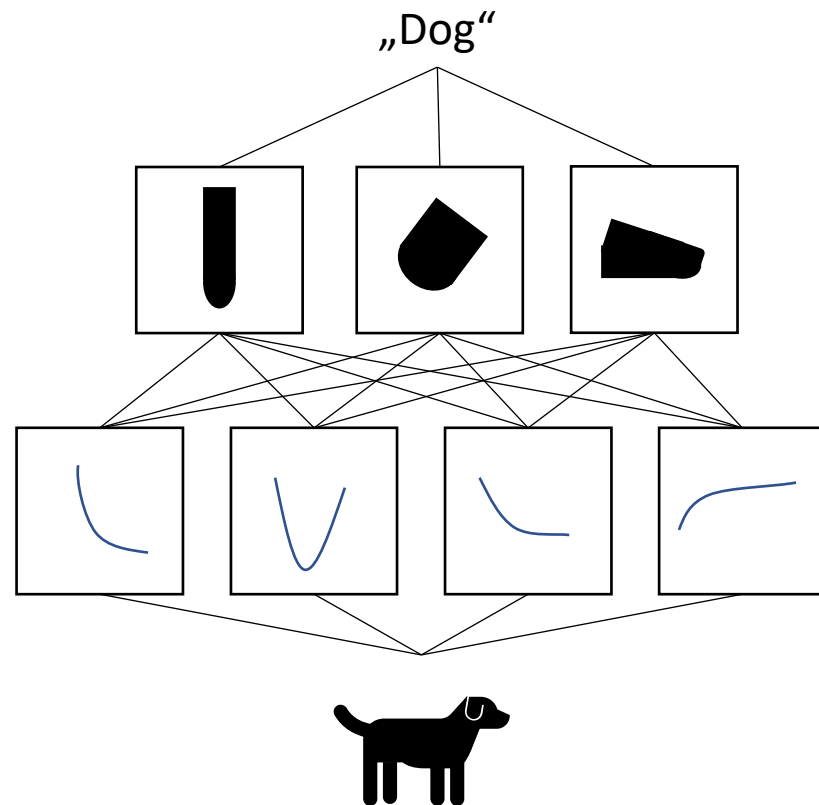


Convolutional Neural Networks 101

Convolutional Neural Networks

Introduction

- Type of deep learning network
- Most commonly applied for computer vision
- CNNs learn local patterns
- Local patterns translational invariant
- Layers learn different hierarchical patterns (from simple to complex)



Convolutional Neural Networks

Convolution

0	1	0	1	1
0	0	1	1	0
1	1	0	1	0
0	1	0	0	1
0	0	1	1	0

Input Image Matrix

x

0	1	0
1	-4	1
0	1	0

Convolutional Filter
(Edge Detector)

=

4	-3	-1
-2	3	-3
-3	2	3

Feature Map

Convolutional Neural Networks

Convolution - Example



x

0	1	0
1	-4	1
0	1	0

=



Input Image

Edge Detector

Feature Map

Convolutional Neural Networks

Convolution - Example



x

1/9	1/9	1/9
1/9	1/9	1/9
1/9	1/9	1/9

=



Input Image

Blur Filter

Feature Map

Convolutional Neural Networks

Convolution - Stride

- Stride equals step size
- Example: Stride = 2



0	1	0	1	1
0	0	1	1	0
1	1	0	1	0
0	1	0	0	1
0	0	1	1	0

Input Image Matrix

x

0	1	0
1	-4	1
0	1	0

Convolutional Filter
(Edge Detector)

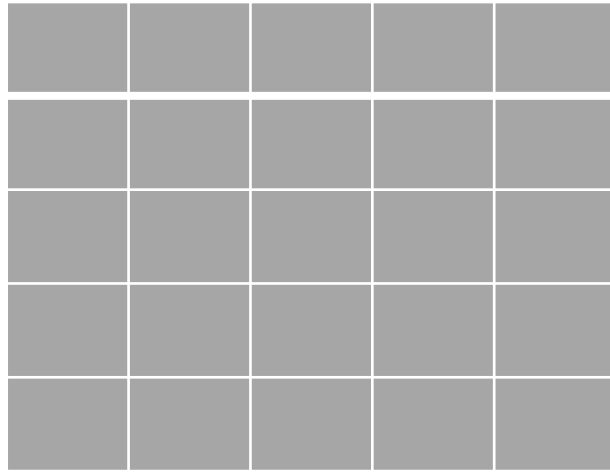
=

4	-1
-3	3

Feature Map

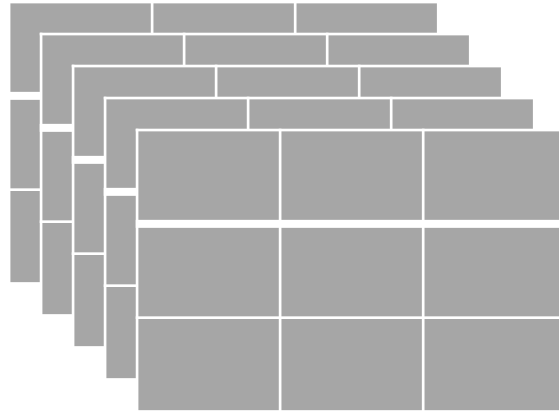
Convolutional Neural Networks

Convolutional Layer



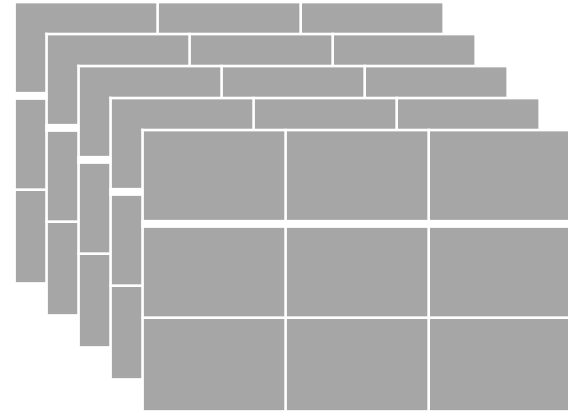
Input Image Matrix

x



Convolutional Filters

=



Convolutional Layer

Feature Maps

Convolutional Neural Networks

Max Pooling

4	-3	-1
-2	3	-3
-3	2	3

Feature Map

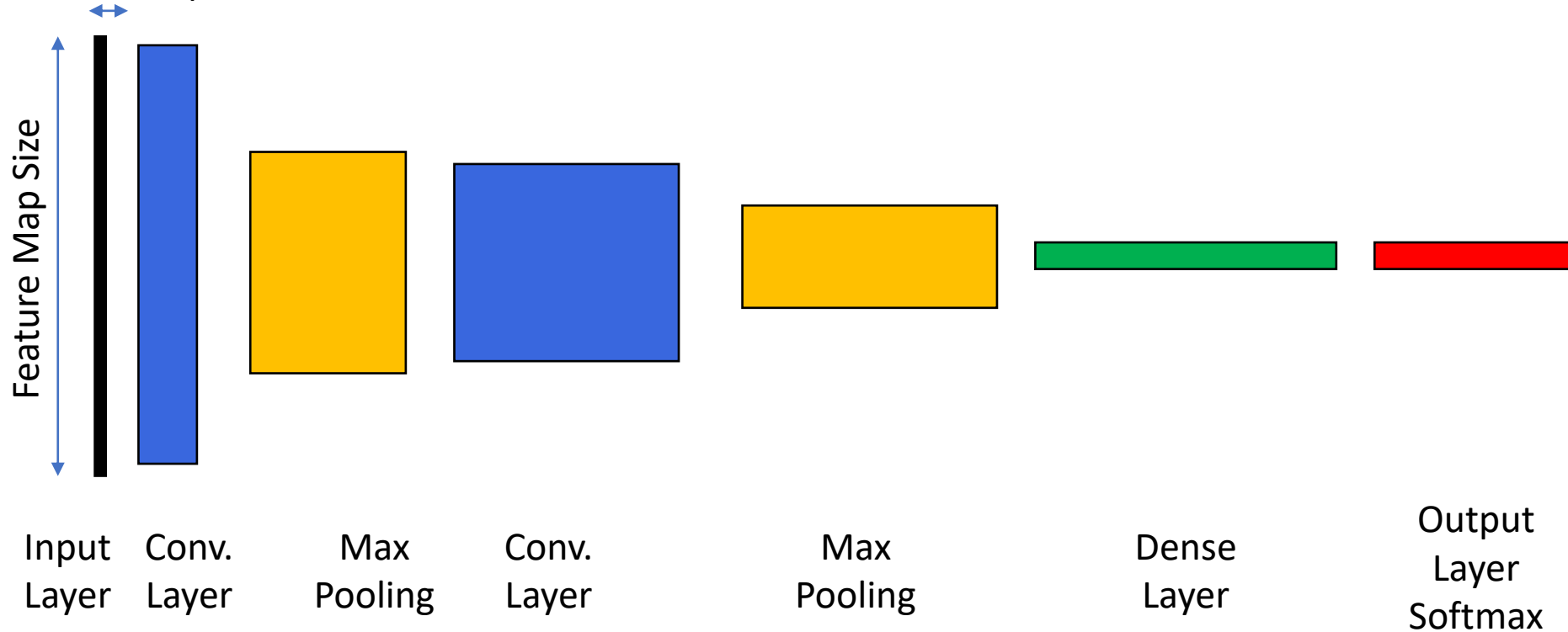
4	3
3	3

Max Pooling

Convolutional Neural Networks

Example Network Setup

Feature Map Count



Convolutional Neural Networks

Example Network Setup

- Count of feature maps increase with layers from (from 32 to 64)
- Size of feature maps decreases (from 148x148 to 16x16)
- Very typical for CNNs

Layer (type)	output shape	Param #
conv2d_19 (Conv2D)	(None, 148, 148, 32)	320
max_pooling2d_16 (MaxPooling2D)	(None, 74, 74, 32)	0
conv2d_20 (Conv2D)	(None, 72, 72, 32)	9248
max_pooling2d_17 (MaxPooling2D)	(None, 36, 36, 32)	0
conv2d_21 (Conv2D)	(None, 34, 34, 64)	18496
conv2d_22 (Conv2D)	(None, 32, 32, 64)	36928
max_pooling2d_18 (MaxPooling2D)	(None, 16, 16, 64)	0
dropout_17 (Dropout)	(None, 16, 16, 64)	0
flatten_7 (Flatten)	(None, 16384)	0
dense_13 (Dense)	(None, 512)	8389120
dropout_18 (Dropout)	(None, 512)	0
dense_14 (Dense)	(None, 10)	5130
Total params: 8,459,242		
Trainable params: 8,459,242		
Non-trainable params: 0		

Convolutional Neural Networks

Advantages / Disadvantages



- Most powerful technique for computer vision tasks
- Achieves high quality predictions



- Many parameters
- Requires a lot of experience
- Very computationally expensive