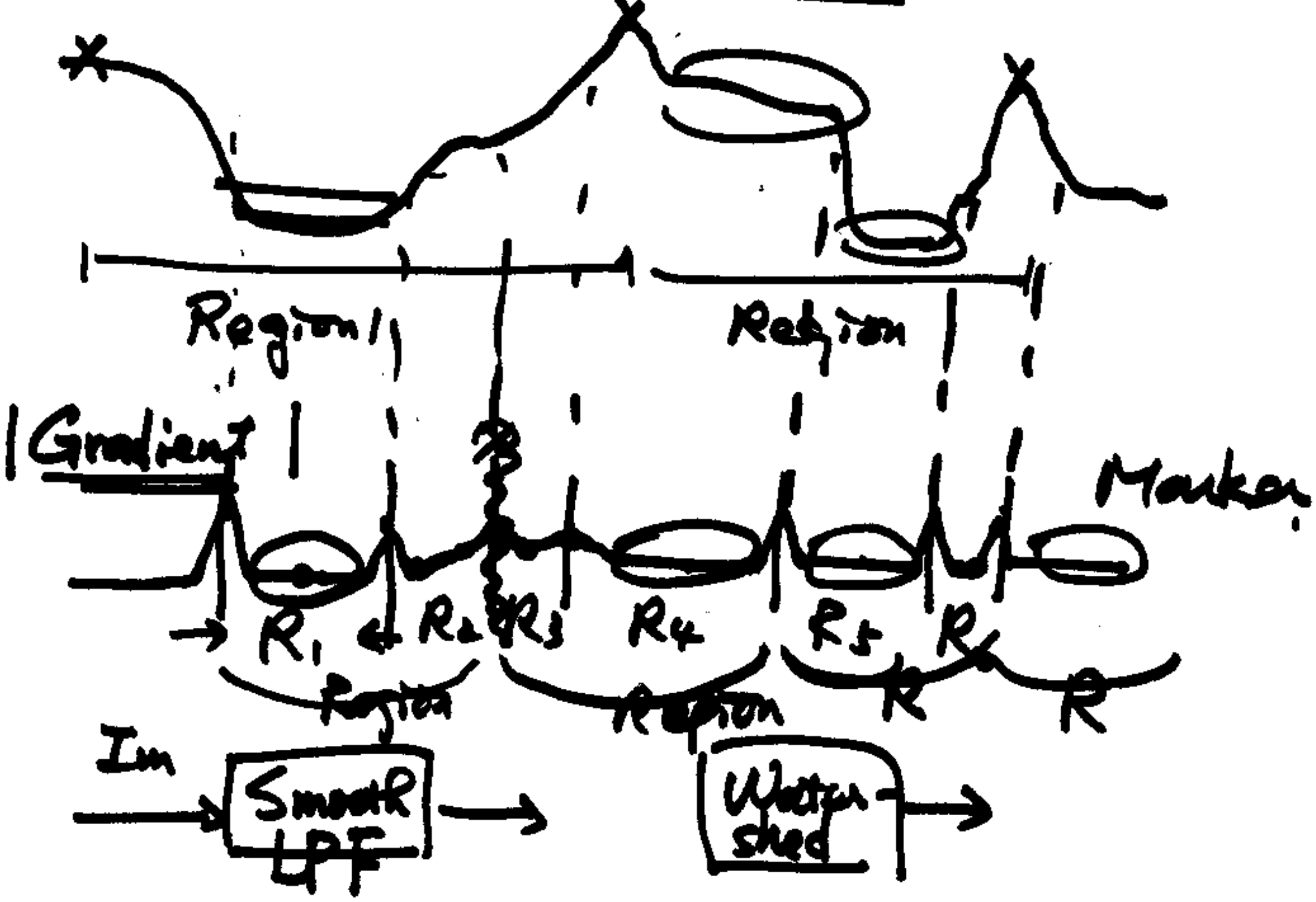
EE 4830 DIP

Lec # 11

Today: Segmentation

Chap 10. Morphological Processing



HW#5 Assigned Today

due Apr. 28.

Final Exam May 12 TR. Thursday.

Image Analysis

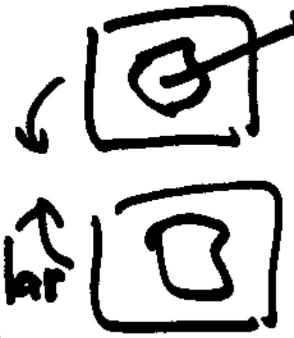
Curve_Lines

Edge Detection — Hough Transform

Region Segmentation — Clustering (Color) + Merging

Watershed. (Color)

Represent Intermediate Results



Region : Set of Points.

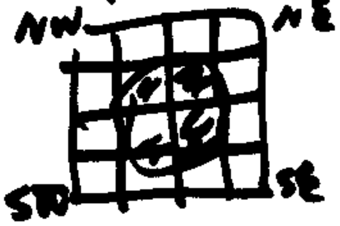
R_1 : $\underline{\{(x_1, y_1), (x_2, y_2) \cdots\}}$

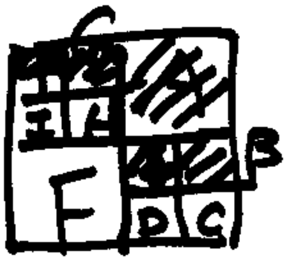
low-level.

Space : Compression ✓

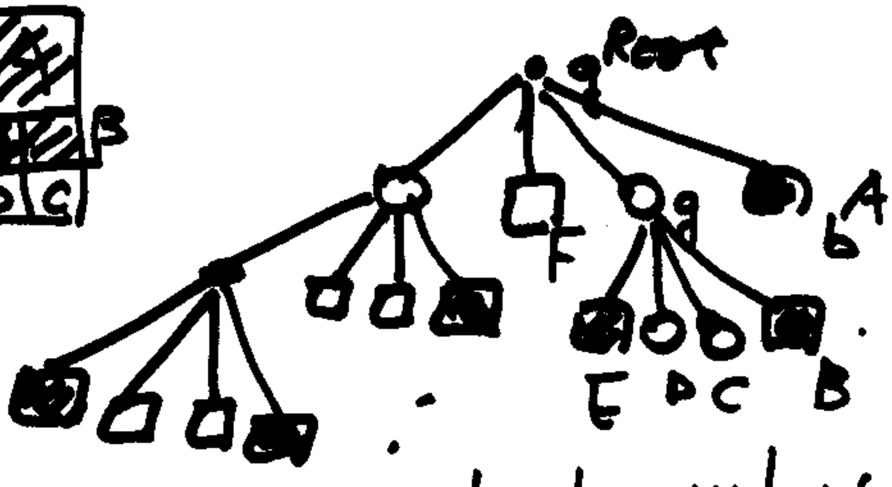
Matching : Features ✓

Compression : Quad - Tree.





Grey



. g b g b w w b w . . . .

Moments:

$$f(x,y) = \begin{cases} 1 & \text{if } x,y \in R \\ 0 & \text{if } \notin R \end{cases}$$

$(p+q)$ th-order moments

$$m_{pq} = \sum_R \sum f(x,y)\, x^p y^q$$

$$m_{10} = \frac{\sum\sum f(x,y)\, x}{\cancel{\#\text{ pixels in } R}}$$

$$\#\text{pixels} = \sum\sum f(x,y) = m_{00}$$

$$\left.\begin{aligned} \frac{m_{10}}{m_{00}} &= \bar{x} \\ \frac{m_{01}}{m_{00}} &= \bar{y} \end{aligned}\right\} \text{Centroid of } R$$

Central Moments

$$\mu_{pq} = \sum_R \sum \underline{f(x,y)} (x - \underline{\bar{x}})^p (y - \underline{\bar{y}})^q$$

$$\mu_{20} = \sum\sum f(x,y)(x-\bar{x})^2$$

μ_{02} = Var in y dim

camera zoom in/out

cause ~~scale~~ scale change

Q: how will moments μ_{pq} change?

~~to~~ m_{10} , m_{01}

$\propto \bar{x}$ $\quad \bar{y}$

μ_{20} $\quad \mu_{02}$

HW5: $f(x,y) \Rightarrow f(\alpha x, \alpha y)$

μ_{pq} ?

Find a feature that's invariant to scale change.

$$\boxed{\mu_{pq} / (\mu_{00})^{p+q+2/2}}$$ scale-invariant moments.

$\theta = ?$ Orientation of the region.

the angle of the axis with the least moments of inertia

axis

D: distance to the axis

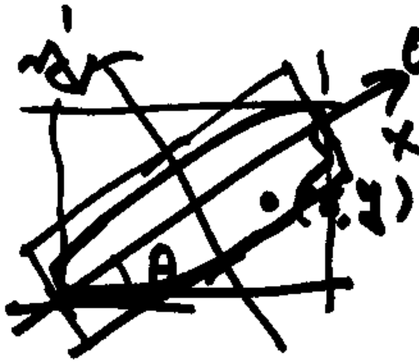
$\underline{\underline{Min}}\left(\sum_R \sum \underline{D}^2\right) \Rightarrow$

$$\theta_{\text{min. moment inertia}} = \frac{1}{2}\tan^{-1}\left[\frac{2\mu_{11}}{\mu_{20}-\mu_{02}}\right]$$

μ_{20} large $\mu_{02} \downarrow$ $\theta \downarrow$

$\mu_{20} \downarrow$ $\mu_{02} \uparrow$ θ $\pi/2$

$\mu_{11} \uparrow$ $\theta = \pi/4$



* Minimal Bounding Rectangle ?

* Best-Fit Minimal Ellipse ?

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \cos\theta & +\sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

Find max, min in x', y'

Moments of Inertia

~~Ellipse:~~

$$\boxed{I_{min} = \frac{\pi}{4} a b^3}$$

$$I_{max} = \frac{\pi}{4} a^3 b$$

$\Sigma\Sigma D^2$

Skeleton Extraction

Structure

OCR

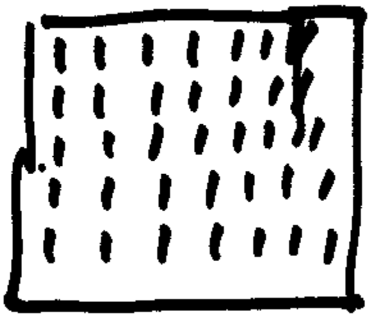
Mean Axis Transform

$$f(m,n) = \begin{cases} 1 & \in R \\ 0 & \notin R \end{cases}$$

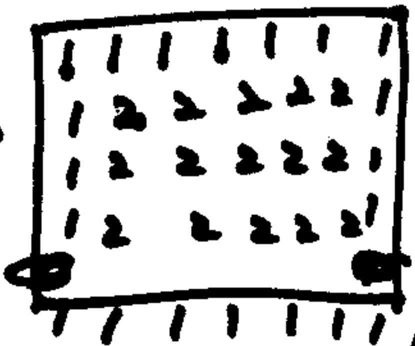
$$f_0(m,n) \triangleq \underline{f(m,n)}$$

$$\Rightarrow f_k(m,n) = \underline{f_0(m,n)} + \min_{N}\left(f_{k-1}(i,j),\ i,j \in N(m,n)\right)$$

$f_0(m,n)$ $\qquad$ $f_1(m,n)$ $\qquad$ N: neighborhood of m,n "4"

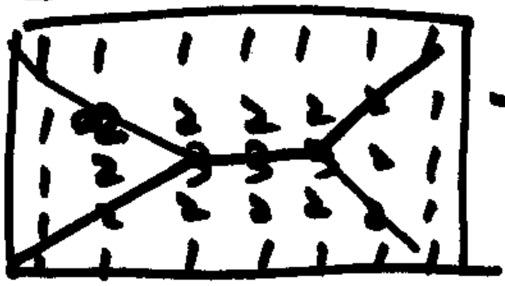


$\rightarrow$



$f_2(m,n)$ $\qquad$ f_3

$\rightarrow$



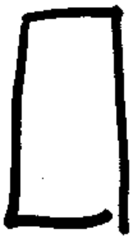
$\rightarrow$

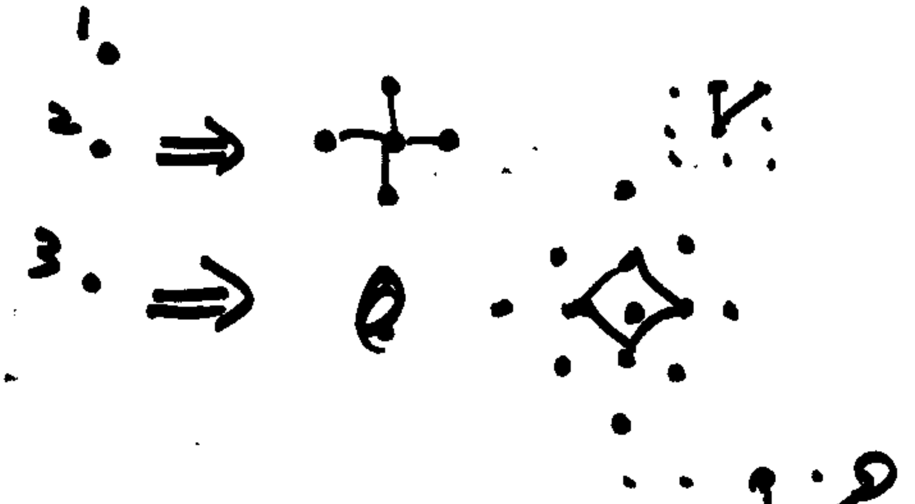
Union of all local max pts.

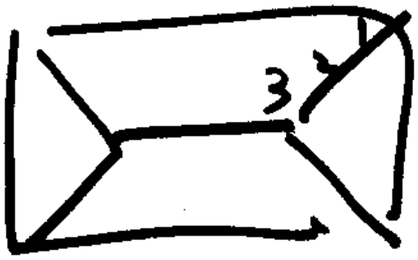
$$f(m,n) \geq f(i,j) \quad i,j \in N(m,n)$$

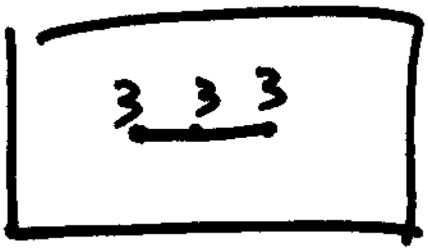
$$\Rightarrow f(m,n) \text{ is local max.}$$

"Reconstruct" the original shape.









Morphological Operation

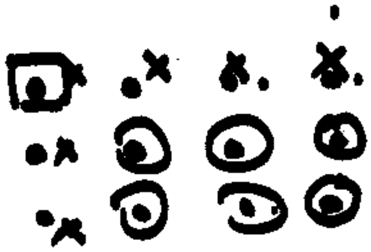
Erosion & Dilation Operators from set theory

Set of points X

smaller set (structural element) : B

Example $B =$  Origin

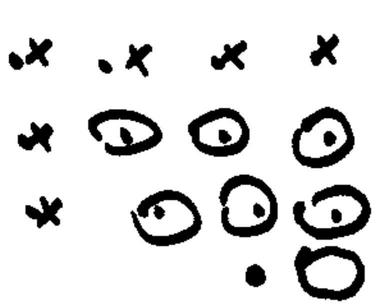
X



$B =$ 

Erosion $X \ominus B \triangleq \{ x ;\ B_x \subset X \}$

X

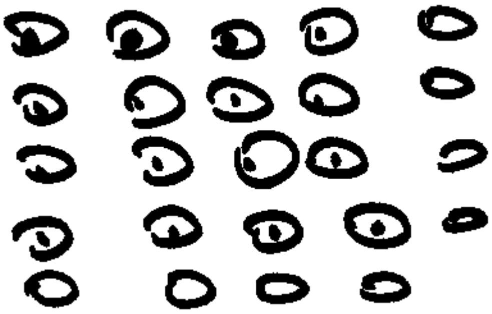


$B =$ 

$B =$ 

Dilation $X \oplus B \stackrel{d}{=} \{ x ;\ B_x \cap X \neq \phi \}$

X



$B =$ 

Open : $X \circ B$

$$= (X \ominus B) \oplus B$$

$B =$ 

Close