Object detection outline

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Classical approach to object detection

- Scale-space search with a classifier
- Famous application Viola Jones face detector
- http://www.intel.com/technology/computing/opencv

Classifier: $f : \mathcal{R}^{N \times M} \to \{+1, -1\}$

$$f(\ \ ) = +1$$

$$f(\ \ ) = -1$$

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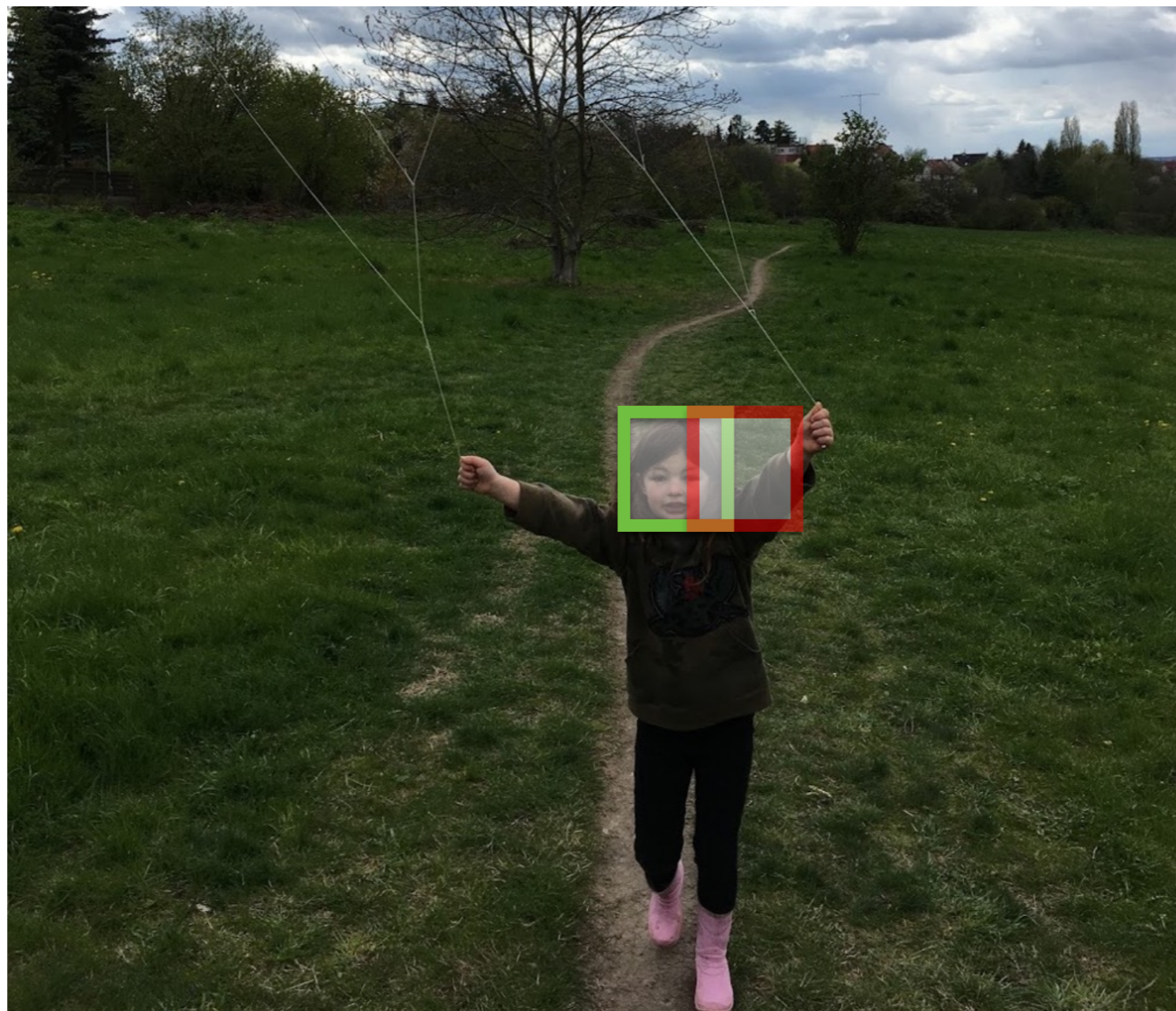- Famous application Viola Jones face detector
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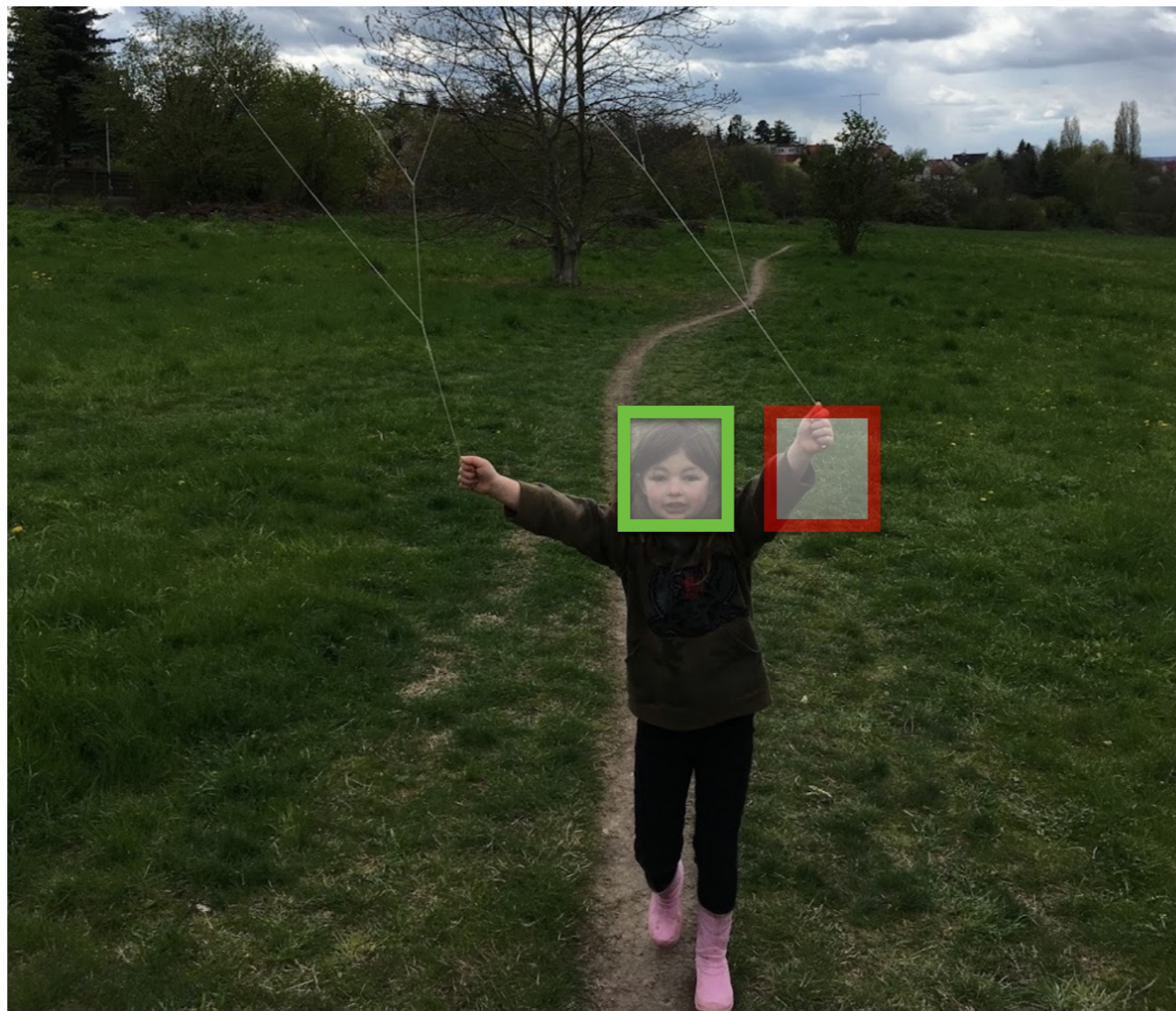- Famous application Viola Jones face detector
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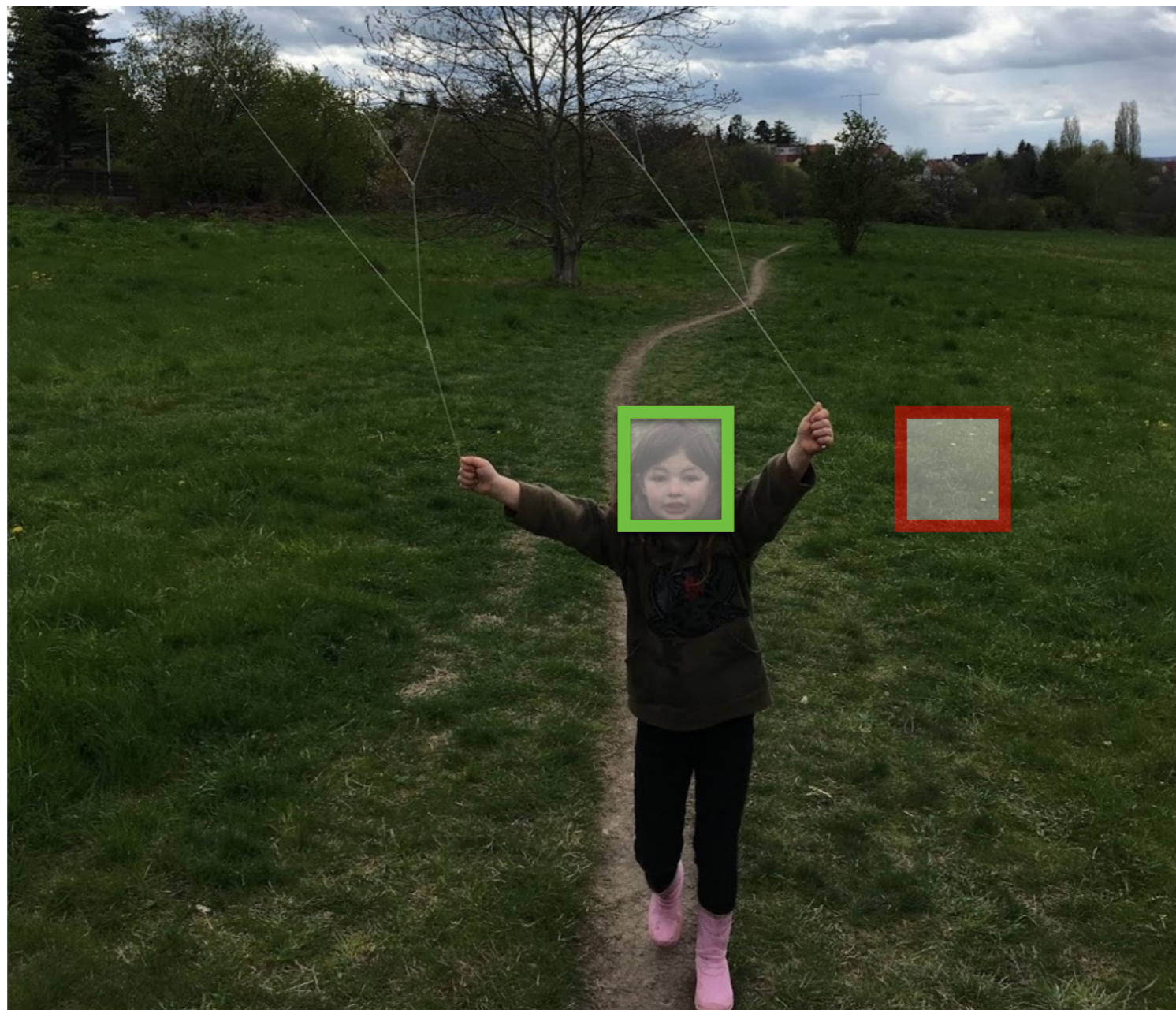- Famous application Viola Jones face detector
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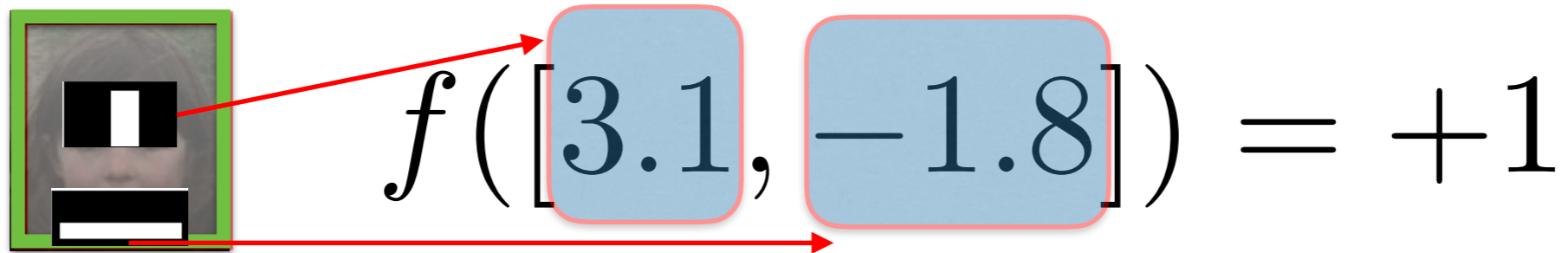- Famous application Viola Jones face detector
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Classifier: $f : \mathcal{R}^{N \times M} \to \{+1, -1\}$

$$f([3.1, -1.8]) = +1$$
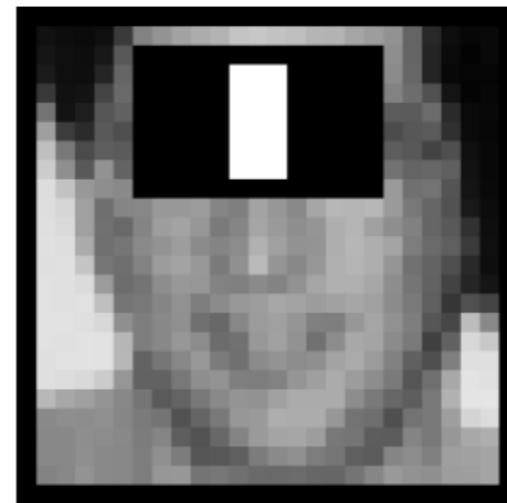
Haar-features use instead of pure pixel intensities

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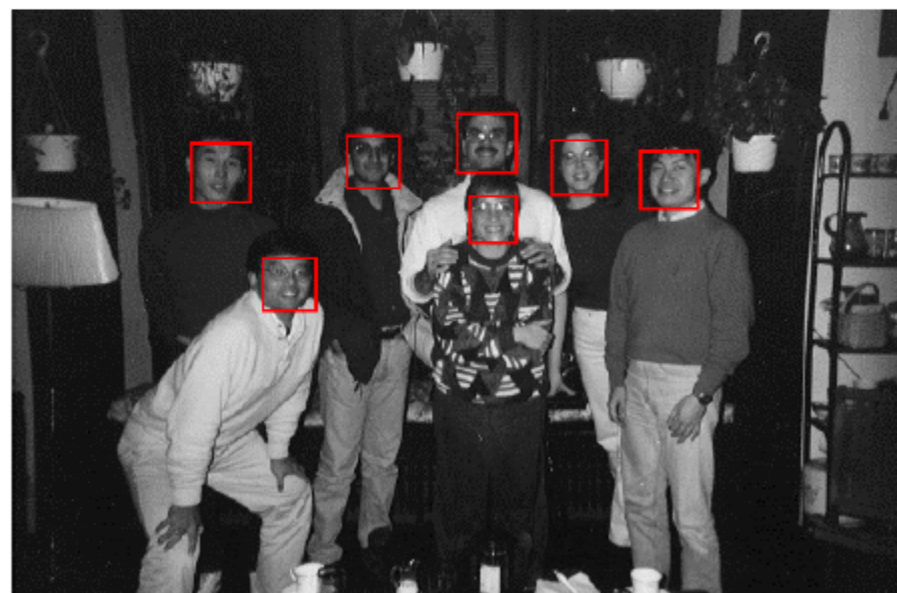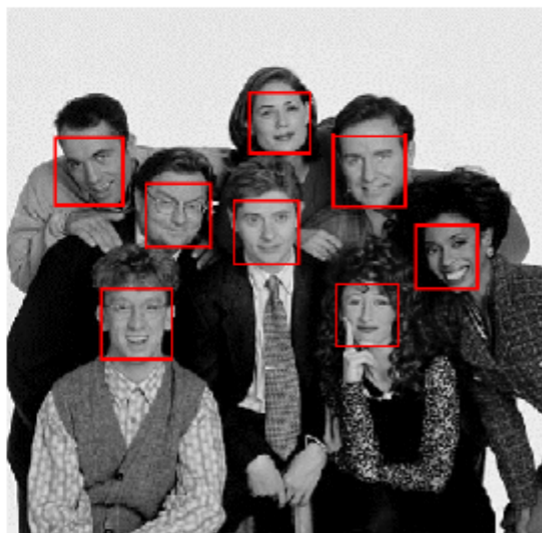- Implementation available in OpenCV: http://www.intel.com/technology/computing/opencv
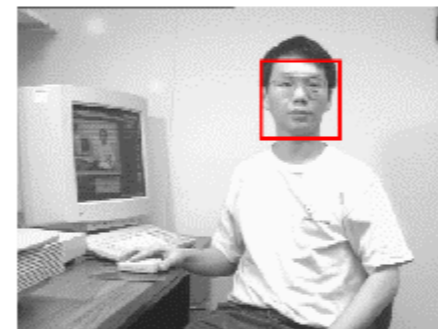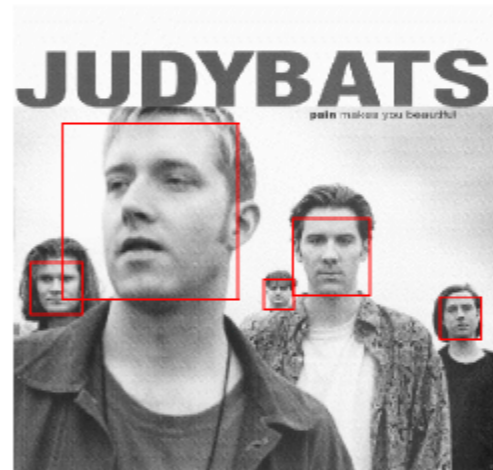
First two selected features for face detection
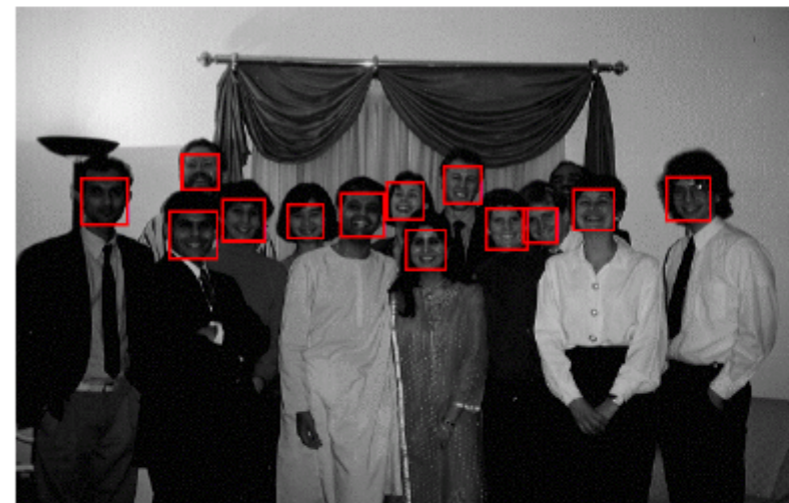
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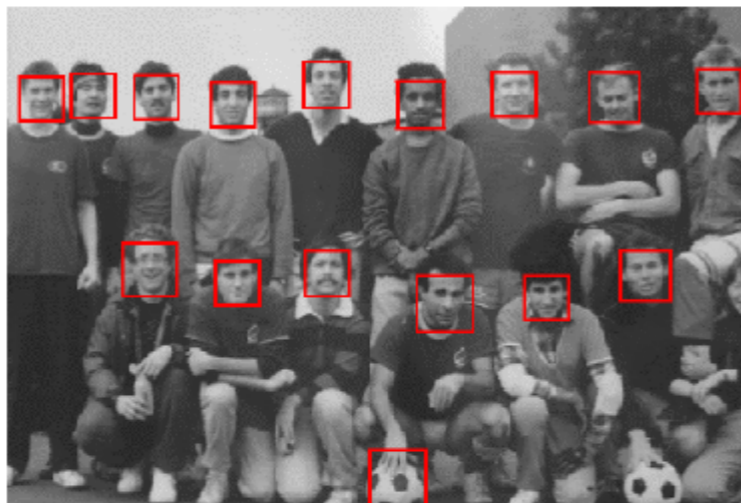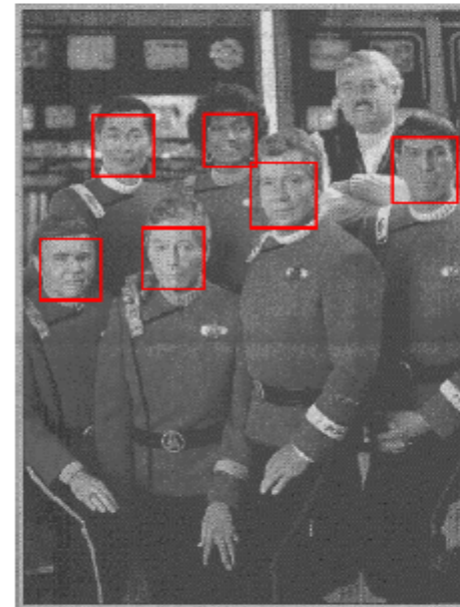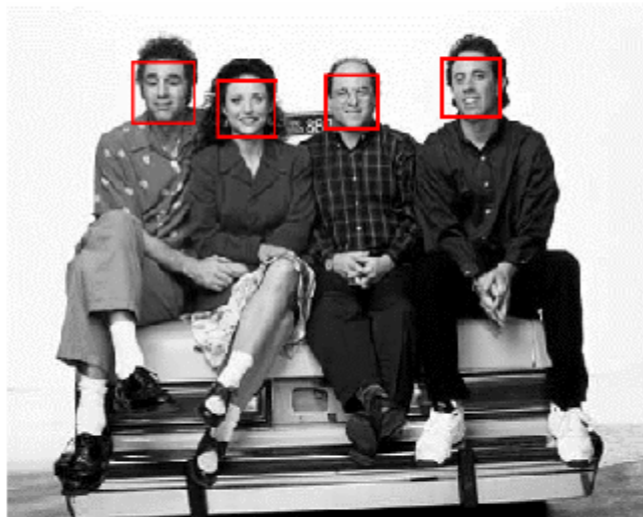- Implementation available in OpenCV: http://www.intel.com/technology/computing/opencv

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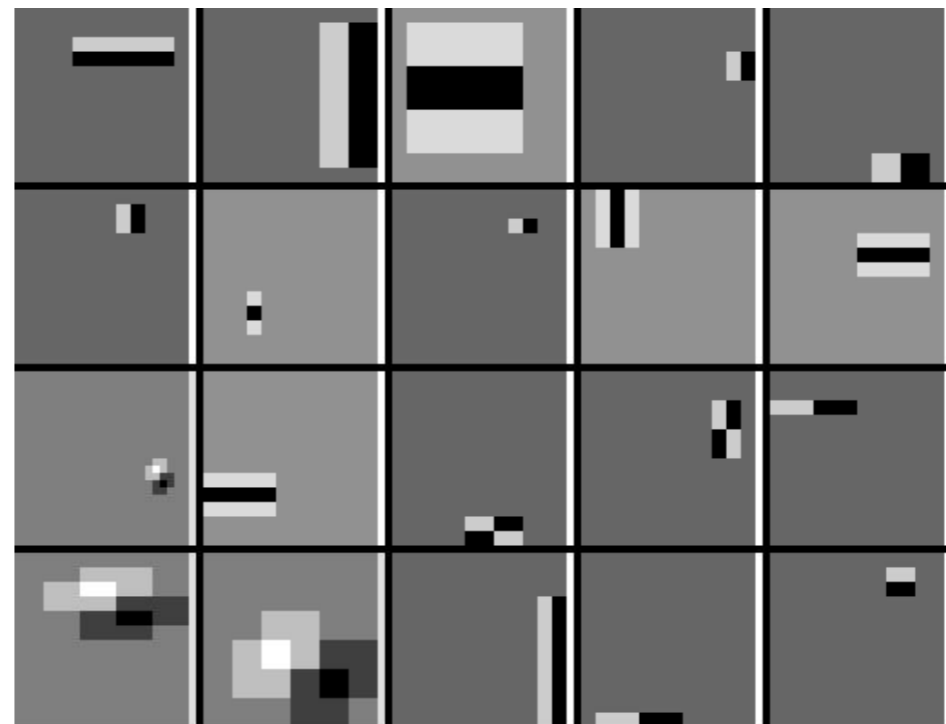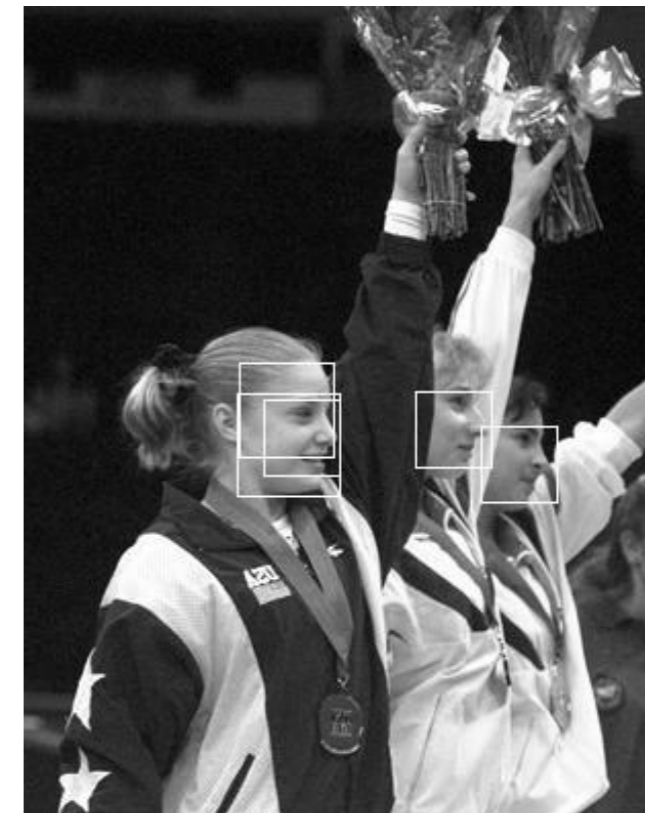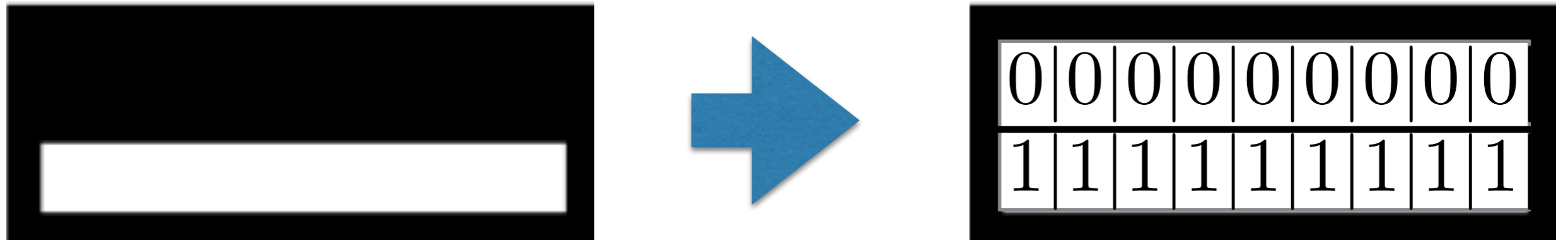Profile detector required completely different features

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Profile detector required completely different features

Haar feature as 2D convolution

Convolutional kernel corresponding to vertical gradient

Classical approach to object detection
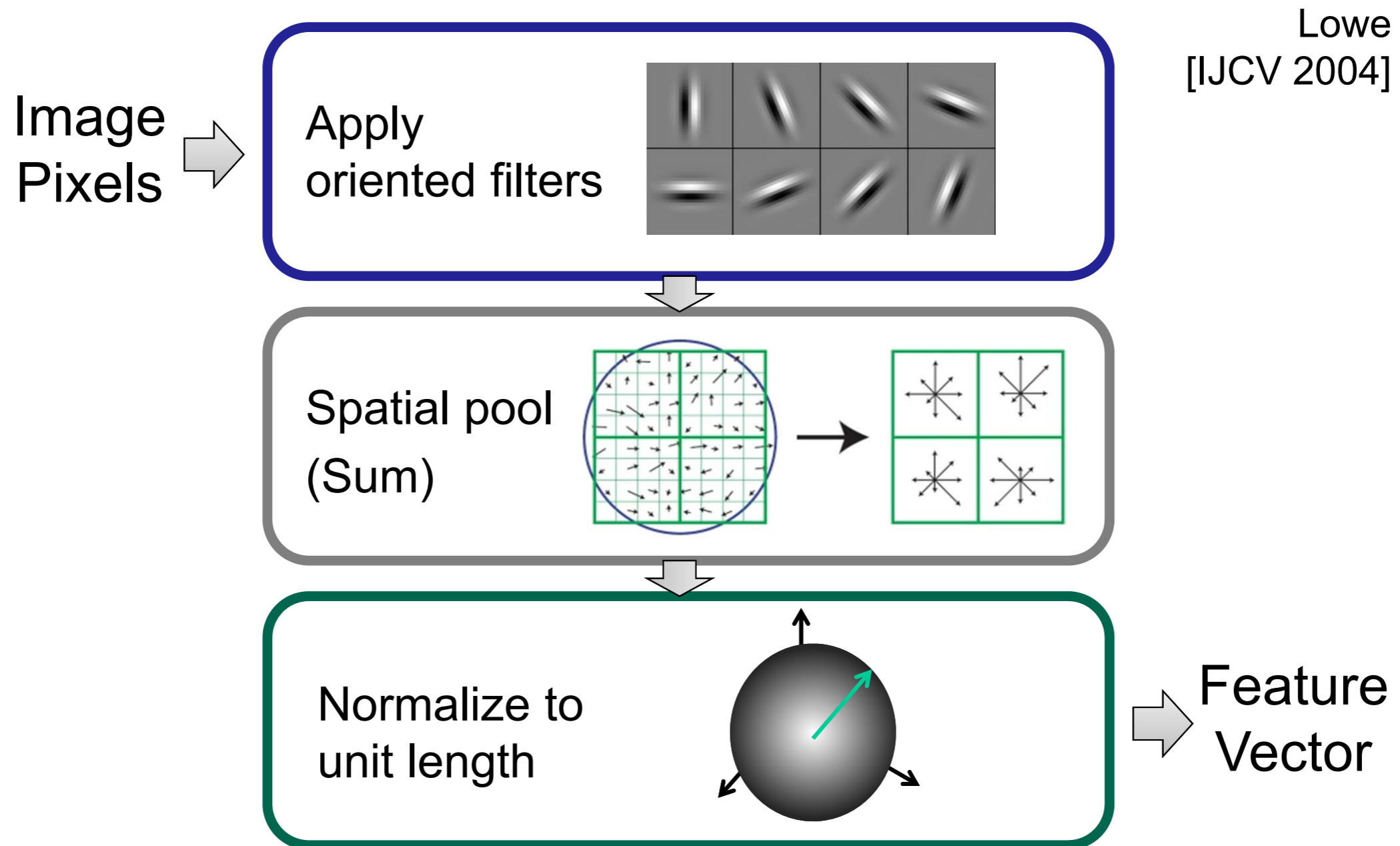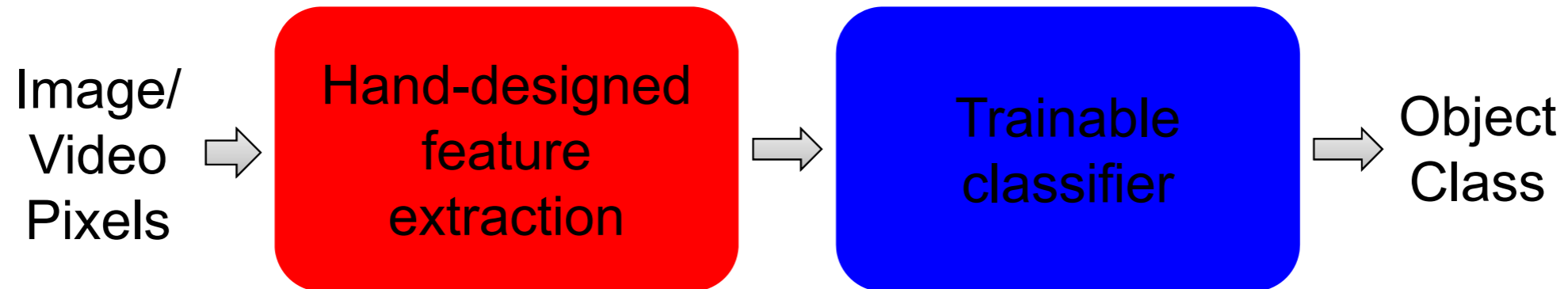

Convolutional kernel

Input

Feature Map

Classical approach to object detection

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

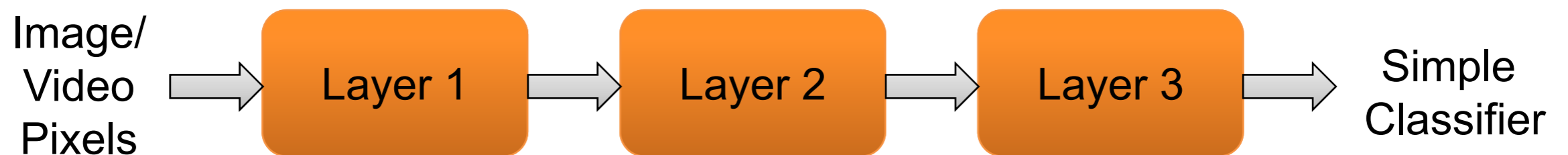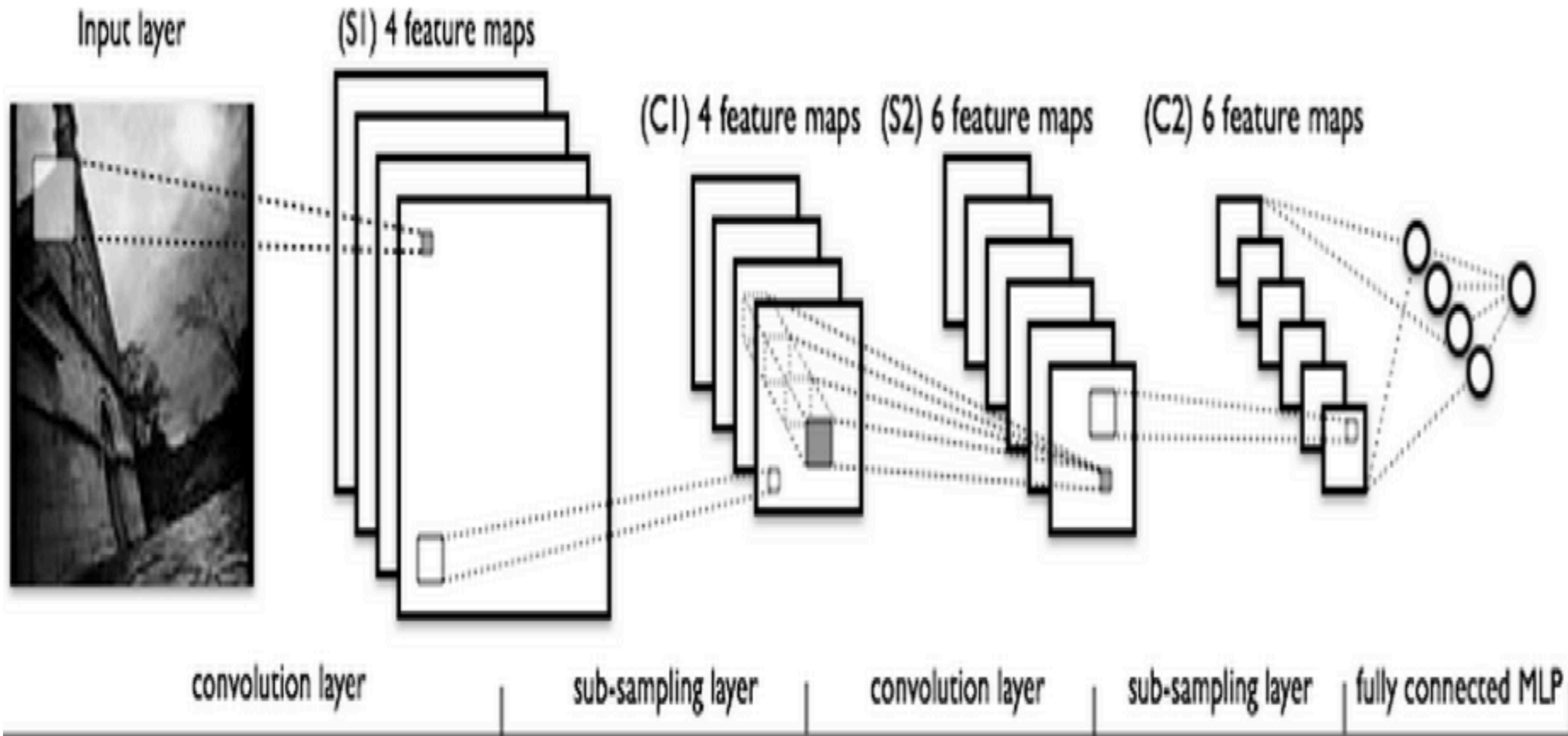# Classical approach to object detection

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

Input layer | (S1) 4 feature maps | (C1) 4 feature maps | (S2) 6 feature maps | (C2) 6 feature maps

convolution layer   sub-sampling layer   convolution layer   sub-sampling layer   fully connected MLP

Deep convolutional neural network

Convolution layer

Features maps

Input image

Max-pooling layer

Input for next layer

max   max

Features maps

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Imagenet

- 14M labeled images
- Human labels via Amazon Turk

[Deng et al. CVPR 2009]

A. Krizhevsky, I. Sutskever, and G. Hinton, ImageNet Classification with Deep Convolutional Neural Networks, NIPS 2012
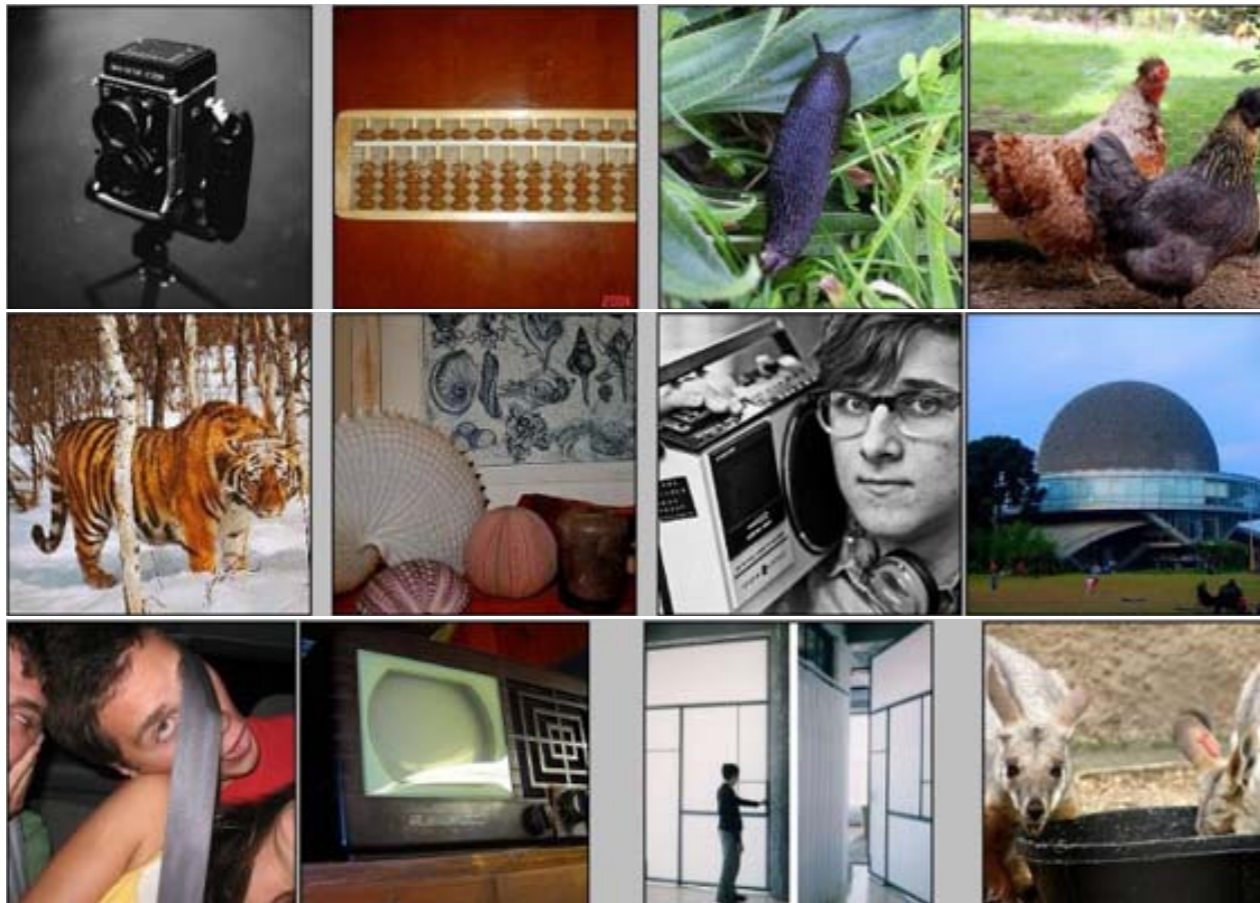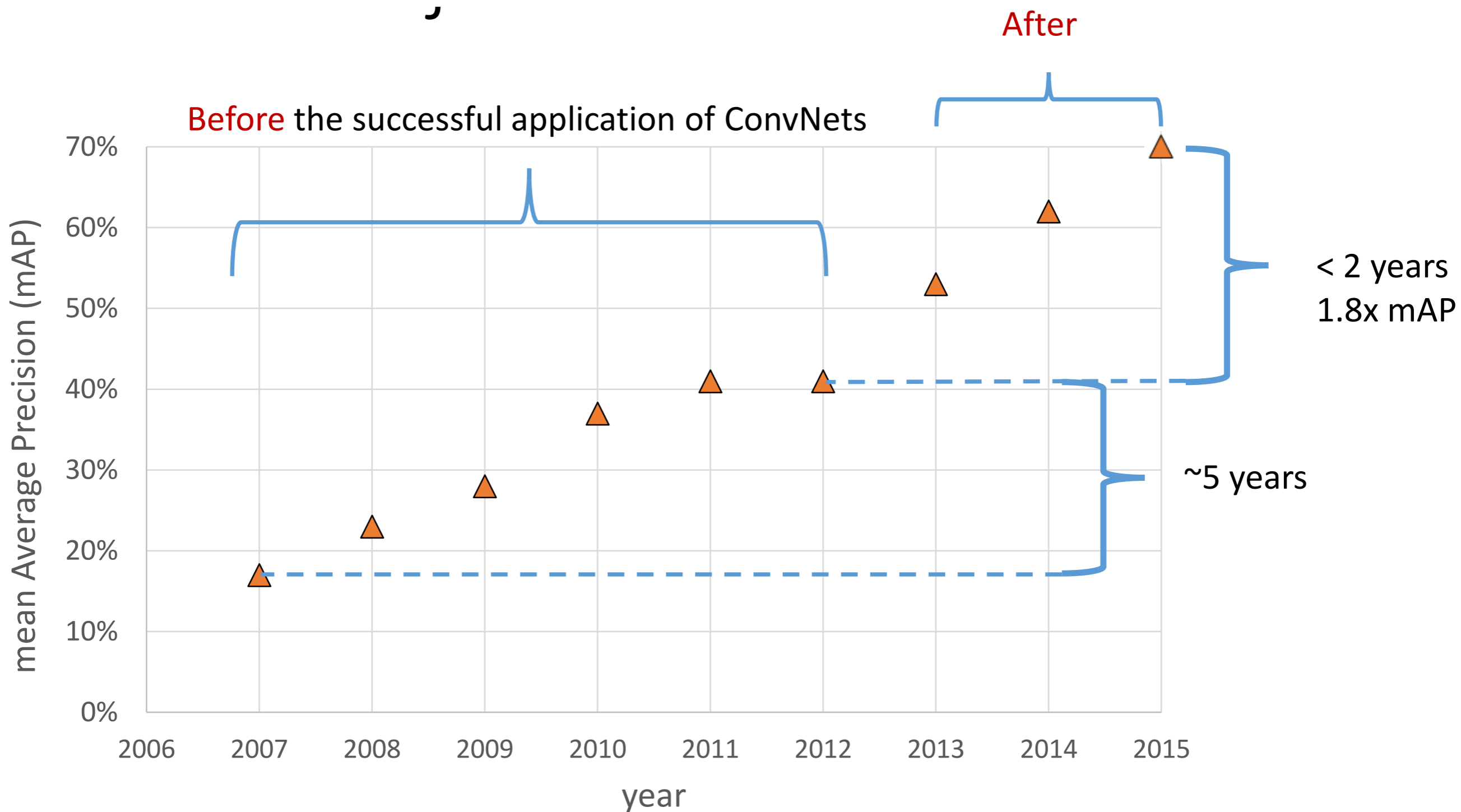
Searching for pulsars using image pattern recognition - Zhu, W.W. et al. Astrophys.J. 781 (2014) 2, 117 arXiv:1309.0776

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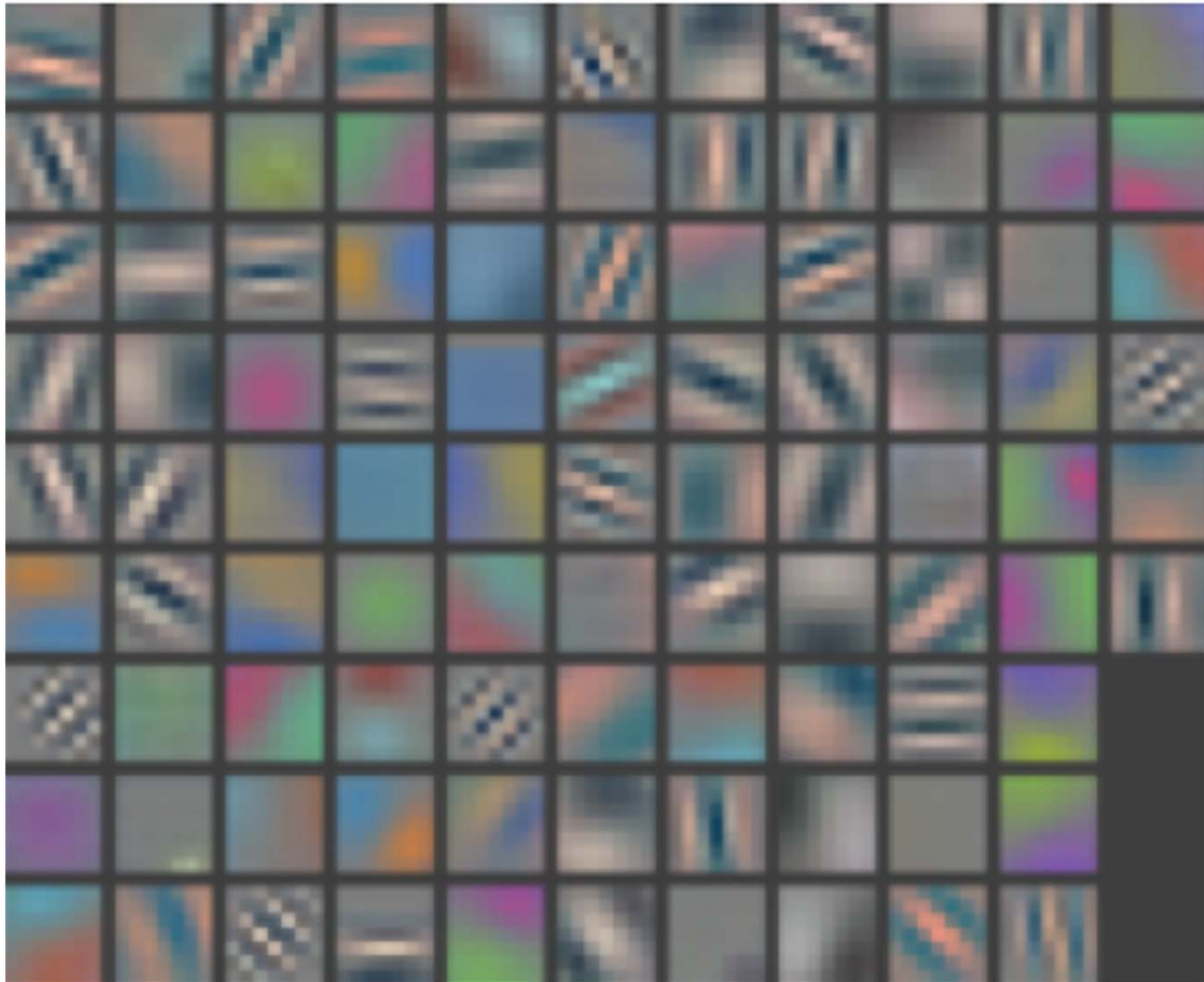Faculty of Electrical Engineering, Department of Cybernetics
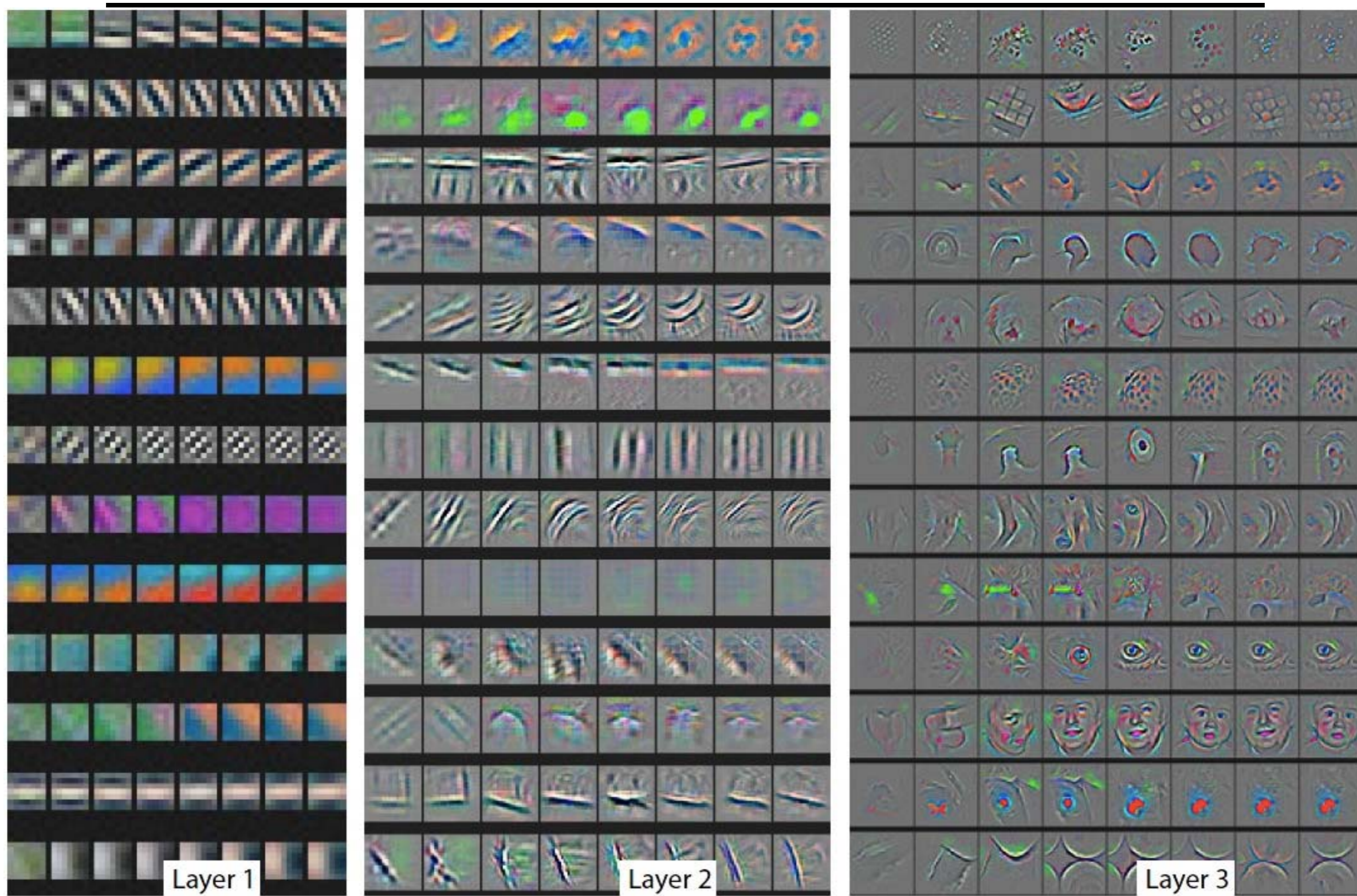
Pascal VOC object detection challenge

Layer 1 filters

Filters in different layers

Layer 1

Layer 2

Layer 3

Deep convolutional nets usefull 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:
    - https://pjreddie.com/darknet/yolo/
    - https://arxiv.org/abs/1512.03385