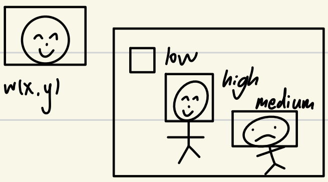
Object detection

edges -> lines -> boundary

1) basic template matching



correlation between template and image

w(x, y) template

I(x, y) image

correlation coefficient:

$$\gamma(x,y) = \frac{\sum_s \sum_t (w(s,t)-\bar{w})(I(x+s,y+t)-\bar{I}_{xy})}{\sqrt{\left(\sum_s \sum_t (w(s,t)-\bar{w})^2\right)\left(\sum_s \sum_t (I(x+s,y+t)-\bar{I}_{xy})^2\right)}}$$

$$= \frac{Cov(w,I)}{\sigma_w \sigma_I} = \frac{E[(w-\bar{w})(I-\bar{I})]}{\sigma_w \sigma_I}$$

$\bar{w}$ average value of template

$\bar{I}_{xy}$ average value of image inside window

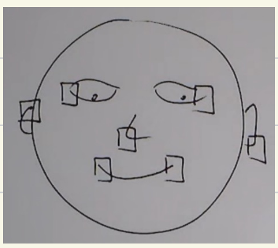
γ(x,y) ranges in [-1,1]

γ = 1 => template is exactly equal to image patch in the window (on a positive multiple)

γ = -1 => template is exactly flipped intersects of image patch (digital negative)

γ = 0 => no correlation / no match

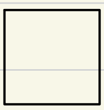
image features



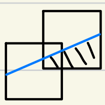
idea: describe object as a collection of smallest features

what makes a good feature?

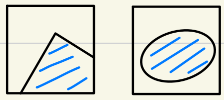
a good feature should have lots of edge strength in 2 directions



flat -> bad



bad “aperture problem”



good

Shi-Tomasi corner detector:

1) compare gx, gy gradients at each point in image

2) for every N*N block of pixels,

a) create
$$\begin{bmatrix} \sum_{(x,y)\in B} g_x^2 & \sum_B g_x g_y \\ \sum_B g_x g_y & \sum_B g_y^2 \end{bmatrix} \quad 2\times 2 \text{ matrix}$$

b) compare eigenvalue of this matrix λ1, λ2

c) if λ1, λ2 are both > τ, accept B as a feature

Shi-Tomasi (related to harris corner detection) is good for finding corners at a certain scale

- there may be many
- only at (small) scale

better features than simple corners:

- multi-scale (windows of different sizes)
- “best” scale for a features
- viewpoint / rotation invariant

neighbourhoods to describe feature

- Harris-Laplace, etc
- sift: scale-invariant feature transform