The Viola/Jones face detector

- Training data
  - ↳ 5000 faces
    - All frontal
  - 300 million non-faces
    - 9400 non-face image
  - faces are normalized
    - Scale, Translation

- Variants
  - Across individual
  - Illumination
  - Pose (rotation both in plane and out).

- Properties
  - Each image contains 10 - 50 thousand locs/scales
  - faces are rare 0 - 50 per image
  - Extremely small # of false positives : 10^{-6}

- Adaboost :-
  - Given a set of weak classifier, originally: $h_j(x) \in \{+1, -1\}$
  - Iteratively combine classifier, $C(x) = \theta\left(\sum_t h_t(x) + b\right)$
  - Training error converge 0 to quickly.
  - Test error is related to training margin.

Boosted face detector! Image feature

$$h_t(x_t) = \begin{cases} \alpha_t & , \text{if } f_t(x_t) > \theta_t \\ \beta_t & , \text{otherwise} \end{cases}$$

→ 60,000 feature to choose from

$$C(x) = \theta\left(\sum_t h_t(x) + b\right)$$

Integral image!- The integral image compute a value at each pixel (x,y) that is the sum of pixel values above and to the left of (x,y).

- This can be quickely be computed in one pass through the image.

Computing sum within rectangle!-

- The sum of original image value within the rectangle can be compured ! sum = A-B-C+D

feature selection!-

- for each round of boosting
  - Evaluate each rectangle filter on each example.
  - Sort example by filter values
  - Select best threshold for each filter (min z)
  - Select best filter/threshold (= feature)
  - Reweight examples
- m filters, T threshold, N examples, L learning time
  - O(mTL(mTN)) Naive wrapper method.
  - O(MN) Adaboost feature selector.

Building fast classifier:-

- Given a nested set of classifier hypothesis classes.
- Computation Risk minimization

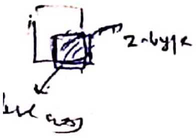
Image sub-window → classifier 1 →(T) classifier 2 →(T) classifier 3 →(T) face

classifier 1 ↓(F) Non-face; classifier 2 ↓(F)

- Cascaded classifier

Image sub-window → 1 feature →(50%) 5 feature →(20%) 20 feature →(2%) face

1 feature ↓ non-face; 5 feature ↓ non-face



Review

- Color :-
  - Spectrum of illumination and surface
  - Human color perception (trichromacy)
  - metameric light, Grassman's laws
  - RGB and CIE color spaces.
  - Uniform color space
  - Detection of Specularities
  - Color constancy

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, Large

- Invarient feature:-
  - Scale invariance, using image pyramid
  - Orientation selection
  - Local region descriptor (vector formation)
  - matching with nearest and 2nd nearest neighbour
  - object recognition
  - Panorama stitching

Classifiers:

- Bayes risk, loss func
- Histogram-based classifier
- Kernel density estimation
- Nearest-neighbor classifier
- Neural network

Grassman's laws:-

- Grassman's law describe empirical results about how the perception of mixture of colored light composed of different spectral power distributions can be algebrically related to one another in a color matching context.

moder interpretation:-

1st law:- Two colored light appear different if they are differ in either dominant wavelength, luminance or purity.

Corollary: for every colored light there exist a light with a complementary color such that a mixture of both light either desaturate for more intense component or give uncolored (grey/white) light.

2nd law: The appearance of mix of light made from two component chan if either component changes.

Corollary: A mix of two colored light that are non-complementary result in a mixture that varies in hue with relative intensities of each light and in saturation acc. the distance b/w the hue of light.

3rd law: There are light with different spectral power distribution but appear identical.

Corollary I :- Such identical appearing light must have identical effects when added to a mixture of light.

Corollary II :- Such identical effects when subtracted (i.e. filtered) from a mixture of light.

4th law: The intensity of mixture of light is the sum of intensities of each component known as Abney's law.

$$R = \int_0^\infty I(\lambda)\, \bar{r}(\lambda)\, d\lambda$$

$$G = \int_0^\infty I(\lambda)\, \bar{g}(\lambda)\, d\lambda$$

$$B = \int_0^\infty I(\lambda)\, \bar{b}(\lambda)\, d\lambda$$