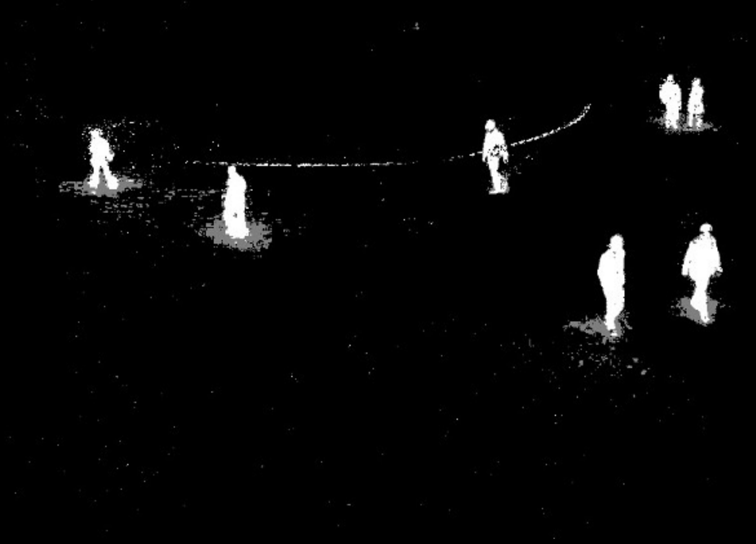
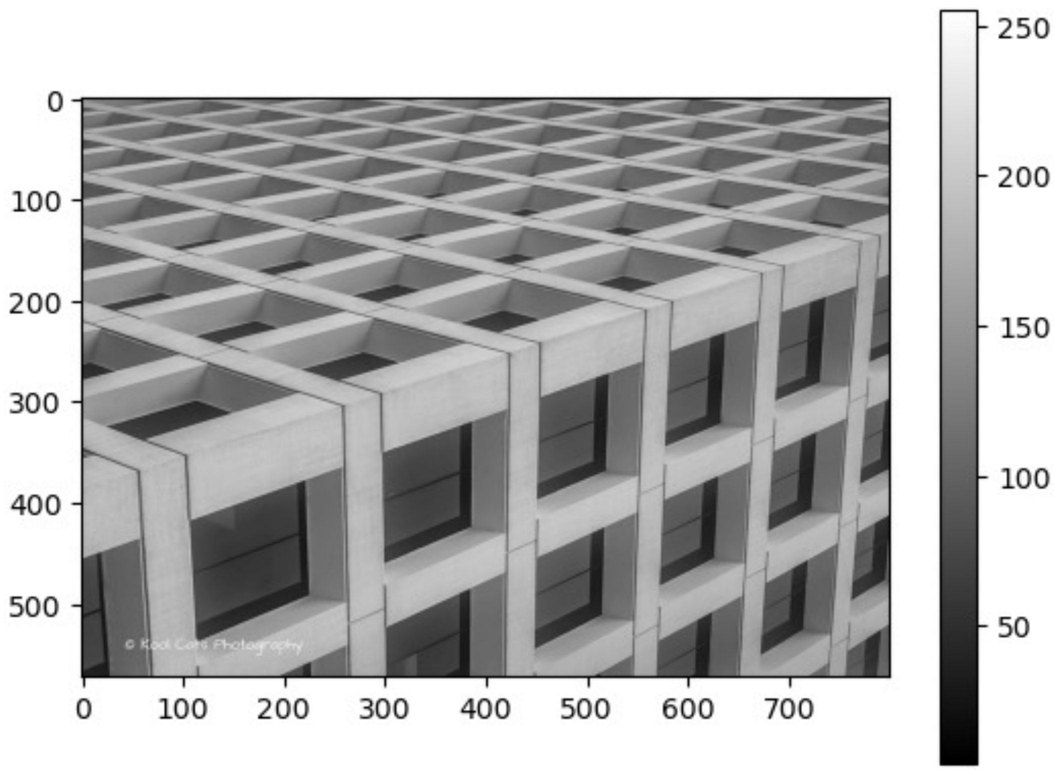


Lecture 8
Image Segmentation

ECE 1390/2390

Gaussian Mixture Models



$$Group1 \in N(I_1, \sigma_1^2)$$

$$Group2 \in N(I_2, \sigma_2^2)$$

Gaussian Mixture Models

$$Group1 \in N(I_1, \sigma_1^2)$$

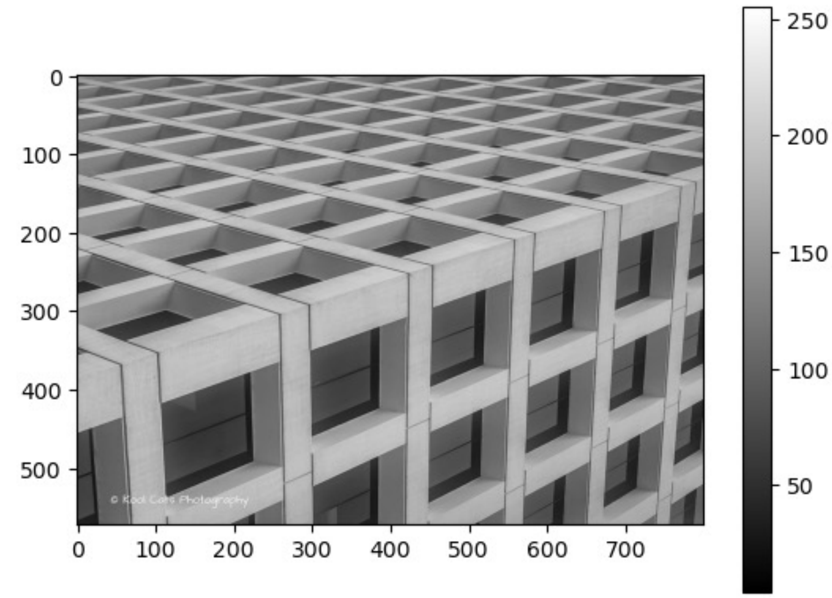
#Step 1. Expectation Step (Initial)

Guess I_1,I_2, σ_1^2, σ_2^2

$$Group2 \in N(I_2, \sigma_2^2)$$

I_1= 50
σ_1^2 = 200

I_2= 200
σ_2^2 = 200



Gaussian Mixture Models

$$Group1 \in N(I_1, \sigma_1^2)$$

$$Group2 \in N(I_2, \sigma_2^2)$$

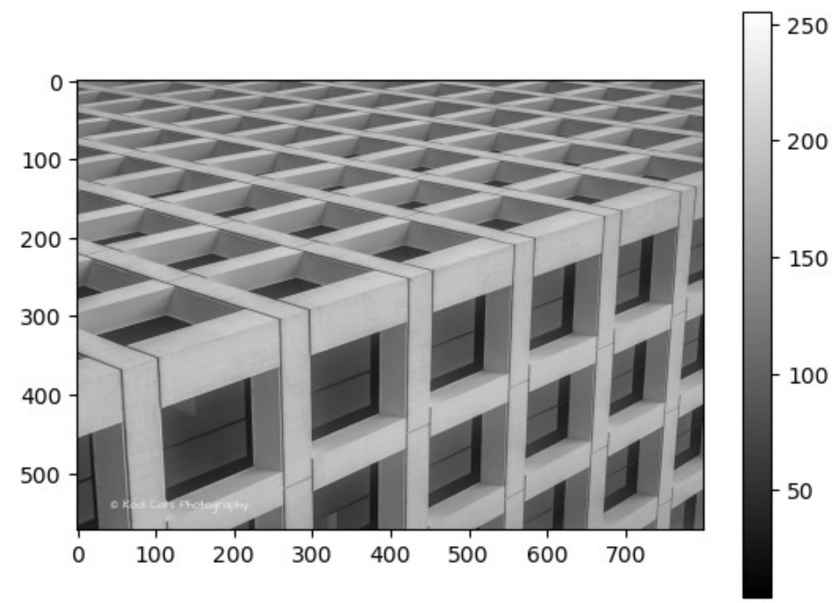
#Step 1. Expectation Step (Initial)
Guess I_1,I_2, σ_1^2, σ_2^2

#Step 2. Maximization Step (Initial)
Assign probability of pixel to each group

$$Prob(I(i,j)|G_1) = \frac{1}{\sqrt{2\pi\sigma_1^2}} e^{-\frac{(I(i,j)-\langle I_1\rangle)^2}{2\sigma_1^2}}$$

$$Prob(I(i,j)|G_2) = \frac{1}{\sqrt{2\pi\sigma_2^2}} e^{-\frac{(I(i,j)-\langle I_2\rangle)^2}{2\sigma_2^2}}$$

$$Prob\big(G_1|I(i,j)\big) = \frac{Prob(I(i,j)|G_1)}{Prob(I(i,j)|G_1) + Prob(I(i,j)|G_2)}$$



Gaussian Mixture Models

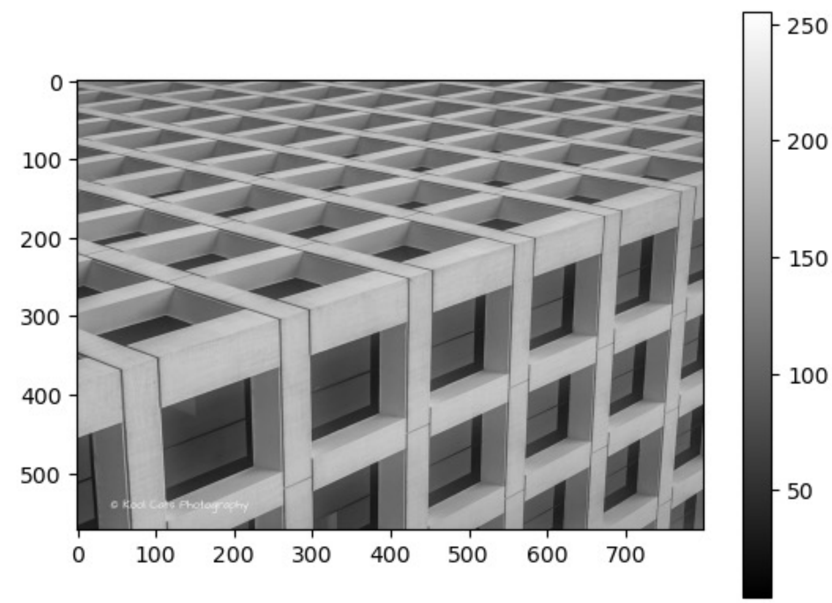
$$Group1 \in N(I_1, \sigma_1^2)$$

$$Group2 \in N(I_2, \sigma_2^2)$$

#Step 1. Expectation Step (Initial)
Guess I_1,I_2, σ_1^2, σ_2^2

#Step 2. Maximization Step (Initial)
Assign probability of pixel to each group

while(.):
# Step a. Expectation Step Update
$\langle I_1 \rangle = \sum_{pixels} Prob(G_1|X(i,j)) * I(i,j)$
$\left\langle \sigma_1^2 \right\rangle = \sum_{pixels} Prob(G_1|X(i,j)) * (I(i,j) \ - \langle I_1 \rangle)^2$



Gaussian Mixture Models

$$Group1 \in N(I_1, \sigma_1^2)$$

$$Group2 \in N(I_2, \sigma_2^2)$$

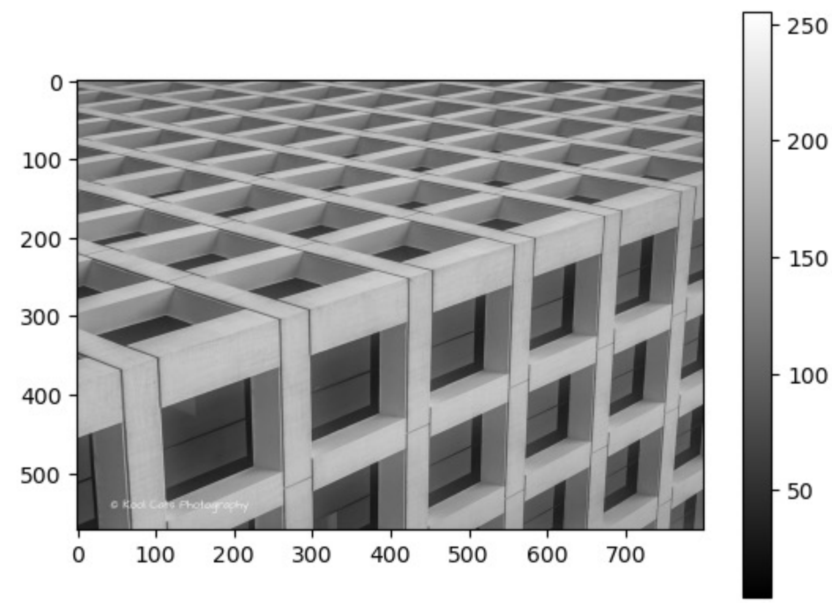
#Step 1. Expectation Step (Initial)
Guess $I_1, I_2, \sigma_1^2, \sigma_2^2$

#Step 2. Maximization Step (Initial)
Assign probability of pixel to each group

while(.):
# Step a. Expectation Step Update
$\langle I_1 \rangle = \sum_{pixels} Prob(G_1|X(i,j)) * I(i,j)$
$\langle \sigma_1^2 \rangle = \sum_{pixels} Prob(G_1|X(i,j)) * (I(i,j) - \langle I_1 \rangle)^2$

Step b. Maximization Step Update

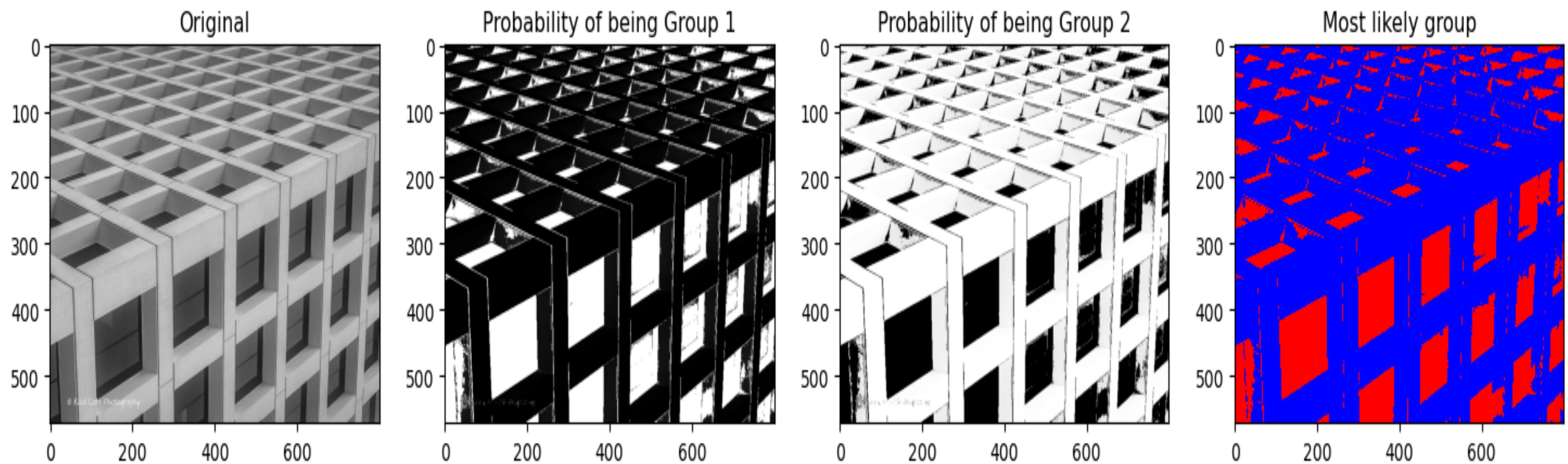
$$Prob(G_1) = \frac{1}{\sqrt{2\pi\sigma_1^2}} e^{-\frac{(I(i,j)-\langle I_1 \rangle)^2}{2\sigma_1^2}}$$



Gaussian Mixture Models

$$Group1 \in N(I_1, \sigma_1^2)$$

$$Group2 \in N(I_2, \sigma_2^2)$$



Gaussian Mixture Models (Color Extension)

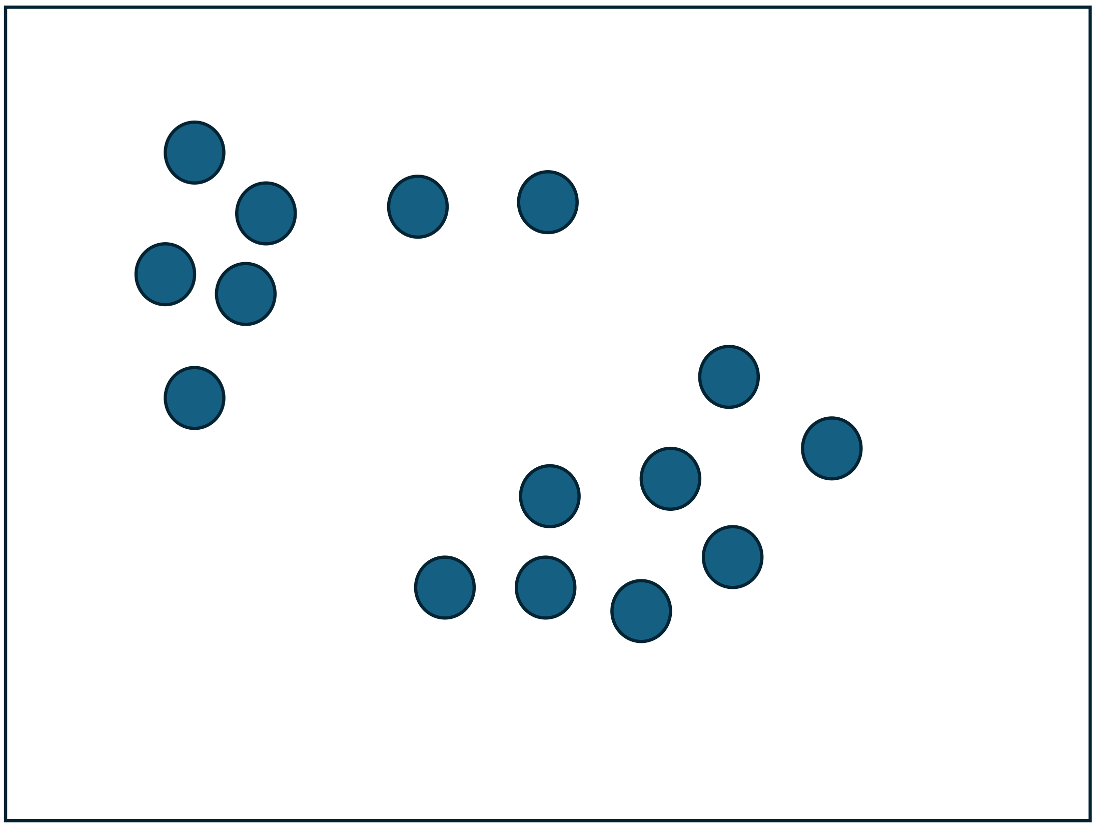
$$Prob(X|G_1) = \frac{1}{\sqrt{|\Sigma_1|(2\pi)^k}} e^{-\frac{1}{2}(X-\mu_1)^T \Sigma_1{}^{-1}(X-\mu_1)}$$

Covariance < 3 x 3 >. [RGB]

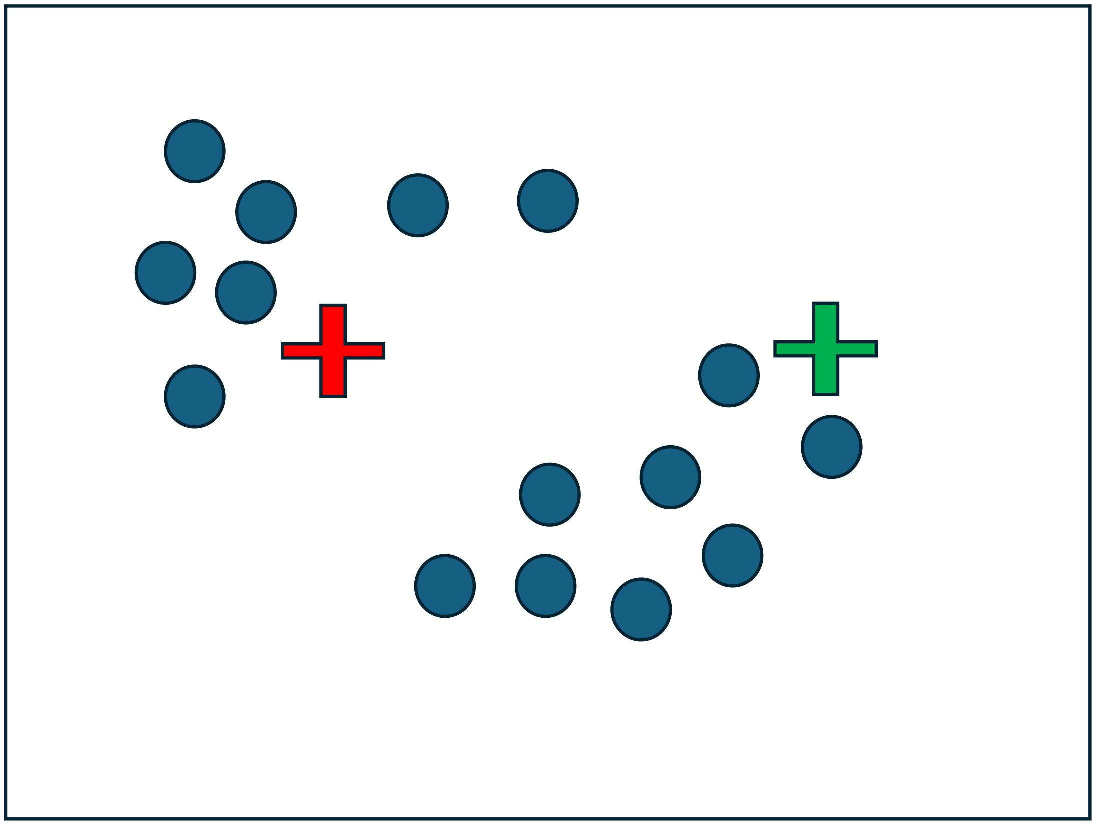
Expected Color < 3 x 1 >. [RGB]

K=3 [RGB]

K-Nearest Neighbors



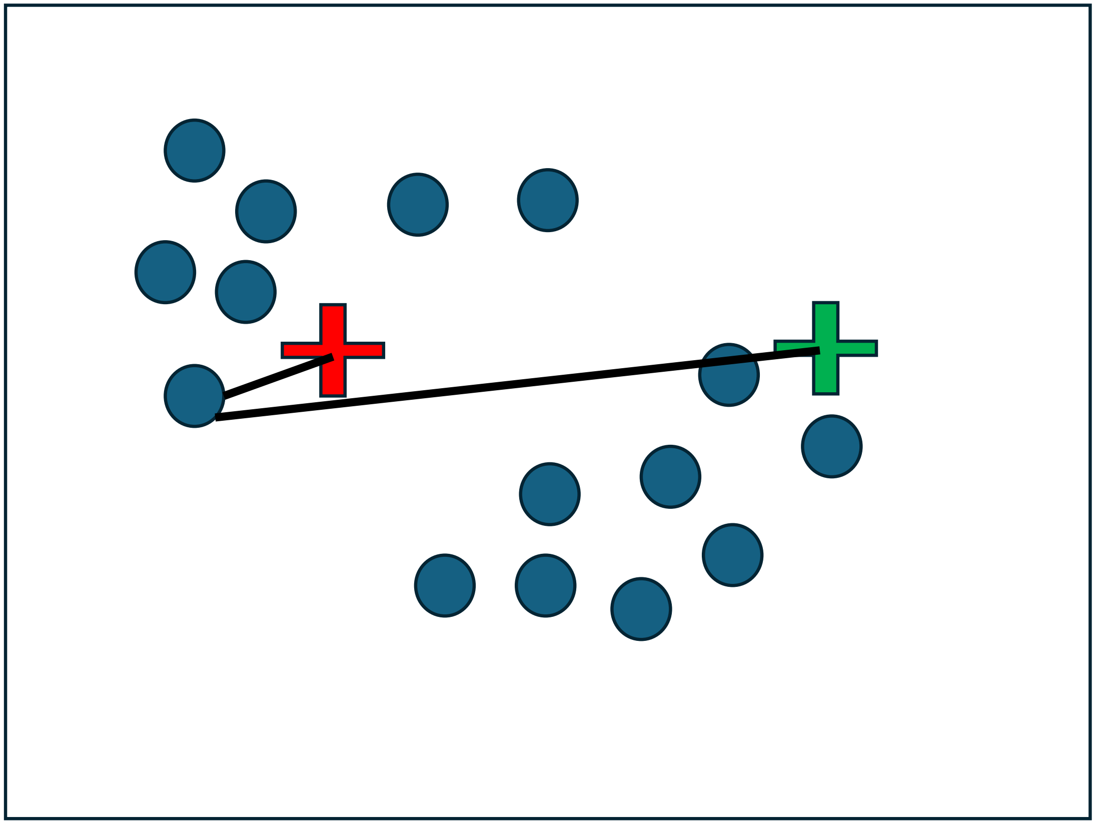
K-Nearest Neighbors



Step 1. Guess the number of groups

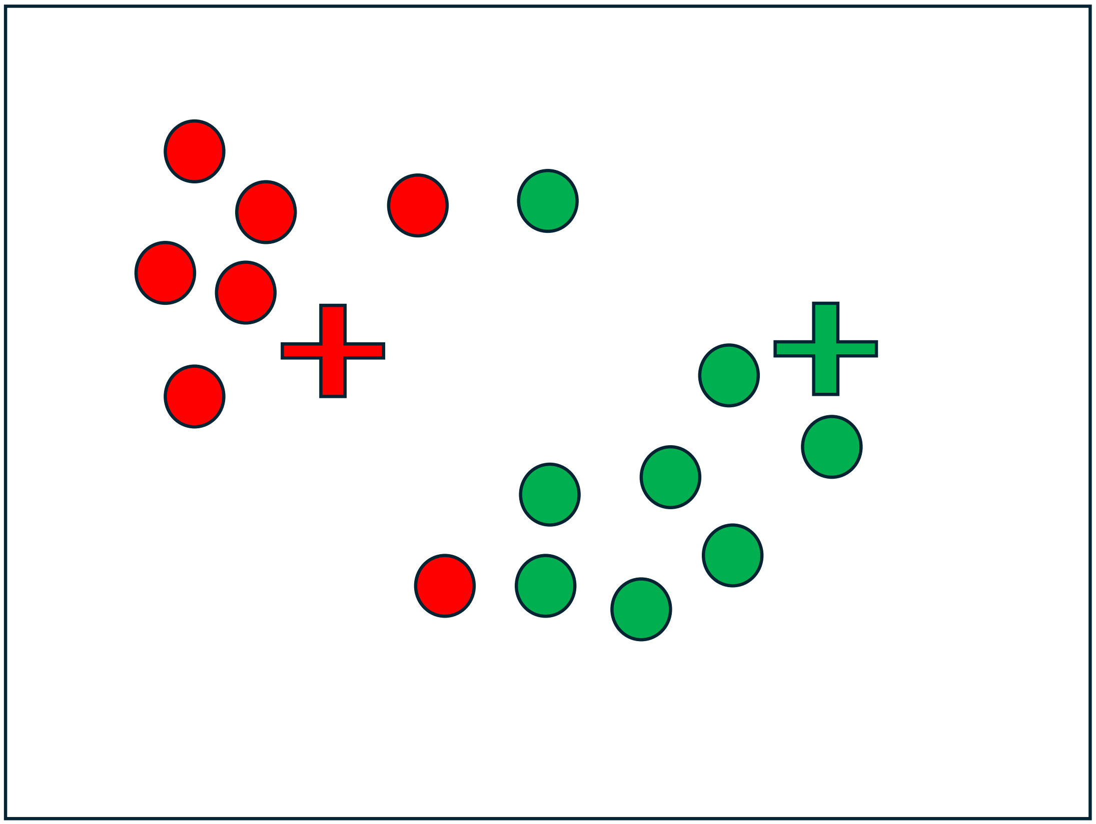
Step 2. Guess the center of the groups

K-Nearest Neighbors



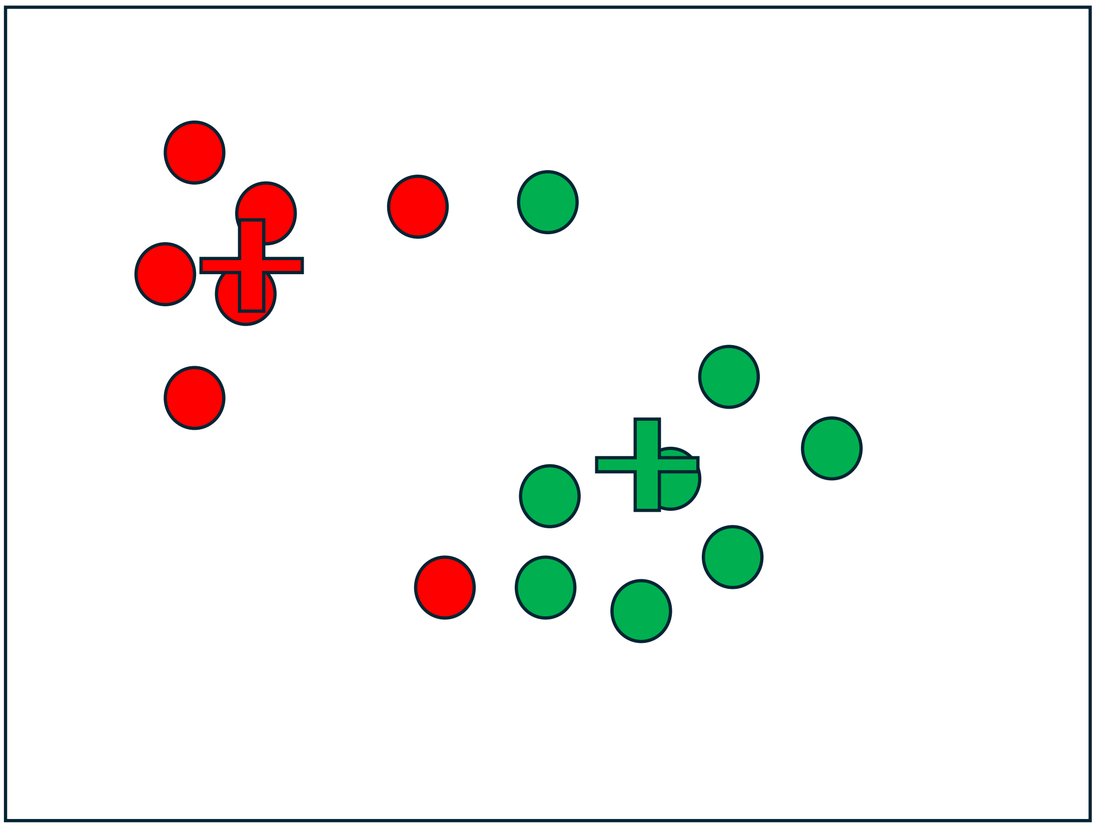
Step 3. Calculate the distance from each sample to the center of each group

K-Nearest Neighbors



Step 4. Assign sample to closest group

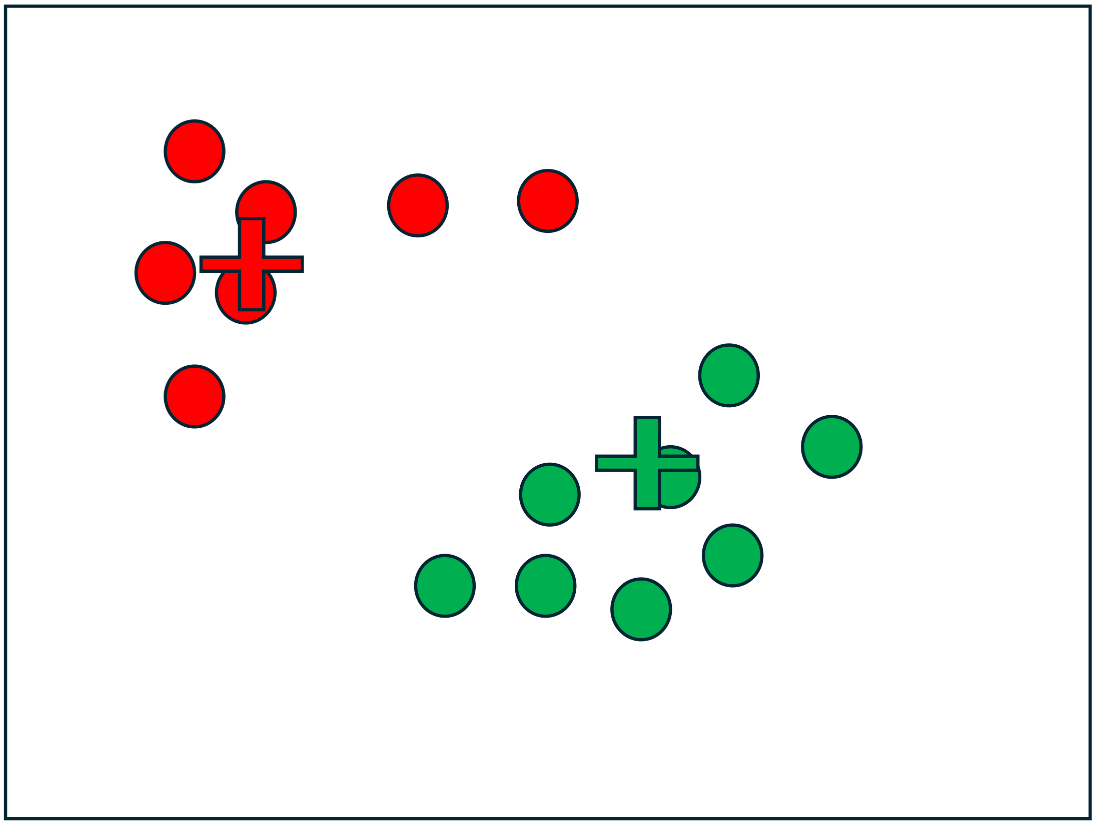
K-Nearest Neighbors



[Step 5. Remove low membership groups]

Step 6. Update the center of the group

K-Nearest Neighbors



Repeat [3-6]

K-Nearest Neighbors

$X = [R, G, B]$ Color only segmentation

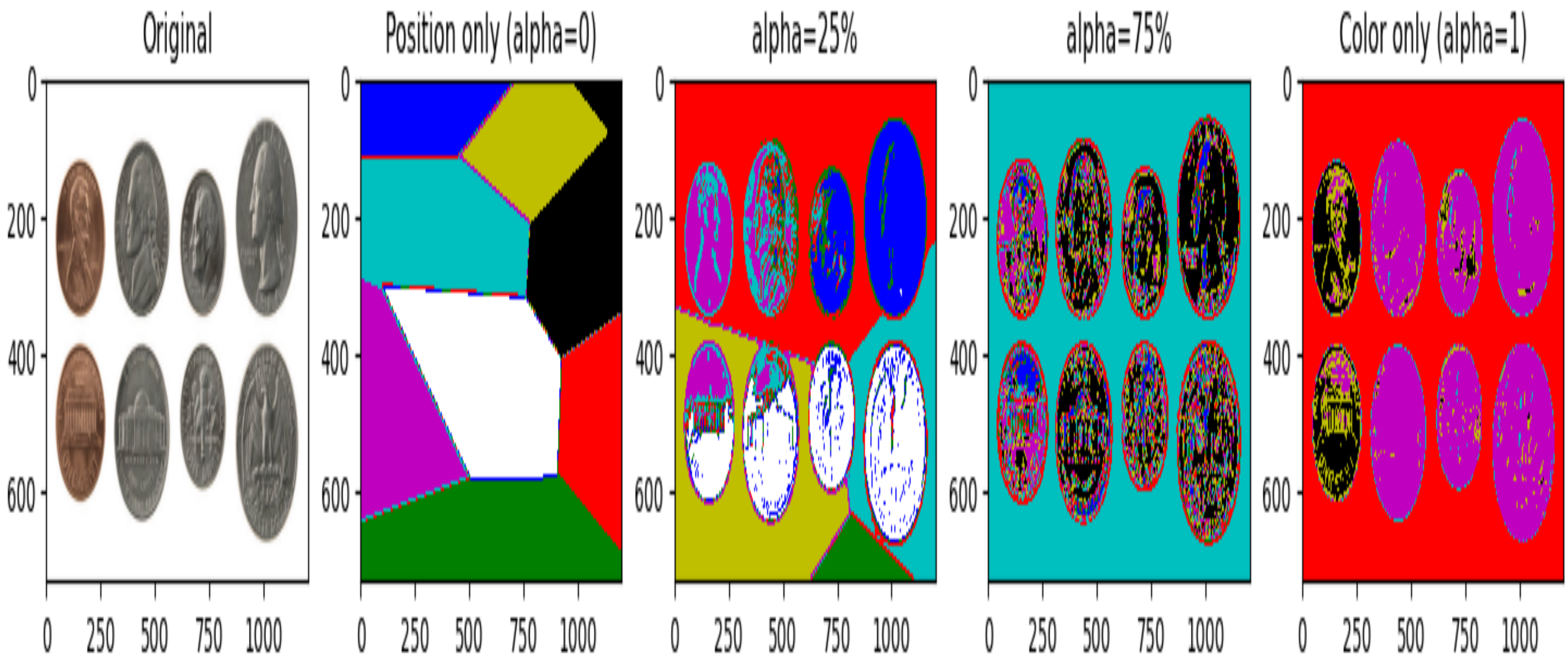
$X = [i, j]$ Position only segmentation

$X = [R, G, B, \alpha * i, \alpha * j]$ Position & Color segmentation

$\alpha \rightarrow$ Large favors position

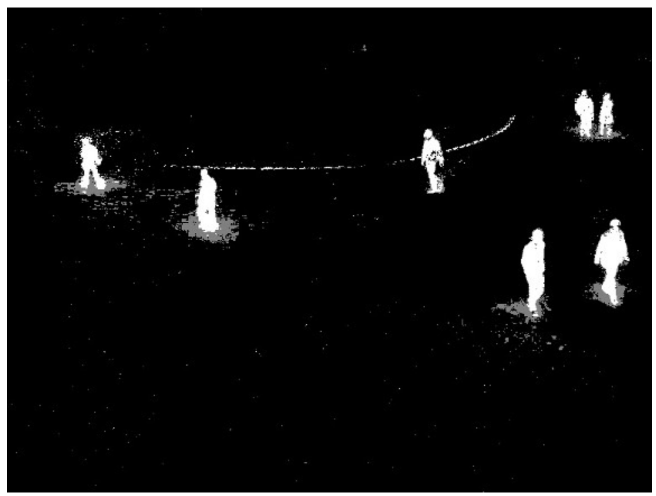
$\alpha \rightarrow$ small favors color

K-Nearest Neighbors



OpenCV
Background Subtractor

cv.createBackgroundSubtractorMOG2()



cv.createBackgroundSubtractorKNN()