

→ HAAR Cascade Classifier

① It is a machine learning method where the model is trained on both positive and negative images.

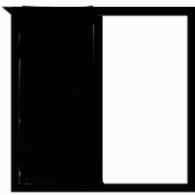
* Positive images :- Which includes the object of interest.

* Negative images :- The background.

② Based on Haar Wavelet Sequence :-

Convolutional kernels used to extract features.

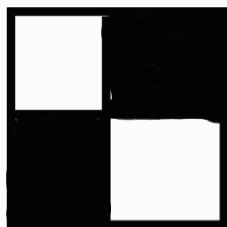
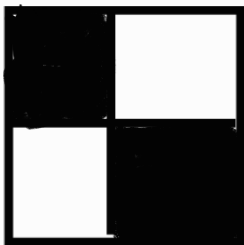
③ Haar like features :-



Edge features



Line features



Four-Rectangle features.

→ The integral image Concept

Integral image is a concept that uses the cumulative sum of pixels above and to the left of the current pixel cell.

1	2	2	4	1
3	4	1	5	2
2	3	3	2	4
4	1	5	4	6
6	3	2	1	3

For the highlighted 3 what is the integral value?

$$\underbrace{(4+2)}_{\text{above}} + \underbrace{(1+3+2)}_{\text{above left or left}} + \underbrace{3}_{\text{itself}} = 15$$

What about the 3 in red?

→ Generally Adaboost Classifier is used to reduce the number of features

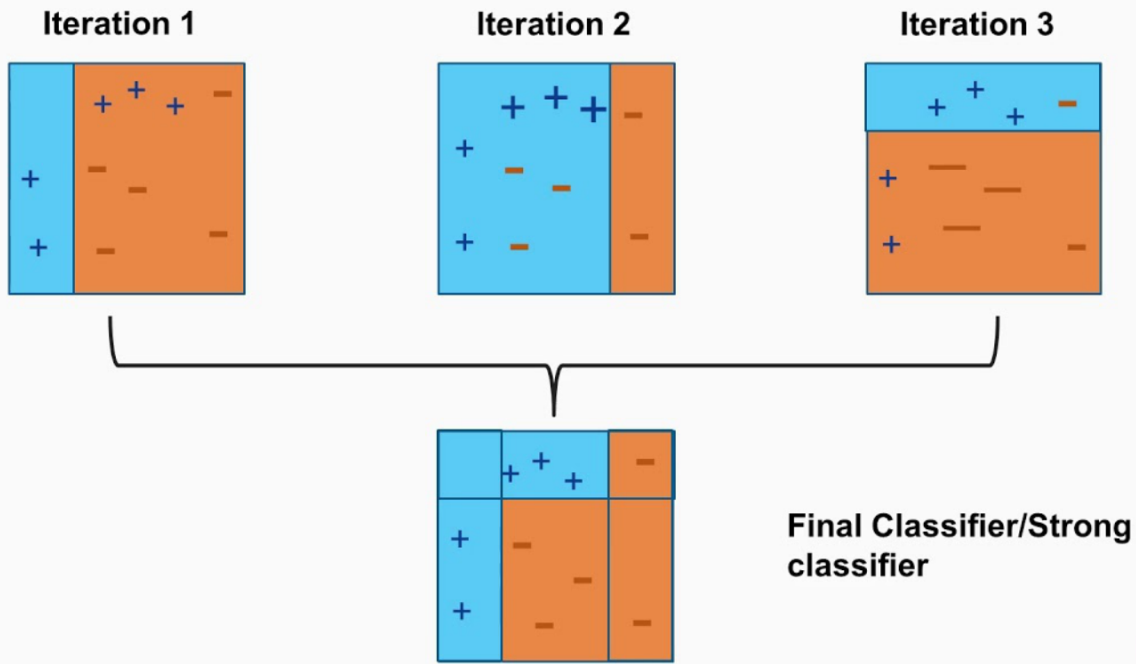
① A weak classifier is made on top of the training data based on weighted samples.

② It selects only those features that help to improve the classifier accuracy.

③ Adaboost cuts down the number of features significantly.

* A strong classifier is a linear combination of weak classifier.

Boosting

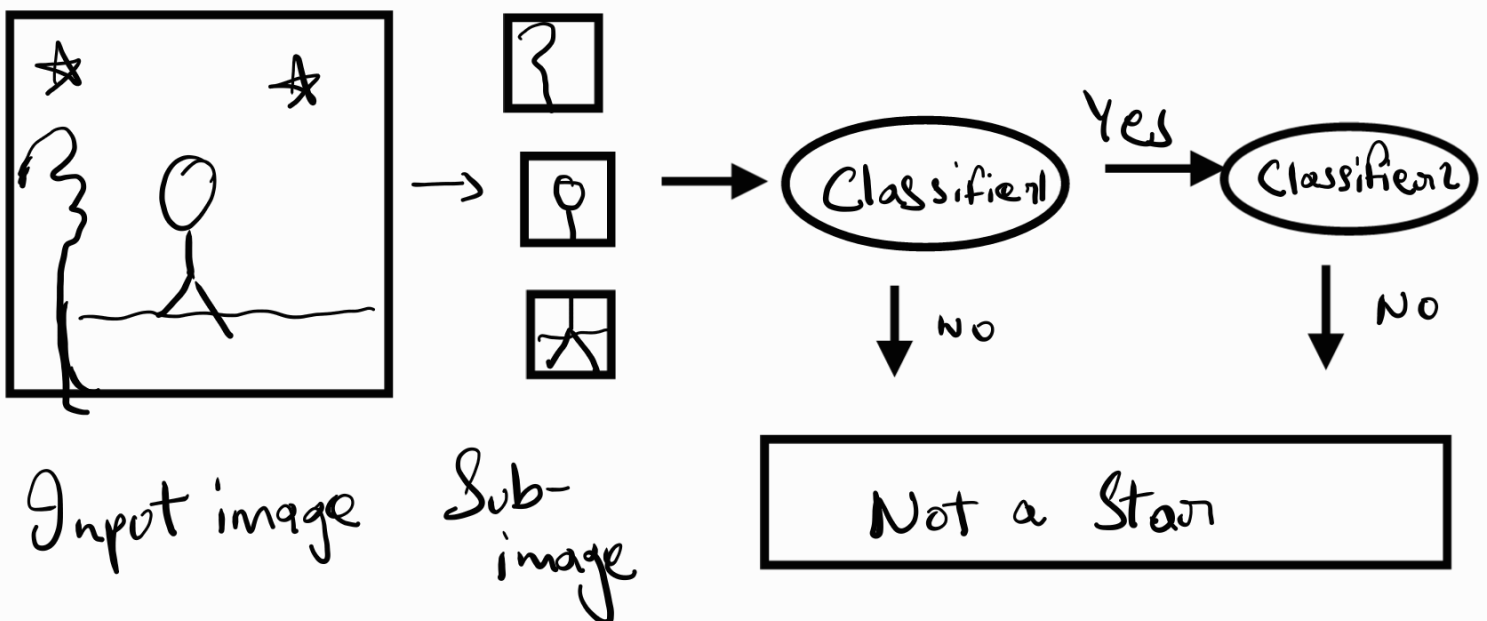


Packt>

A Rough Idea!

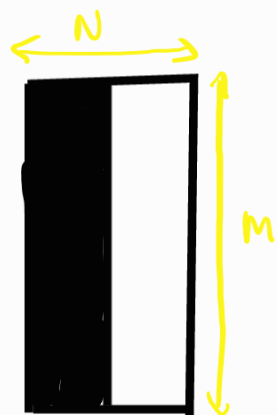
→ In Haar!

A cascade of classifiers is used.



→ How are Haar features calculated?

→ For a given pixel i, j we say that the value of the Haar feature (using the Haar filter)



Haar filter

H_A

White = 1

Black = -1

Response to filter H_A at location (i, j)

$$V_A[i, j] = \sum_m \sum_n I[m-i, n-j] H_A[m, n]$$

But since the values of the HAAR filters are binary (-1, or, 1)

the expressions can be written in the following way:-

$$V_A[i, j] = \sum (\text{pixel intensities in the white area}) - \sum (\text{pixel intensities in the black area}).$$

{ Clearly this involves just addition & subtraction of the values, which is computationally very efficient).

Computational Cost = $(N \times M - 1)$ additions per pixel per filter.

Can something better be done?