Technical Communication Presentation

A Review of Two Face Detectors

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Image Source: Google

Introduction

- Viola-Jones Rapid Face Detection
- Hu-Ramanan Finding Tiny Faces
  - *Discuss methods*
  - *Analyse results*

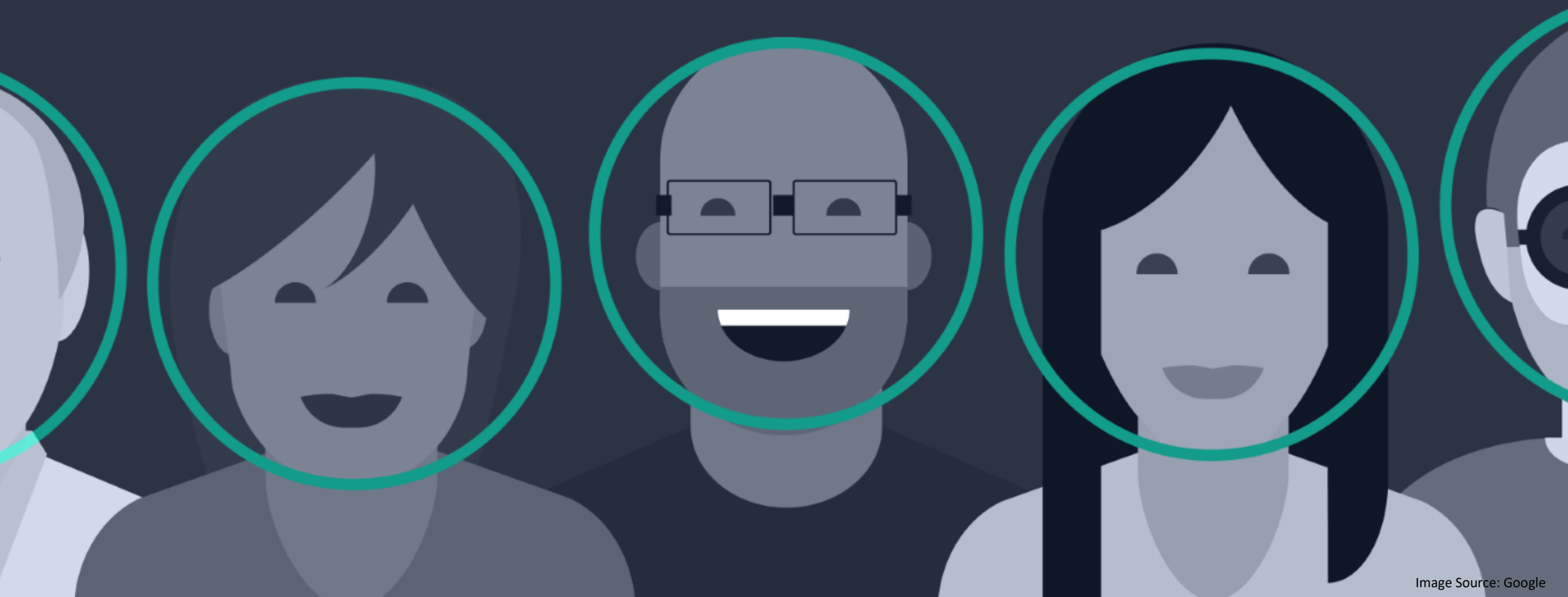


Image Source: Google

RAPID OBJECT DETECTION USING A BOOSTED CASCADE OF SIMPLE FEATURES

Paul Viola and Michael Jones

CVPR 2001

Introduction

- One of the 1st object detection frameworks
- Competitive object detection rates in real time
- Detects faces rapidly
- Requires full frontal upright faces

Image Source: Viola-Jones Original Paper

Viola-Jones Algorithm

1. Haar Feature Selection
2. Creating Integral Image
3. AdaBoost Training
4. Cascading Classifiers

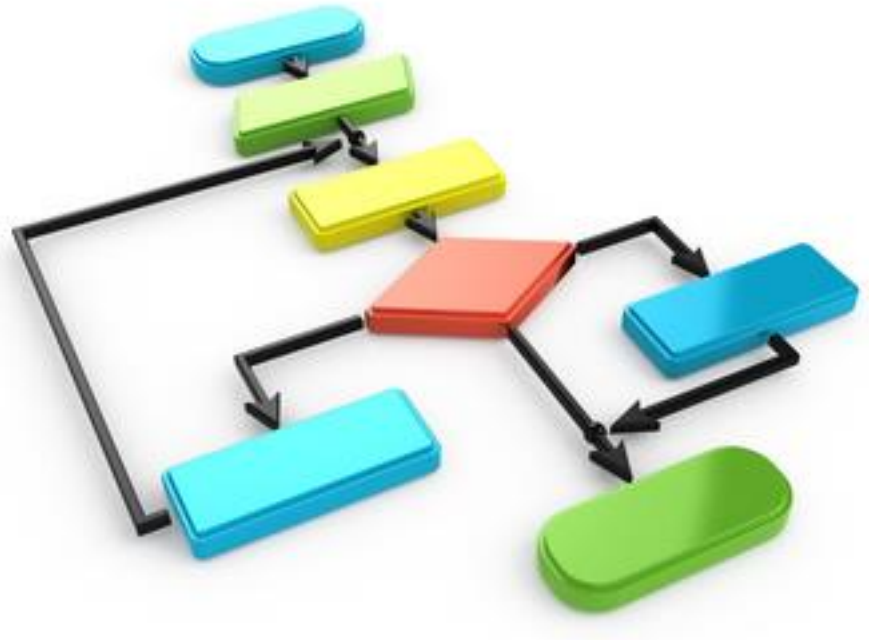


Image Source: https://www.bobology.com/public/What-is-an-Algorithm.cfm

Haar Features

- All human faces share some similar properties. These regularities may be matched using Haar Features.
- 4 types of Haar Features:

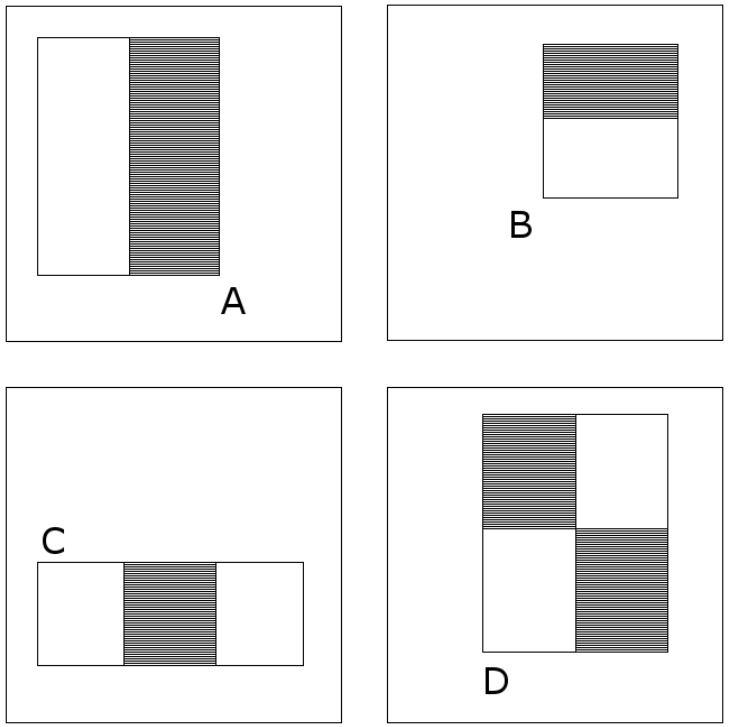
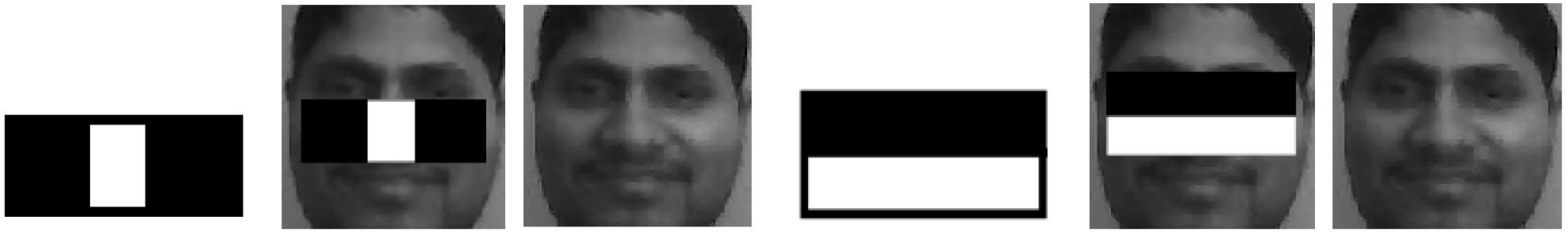


Image Source: https://en.wikipedia.org/wiki/Viola%E2%80%93Jones_object_detection_framework

$$\text{Value} = \sum(\text{pixels in black area}) - \sum(\text{pixels in white area})$$

Haar Features *Conti…*

- Viola-Jones used Haar features with 2 or 3 rectangles.
- Viola-Jones algorithm uses 24x24 window as the base size window.
- Place the features at every position with every shape possible.
  - Exhaustive set of 160,000+ features
  - Very expensive to calculate



Detecting Nose using Type C Haar feature.

Detecting Eyes using Type B Haar feature.

Images Source: https://en.wikipedia.org/wiki/Viola%E2%80%93Jones_object_detection_framework

Integral Image

- A new image representation that allows fast feature evaluation.
- Constant time computation
  - Only a few operations per pixel.
- Value at location (x, y) equals the sum of the pixels above and to the left of (x, y) inclusive.

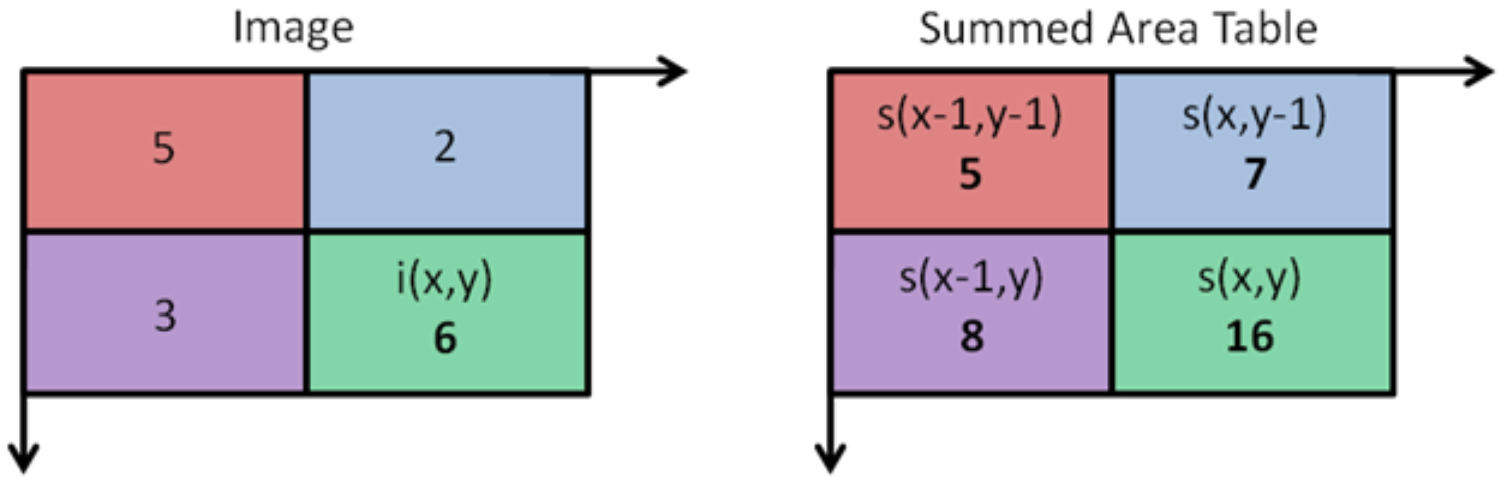


Image Source: https://computersciencesource.wordpress.com/2010/09/03/computer-vision-the-integral-image/

Learning Algorithm: AdaBoost

- Machine Learning Algorithm that selects only best features from 160,000+ features.
- Builds a strong classifier using a weighted combination of weak classifiers (the best features).

$$F(x) = \alpha_1 f_1(x) + \alpha_2 f_2(x) + \cdots$$

where $f_i \in \{0,1\}\ \forall i$ and α_is are the weights.

- If face is detected, $F = 1$, otherwise, 0.

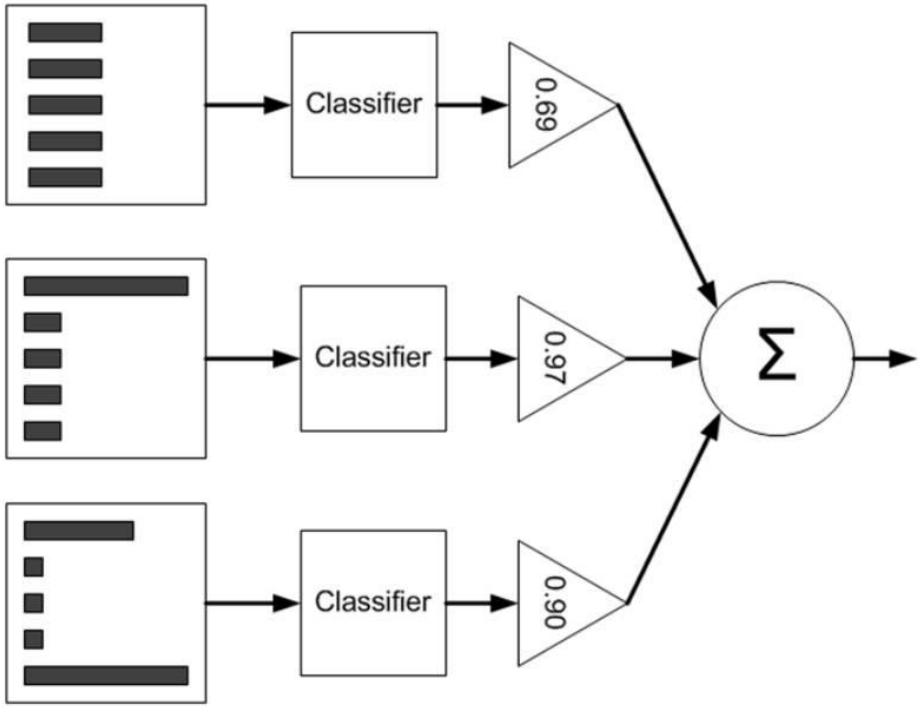


Image Source: http://vivekmishra1991.github.io/blog/2015/09/28/adaboost-why-it-is-robust-to-overfitting/

Cascade Classifiers

- A single strong linear classifier not efficient
  - Computation Time
  - Lots of false negatives
- Replace it by cascade classifiers
  - Multiple stages each having a strong classifier
  - Stages are of increasing complexity
- Boosts up speed
  - Boosted Cascade Classifier

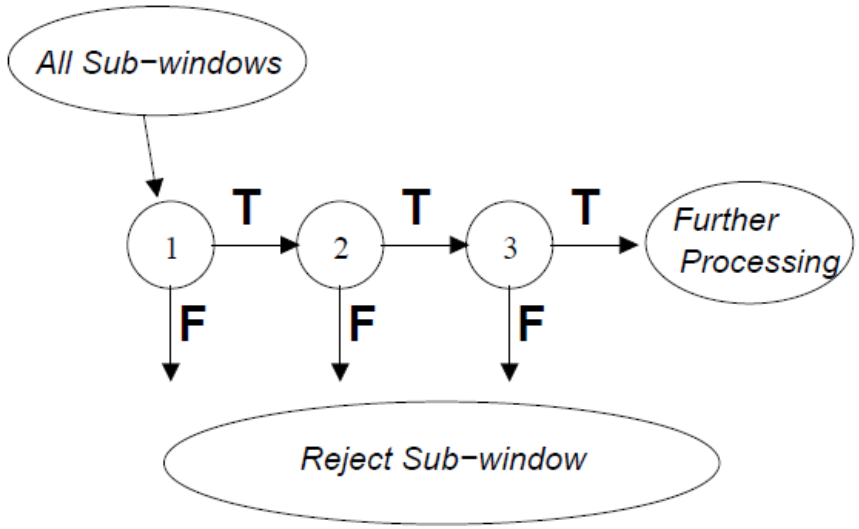
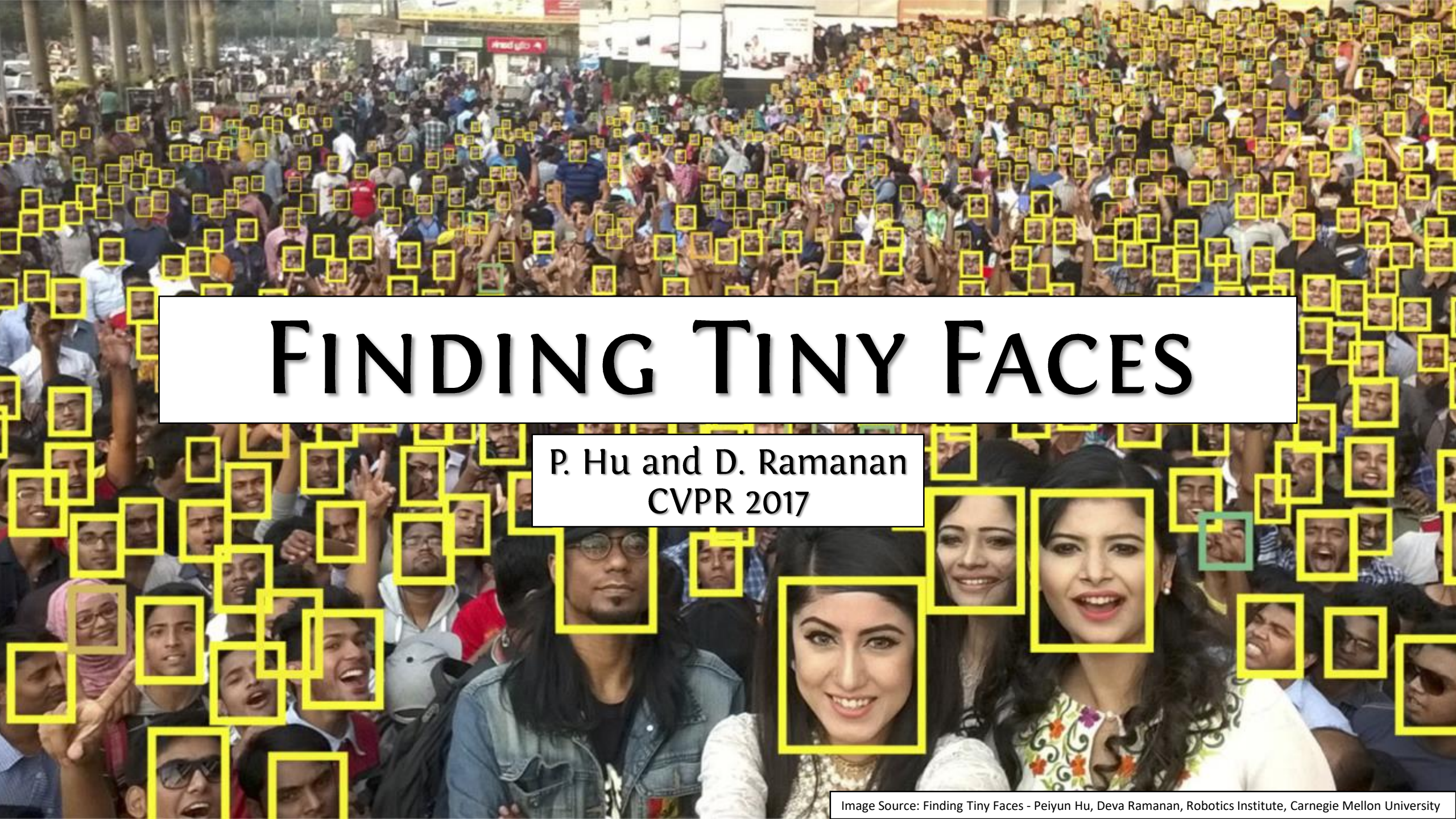


Image Source: Viola-Jones Original Paper



Finding Tiny Faces

P. Hu and D. Ramanan
CVPR 2017

Image Source: Finding Tiny Faces - Peiyun Hu, Deva Ramanan, Robotics Institute, Carnegie Mellon University

Convolutional Neural Networks – an Overview

- Effective in areas such as image recognition and classification.
- Use convolutional layers for learning features.

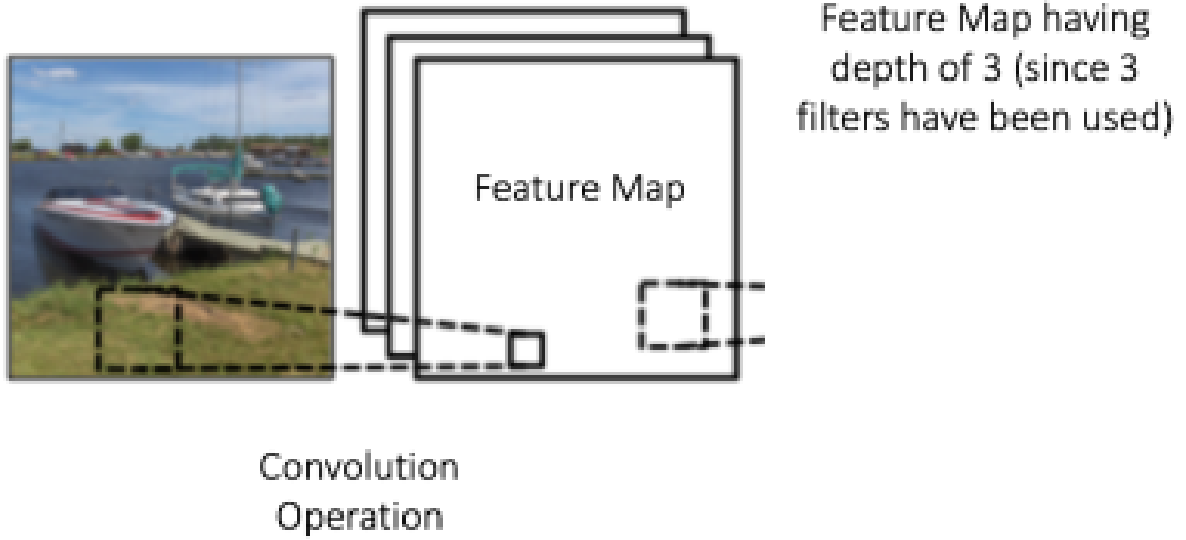


Image Source: https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/

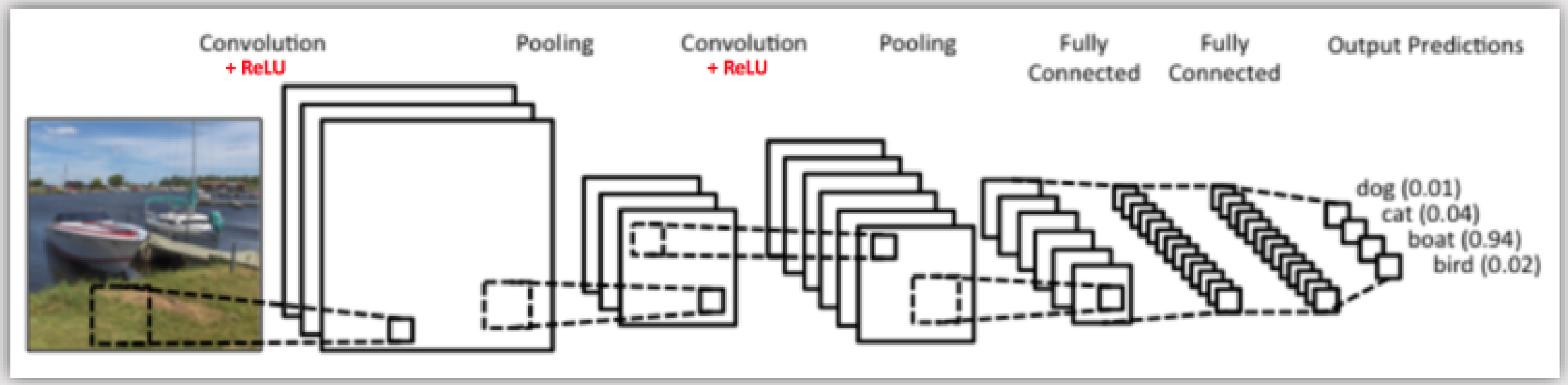


Image Source: https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/

Context – Does it help?

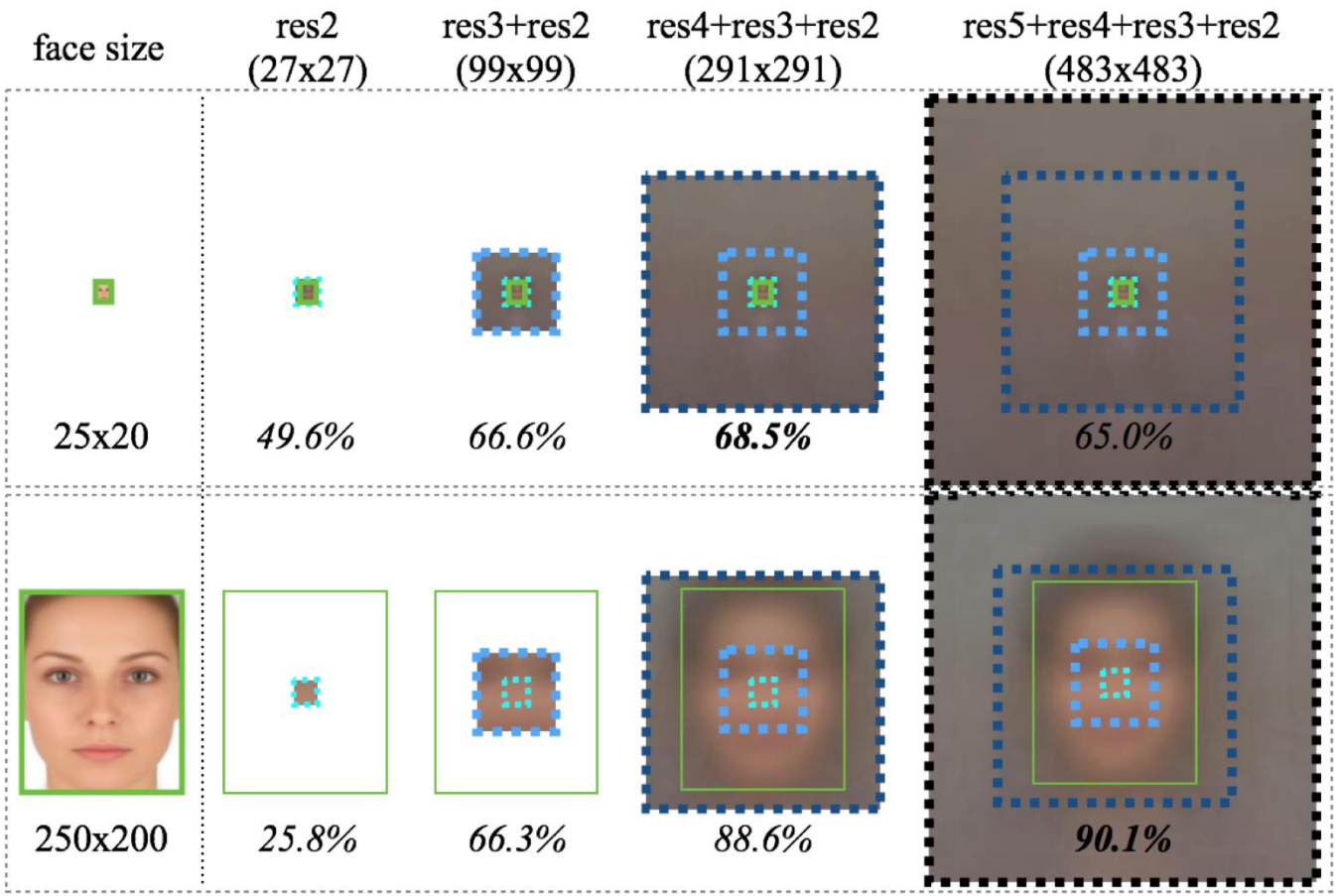


Image Source: Finding Tiny Faces - Peiyun Hu, Deva Ramanan, Robotics Institute, Carnegie Mellon University

Considering a small region around the face increases accuracy by 18.9% for small faces and 1.5% for large faces.

The Role of Resolution

Enlarging a small face and shrinking a large face on a medium template can improve accuracy!

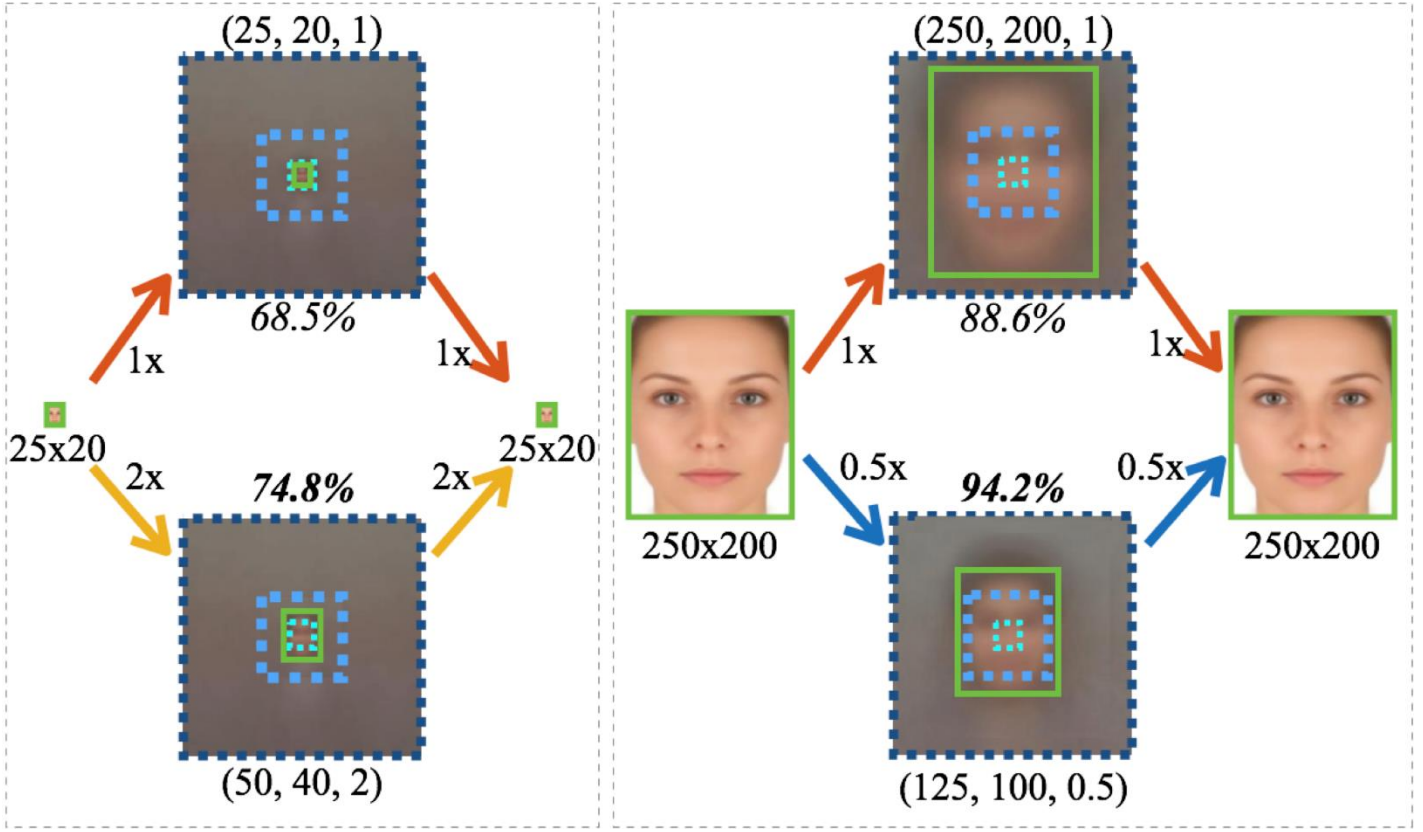


Image Source: Finding Tiny Faces - Peiyun Hu, Deva Ramanan, Robotics Institute, Carnegie Mellon University

The Model

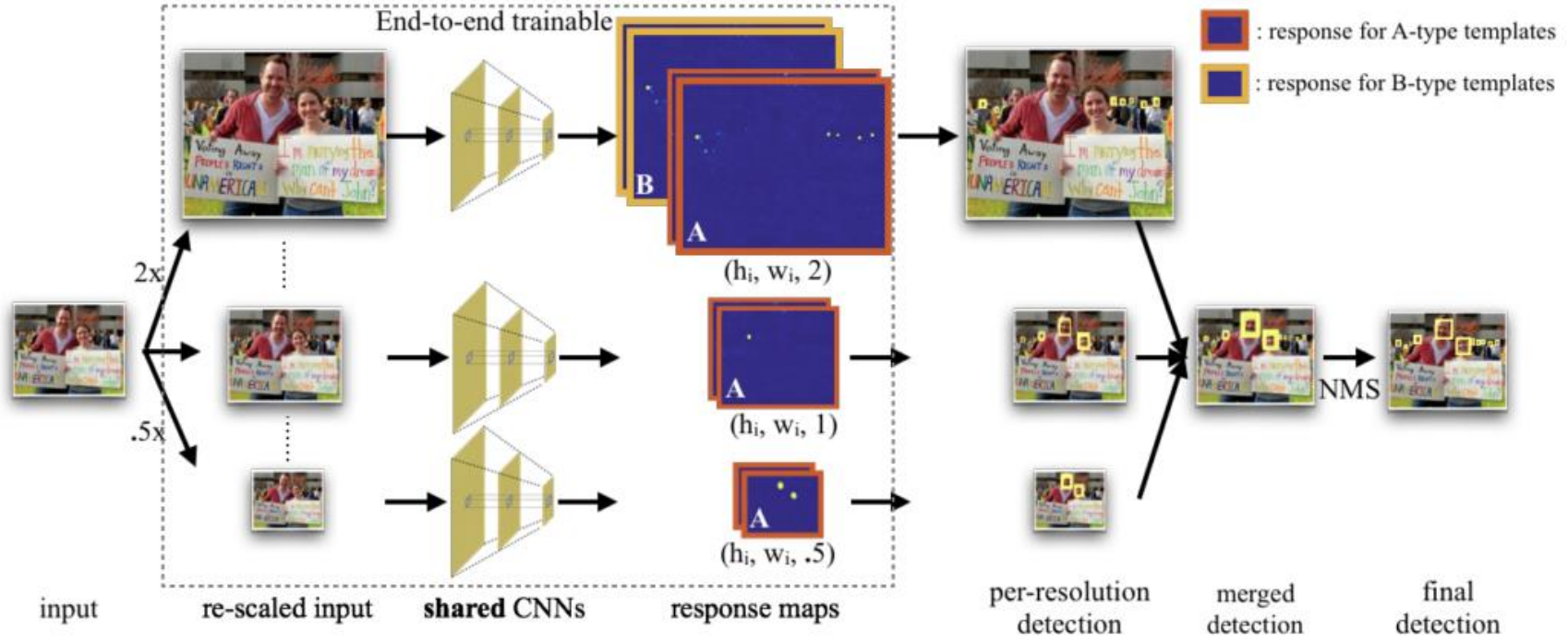


Image Source: Finding Tiny Faces - Peiyun Hu, Deva Ramanan, Robotics Institute, Carnegie Mellon University

- Multi-task learning
- 3 Convolutional neural networks
- ResNet101

Results

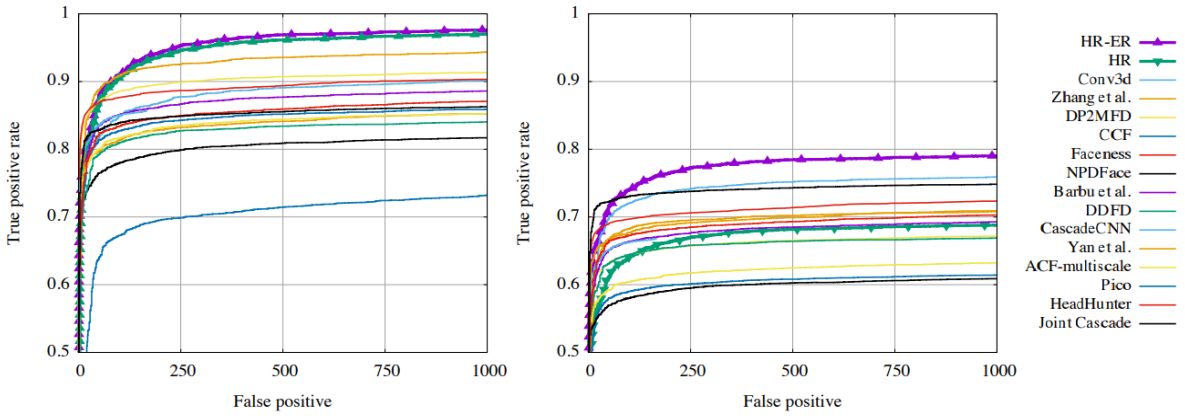


Image Source: Finding Tiny Faces - Peiyun Hu, Deva Ramanan, Robotics Institute, CMU

Tiny Faces detector results on FDDB

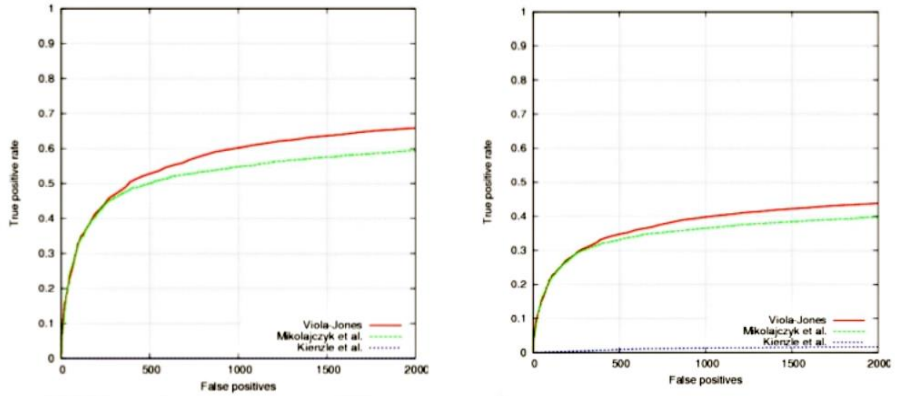


Image Source: www.slideshare.net/GeeksLab/datascience-lab-2017-76649083

Viola-Jones detector results on FDDB

Results *Conti…*

- Tiny faces detector provides much better accuracy in detecting faces than does the Viola-Jones detector.
- Tiny faces is also faster and can be used in real-life scenarios.

REFERENCES

- P. Viola and M. Jones, Rapid object detection using a boosted cascade of simple features, 2001
  - http://wearables.cc.gatech.edu/paper_of_week/viola01rapid.pdf
- P. Hu and D. Ramanan, Finding tiny faces, CoRR, 2017
  - https://arxiv.org/pdf/1612.04402.pdf

Any Questions ?

thank you!

Image Source: Google