Object detection outline

Karel Zimmermann
Classical approach to object detection

- Scale-space search with a classifier
- Famous application Viola Jones face detector

Classifier: \( f : \mathcal{R}^{N \times M} \rightarrow \{+1, -1\} \)

\[
f(\text{face}) = +1
\]
\[
f(\text{background}) = -1
\]
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\[ f : \mathcal{R}^{N \times M} \rightarrow \{+1, -1\} \]

\[ f([3.1, -1.8]) = +1 \]

Haar-features use instead of pure pixel intensities
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First two selected features for face detection
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Profile detector required completely different features
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Profile detector required completely different features
Haar feature as 2D convolution

Convolutional kernel corresponding to vertical gradient
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Convolutional kernel

Input

Feature Map
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- Many different feature types manually designed (SIFT, HOG)
- Most of them consists of convolution, spatial pool and norm

_Lowe [IJCV 2004]_
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**Shallow architecture**

- Image/Video Pixels
- Hand-designed feature extraction
- Trainable classifier
- Object Class

**Deep architecture:**

- Image/Video Pixels
- Layer 1
- Layer 2
- Layer 3
- Simple Classifier
Deep convolutional neural network
Deep convolutional neural network

Convolution layer

Max-pooling layer

Features maps

Input for next layer

Input image

Features maps


Czech Technical University in Prague
Faculty of Electrical Engineering, Department of Cybernetics
Imagenet

- 14M labeled images
- Human labels via Amazon Turk

[Deng et al. CVPR 2009]
Pascal VOC object detection challenge

Before the successful application of ConvNets

Mean Average Precision (mAP)

Year


< 2 years 1.8x mAP

~5 years

Precision: higher is better
Layer 1 filters
Filters in different layers

Layer 1

Layer 2

Layer 3
Deep convolutional nets useful links

- Many Python/C++/Matlab frameworks with tutorials:
  - https://www.tensorflow.org
  - http://caffe.berkeleyvision.org
  - http://deeplearning.net/software/theano/
  - http://www.vlfeat.org/matconvnet/

- Many datasets with competitions:
  - http://mscoco.org
  - http://www.image-net.org
  - http://host.robots.ox.ac.uk/pascal/VOC/

- Many ready-to-use applications and pre-trained models: