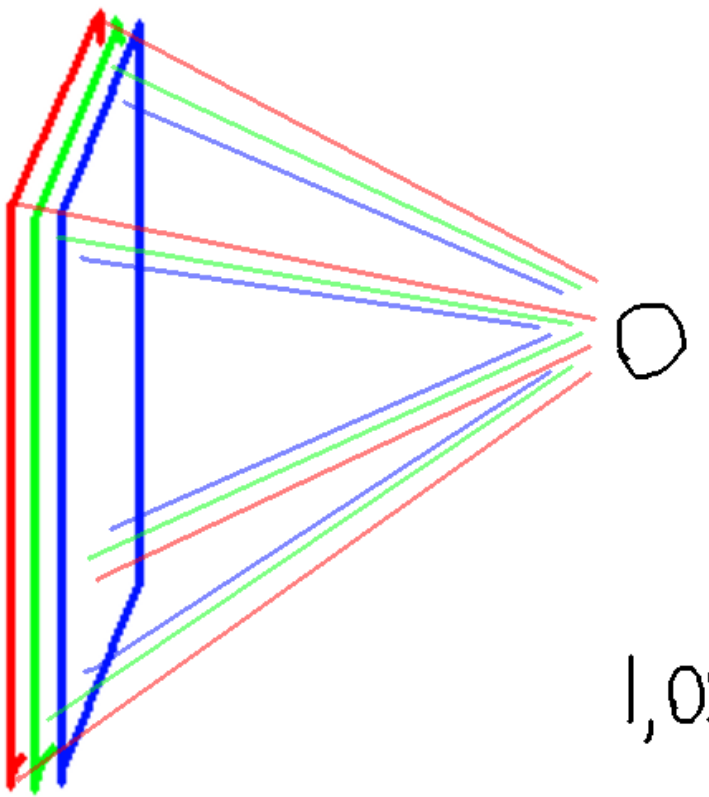
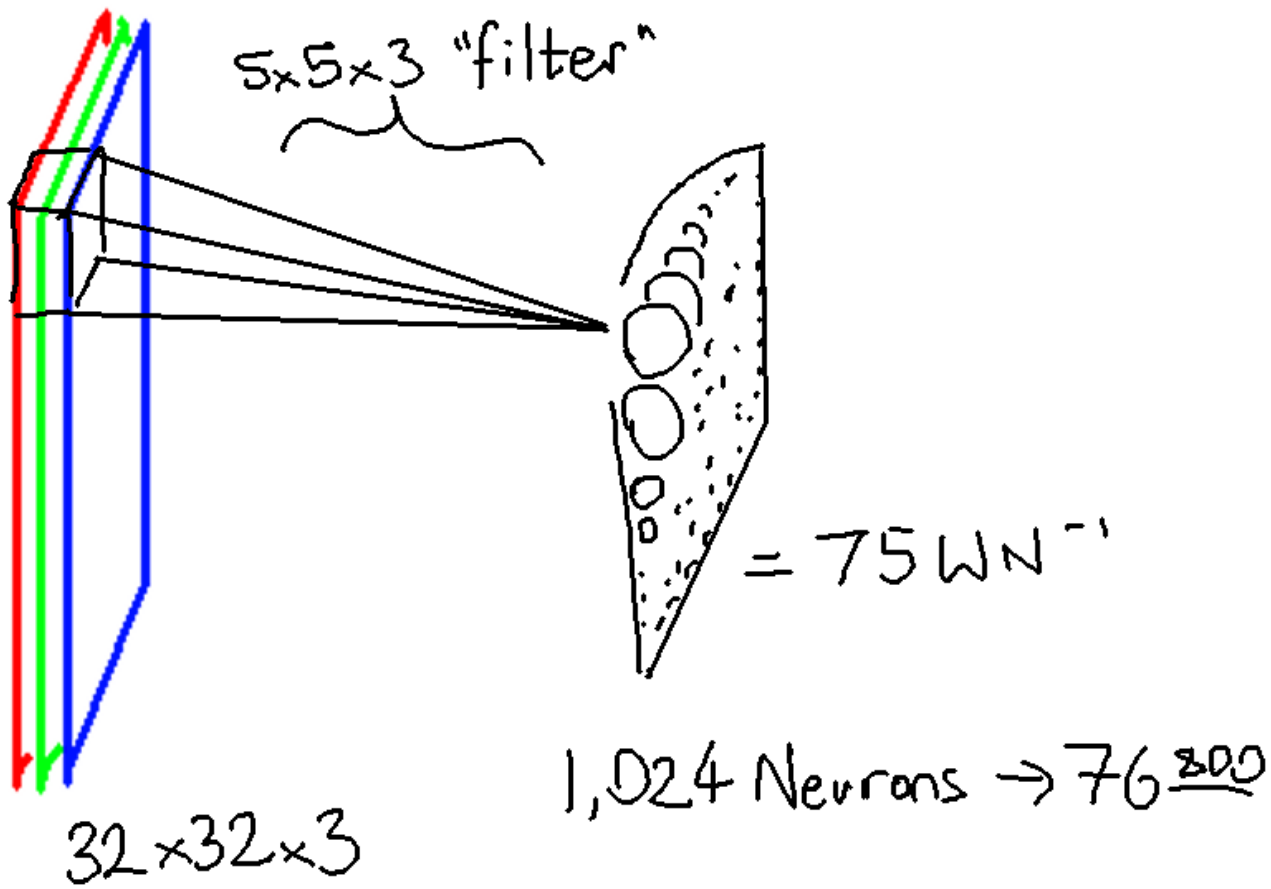


$= 3,072$ weights N^{-1}

1,024 Neurons

$\rightarrow$ >3M weights

Local connectivity



Local connectivity + convolution

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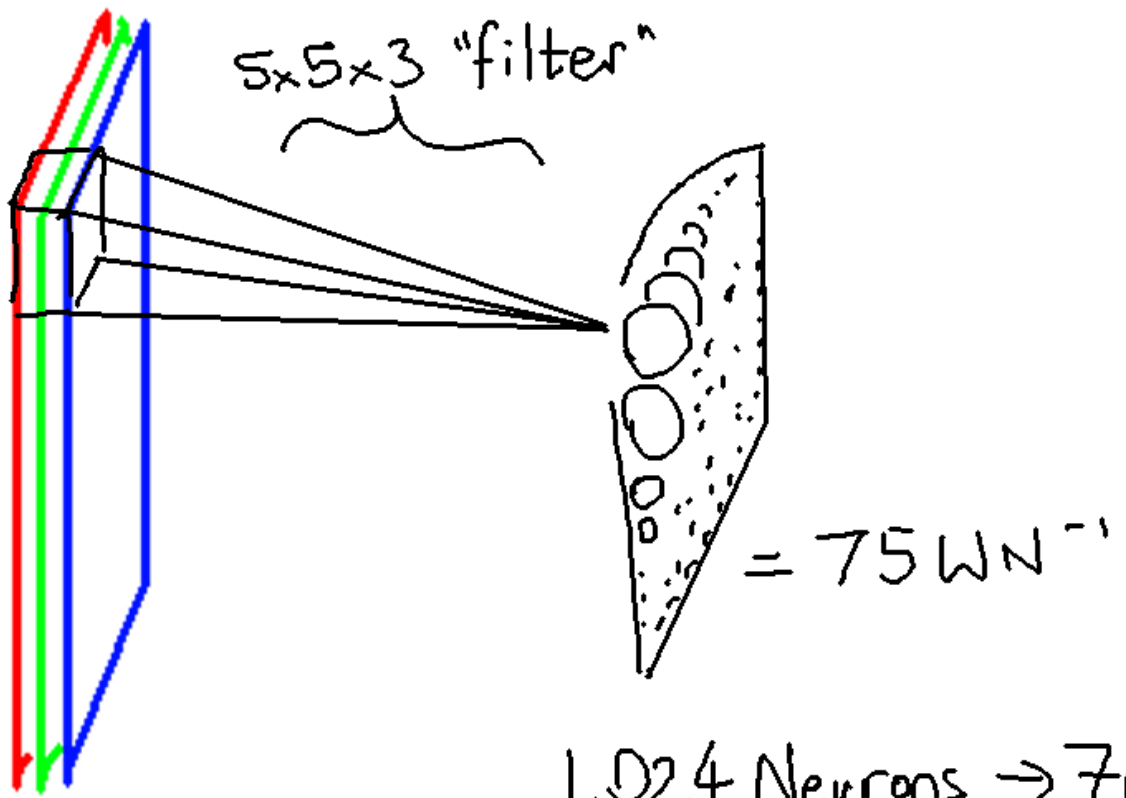
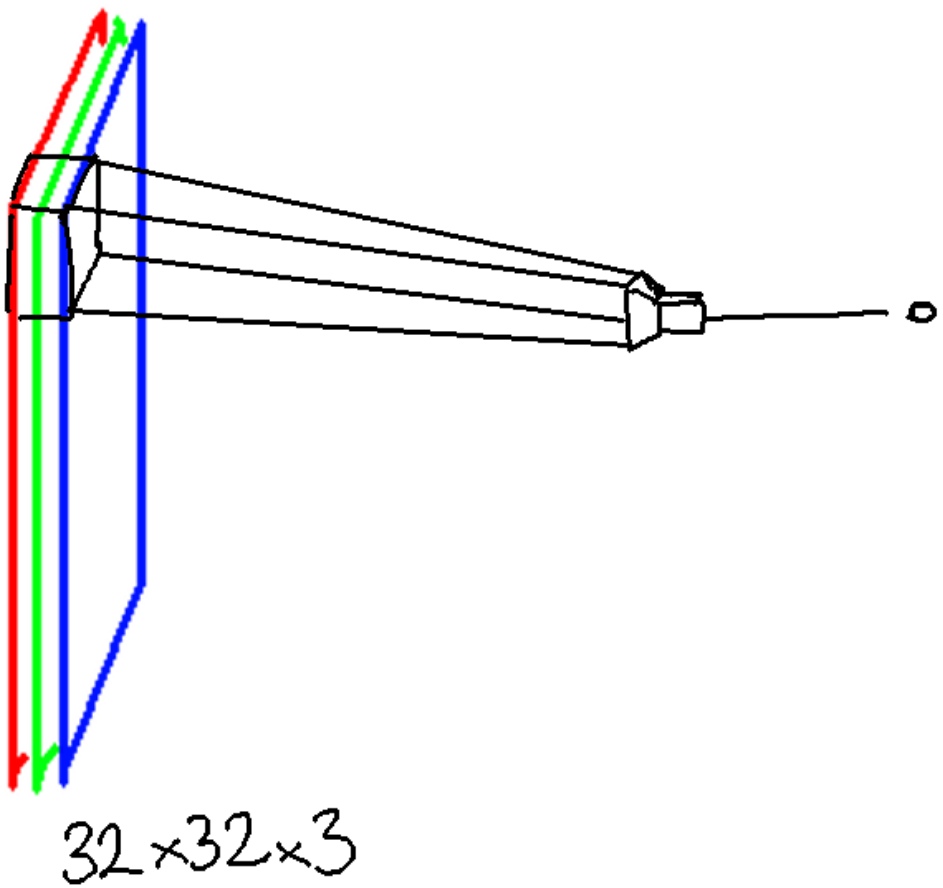


Local connectivity + convolution



Local connectivity + convolution

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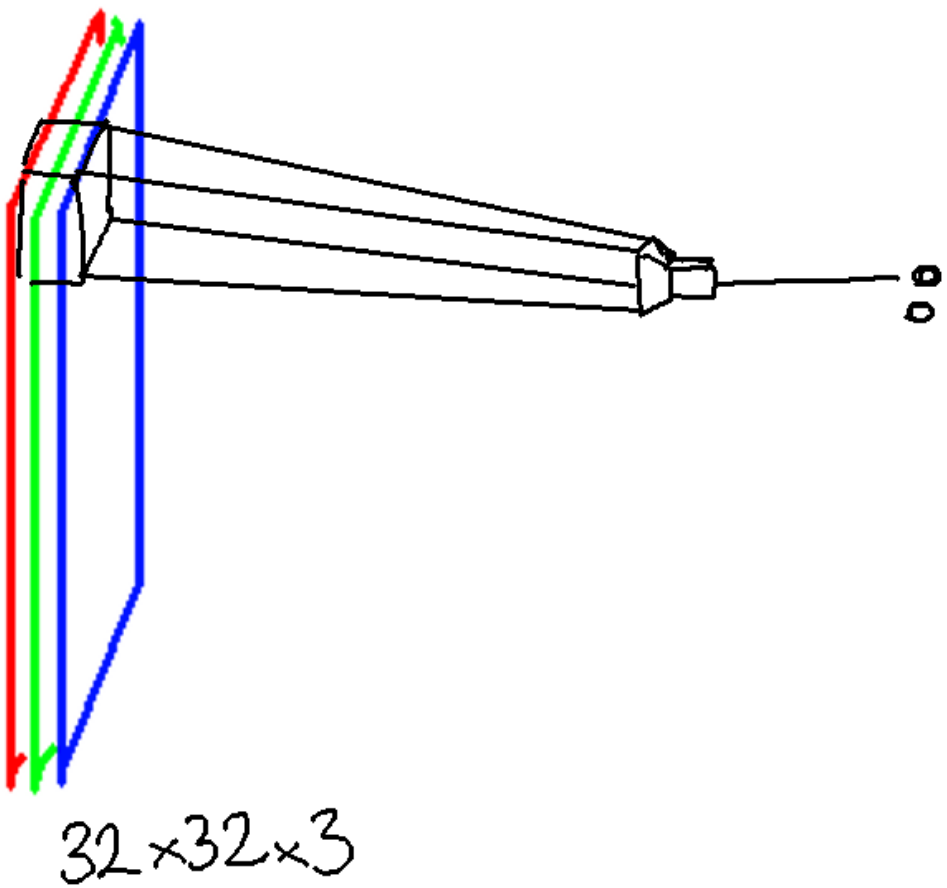
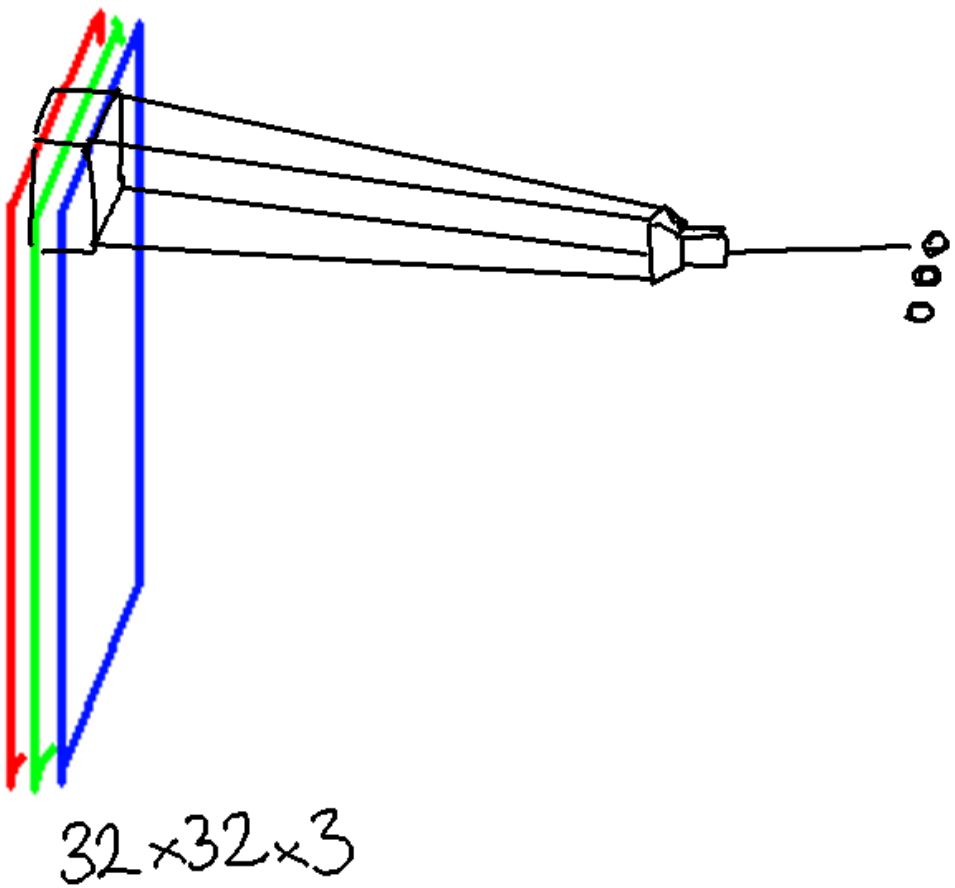


Local connectivity + convolution



Local connectivity + convolution

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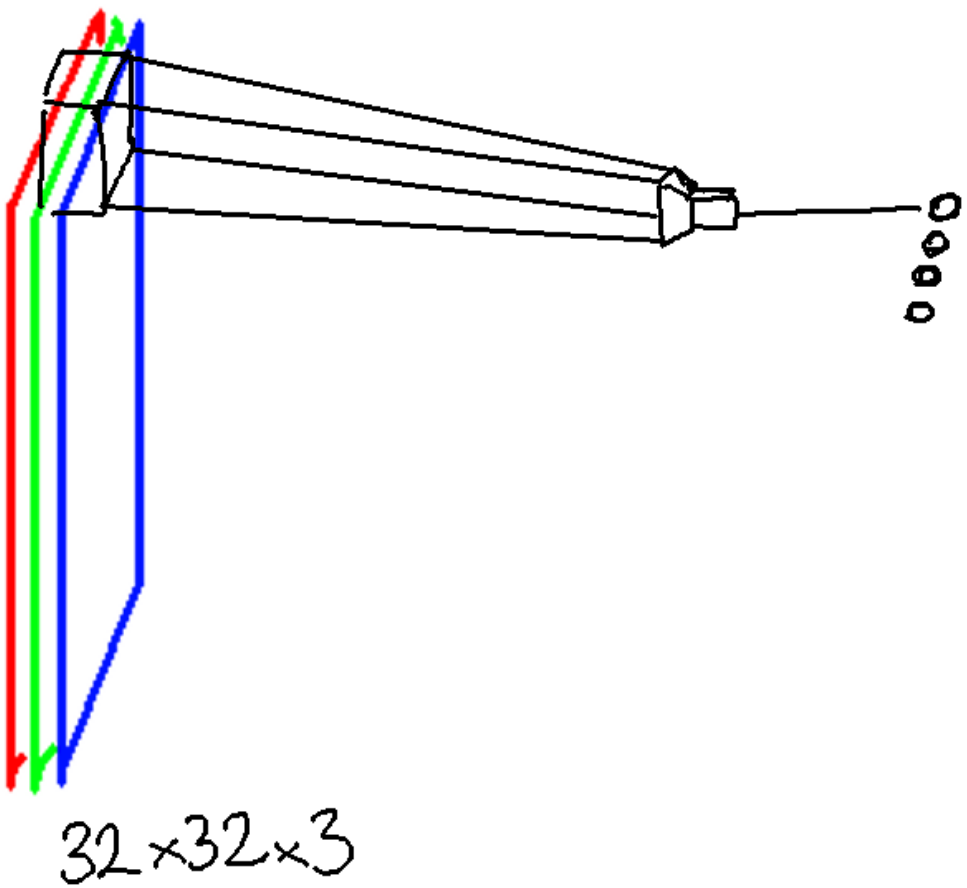

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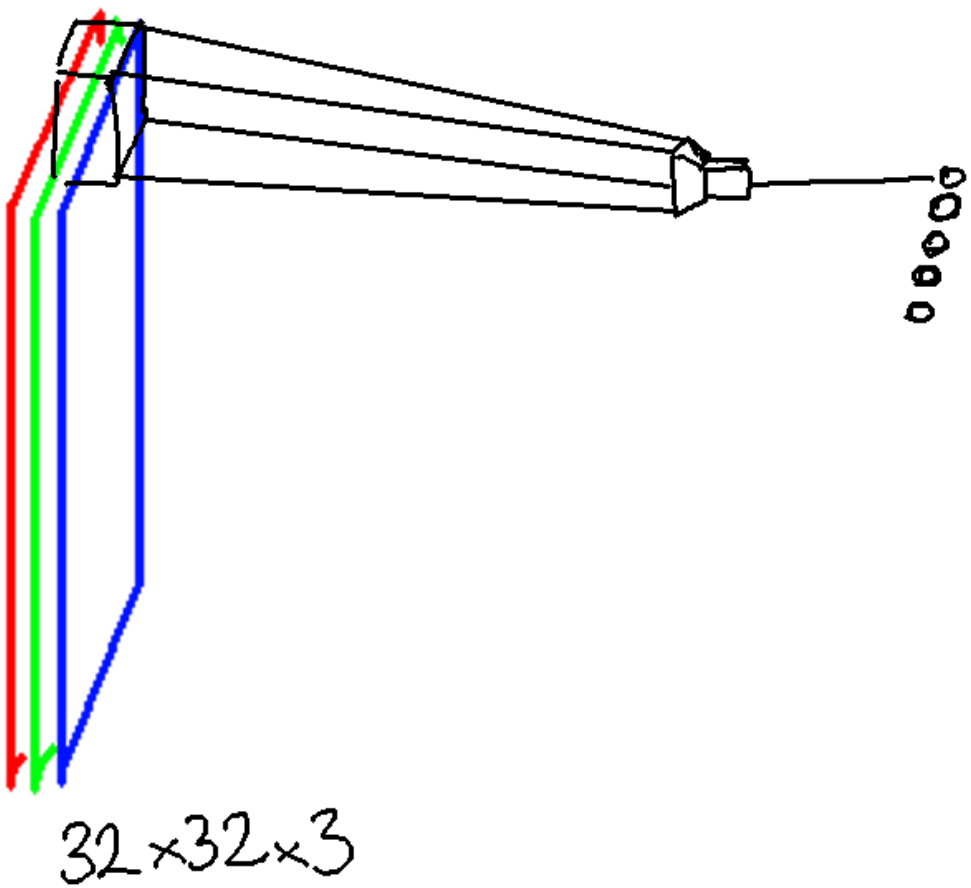
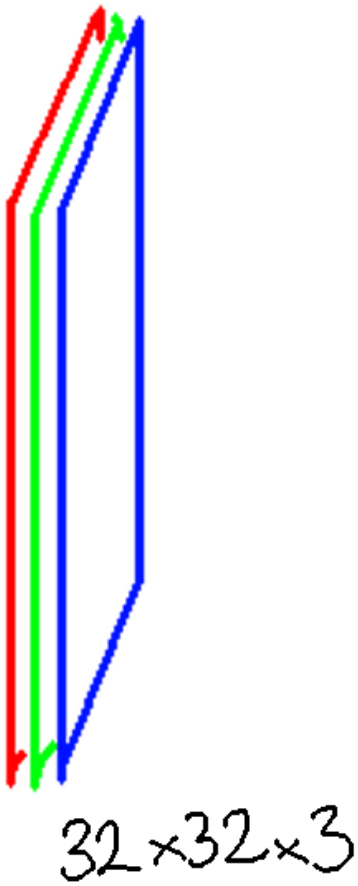
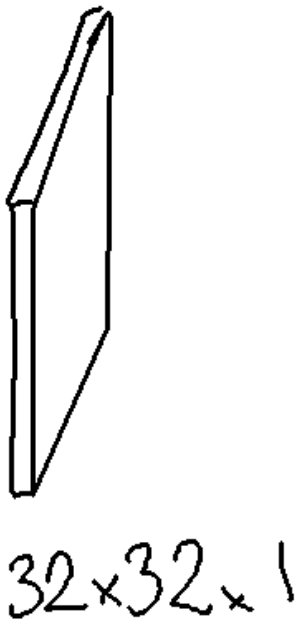
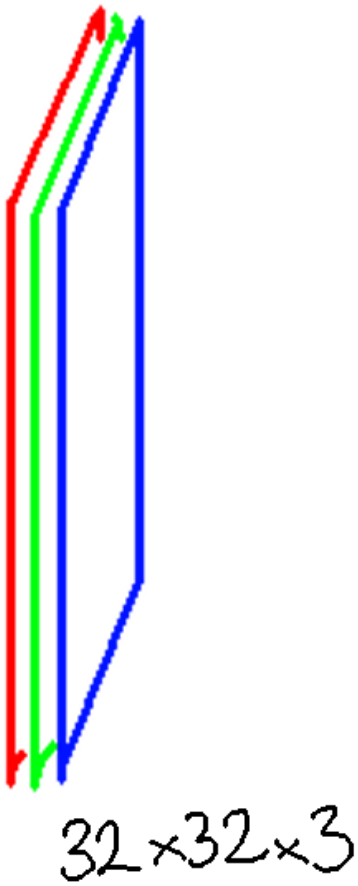


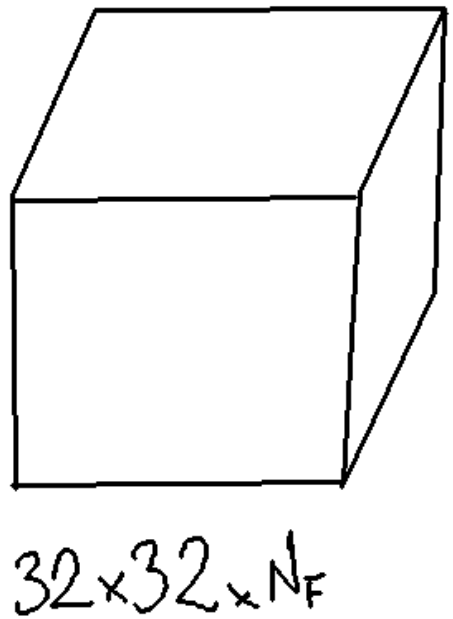
One filter has a surface



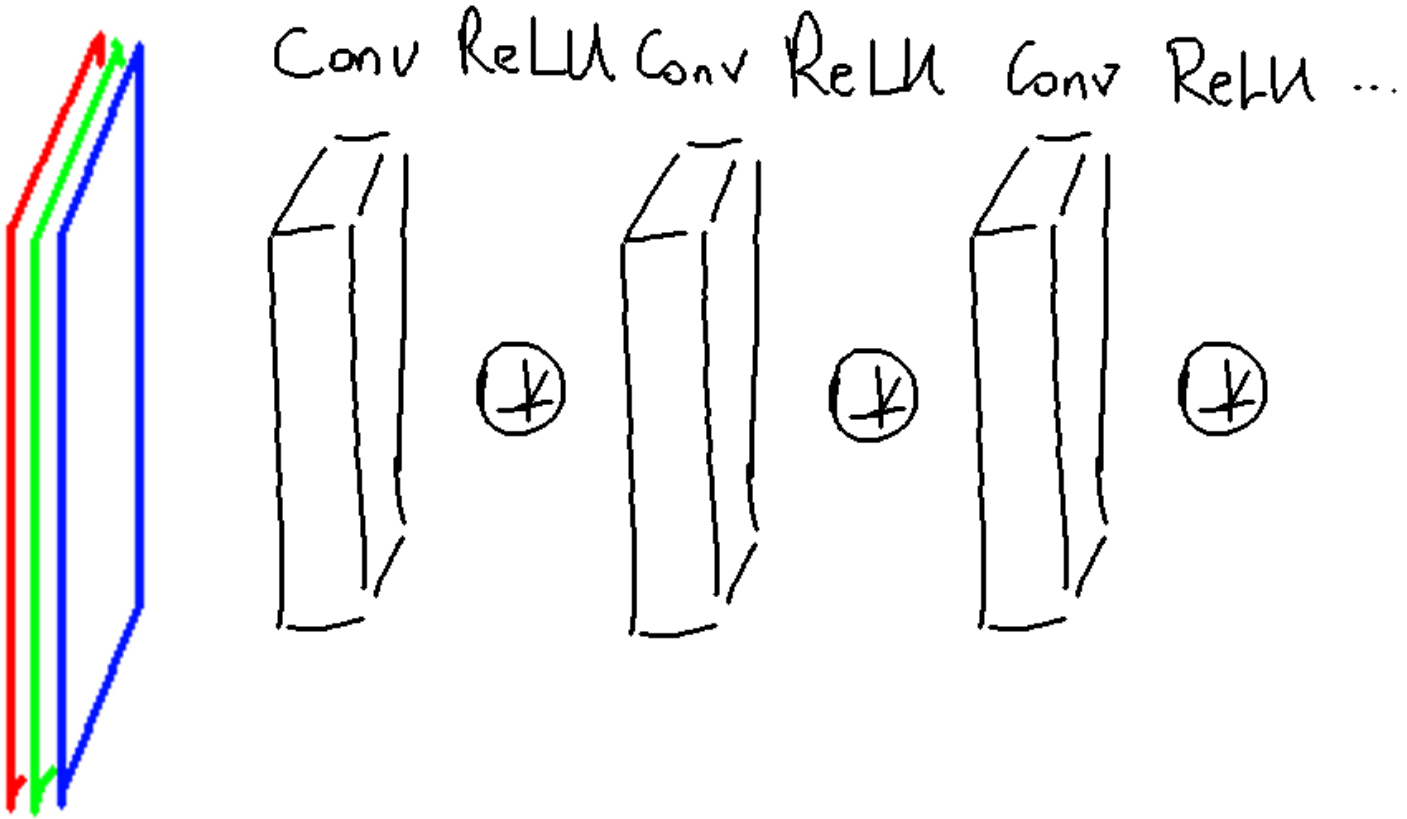


Many filters form a volume





Typical processing structure



AlexNet's filters

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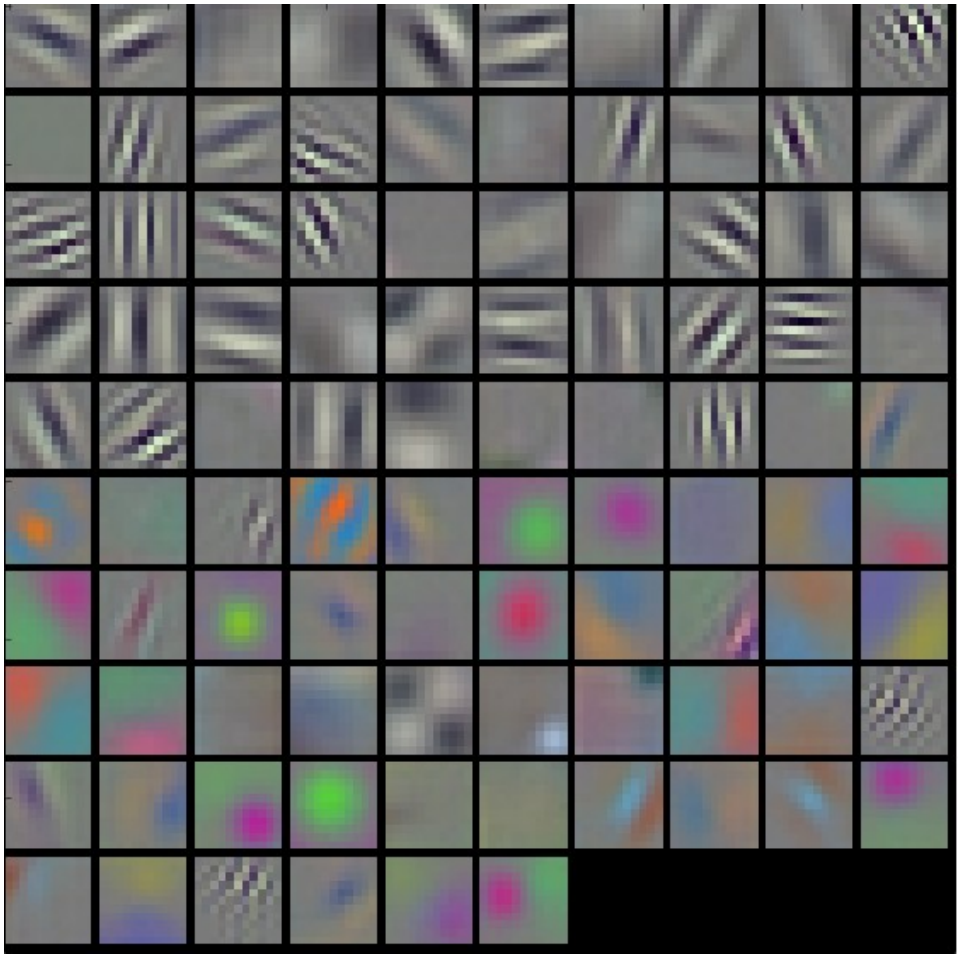

Pooling

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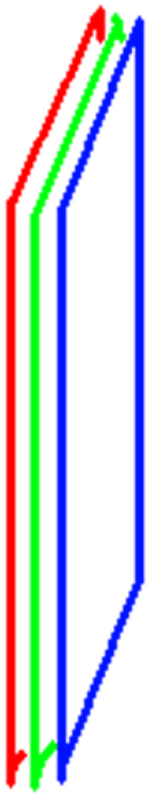
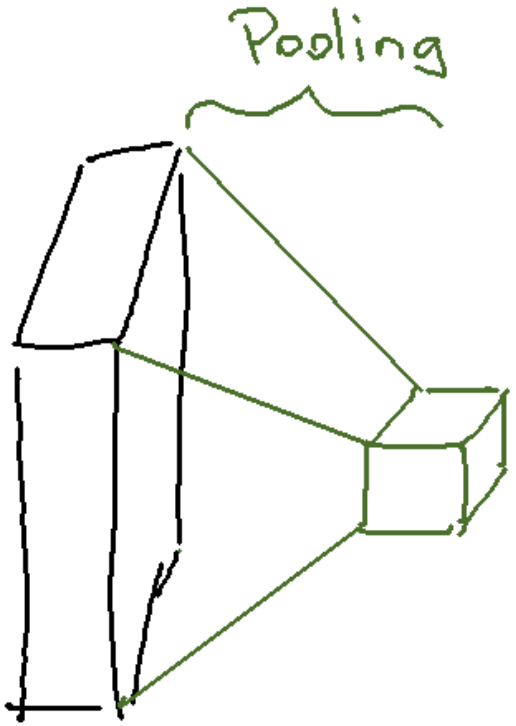


$\{Conv, ReLU\}_M$



$\{X, Y, 3\} \rightarrow \{X, Y, K\} \rightarrow \{<X, <Y, K\}$

Pooling

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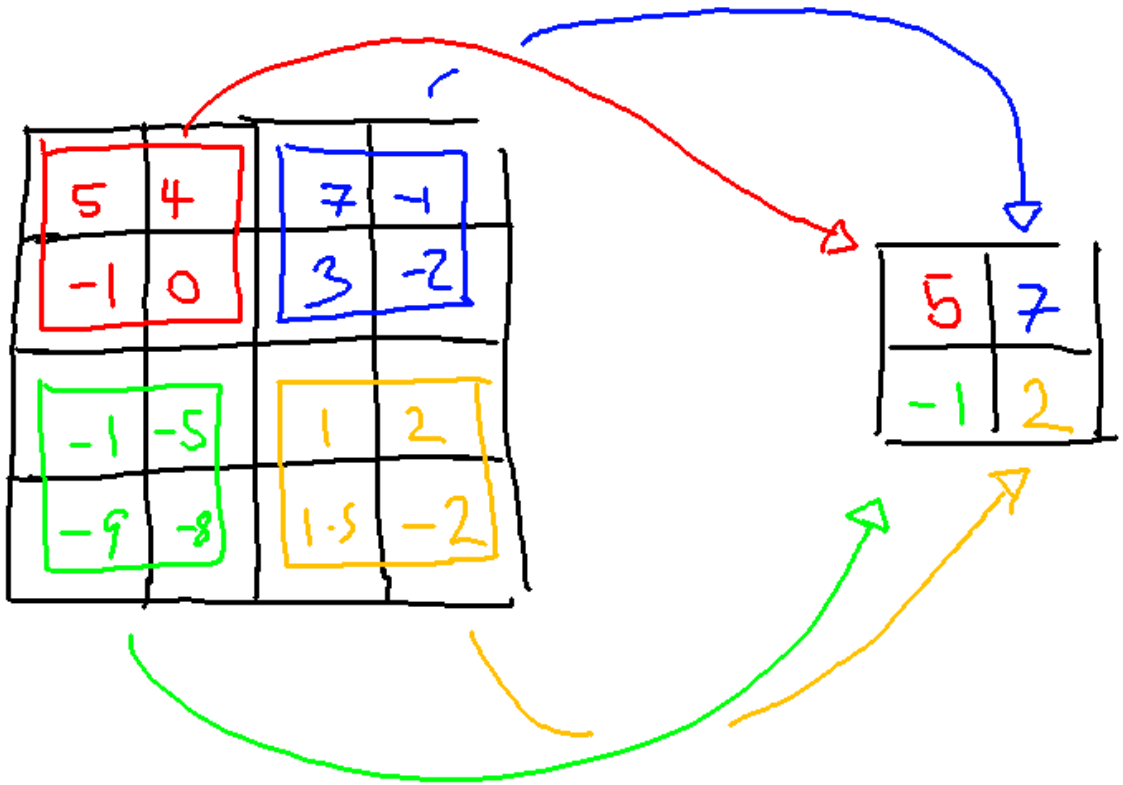

Typical structure of a CNN

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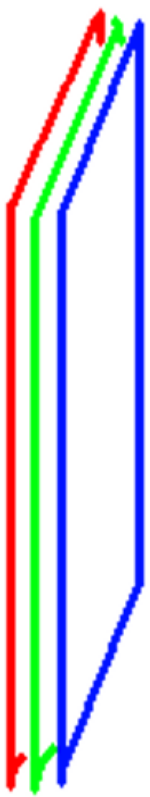

Standard Convnet

$$\{\{\text{Conv, ReLU}\}_M \text{ Pool}\}_N \quad \{\text{FC}\}_K \rightarrow \hat{y}$$