

Face Detection

April 7, 2015

赵海伟 戴嘉伦 王如晨

CVBIOUC

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Agenda

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State-of-the-art

Haar-Classifier

Haar

Adaboost

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Face Recognition System



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Face Recognition System:

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Face Recognition



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The **goal** of face detection is to determine **whether** or not there are any faces in the image and, if present, return the image **location and extent** of each face¹.



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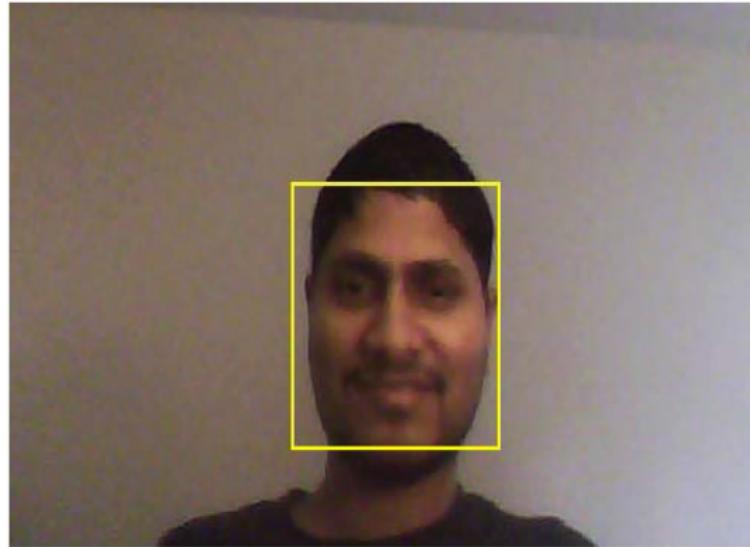
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► Verification²



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²Subrat Kumar Rath *et al.*, "A Survey on Face Detection and Recognition Techniques in Different Application Domain", MECS, 2014



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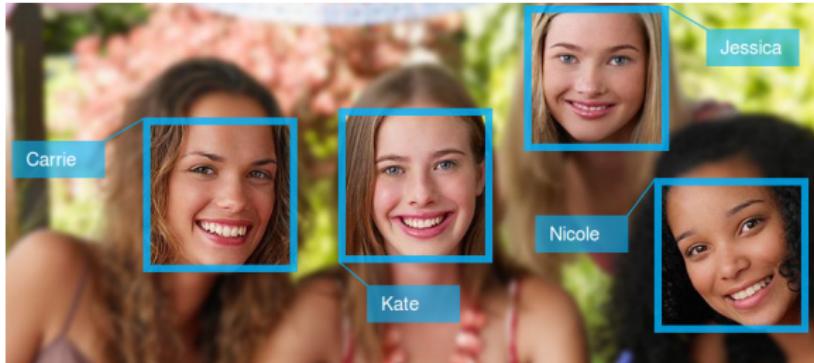
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▶ Identification





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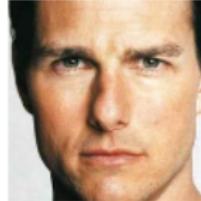
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► Face Search



1. 汤姆 克鲁斯

2. 汤姆 克鲁斯



3. 汤姆 克鲁斯

4. 汤姆 克鲁斯



5. 汤姆 克鲁斯



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▶ Face Track





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► Pose³





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► Facial Expression⁴





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▶ Occlusion



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▶ Imaging Conditions





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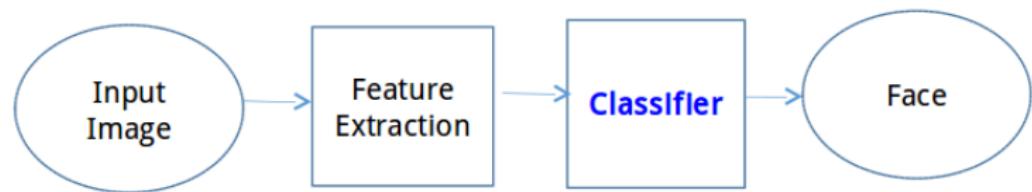
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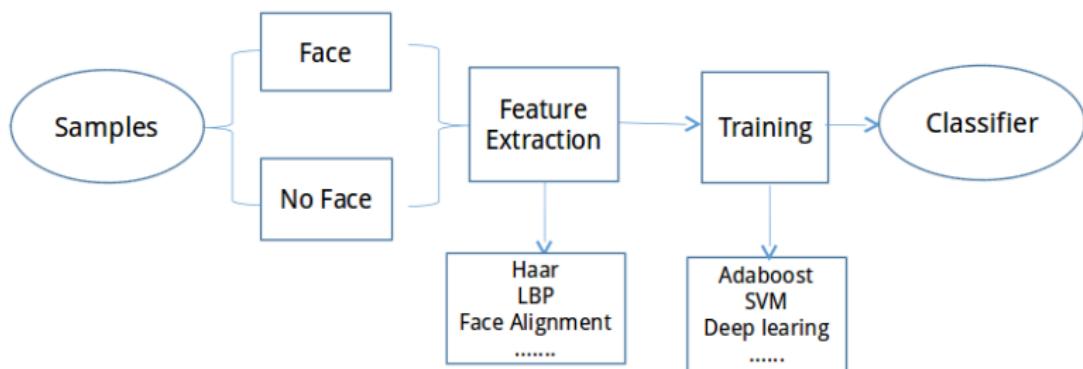
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- ▶ Classical Methods
- ▶ State-of-the-art

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Classical Methods

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- ▶ Knowledge-Based Methods
- ▶ Feature Invariant Approaches
 - ▶ Texture
 - ▶ Skin Color
- ▶ Template Matching Methods
 - ▶ Predefined Templates
 - ▶ Deformable Templates
- ▶ Appearance-Based Methods
 - ▶ Neural Networks
 - ▶ Support Vector Machines
 - ▶ Information-Theoretical Approach

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State-of-the-art

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1. Real-Adaboost⁵

2. Sparse Representation⁶

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⁵"Efficient Boosted Exemplar-based Face Detection". Haoxiang Li, Zhe Lin, Jonathan Brandt, Xiaohui Shen, Gang Hua, CVPR, 2014

⁶"Single-Sample Face Recognition with Image Corruption and Misalignment via Sparse Illumination Transfer". Liansheng Zhuang, Allen Y. Yang, Zihan Zhou, S. Shankar Sastry, and Yi Ma. CVPR, 2013



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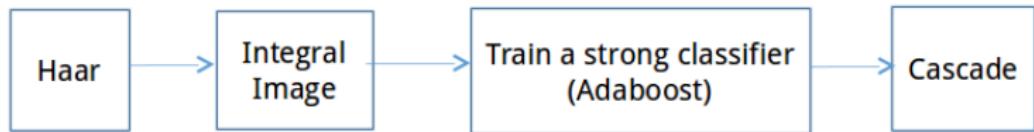
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Viola-Jones Face Detector⁷:
Haar + Integral Image + Classifier + Cascade





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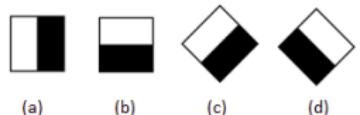
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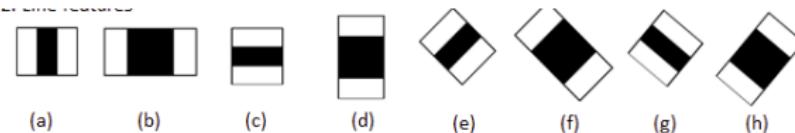
⁸CP Papageorgiou et al., "A general framework for object detection", ICCV, 1998

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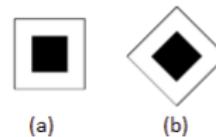
► Edge features⁸



► Lines features



► Center-Surround features





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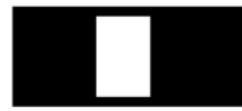
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- ▶ Boosting
- ▶ Adaboost(adaptive boosting)

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Boosting

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- ▶ Weak learning⁹
- ▶ Strong learning
- ▶ Weak Classification → Stronger Classifier¹⁰

⁹L. G. VALIANT, "A Theory of the Learnable", ACM, 1984

¹⁰MJ Kearns, "The Computational Complexity of Machine Learning", ACM,



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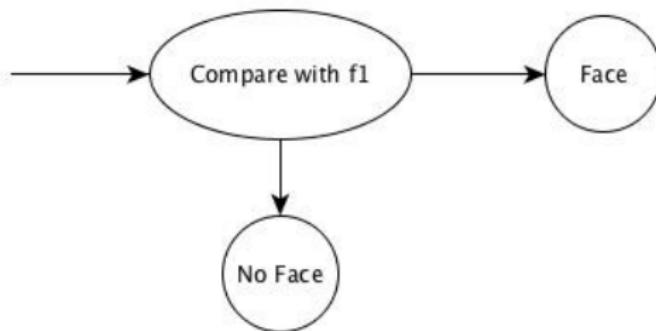
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► Weak Classifier¹¹

$$f(x, f, p, \theta) = \begin{cases} 1 & pf(x) > p\theta \\ 0 & \text{other} \end{cases}$$



¹¹Y Freund, RE Schapire, "A Decision-Theoretic Generalization of On-Line Learning and an Application to Boosting", J COMPUT SYST SCI, 1997



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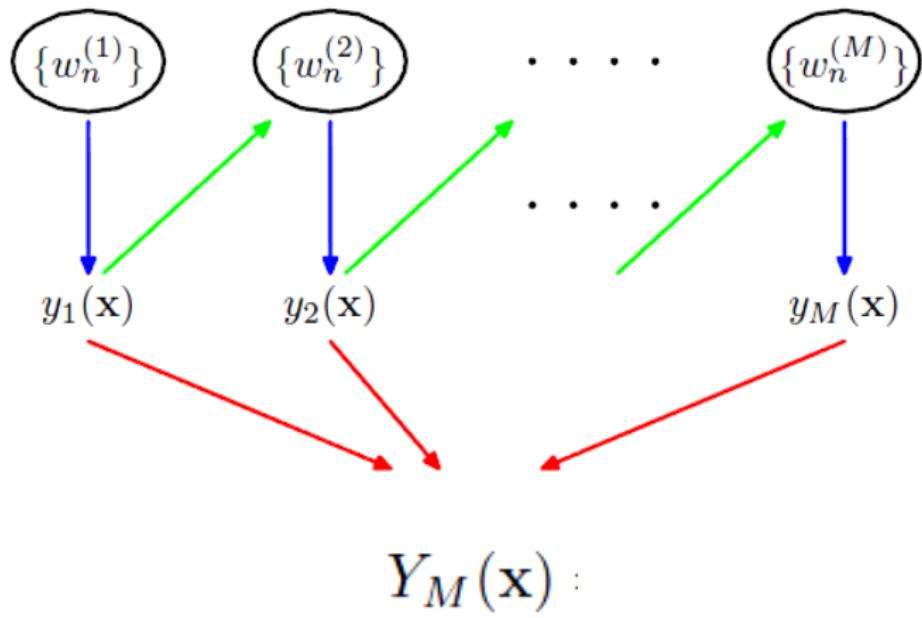
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► Strong Classifier





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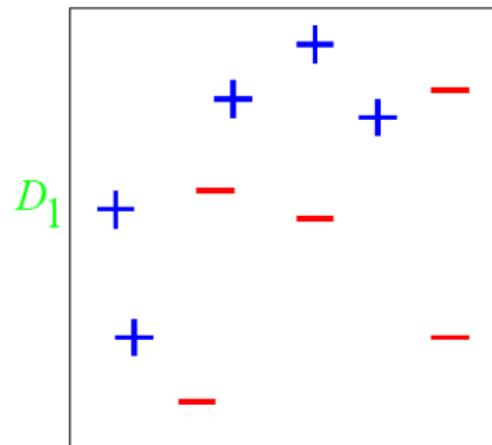
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12 Y Freund, RE Schapire, "A Decision-Theoretic Generalization of On-Line Learning and an Application to Boosting", J COMPUT SYST SCI, 1997



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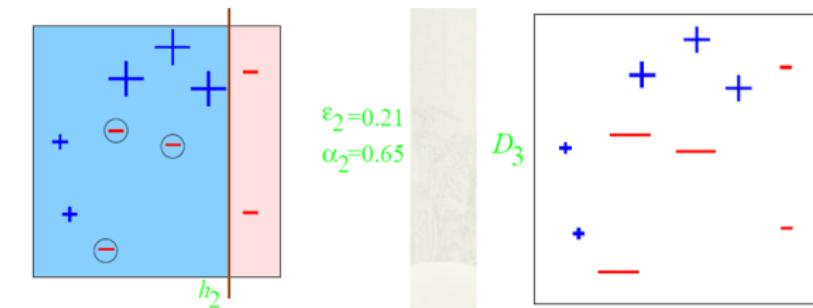
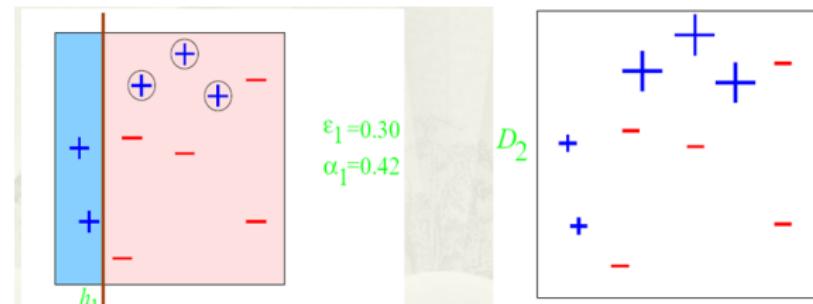
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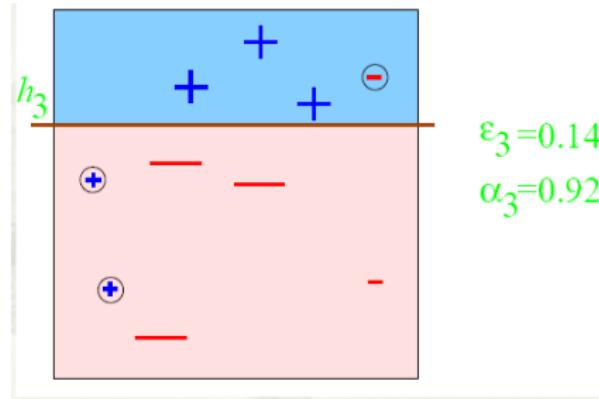
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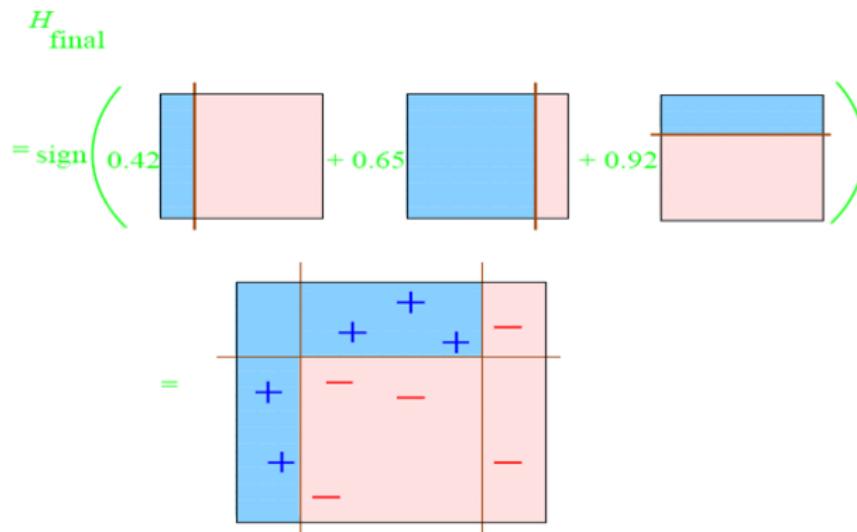
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Weight:

$$H(x) = \text{sign}\left(\sum_{t=1}^T \alpha_t h_t(x)\right)$$

$$\alpha_t = \frac{1}{2} \ln\left(\frac{1 - \varepsilon_t}{\varepsilon_t}\right)$$

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IMAGE
SUB-WINDOW

Classifier 1

Classifier 2

Classifier 3

T

F

FACE

NON-FACE

NON-FACE

NON-FACE

Thank You Very Much

