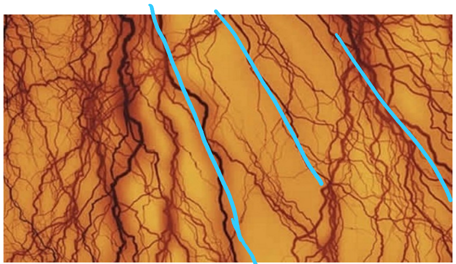
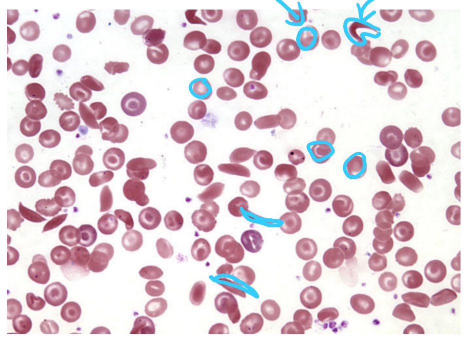
Geometric Properties of Binary Objects

Tuesday, February 2, 9:30 am CS 585 Class, Margrit Betke

Dominant Direction of Blood Vessels?



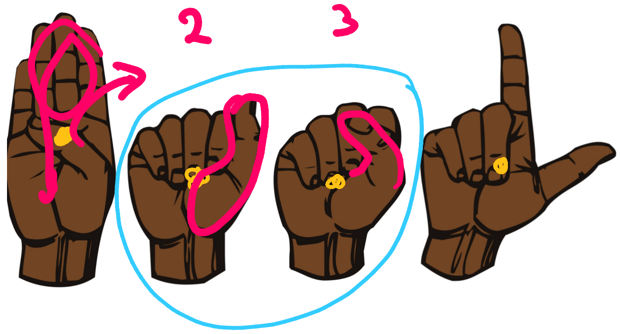
Shape of Blood cells? Round=normal, otherwise sickle cell



Recognizing American Sign Language by Hand Shape & Center of Mass

B A S L Motion

1 2 3



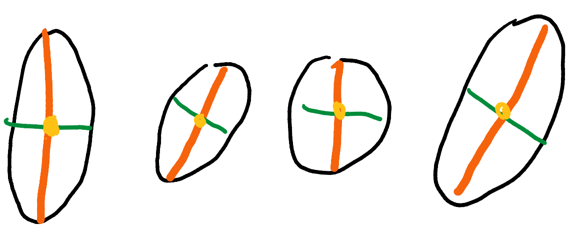
Differences based on area

If $B(x,y) = \underline{1}$ (forground)

sum+

$$\boxed{\text{area} = \sum_x \sum_y B(x,y)}$$

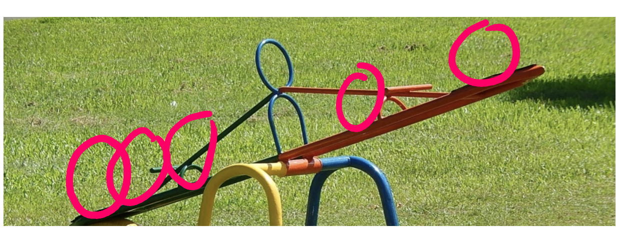
Equivalent ellipse



Major axis of equivalent ellipse = direction

Center of Mass = location

ID



$$\vec{F} \cdot \vec{x} = 0 \qquad F_i = B(x)$$

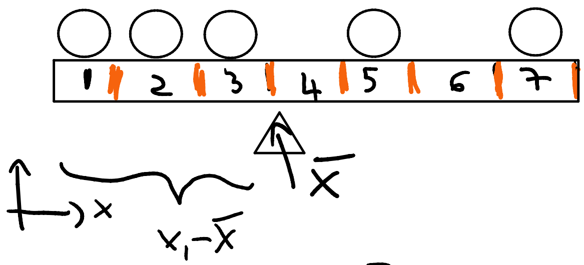
$$\begin{pmatrix} F_1 \\ \vdots \\ F_n \end{pmatrix} \begin{pmatrix} x_1 - \bar{x} \\ \vdots \\ x_n - \bar{x} \end{pmatrix} = 0 \qquad \sum_x B(x)(x - \bar{x}) = 0$$

$$\begin{pmatrix} \vdots \\ F_n \end{pmatrix} \cdot \begin{pmatrix} \vdots \\ x_n - \bar{x} \end{pmatrix} = 0 \qquad \sum_x B(x)(x - \bar{x}) = 0$$

$$\sum_x B(x)x - \bar{x}\sum_x B(x) = 0$$

$$\sum_x B(x)\bar{x} = \bar{x}\sum_x B(x)$$

$$\bar{x}\sum_x B(x) = \sum_x xB(x)$$



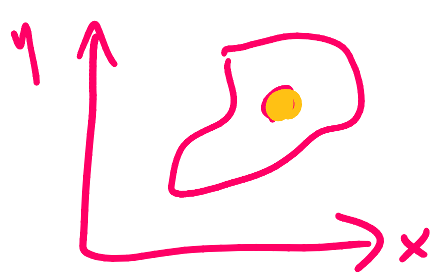
$$\boxed{\bar{x} = \frac{\sum_x xB(x)}{\sum_x B(x)}}$$

area

\# pixels in object

$$\bar{x} = \frac{1+2+3+5+7}{5} = 3.6$$

2D



$$\bar{x} = \frac{\sum_x xB(x,y)}{\sum_{x,y} B(x,y)}$$

$$\bar{y} = \frac{\sum_y yB(x,y)}{\sum_{x,y} B(x,y)}$$

$(\bar{x}, \bar{y})$ centroid = location

Representation of Lines

① $\boxed{y = mx + n}$

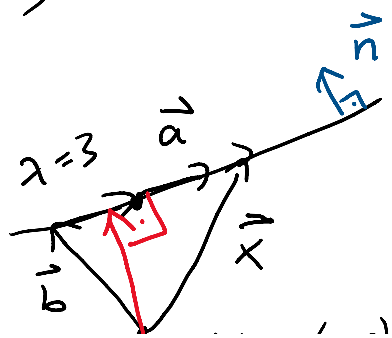
$m = \frac{\Delta y}{\Delta x}$ $\Delta x \neq 0$ $\alpha = 90°$ problem

② $\vec{x} = \lambda \vec{a} + \vec{b}$

$\vec{x}$: any point on line

$\vec{a}$: vector along line

$\vec{b}$: vector to line



normal

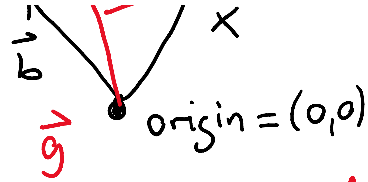
$\|\vec{n}\| = 1$

length one

perpendicular

⇕ dotproduct zero

point on line   along line   line



⇕ dotproduct zero

③ $\vec{x} = \lambda \vec{a} + \vec{g}$

$\vec{n} \cdot \vec{x} = \underbrace{\lambda \vec{n} \cdot \vec{a}}_{=0} + \vec{n} \cdot \vec{g}$

$\vec{n} \cdot \vec{x} = \underbrace{\vec{n} \cdot \vec{g}}_{g}$

g = distance of line to origin of coordinate system

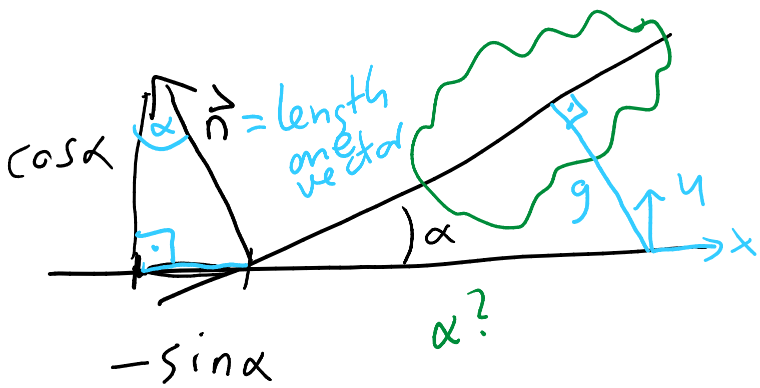
$\vec{n} \cdot \vec{x} = g$ $\vec{x} = \begin{pmatrix} x \\ y \end{pmatrix}$

$$\boxed{\vec{n} \cdot \vec{x} - g = 0}$$

④ specific $\vec{n} = \begin{pmatrix} -\sin\alpha \\ \cos\alpha \end{pmatrix}$

$$\boxed{-\sin\alpha\, x + \cos\alpha\, y - g = 0}$$

$$\boxed{x \sin\alpha - y \cos\alpha + g = 0}$$



graphics & vision

continuous changes in α

no problem