# Convolutional Neural Networks (CNN)

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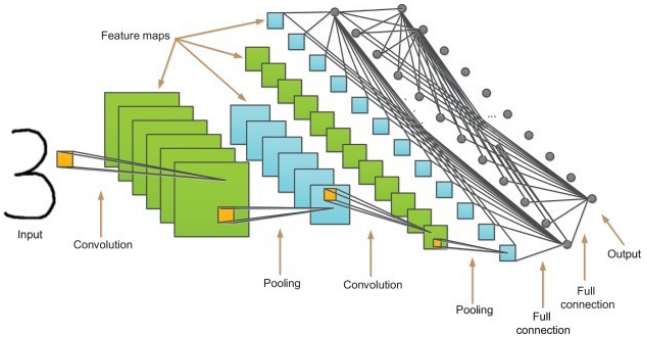
## CNN first designed to deal with images




(source: Li et al., 2016)

## Why convolutions ?

- Parameter sharing
- Sparsity of connections
- Less sensitive to transformations (e.g., translation)

## Filter (aka convolution) can detect patterns

- Example of vertical lines

| | | | | | |
|---|---|---|---|---|---|
| 10 | 10 | 10 | 0 | 0 | 0 |
| 10 | 10 | 10 | 0 | 0 | 0 |
| 10 | 10 | 10 | 0 | 0 | 0 |
| 10 | 10 | 10 | 0 | 0 | 0 |
| 10 | 10 | 10 | 0 | 0 | 0 |
| 10 | 10 | 10 | 0 | 0 | 0 |

*

| | | |
|---|---|---|
| 1 | 0 | -1 |
| 1 | 0 | -1 |
| 1 | 0 | -1 |

=

| | | | |
|---|---|---|---|
| 0 | 30 | 30 | 0 |
| 0 | 30 | 30 | 0 |
| 0 | 30 | 30 | 0 |
| 0 | 30 | 30 | 0 |

- Different kinds of patterns

| | | |
|---|---|---|
| 1 | 0 | -1 |
| 1 | 0 | -1 |
| 1 | 0 | -1 |

Vertical

| | | |
|---|---|---|
| 1 | 1 | 1 |
| 0 | 0 | 0 |
| -1 | -1 | -1 |

Horizontal

| | | |
|---|---|---|
| 1 | 0 | -1 |
| 2 | 0 | -2 |
| 1 | 0 | -1 |

Sobel filter

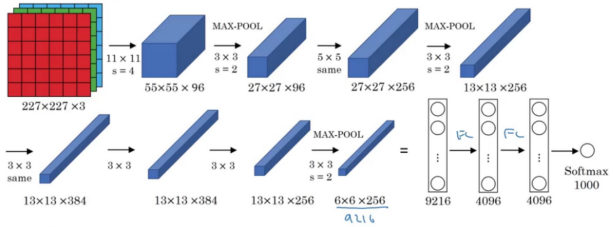
| | | |
|---|---|---|
| 3 | 0 | -3 |
| 10 | 0 | -10 |
| 3 | 0 | -3 |

Scharr filter

(source : https://www.analyticsvidhya.com/blog/2018/12/guide-convolutional-neural-network-cnn/)

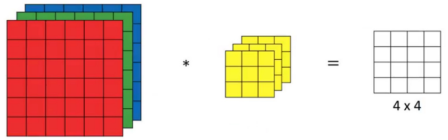
# Automatically learn filters

- Example with AlexNet:




# Some technical details

- One layer = *multiple* filters
- Add padding to better handle the borders
- Strided convolutions
- Convolution over volumes




# CNN can be applied to other kind of data

- Textual data as 1D CNN

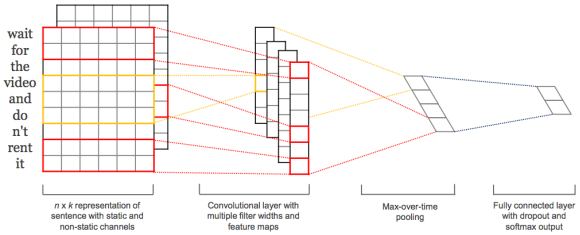



Figure 1: Model architecture with two channels for an example sentence.

(source : https://cezannec.github.io/CNN_Text_Classification/)