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# Fuzzy C Means and its variants

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sFCM  
(spatial)

Conventional FCM

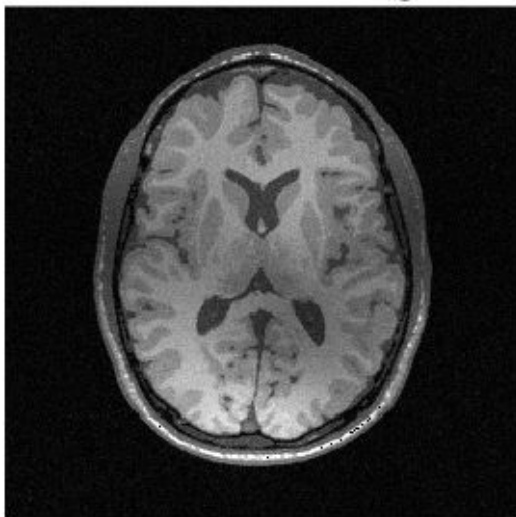
Bias-corrected FCM

Bias-corrected  
embedded FCM  
with regularisation

Bias-corrected FCM  
with spatial

# MRI Image and Coin Image

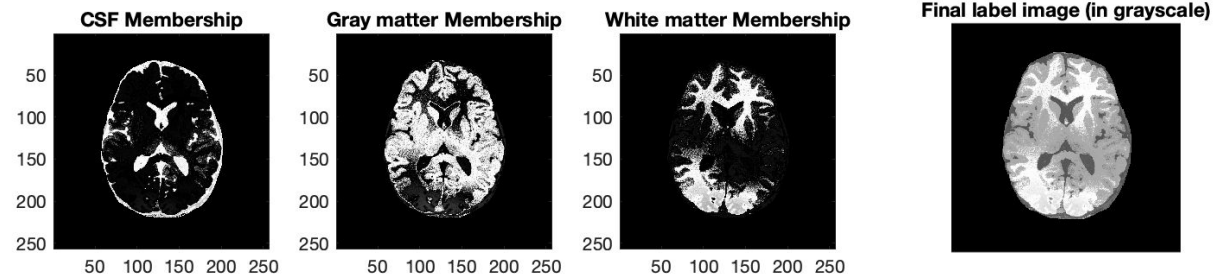
**UnMasked Image**



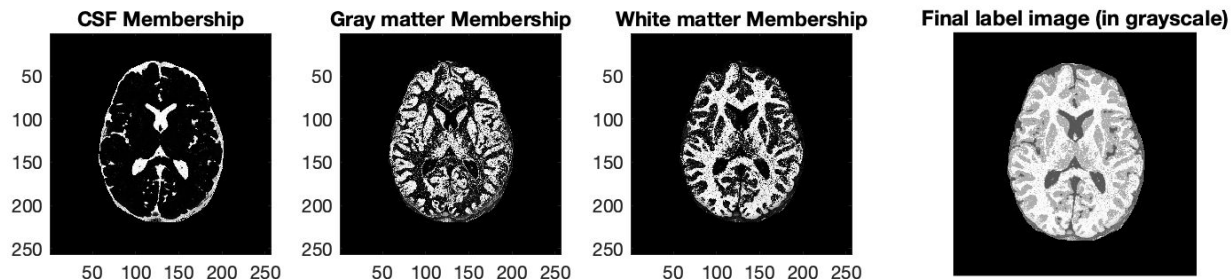
**UnMasked Image**



# Conventional and Bias Corrected FCM



Conventional



Bias Corrected

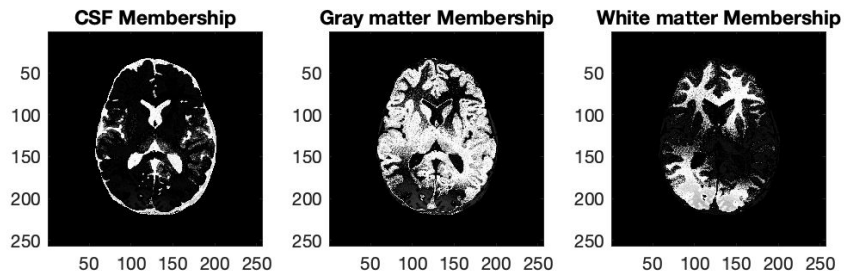
## sFCM

$$h_i(\mathbf{x}) = \sum_{\mathbf{y} \in N_{\mathbf{x}}} u_i(\mathbf{y})$$

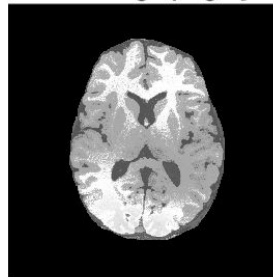
Spatial  
smoothness

$$\hat{u}_i(\mathbf{x}) = \frac{h_i^o(\mathbf{x}) u_i^p(\mathbf{x})}{\sum_{k=1}^C h_k^o(\mathbf{x}) u_k^p(\mathbf{x})}$$

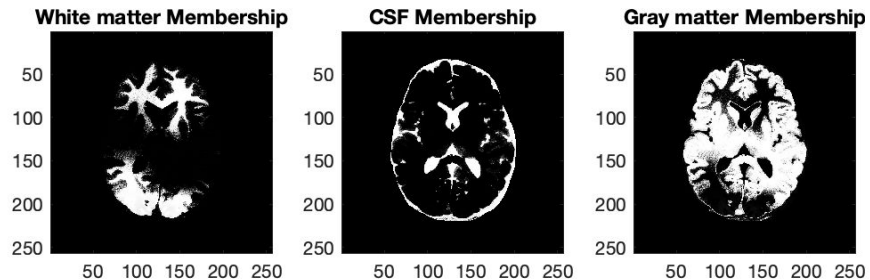
# sFCM



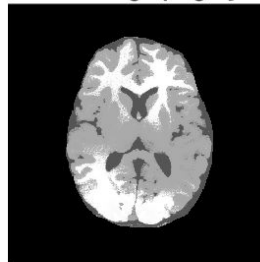
Final label image (in grayscale)



Conventional

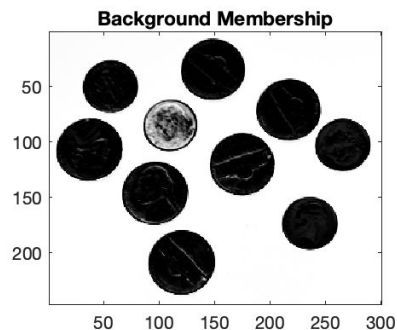
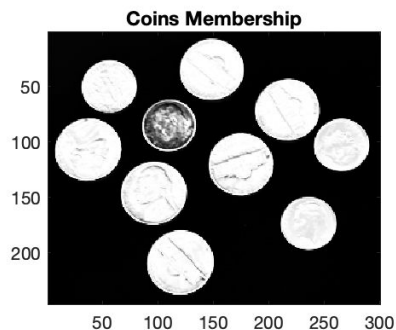


Final label image (in grayscale)



sFCM

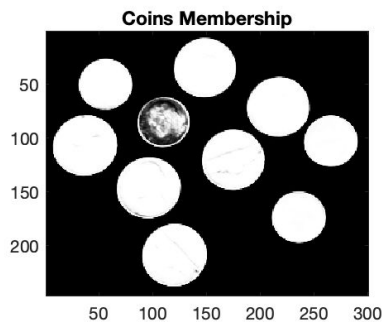
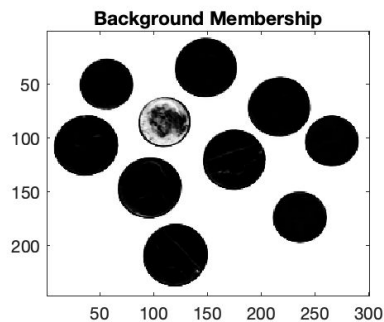
# sFCM



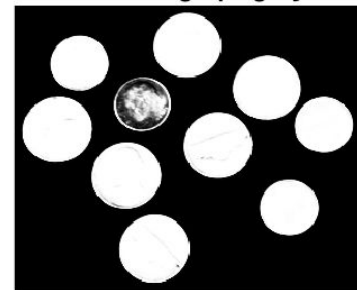
**Final label image (in grayscale)**



Conventional

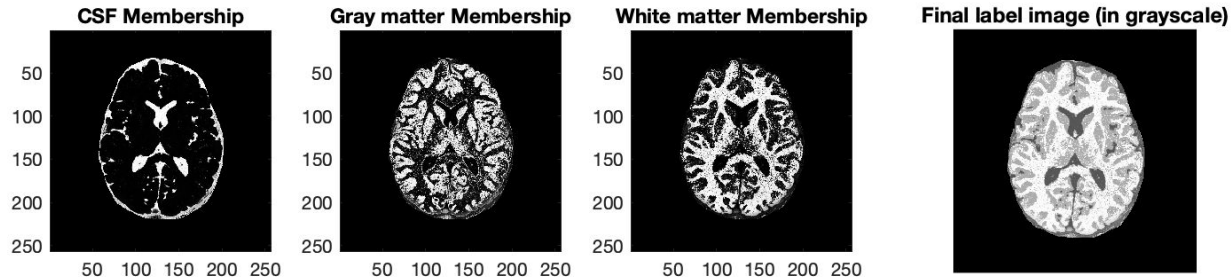


**Final label image (in grayscale)**

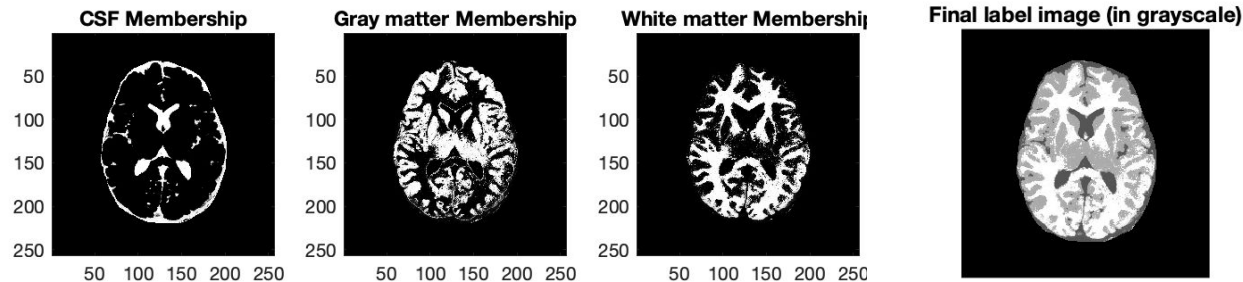


sFCM

# Bias Corrected FCM with Spatial



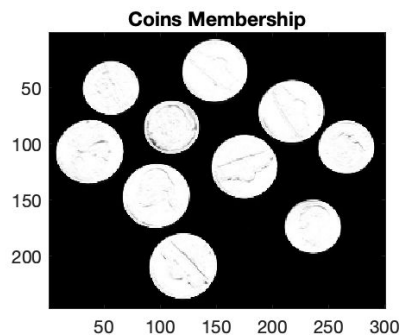
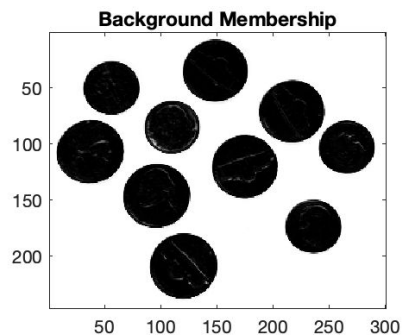
Bias Corrected



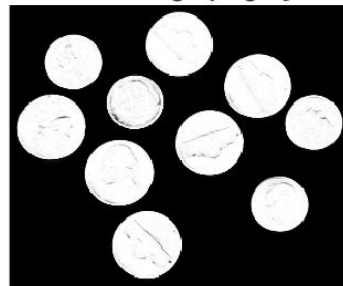
BCFCM\_S



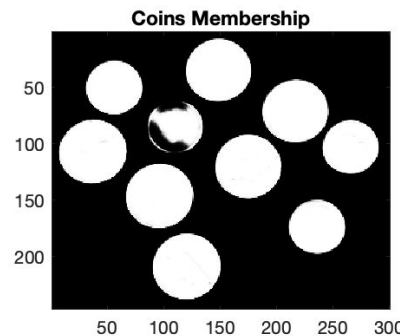
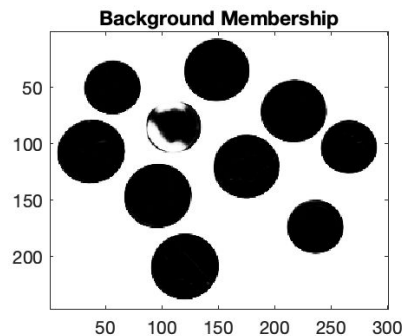
# Bias Corrected FCM with Spatial



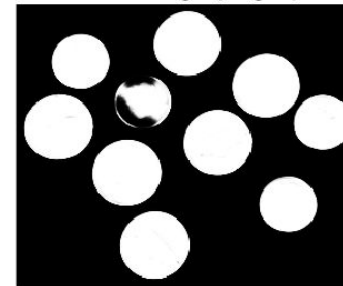
Final label image (in grayscale)



Bias Corrected



Final label image (in grayscale)



BCFCM\_S

# Bias corrected Embedded FCM with regularisation

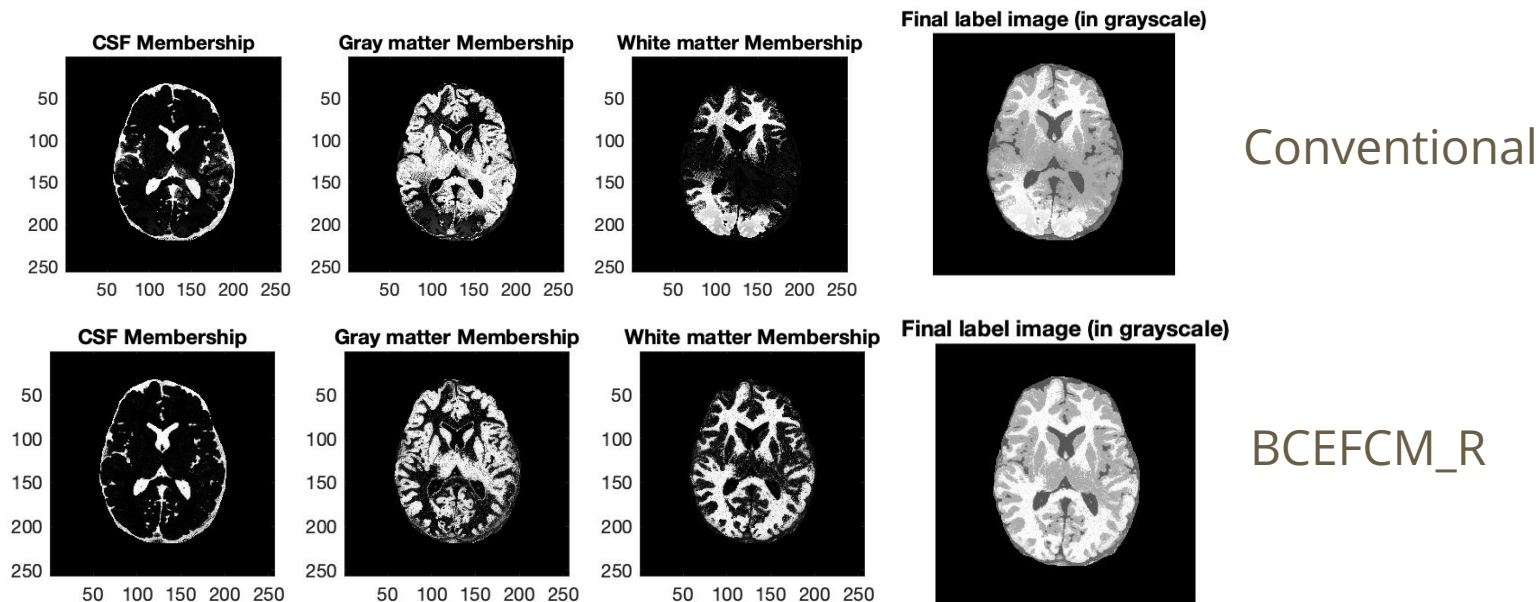
$$\mathcal{F}_{bcefcms} = \int_{\Omega} \sum_{i=1}^c \lambda_i \left\| \mathbf{I}(\mathbf{x}) - \mathbf{b}(\mathbf{x}) \circ \mathbf{c}_i \right\|_2^2 u_i^q(\mathbf{x}) d\mathbf{x} + \frac{\alpha}{N_R} \int_{\Omega} \sum_{i=1}^c \lambda_i u_i^q(\mathbf{x}) \sum_{\mathbf{y} \in N_{\mathbf{x}}} (1 - u_i(\mathbf{y}))^q d\mathbf{x}$$

Balances cluster sizes

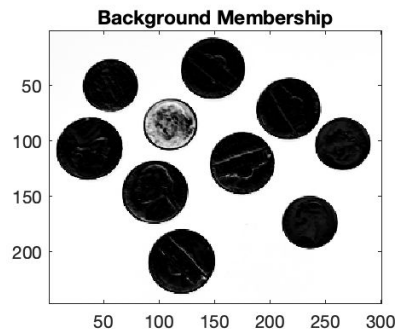
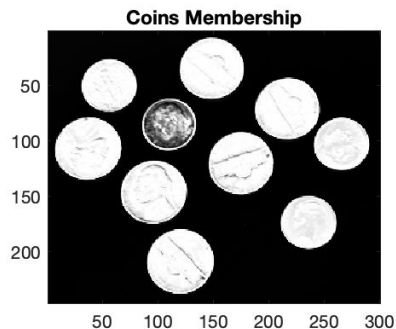
Bias corrected FCM

Regularization term

# Bias corrected Embedded FCM with regularisation



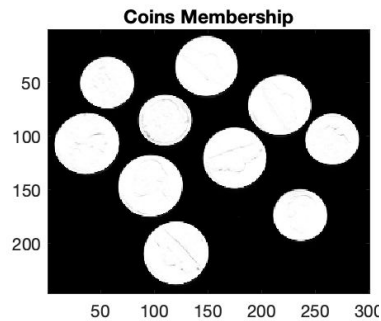
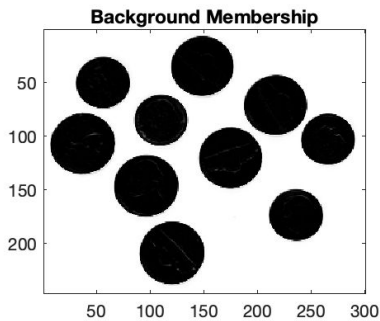
# Bias corrected Embedded FCM with regularisation



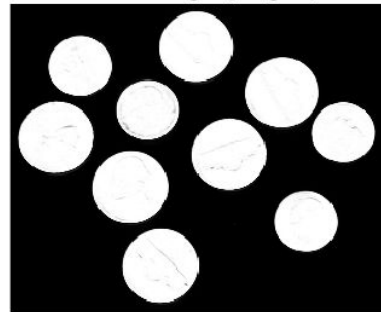
**Final label image (in grayscale)**



Conventional

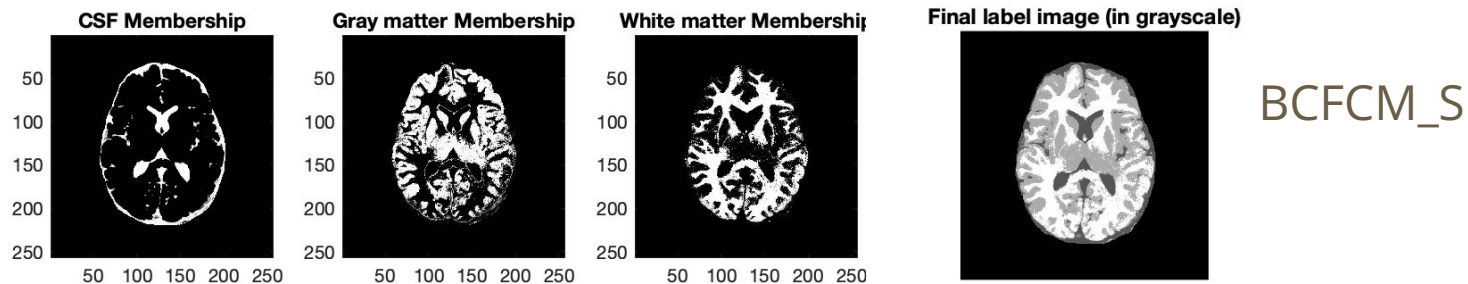
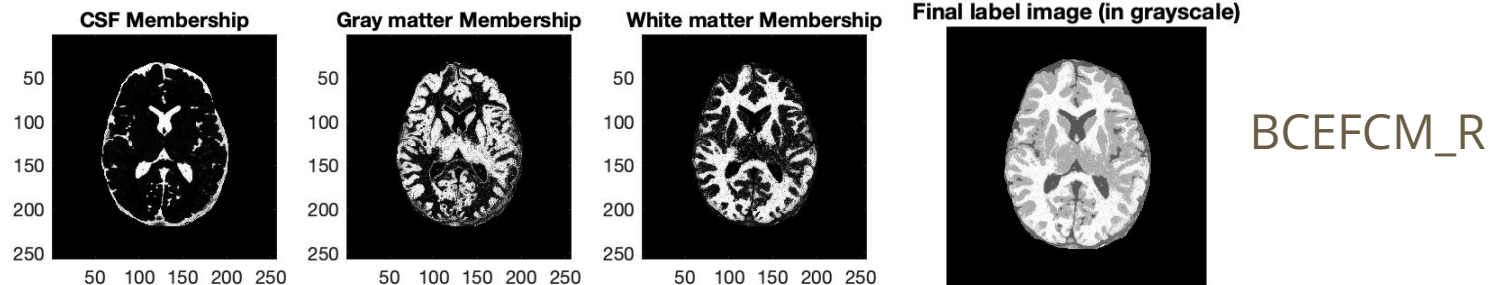


**Final label image (in grayscale)**

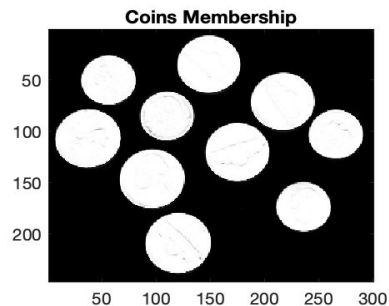
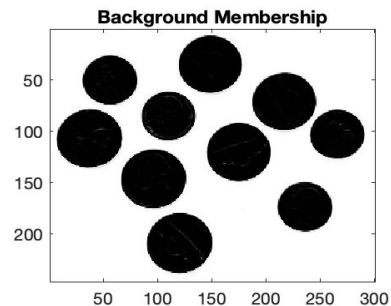


BCEFCM\_R

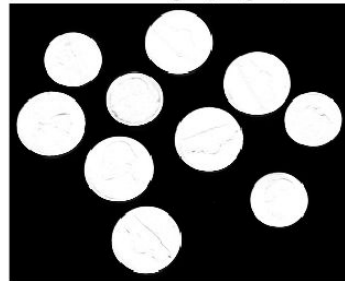
# BCEFCM\_R & BCFCM\_S



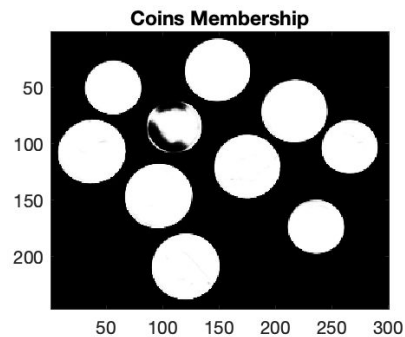
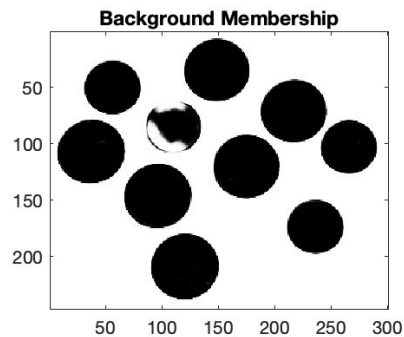
# BCEFCM R & BCFCM S



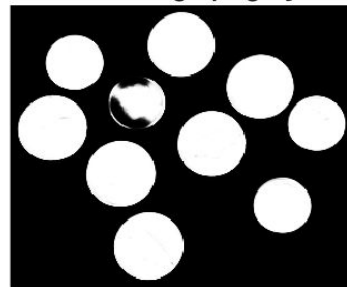
Final label image (in grayscale)



BCEFCM\_R



Final label image (in grayscale)



BCFCM\_S

# Fundamental Limitation

- Usage of only intensity values
- Spatial information is very limited

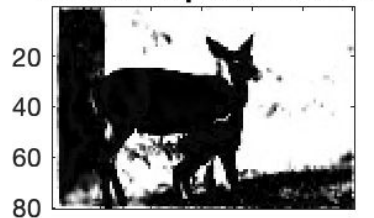
Intensity essentially dictates membership values.

# Deer Image



## Conventional FCM

Membership for cluster 1



20 40 60 80 100 120

Membership for cluster 2



20 40 60 80 100 120

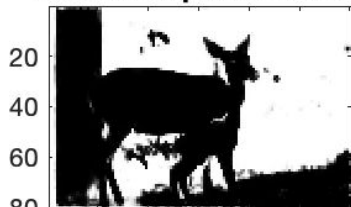
Membership for cluster 3



20 40 60 80 100 120

## BCFCM\_S

Membership for cluster 1



20 40 60 80 100 120

Membership for cluster 2



20 40 60 80 100 120

Membership for cluster 3

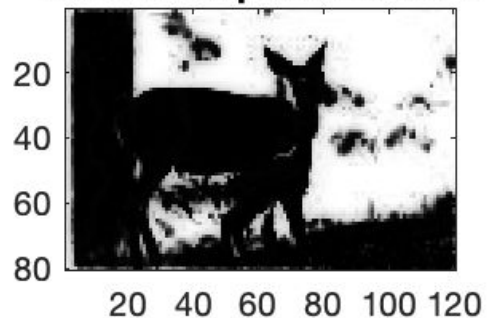


20 40 60 80 100 120

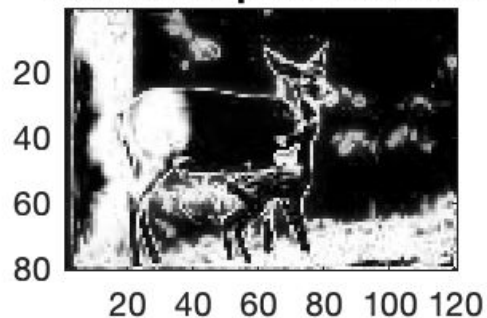


## BCFECM\_R

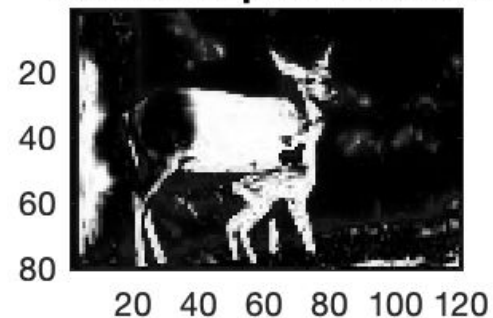
**Membership for cluster 1**



**Membership for cluster 2**



**Membership for cluster 3**



**Thank you**