FACE DETECTION

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Outline

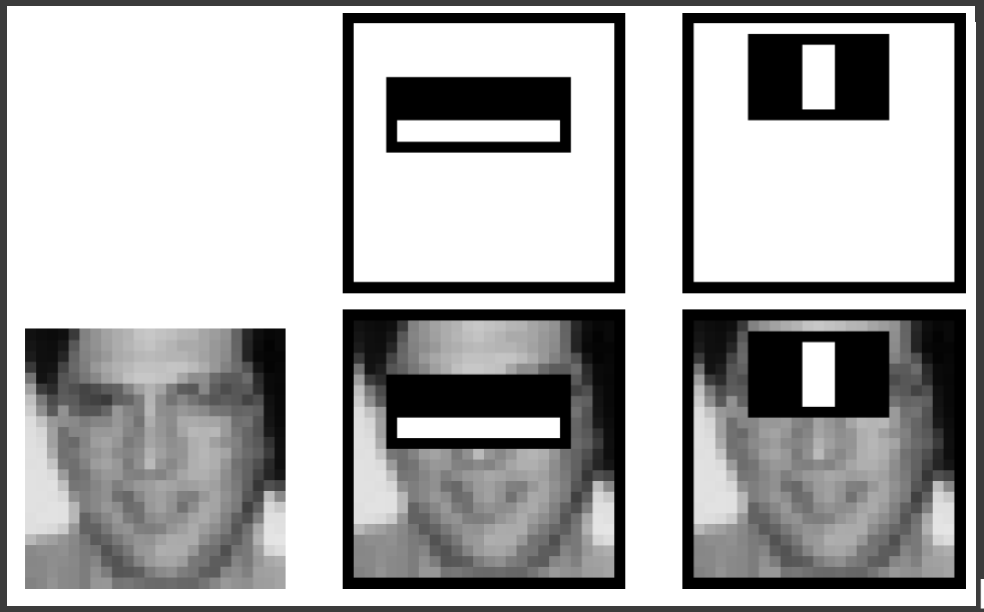
- Introduction
- Adaboost
- Adaboost cascade
- Posibilistic Boosting-Tree
- Experimental results

INTRODUCTION

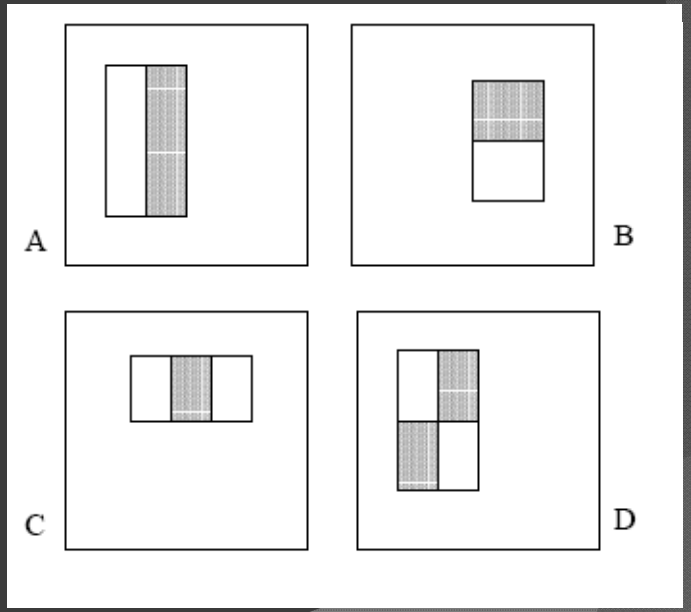
- Detects faces in an image
- Subwindows
  - 16*16

INTRODUCTION

- Features
  - Difference between rectangles



[1]

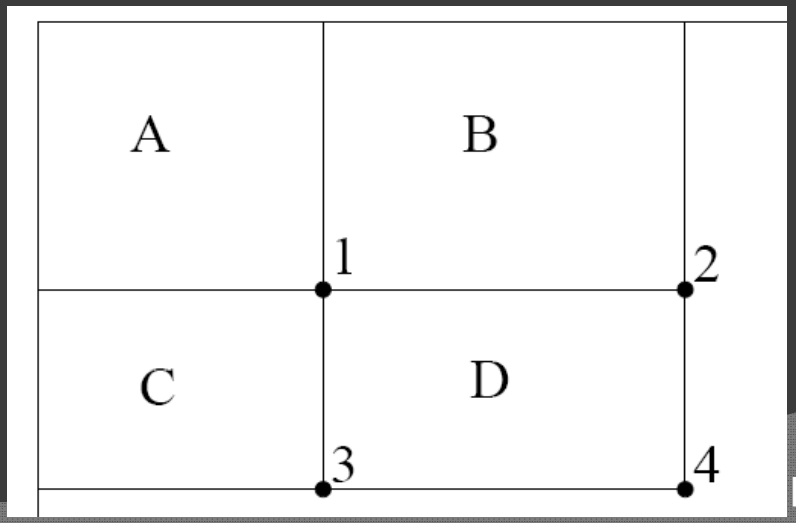


[1]

INTEGRAL IMAGE

- Allows the features used by our detector to be computed very quickly

$$ii(x,y) = \sum_{x' \leq x, y' \leq y} i(x,y)$$



The value of the integral image at location 1 is the sum of the pixels in rectangle A. The value at location 2 is A+B, at location 3 is A+C, and at location 4 is A+B+C+D. the sum within D can be computer as 4+1-(2+3).

[1]

INTEGRAL IMAGE

- Compute ii
  - s(x,y) = s(x,y-1) + i(x,y)
  - ii(x,y) = ii(x-1,y) + s(x,y)
    - s(x,y) is the cumulative row sum, s(x,-1) = 0.
    - Ii(-1,y) = 0

Adaboost

- given a feature set and a training set of positive and negative images
- select a small set of features (weak learner) and train the classifier (strong learner)

Adaboost

- Weak learner
  - Single feature

$$h_t(\mathbf{x}) = \begin{cases} +1 & \text{if } p_t f_t(\mathbf{x}) < p_t \theta_t \\ -1 & \text{otherwise.} \end{cases}$$

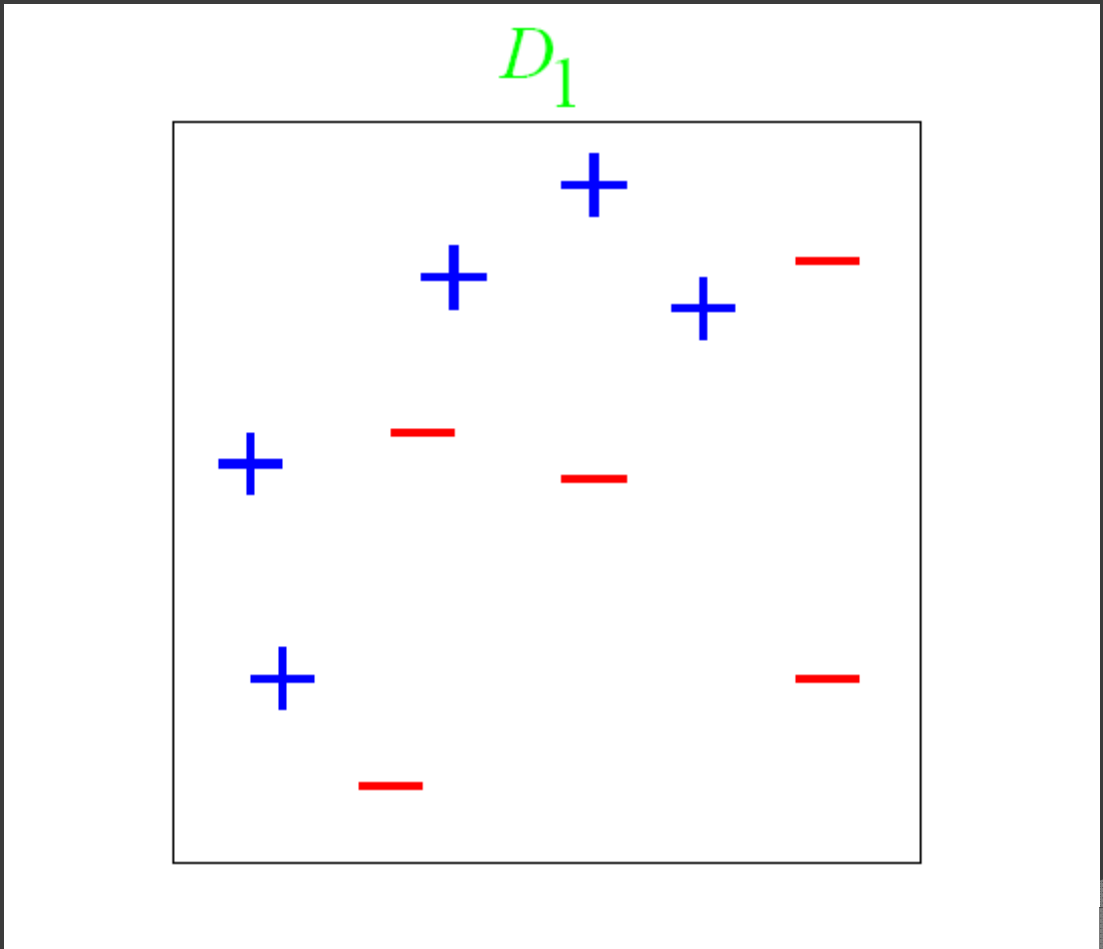
- Weight
  - Update based on error

$$w_{t+1,i} = w_{t,i} \beta_t^{1-e_i}$$

$$\beta_t = \frac{e_t}{1 - e_t}.$$

- Strong learner
  - Combine weak learners

Adaboost --- example



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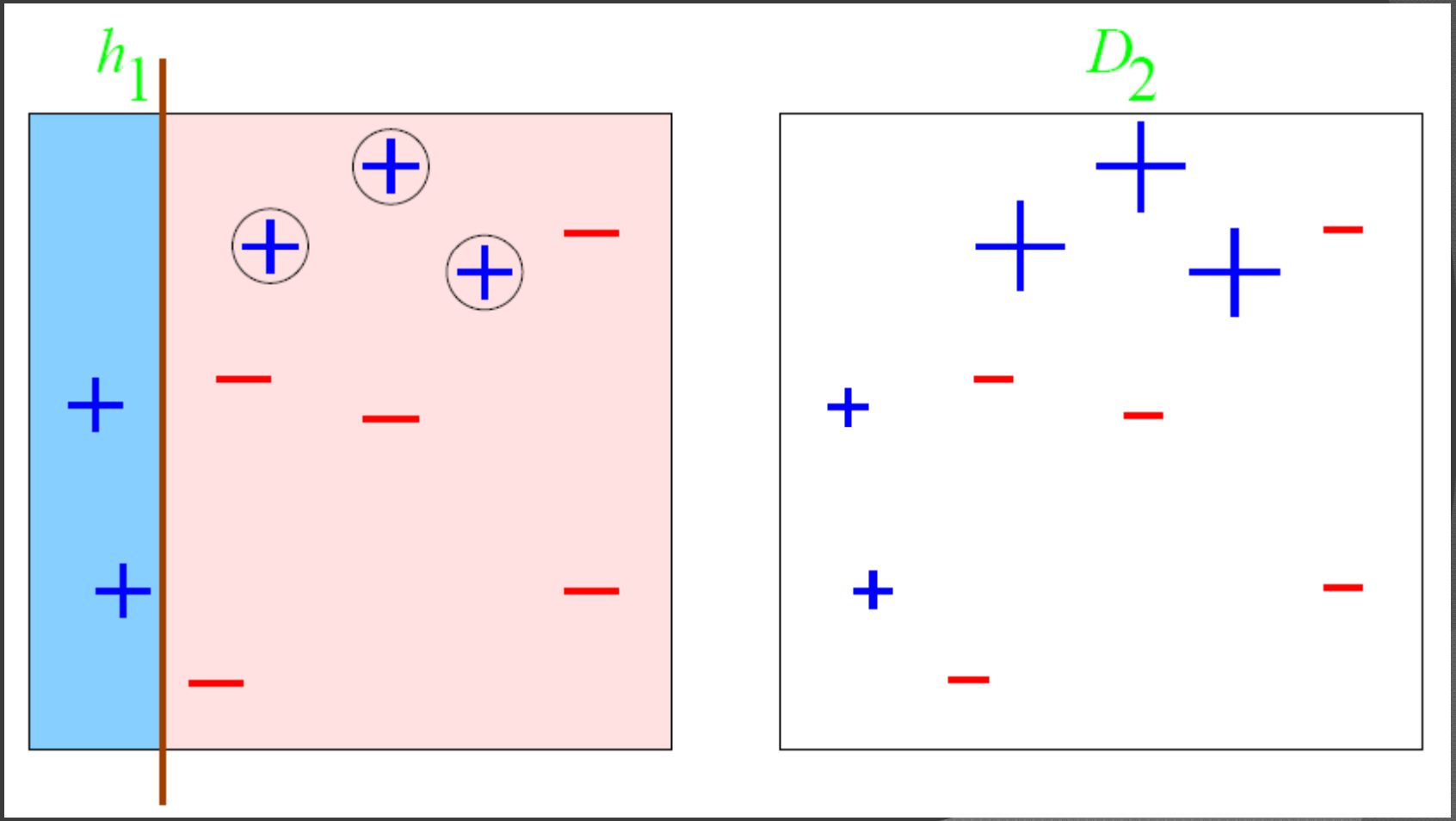
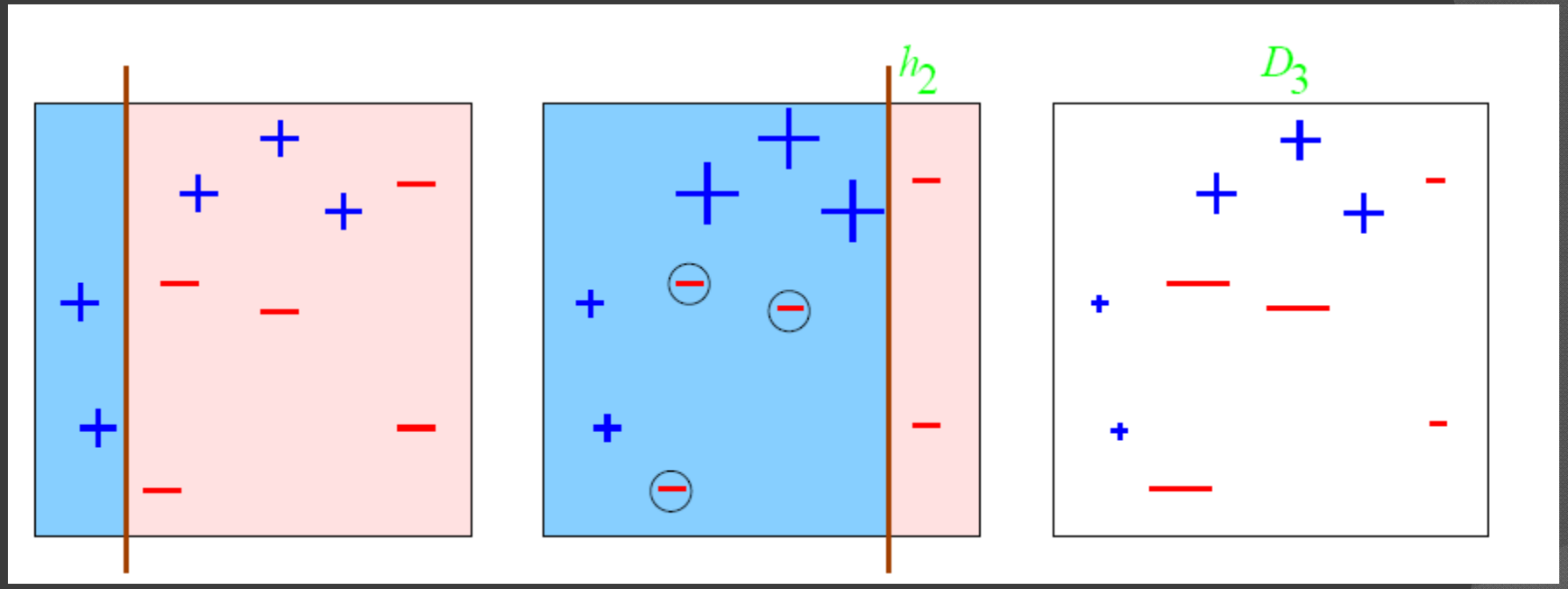
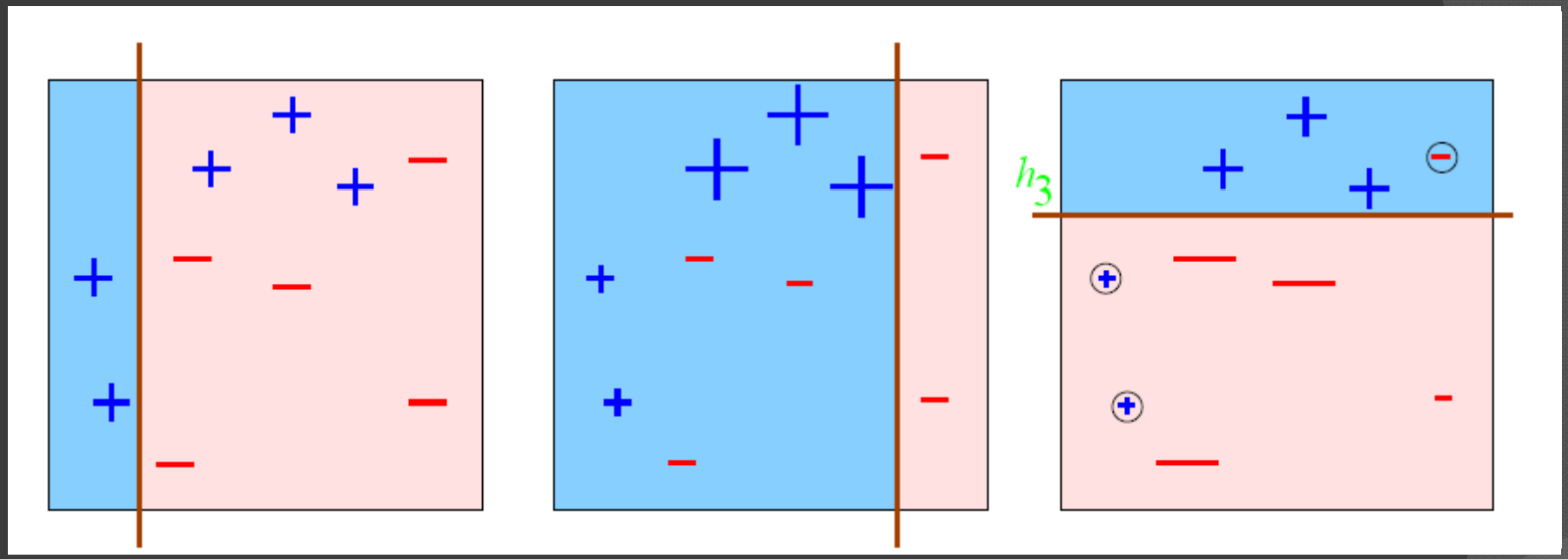
Adaboost --- example



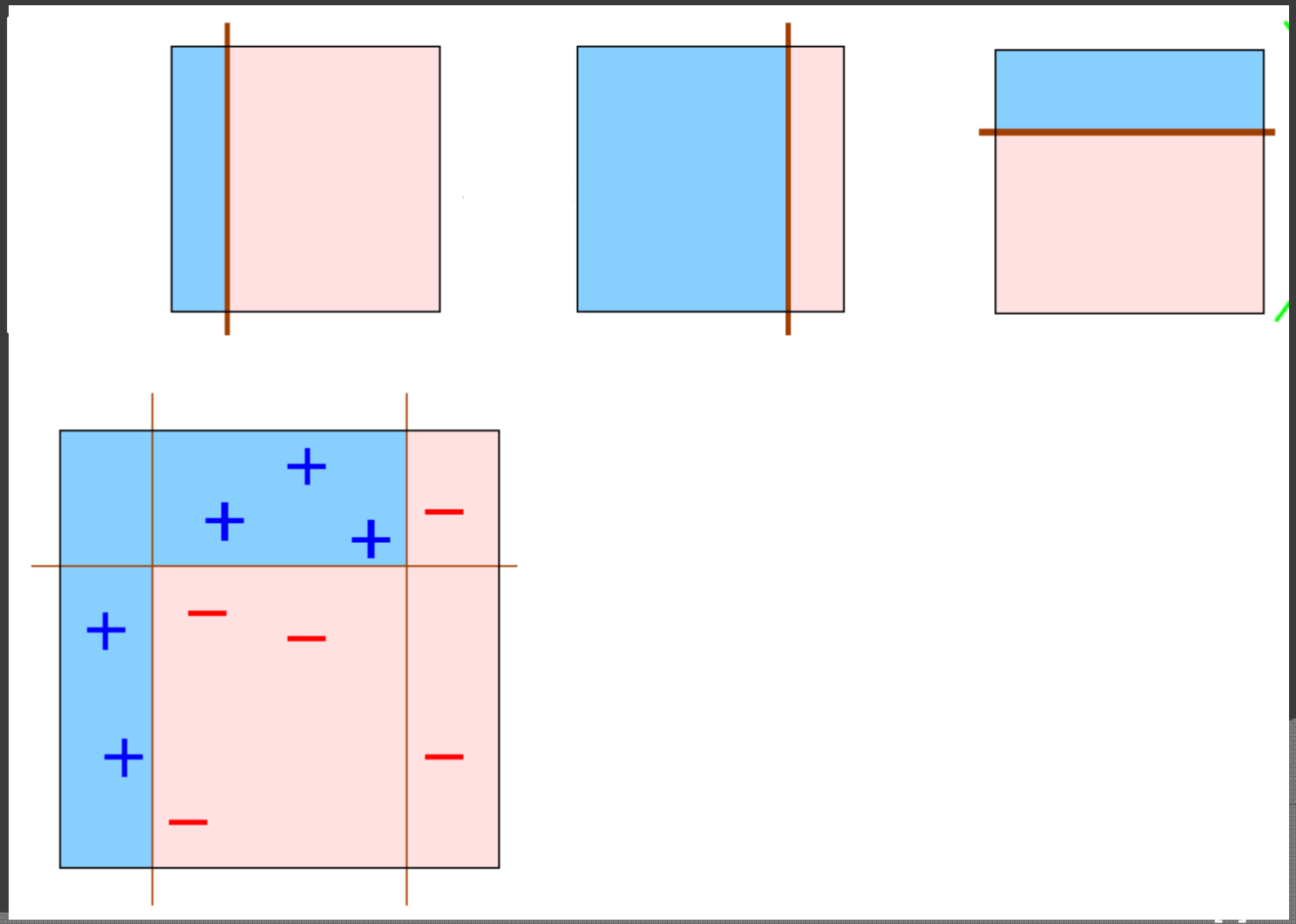
Adaboost --- example



Adaboost --- example

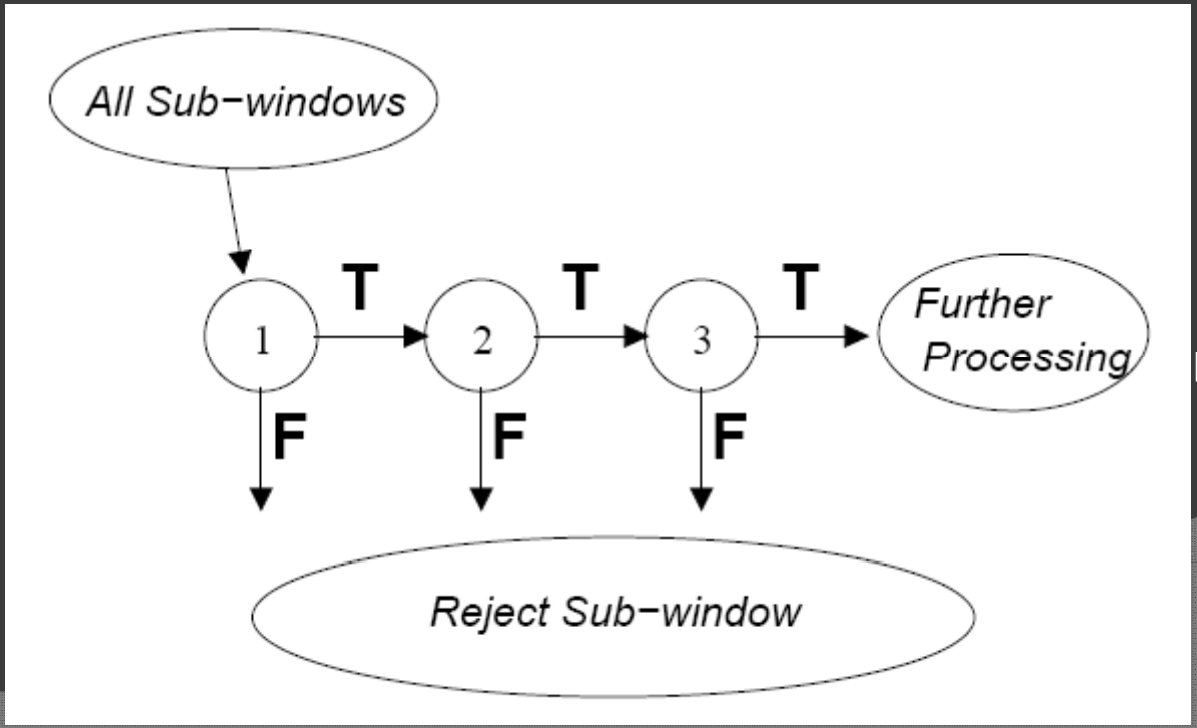


Adaboost --- example



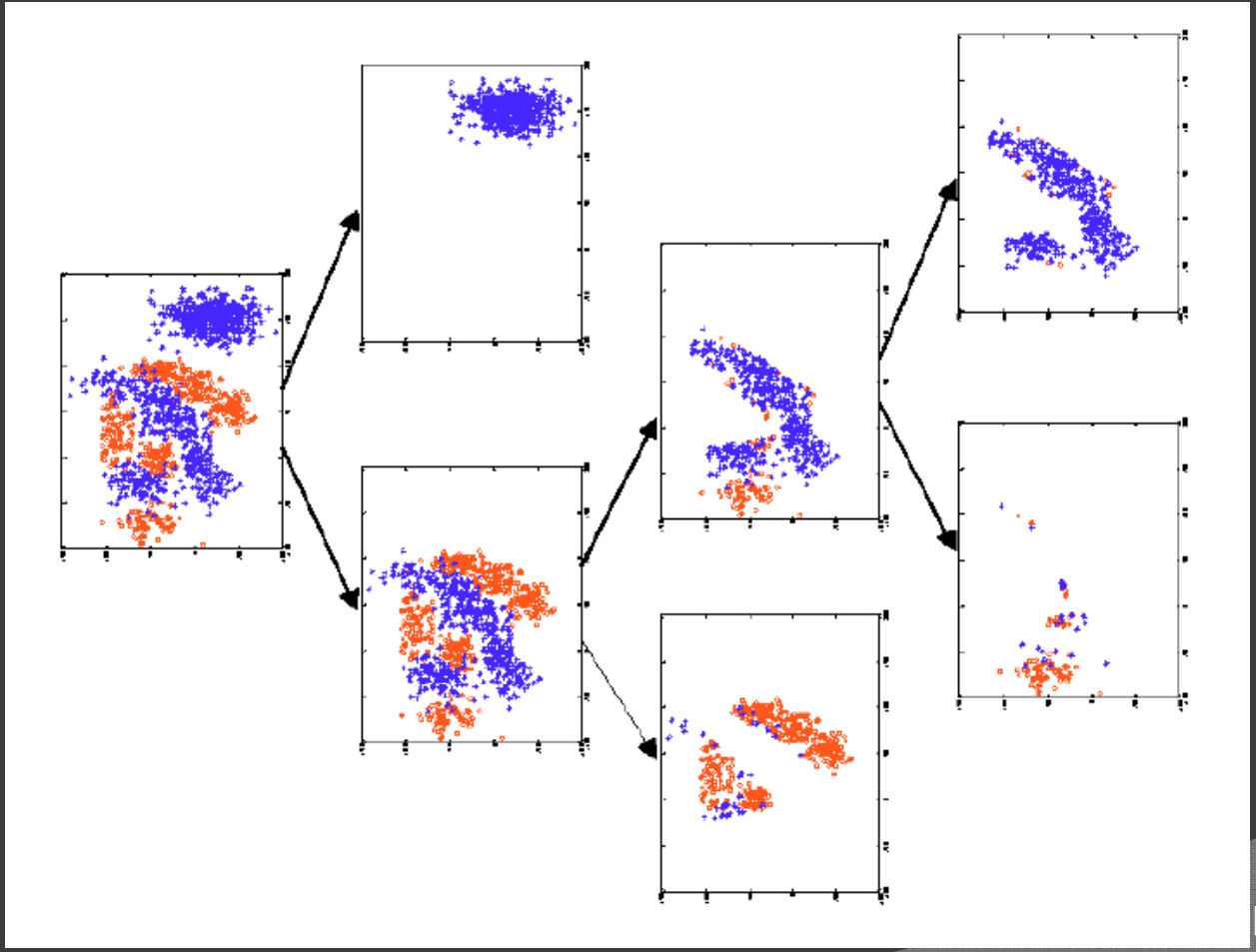
ADABOOST CASCADE

- reject negative results
- reduce the threshold to minimize false negatives.



[1]

POSIBILISTIC BOOSTING-TREE



[2]

EXPERIMENTAL RESULTS

Adaboost cascade

stage	Right detection	False positive	T
1	1000	496	5
2	999	401	15
3	999	339	25
4	999	288	35
5	999	243	45
6	999	207	55
7	999	182	65
8	999	167	75
9	999	152	85
10	999	138	100

2000 training images

EXPERIMENTAL RESULTS

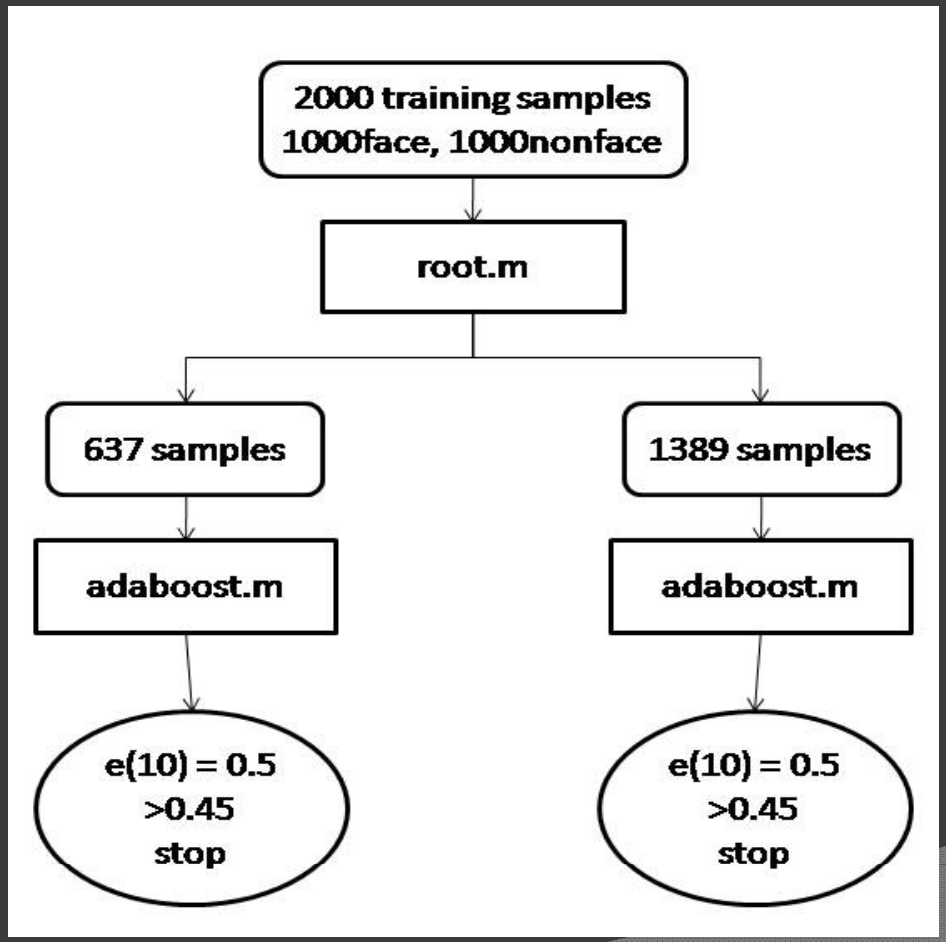
Adaboost cascade

stage	Right detection	False positive	T
1	100	56	5
2	100	41	15
3	100	35	25
4	100	29	35
5	100	20	45
6	100	17	55
7	100	14	65
8	100	13	75
9	100	12	85
10	100	11	100

200 training images

EXPERIMENTAL RESULTS

Positivistic boosting-tree



2000 training images

EXPERIMENTAL RESULTS

Positivistic boosting-tree

1 1: right detection 1 0: false nagetive
0 1: false detection 0 0: right rejection

	1 1	1 0	0 1	0 0
Train	838	162	189	811
test	100	0	67	33

2000 training images

Reference

- **Rapid Object Detection using a Boosted Cascade of Simple Features,** Paul Viola , Michael Jones
- **Probabilistic Boosting-Tree: Learning Discriminative Models for Classification, Recognition, and Clustering ,** Zhuowen Tu , Integrated Data Systems Department Siemens Corporate Research, Princeton, NJ, 08540

THANG YOU