Department of Computer Science
University of Bristol

Image Processing and Computer Vision

www.ole.bris.ac.uk/bbcswebdav/courses/COMS30121_2018/content
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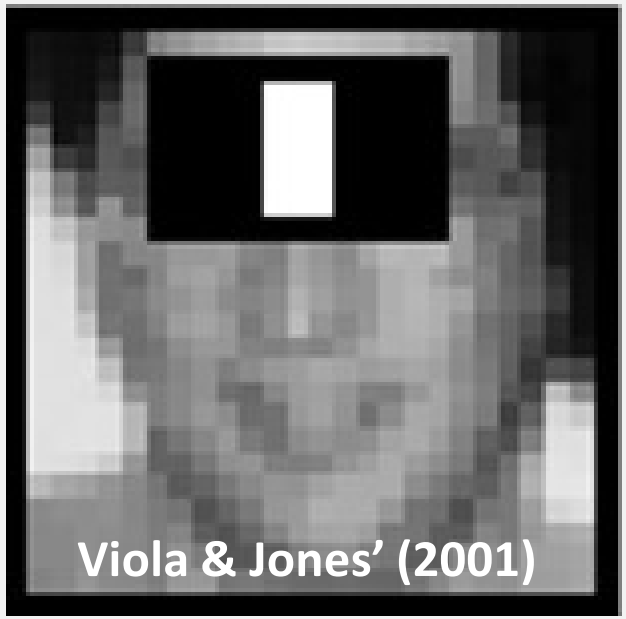

Lecture 06

Object Detection Basics I

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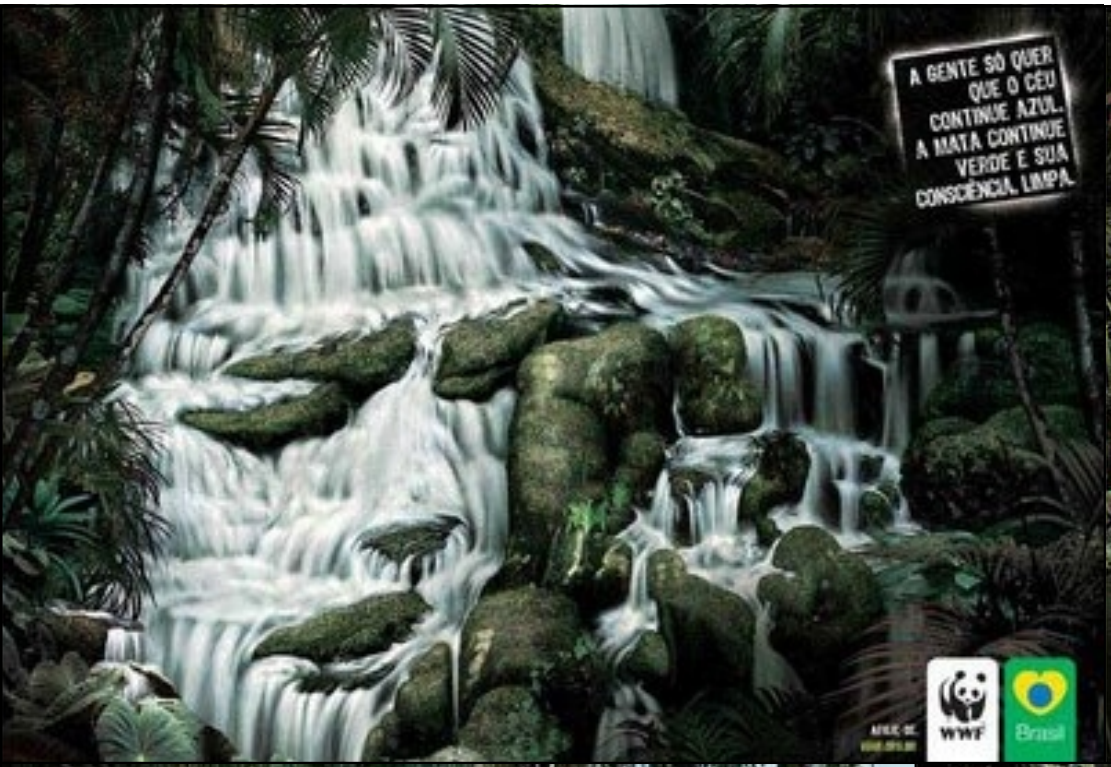
15 Slides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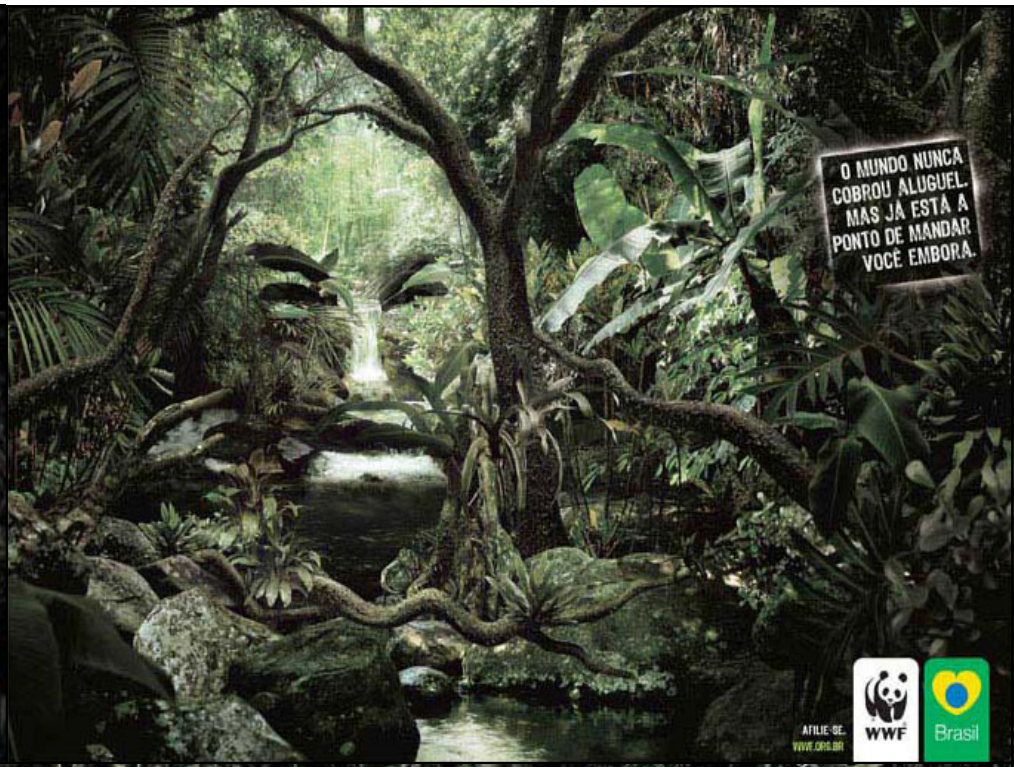
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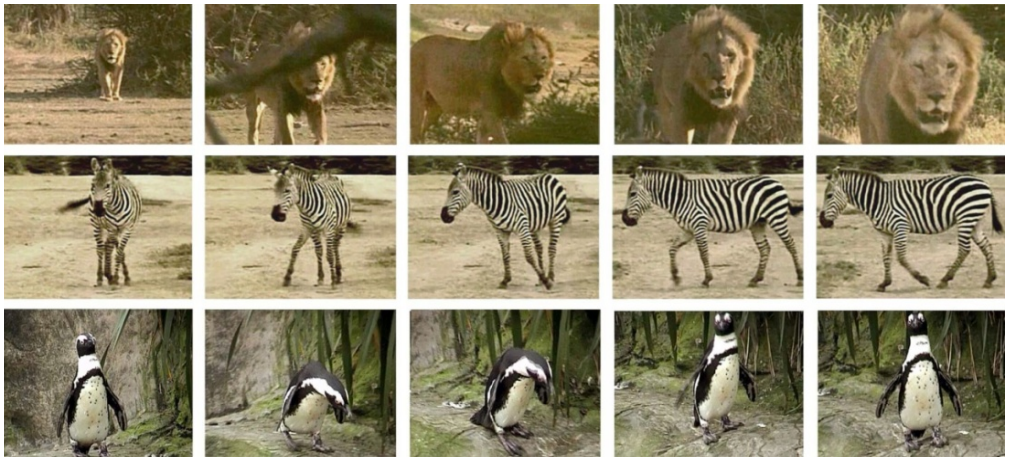
What is ‘Object Recognition’?

- Object Recognition aims at bridging the ‘semantic gap‘ between...
  - given pixel values, *and*
  - meaningful objects (grouping of pixels + classification of groups)

→ **image regions need to be found and assigned with semantic labels from a space of object classes**

- Why do shape detection and segmentation rarely work for real-world object detection?
  - high intra-class, low inter-class variance
  - classes are rarely well defined
  - change of illumination, scale, pose + deformation, occlusion...

Variable visual appearance



→ **object recognition is a difficult task**

First Real-time Detection Method: Viola & Jones' (2001)
(previous baseline standard for off-the-shelf method for several years)

Viola & Jones' Real-time Method (2001)

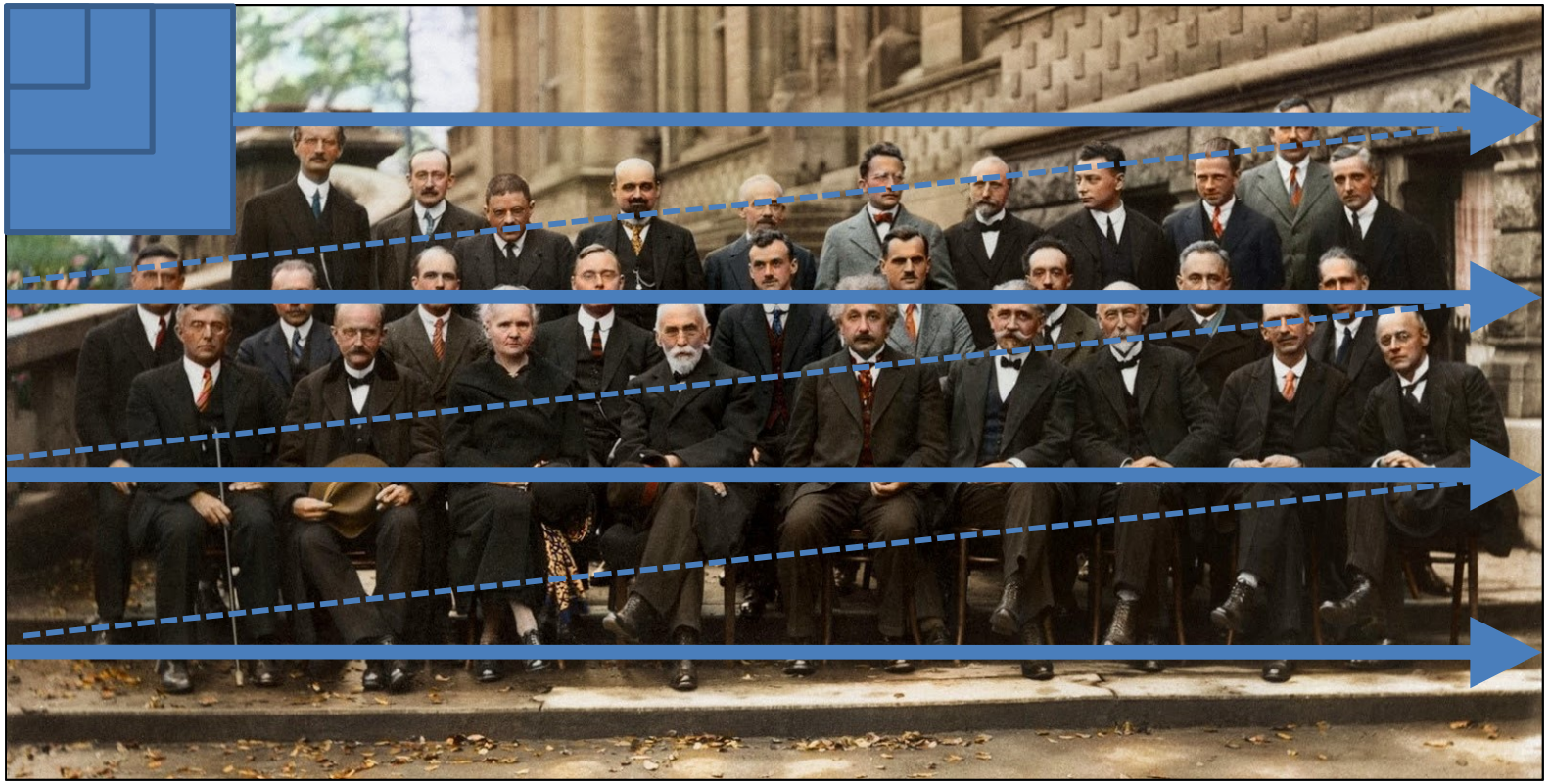
Our Agenda:

- Viola Jones technique overview
- Sliding Window Detectors
- Haar-like Features
- Feature Extraction and Integral Images
- Weak Classifiers
- Boosting and Classifier Evaluation
- Cascades of Boosted Classifiers

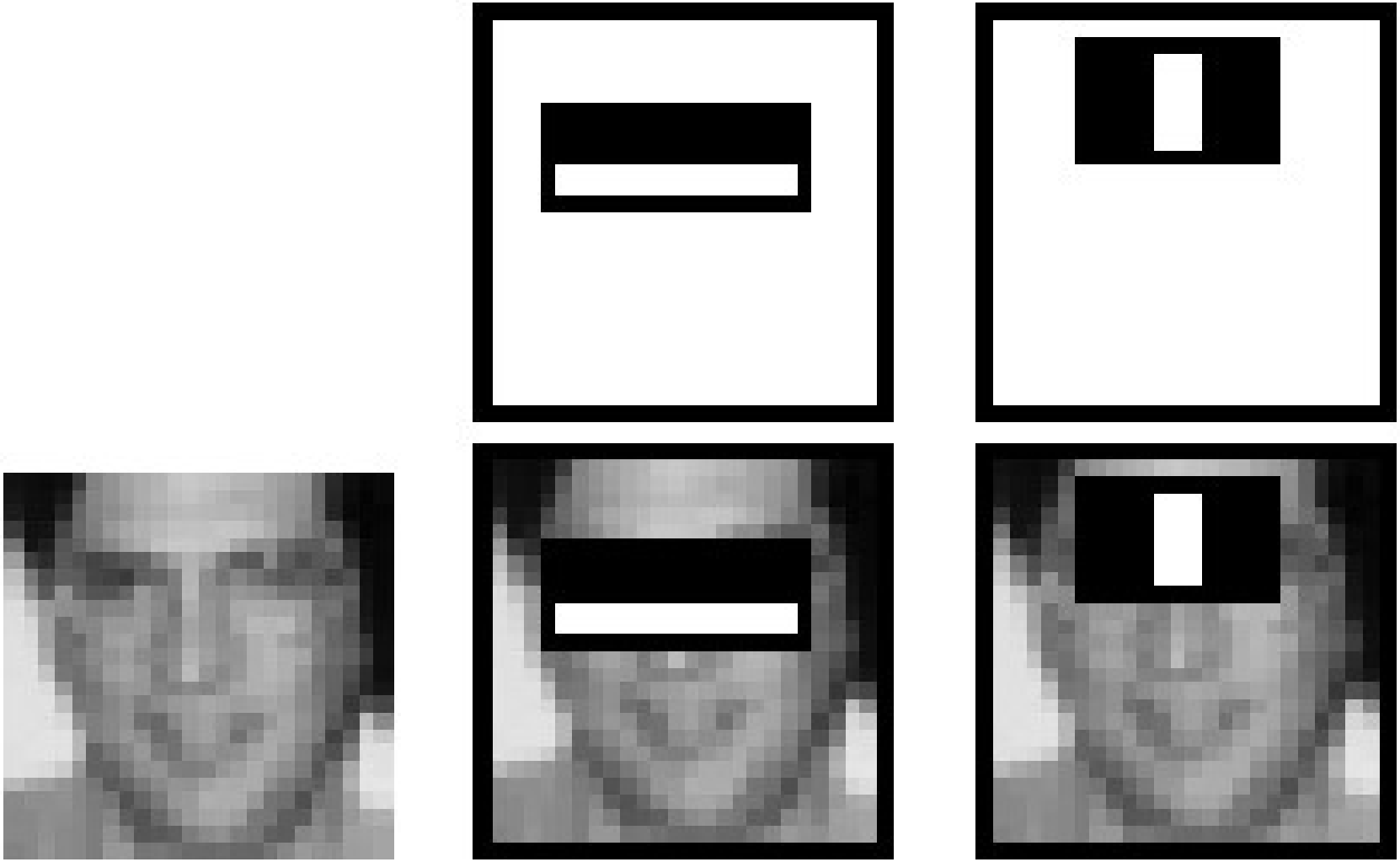
Best description of full details available in consolidated paper by Viola and Jones, International Journal of Computer Vision, 2004

Shift and Scale Invariance: Sliding Window Detectors

- image is tested for object presence window-by-window
- the window is `slided' and `scaled' throughout the image
- each resulting window is judged w.r.t. an object model giving a response indicating object presence or absence

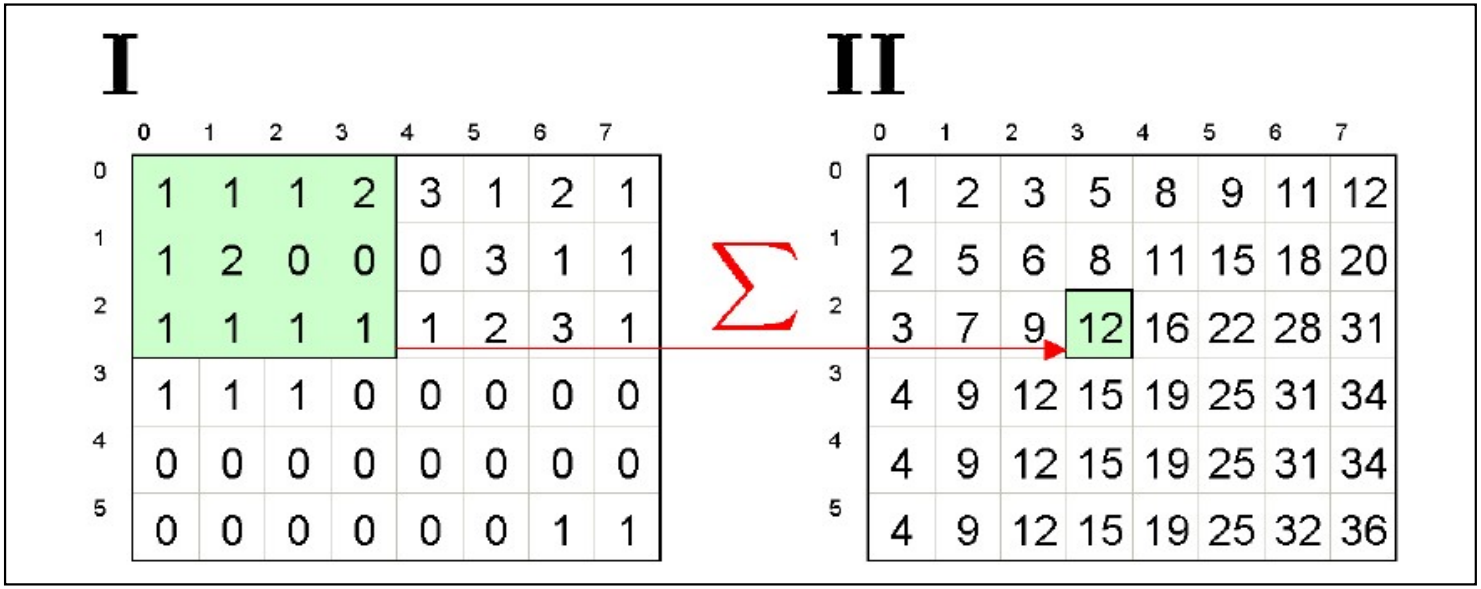


Basic Object Model Idea:
Characteristic Set of Block Features



Viola & Jones' (2001)

Integral Images

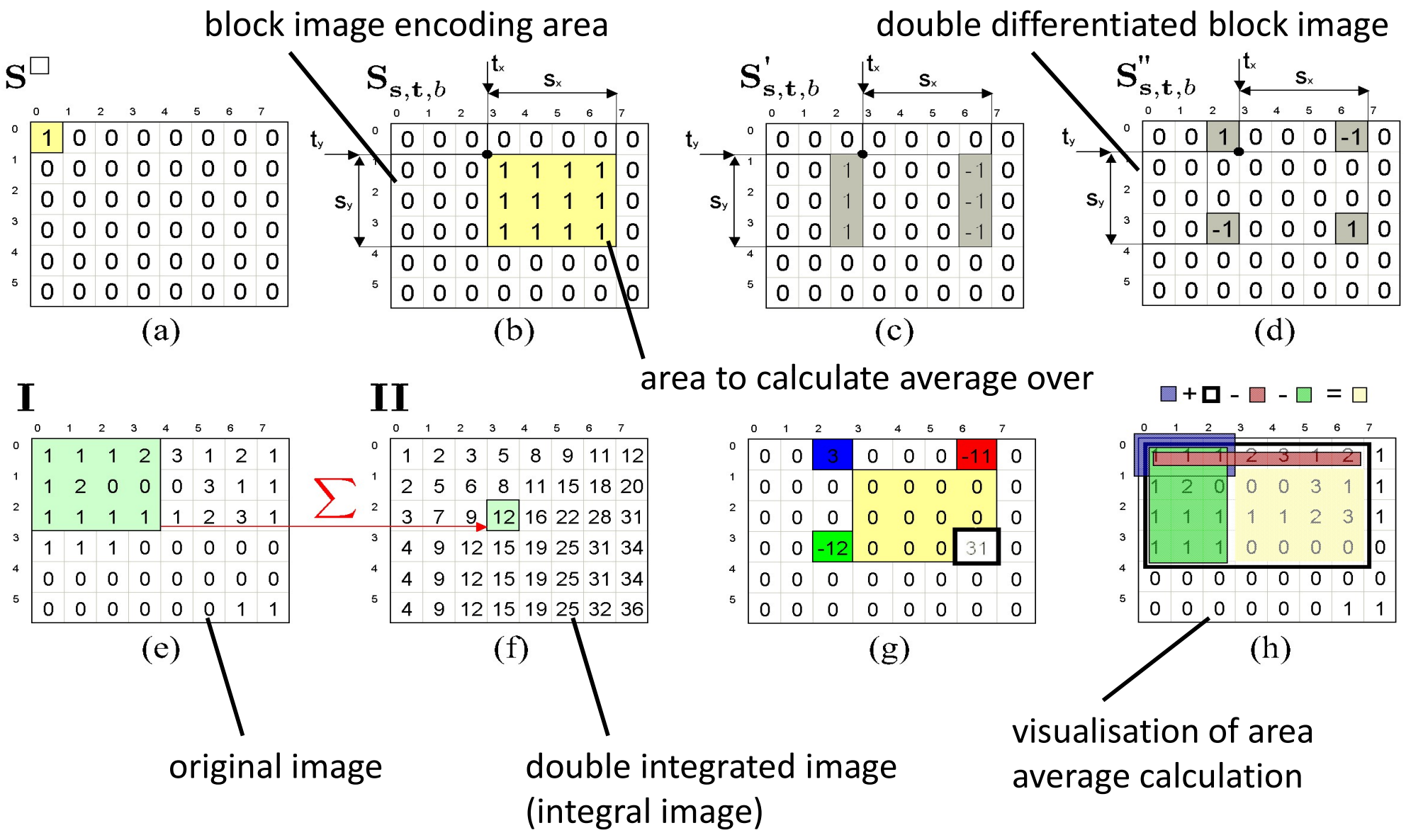


(IMAGE INTEGRATION)

$$\mathbf{II}(-1, y) = 0; \qquad \mathbf{II}(x, y) = \mathbf{II}(x-1, y) + A(x, y);$$

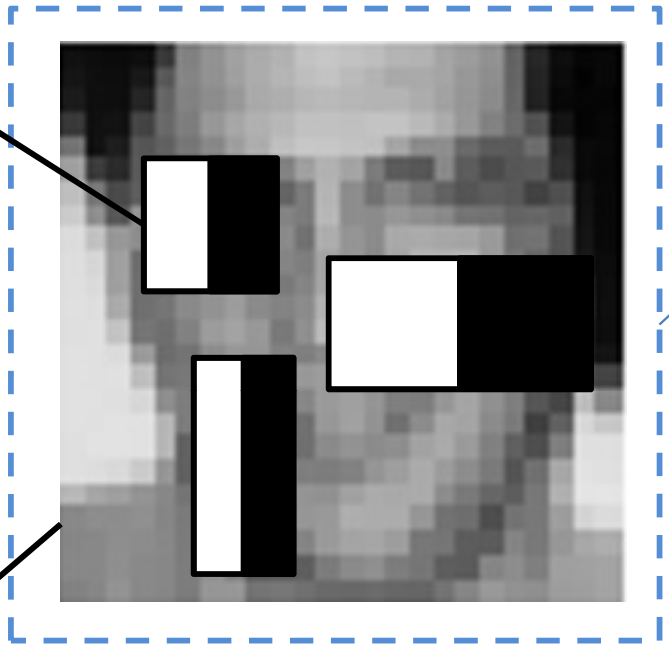
$$A(x, -1) = 0; \qquad A(x, y) = A(x, y-1) + \mathbf{I}(x, y).$$

Fast ‘BlockImage’ Calculation of Block Average



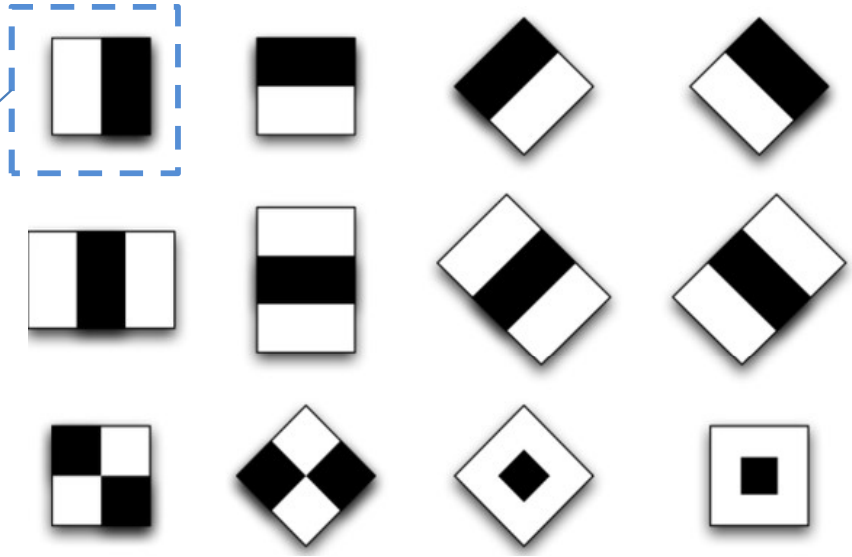
Haar-like Feature Response

instance response $h_j(x_i)$



sample image x_i

Examples of Instances of 1 Feature Type (scaled and positioned acrossa window)



Haar-like Feature Types

Adapted from Viola & Jones' (2001)

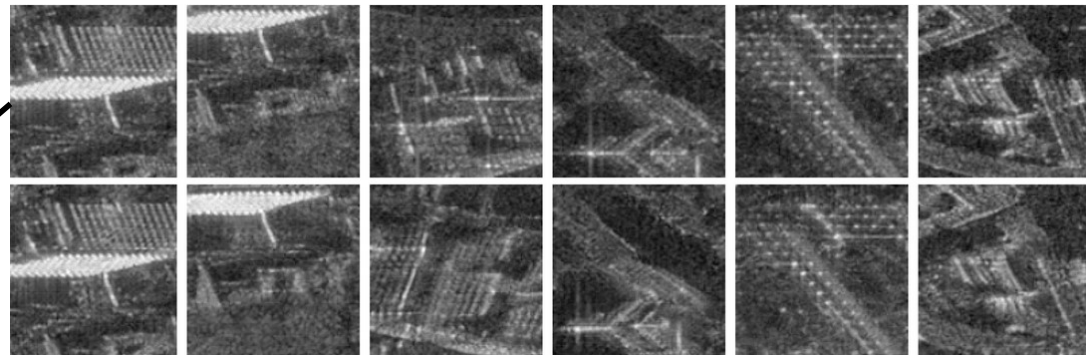
Annotated Training Data (representing single windows)

sample image x_i

Source: MIT CBCL

Positive Samples (e.g. FACE) … $(x_i, y_i = 1),\ w_i = 1$

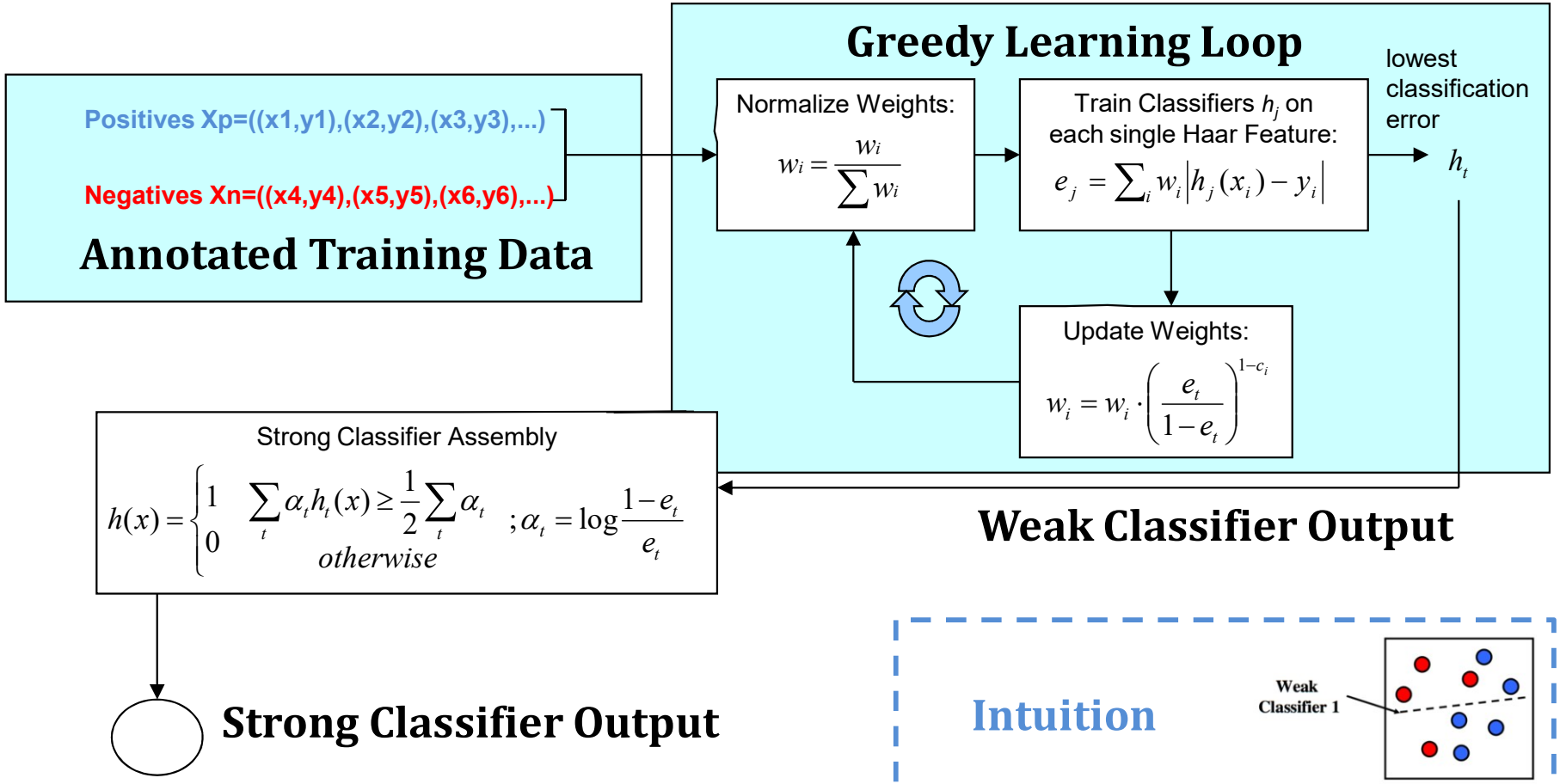
sample image x_i



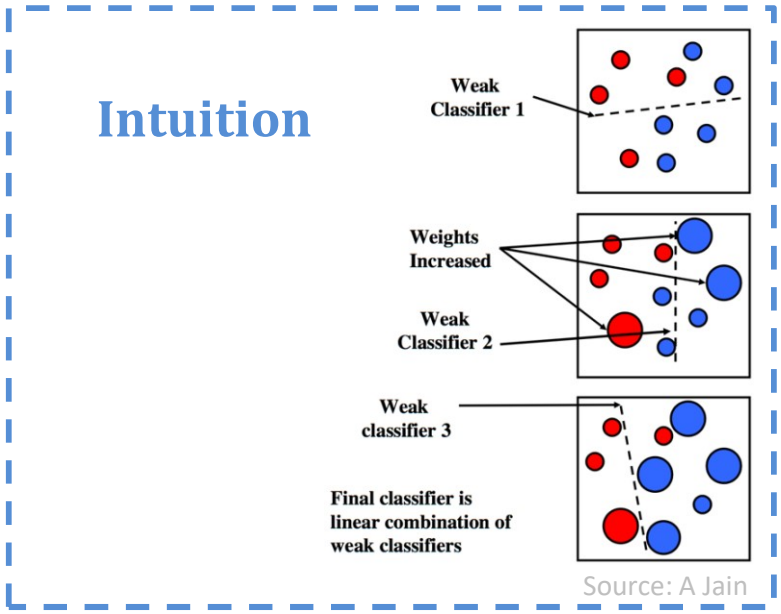
Source: MDPI

Negative Samples (e.g. NO-FACE) … $(x_i, y_i = 0)\ ,\ w_i = 1$

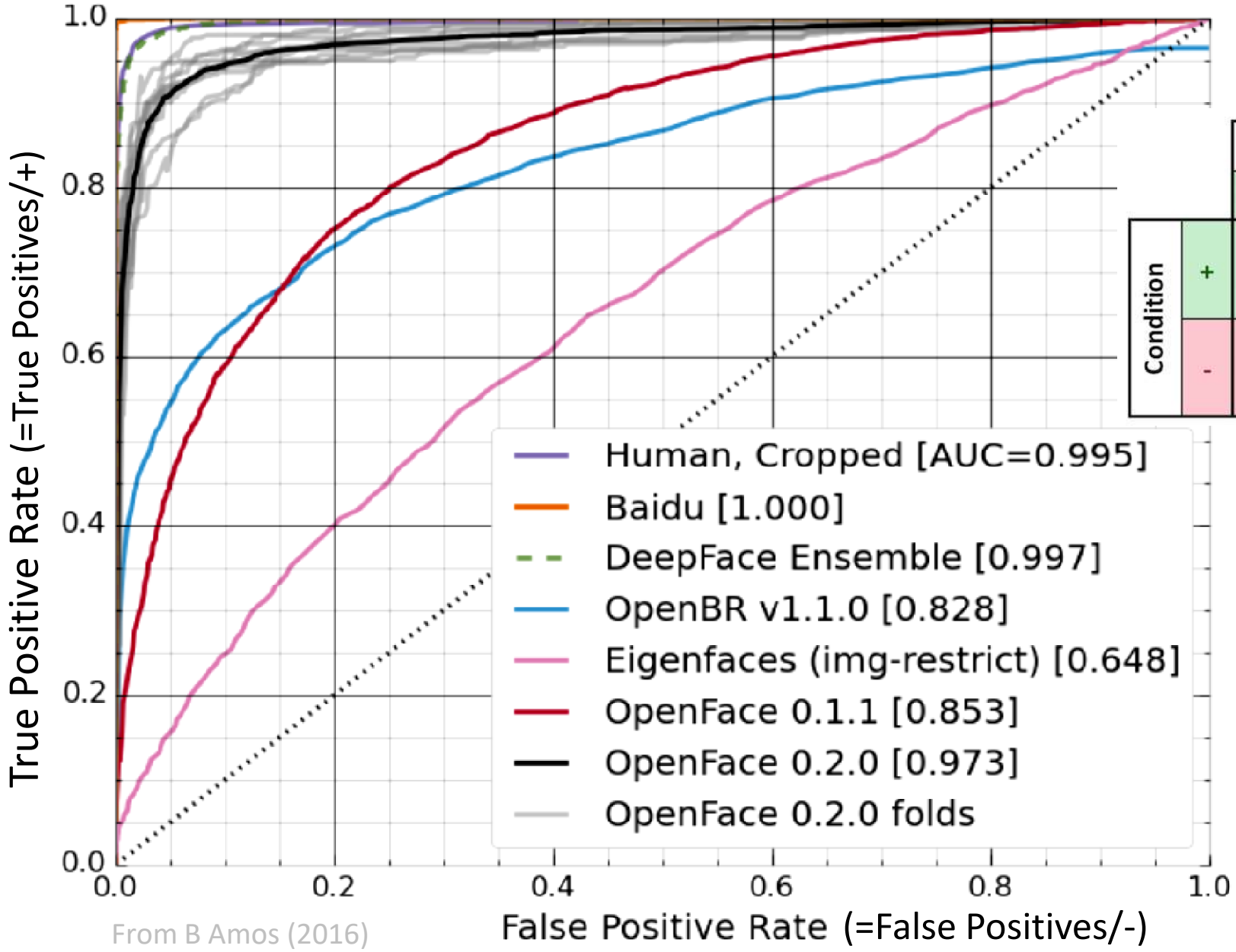
Supervised Object-class Learning: AdaBoost



(also see paper by Viola and Jones 2004)



ROC Curves for Performance Analysis



From B Amos (2016)

		Classification	
		Positive	Negative
Condition	+	True Positive	False Negative
	-	False Positive	True Negative

From R Wingate (2016)

On Window Resolution