



# Automatic segmentation of *Chaetoceros* microscopic images via pixel-wise classification

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## 2 Method

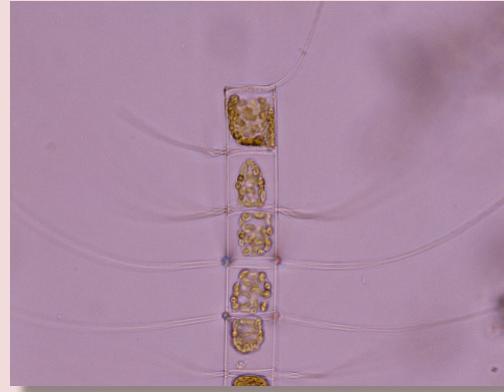
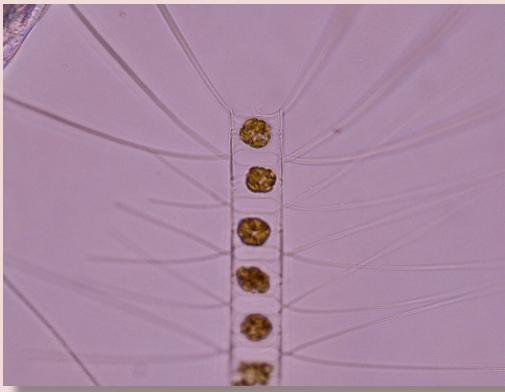
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# *Chaetoceros* segmentation: why do we do this?

Three different types of *Chaetoceros* microscopic images



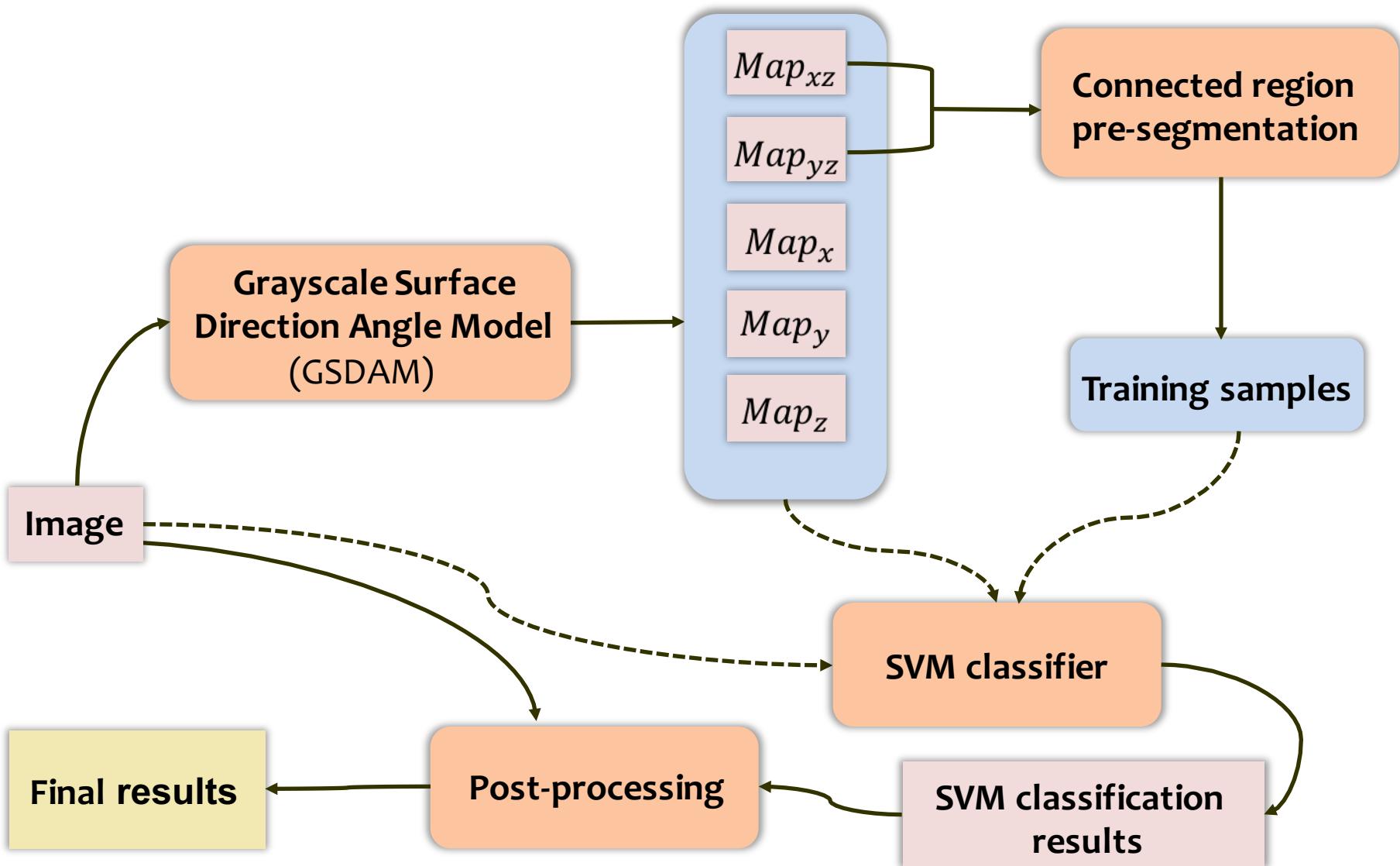
*Chaetoceros* segmentation is the prior step for the identification and classification of *Chaetoceros*.

# The biggest difficulty of segmenting *Chaetoceros*

- Unique **biomorphic characteristics** of Chaetoceros
  - Chain-forming cells
  - Long and thin setae structures
- **Low contrast** and **noise interference**



# Brief framework of our method



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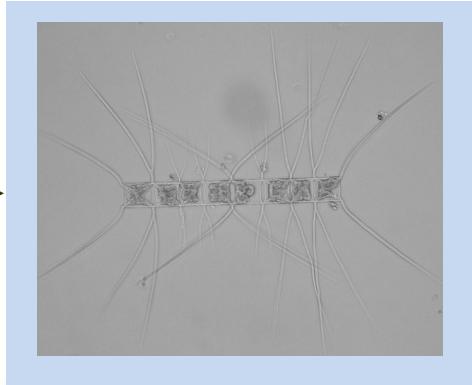
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# Before our method



**Resize  
Grayscale**



- Decrease the computational complexity of SVM classification
- The effect of imaging device and the filters on color

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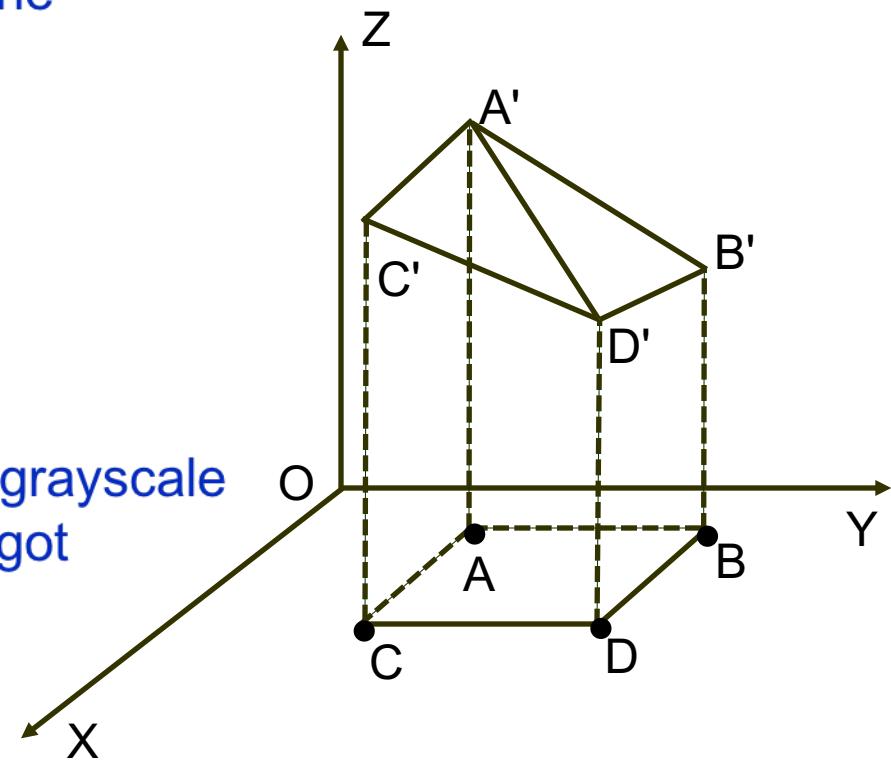
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# The steps of GSDAM

1 Calculate the normal vector of the plane  $A'C'B'$ ,  $B'A'D'$ ,  $D'B'C'$ , and  $C'D'A'$ .

2 Estimate the normal vector  $\vec{f}_{A'}$  to the grayscale surface at  $A'$  by four normal vectors we got before.



$A(i, j), B(i, j + 1), C(i + 1, j), D(i + 1, j + 1)$

# The steps of GSDAM

- 3 Calculate the angles between  $\vec{f_{A'}}$  with the coordinates  $(f_x, f_y, f_z)$ .

$$\theta_x(i,j) = 360 \times \cos^{-1}(f_x / |\vec{f_{A'}}|) / 2\pi$$

$$\theta_y(i,j) = 360 \times \cos^{-1}(f_y / |\vec{f_{A'}}|) / 2\pi$$

$$\theta_z(i,j) = 360 \times \cos^{-1}(f_z / |\vec{f_{A'}}|) / 2\pi$$

# The steps of GSDAM

- 4 Obtain five maps from degrees of five direction angles to grayscale intensity values.

$$Map_x(i, j) = 255 \times \frac{\theta_x(i, j) - \min(\theta_x)}{\max(\theta_x) - \min(\theta_x)}$$

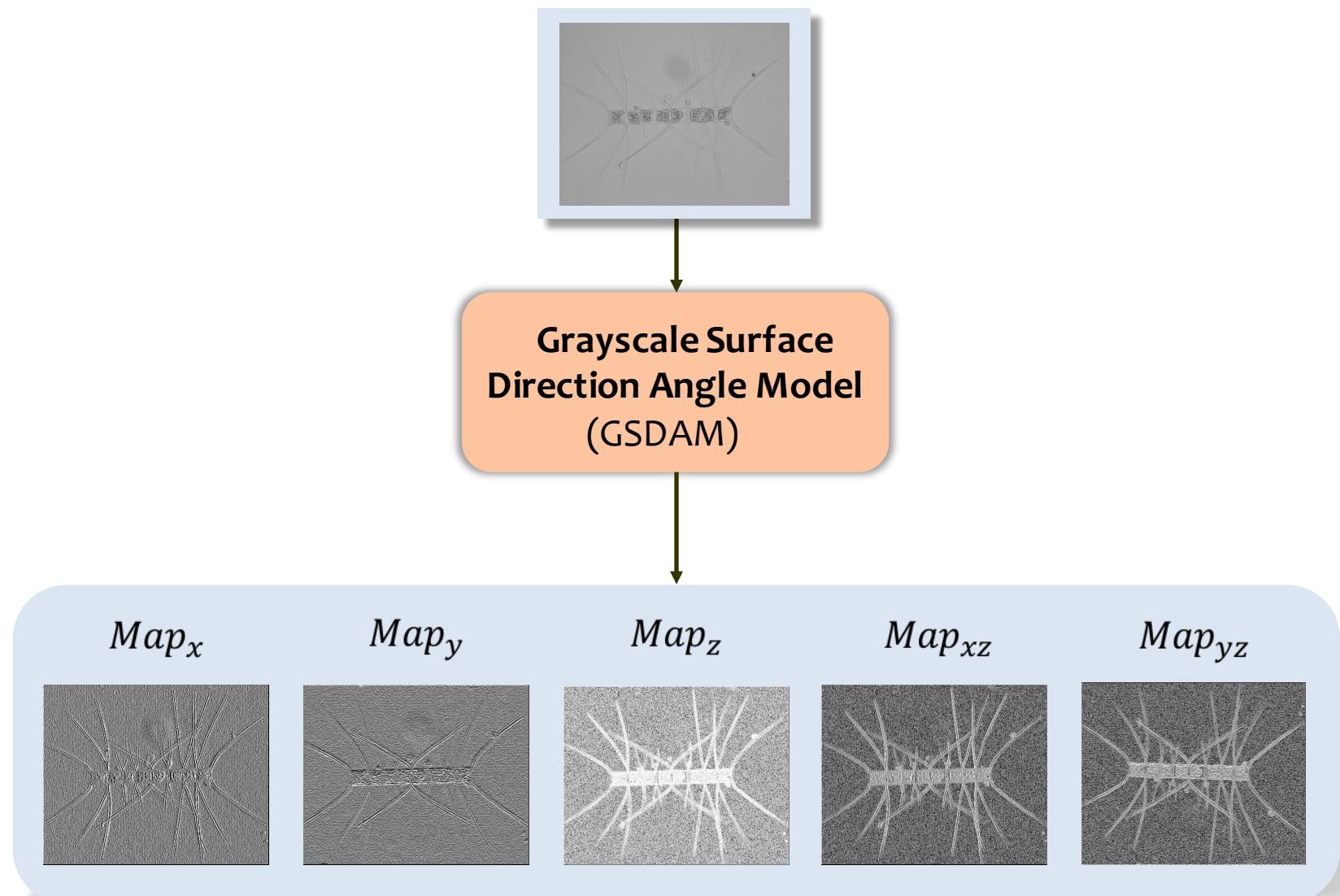
$$Map_y(i, j) = 255 \times \frac{\theta_y(i, j) - \min(\theta_y)}{\max(\theta_y) - \min(\theta_y)}$$

$$Map_z(i, j) = 255 \times \frac{\theta_z(i, j) - \min(\theta_z)}{\max(\theta_z) - \min(\theta_z)}$$

$$Map_{xz}(i, j) = \sqrt{Map_x(i, j)^2 + Map_z(i, j)^2}$$

$$Map_{yz}(i, j) = \sqrt{Map_y(i, j)^2 + Map_z(i, j)^2}$$

# Grayscale Surface Direction Angle Model



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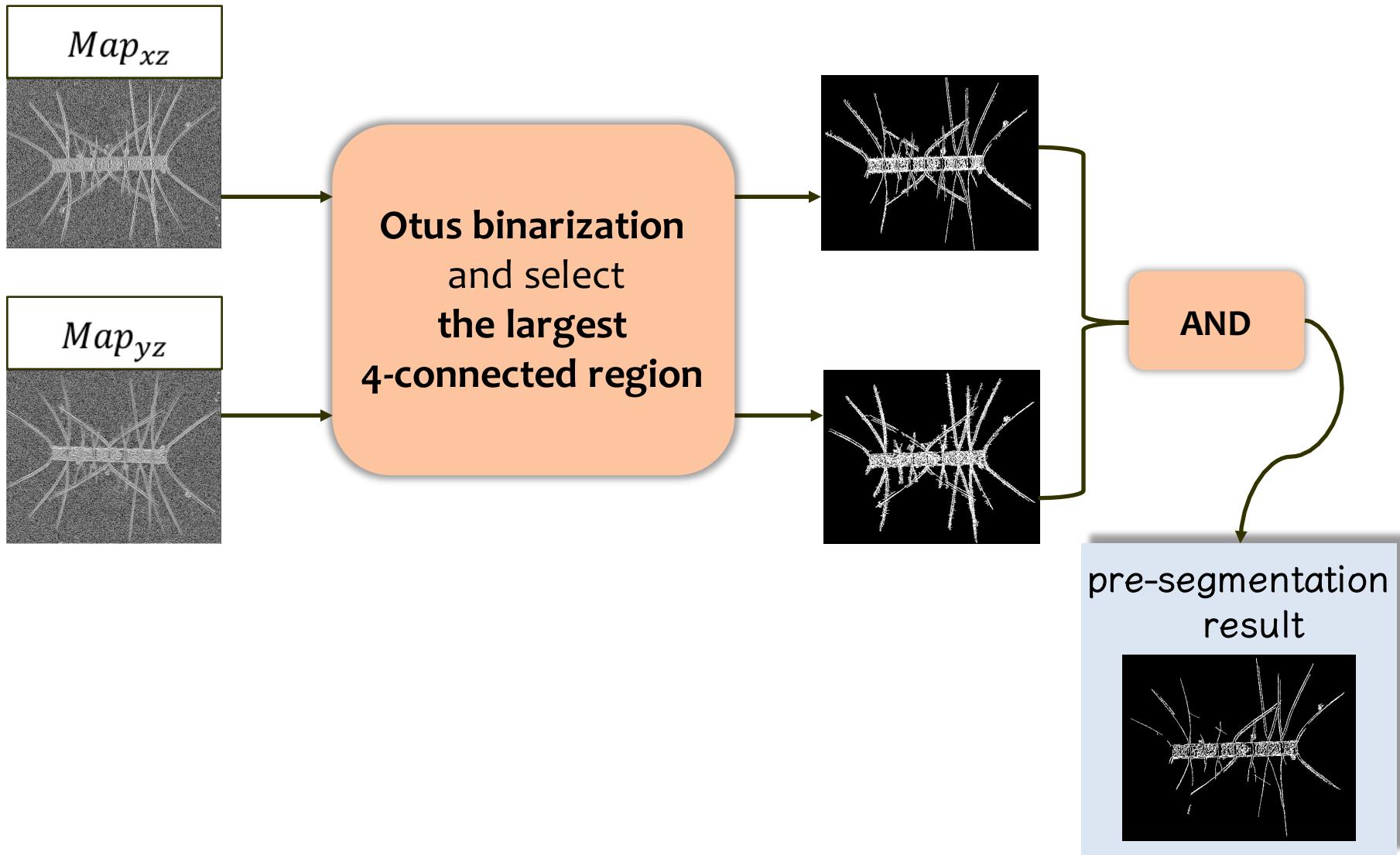
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# Connected region pre-segmentation



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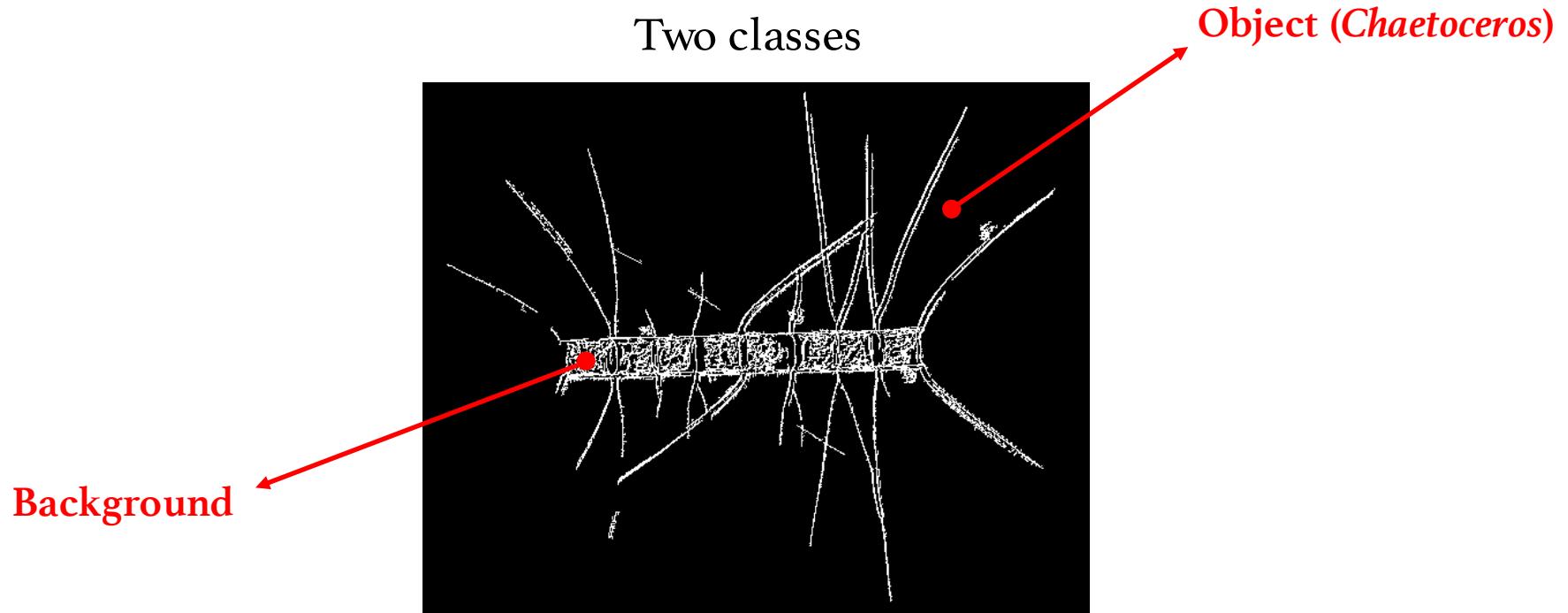
## 2 Method

- Step 1: Grayscale Surface Direction Angle Model
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- **Step 3: SVM classification and Post-processing**

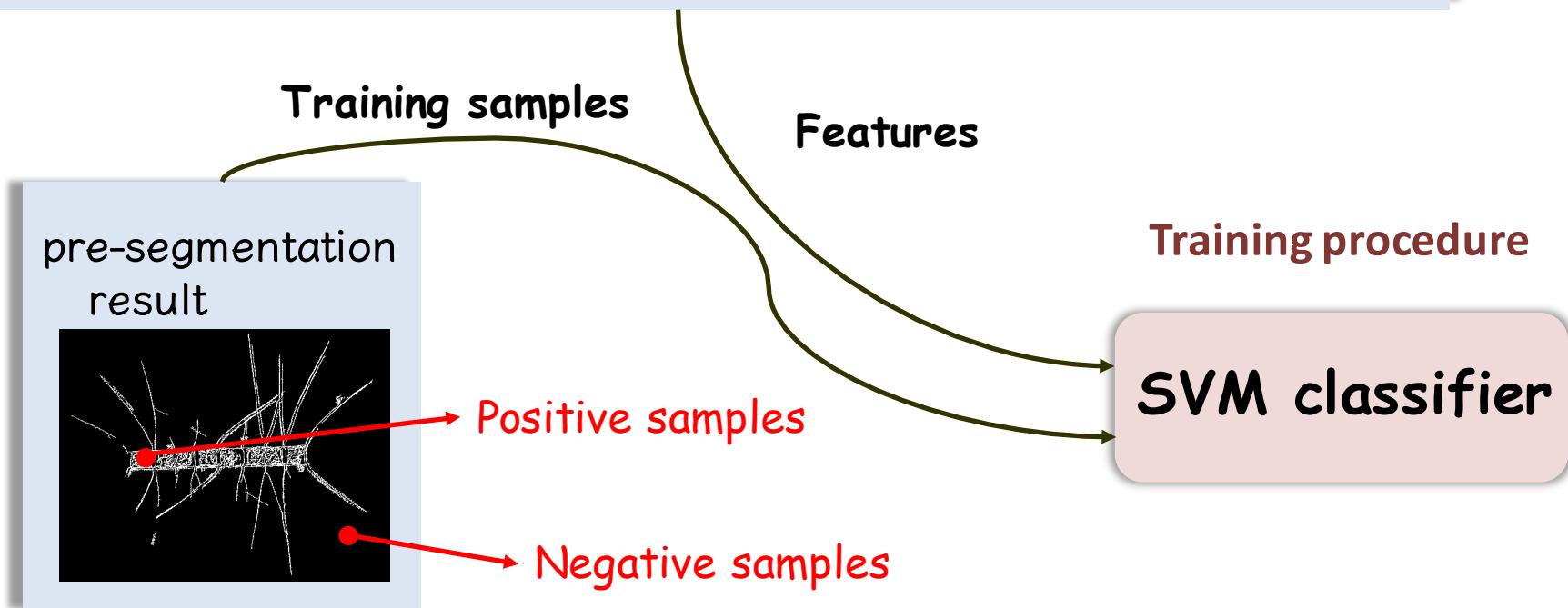
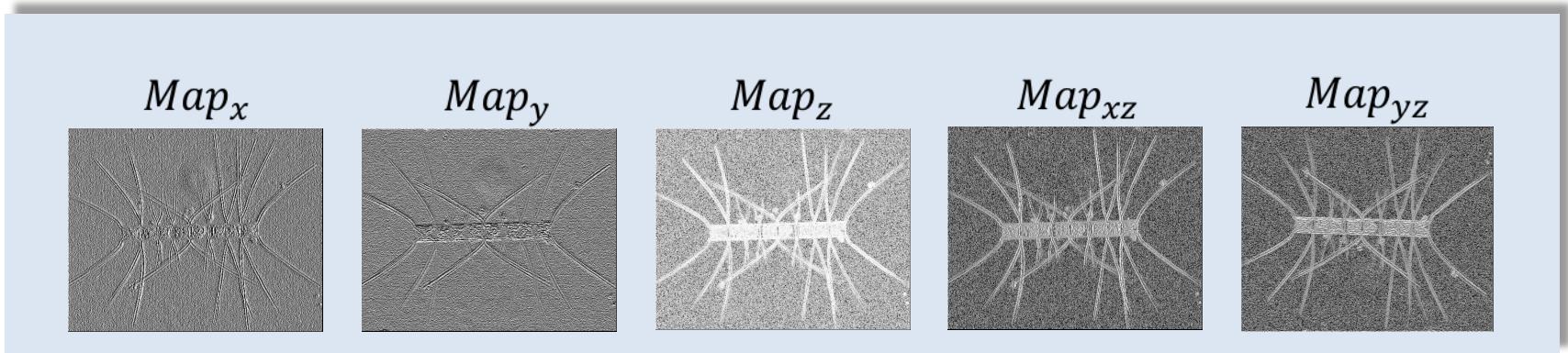
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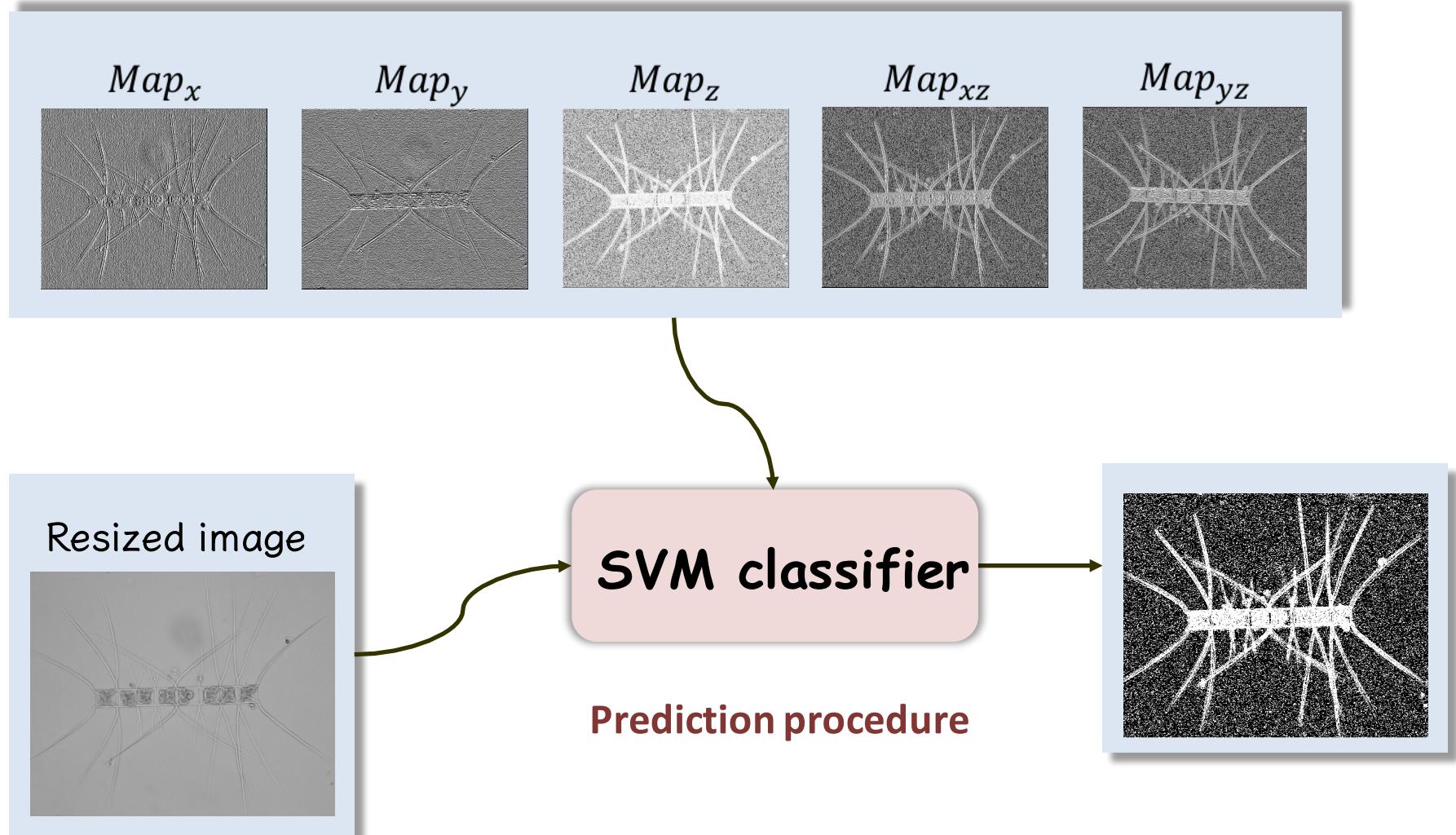
# SVM classification



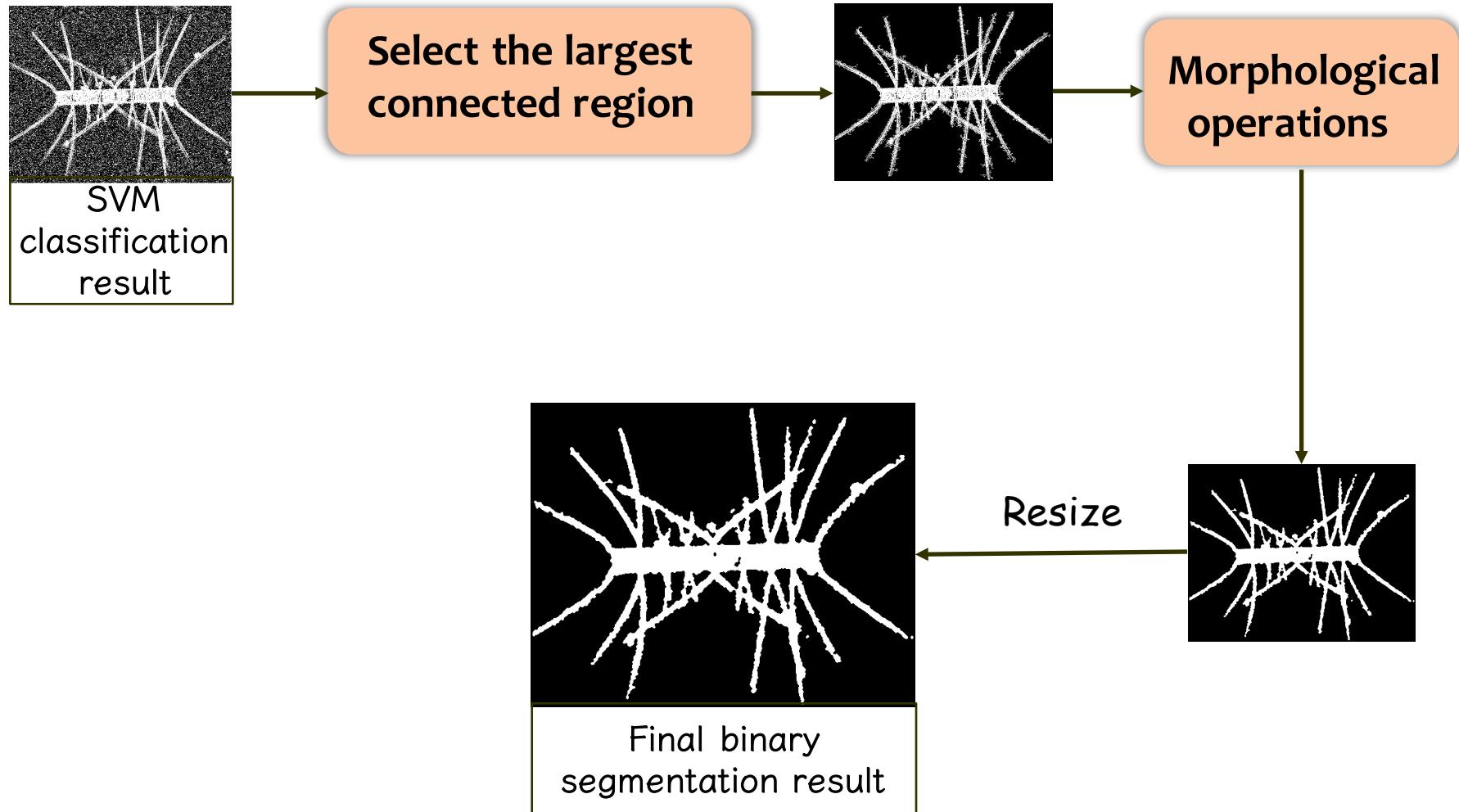
# SVM classification – Training procedure



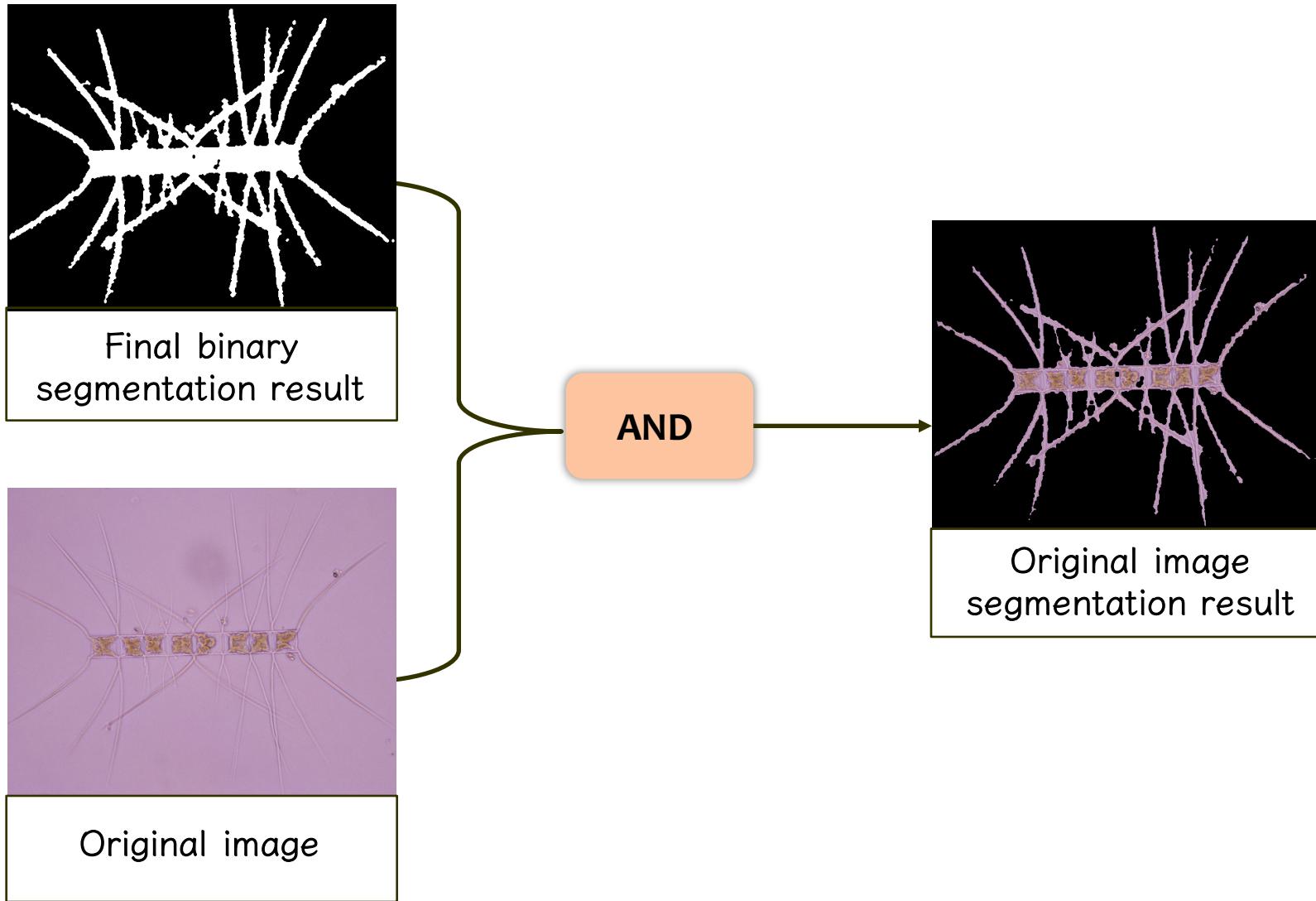
# SVM classification – Prediction procedure



# Post-processing



# Post-processing



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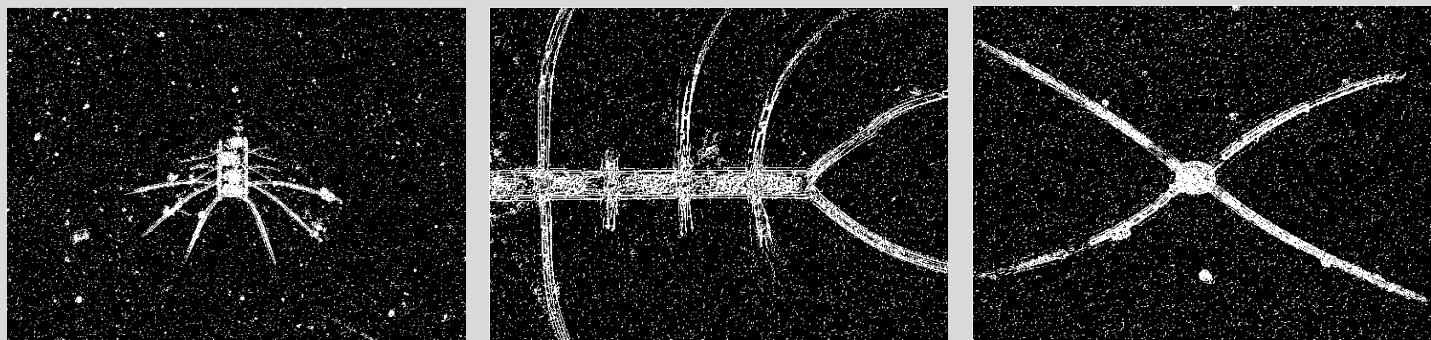
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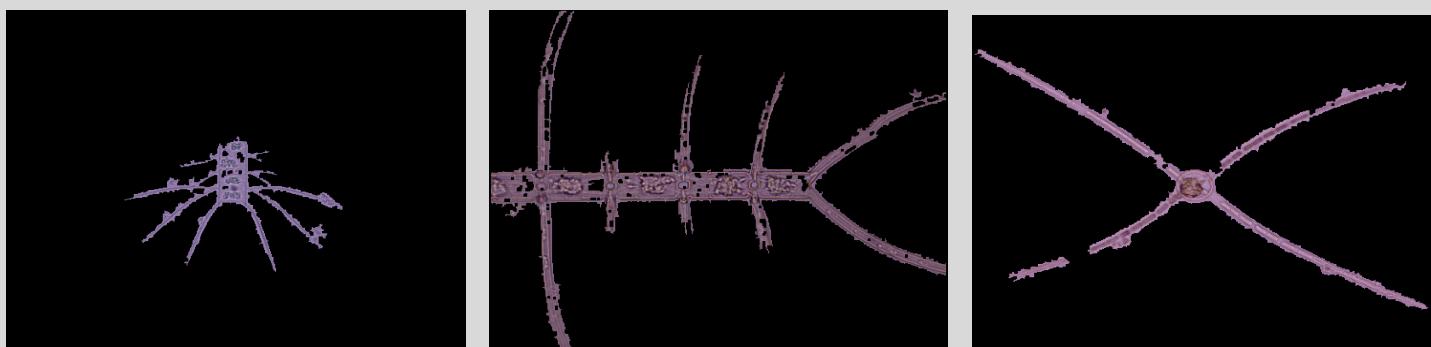
(a)  
Original image



(b)  
SVM  
classification  
results



(c)  
Final  
segmentation  
results



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- 1** Segment *Chaetoceros* microscope images by using SVM combined with Grayscale Surface Direction Angle Model.
  
- 2** We regard the segmentation problem as a classification task.
  
- 3** GSDAM provides five maps as features for SVM, and the connected region pre-segmentation offers training samples.

Thank you