



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

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- Step 1: Grayscale Surface Direction Angle Model
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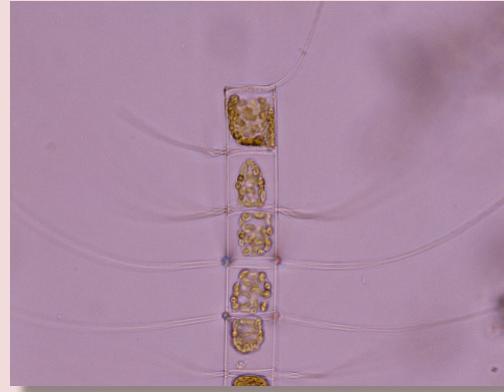
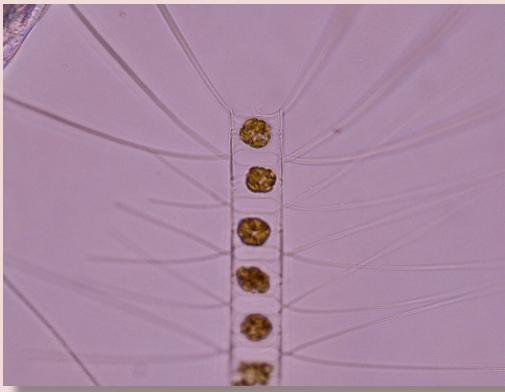
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Chaetoceros segmentation: why do we do this?

Three different types of *Chaetoceros* microscopic images



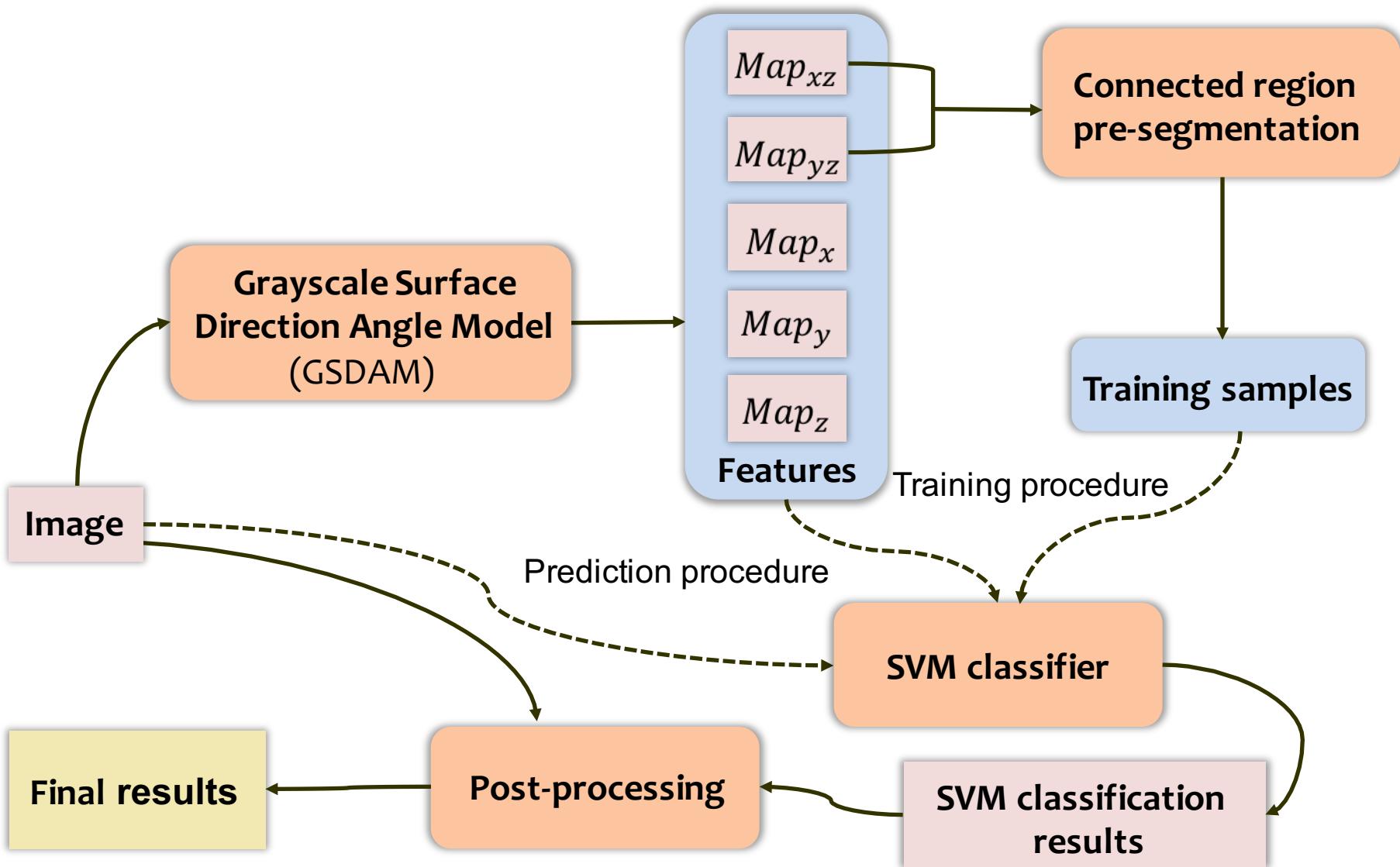
Chaetoceros segmentation is **the prior step** for the identification and classification of *Chaetoceros*.

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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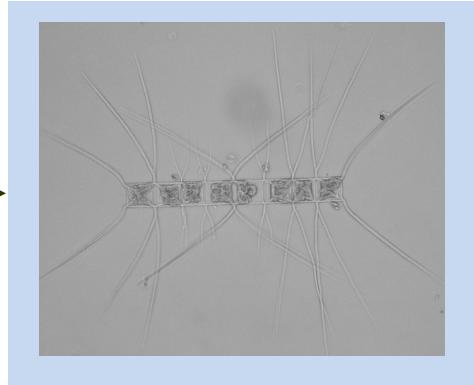
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Before our method



**Resize
Grayscale**



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

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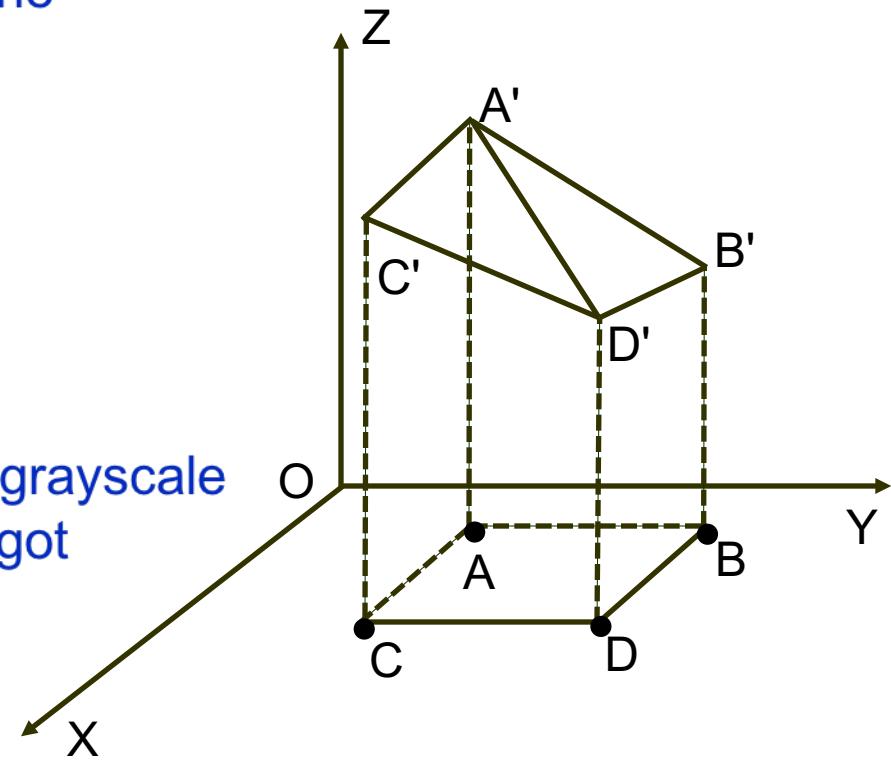
Grayscale Surface Direction Angle Model (GSDAM)

“Automatic setae segmentation from chaetoceros microscopic images,” H. Zheng, H. Zhao, X. Sun, H. Gao, and G.Ji, *Microscopy Research and Technique*, vol. 77, no. 9, pp. 684–690, 2014.

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.

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

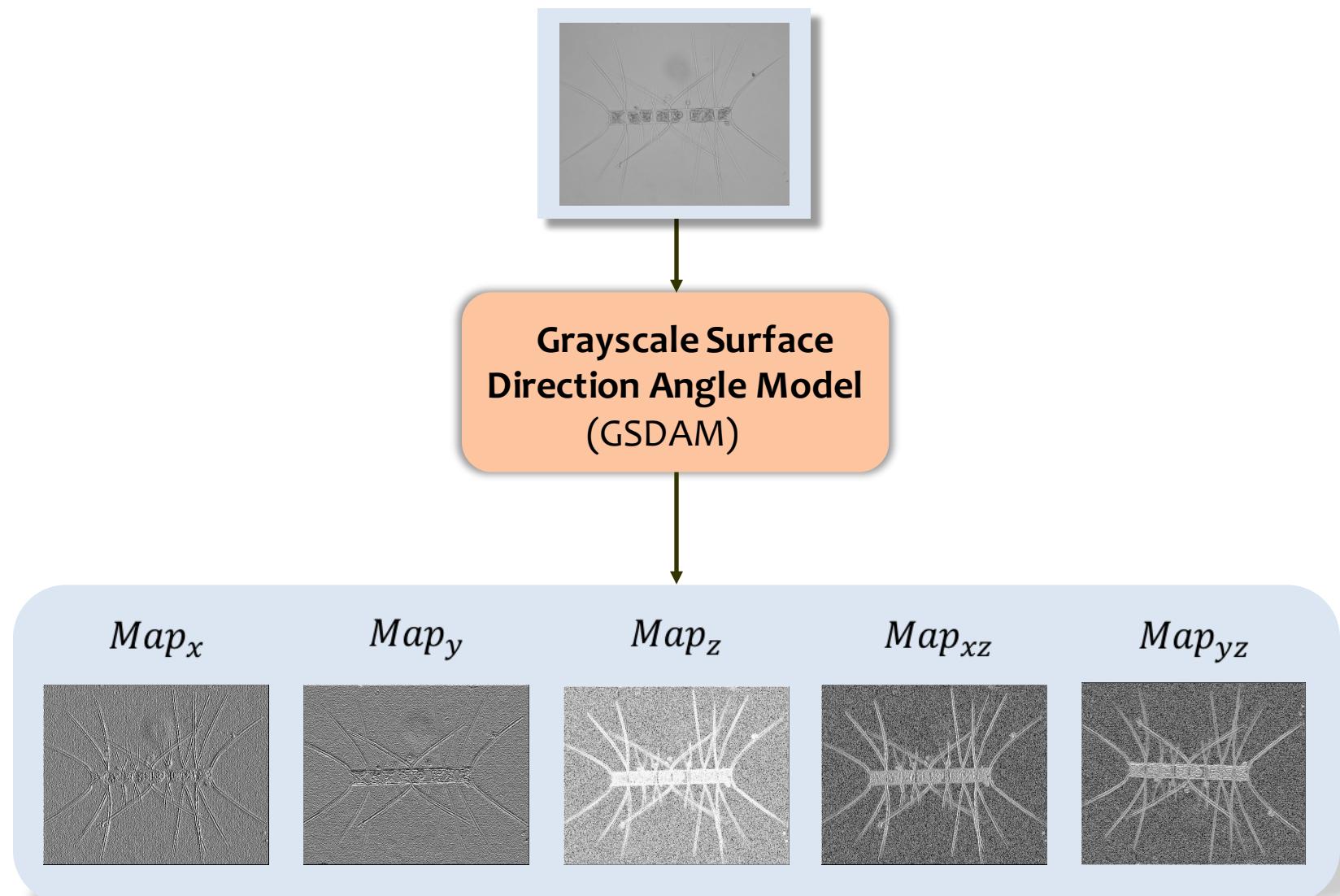
$$Map_y(i, j) = 255 \times \frac{\theta_y(i, j) - \min(\theta_y)}{\max(\theta_y) - \min(\theta_y)}$$

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

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

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

Grayscale Surface Direction Angle Model



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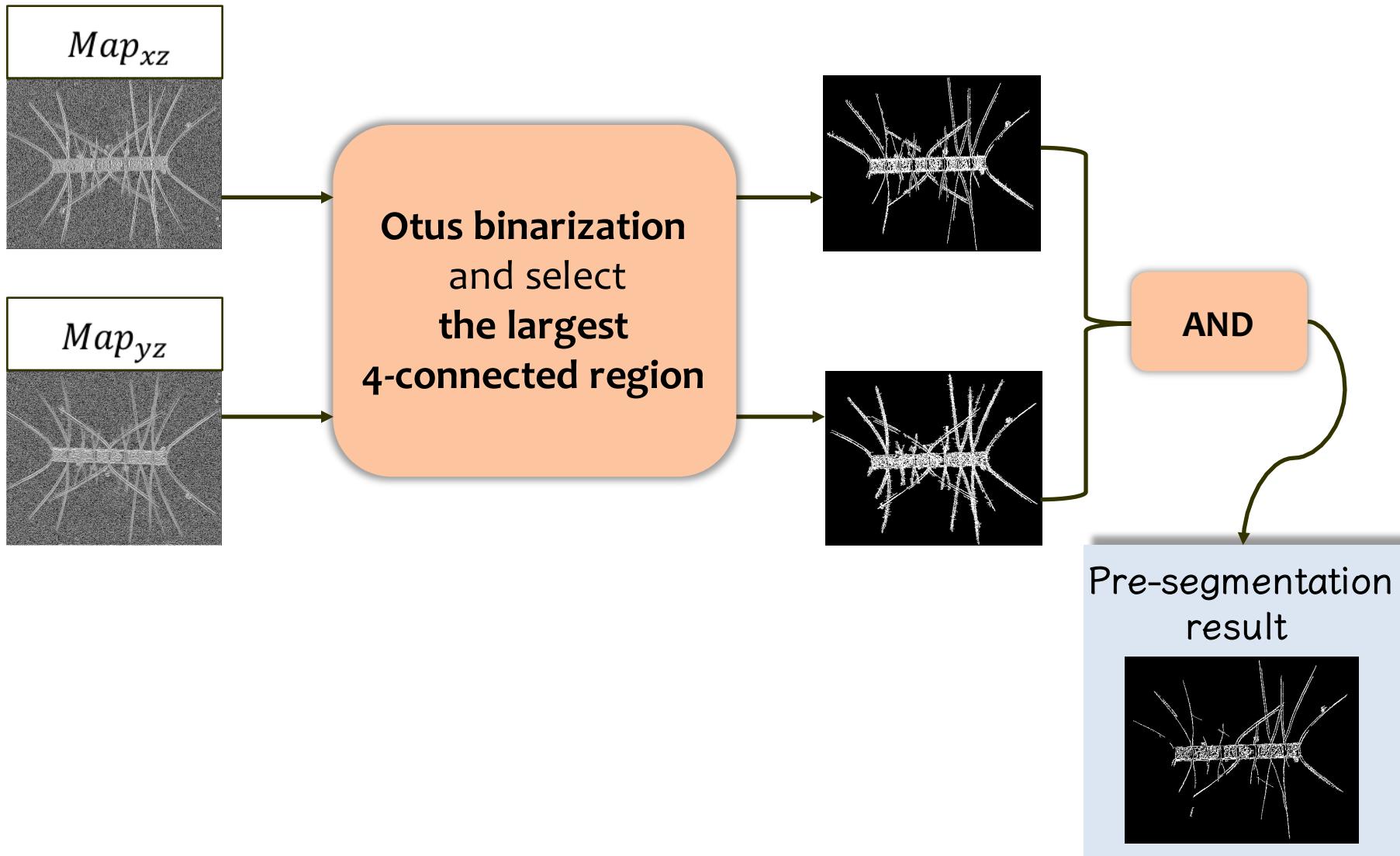
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Connected region pre-segmentation



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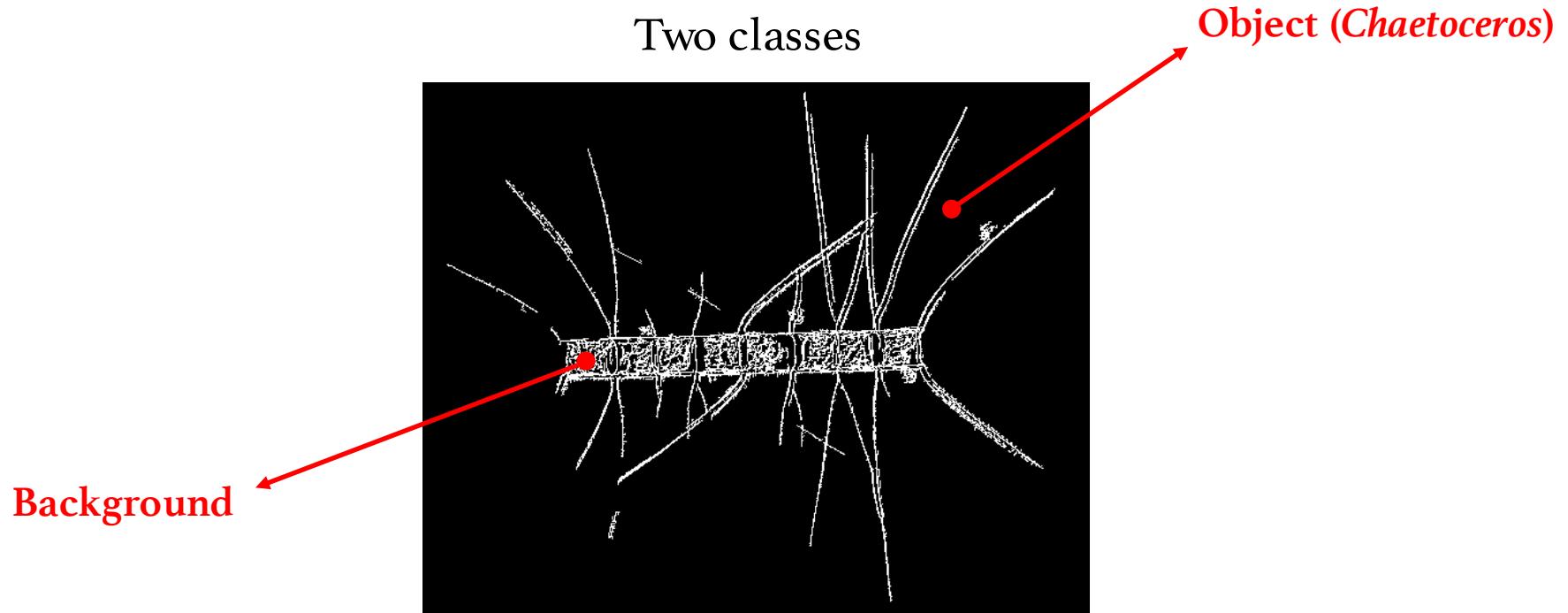
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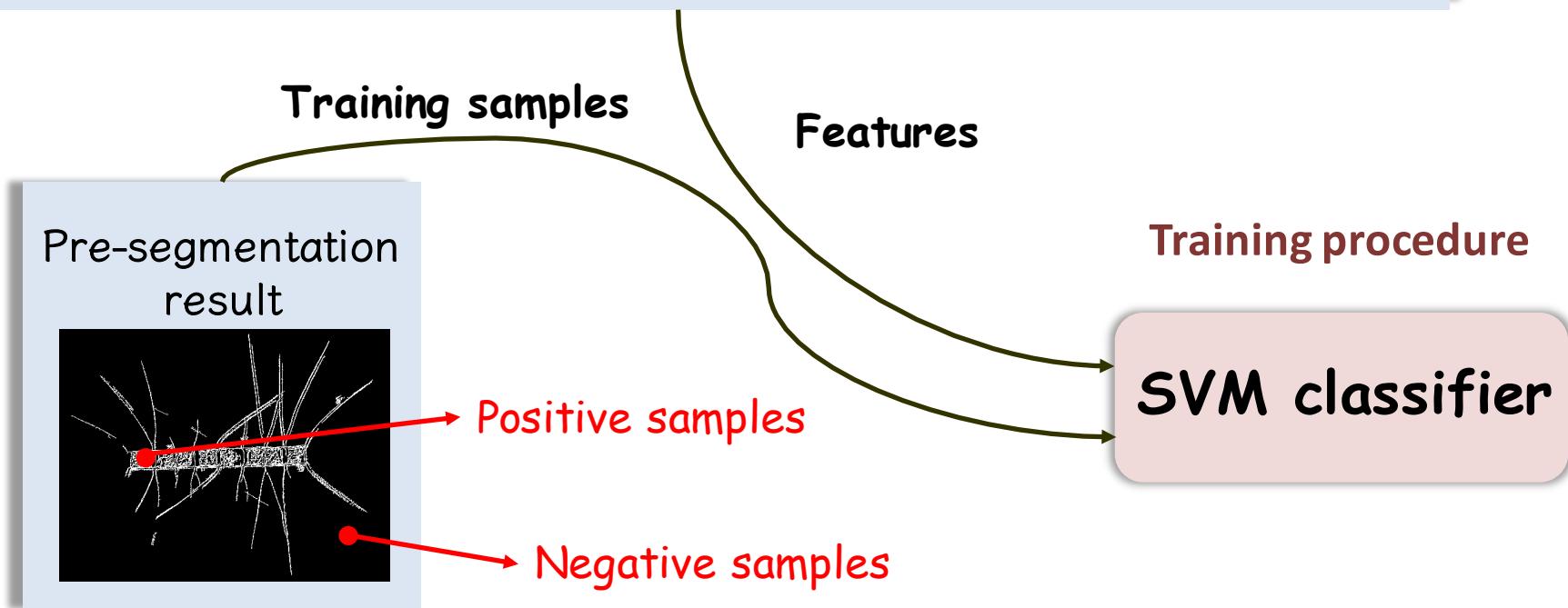
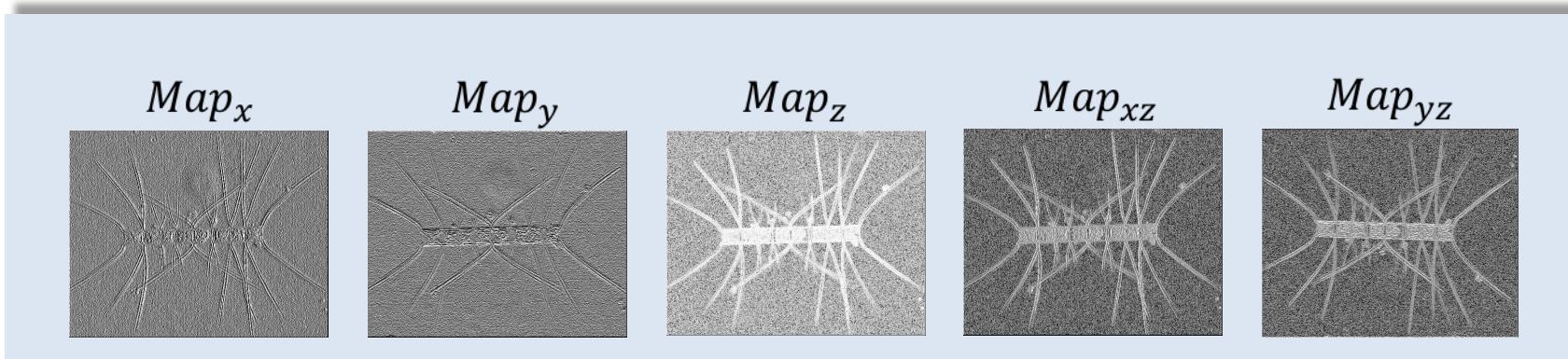
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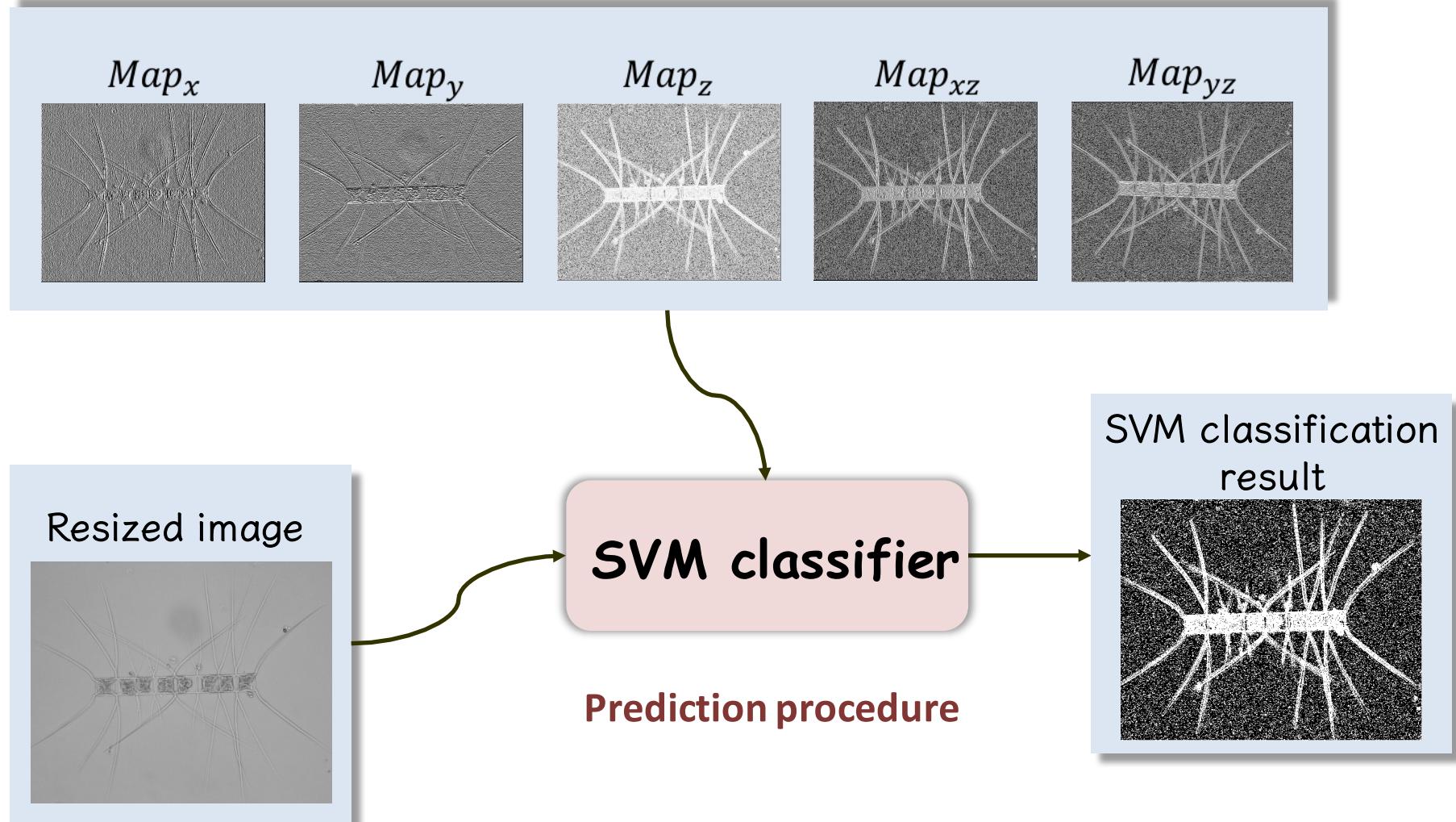
SVM classification



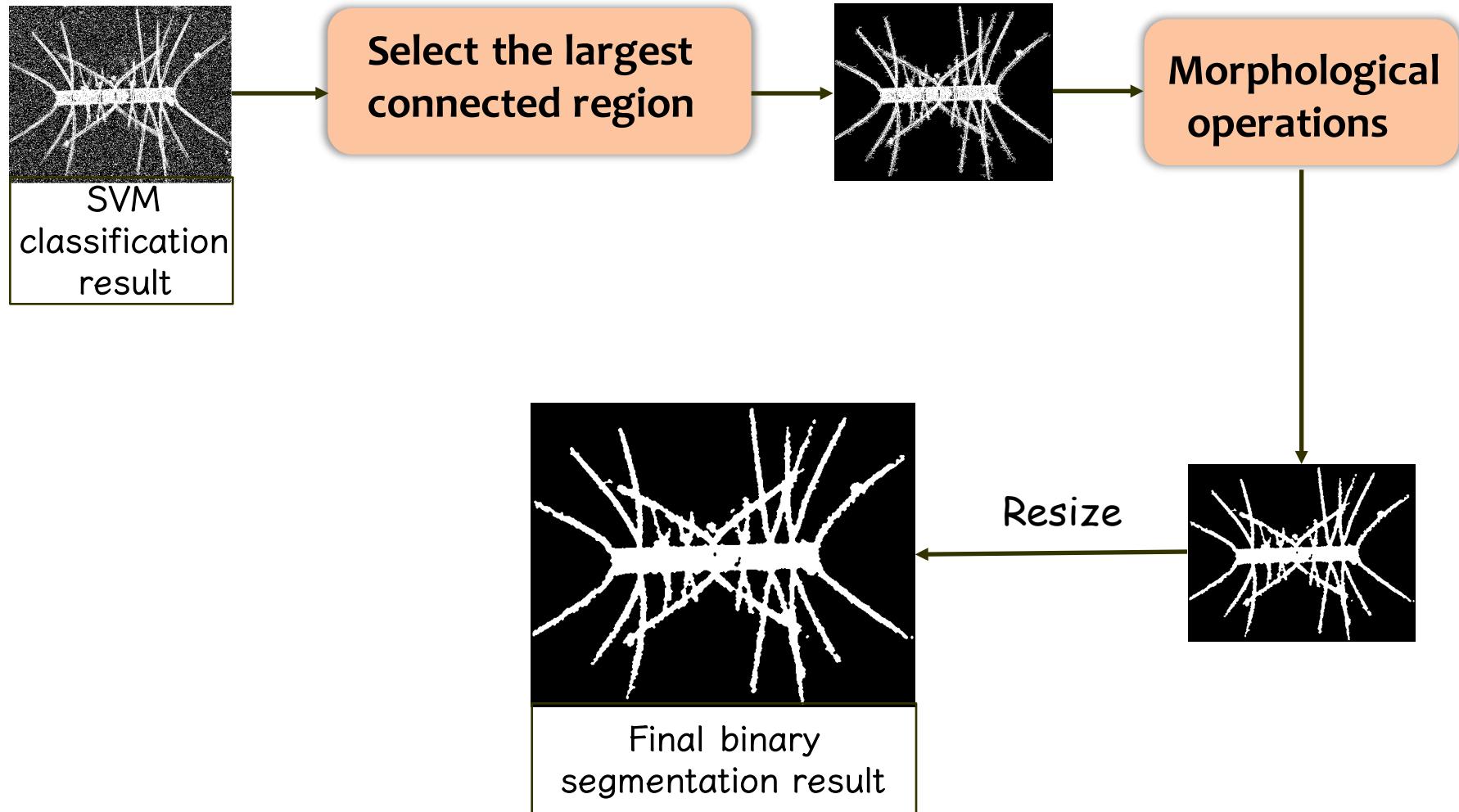
SVM classification – Training procedure



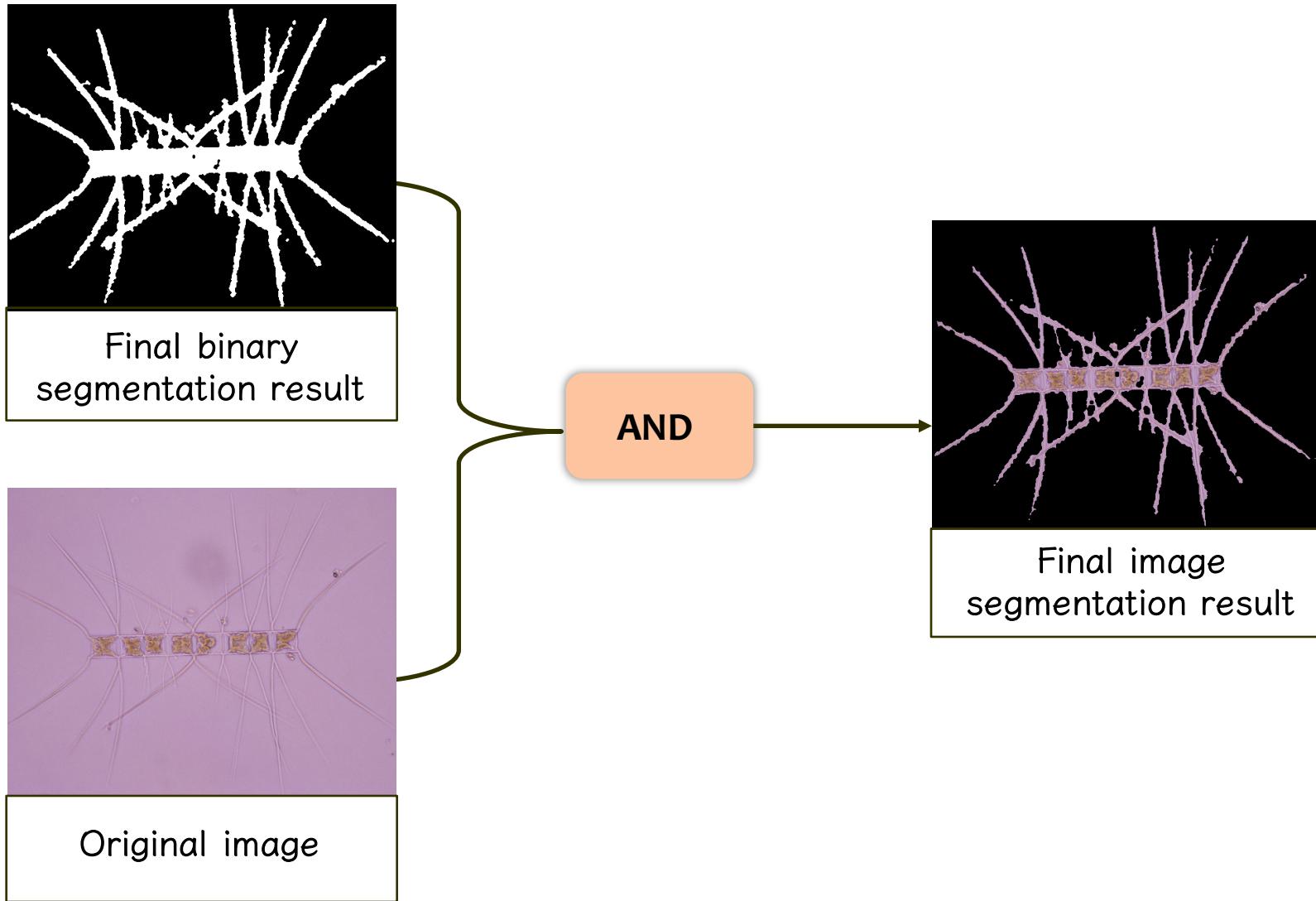
SVM classification – Prediction procedure



Post-processing



Post-processing



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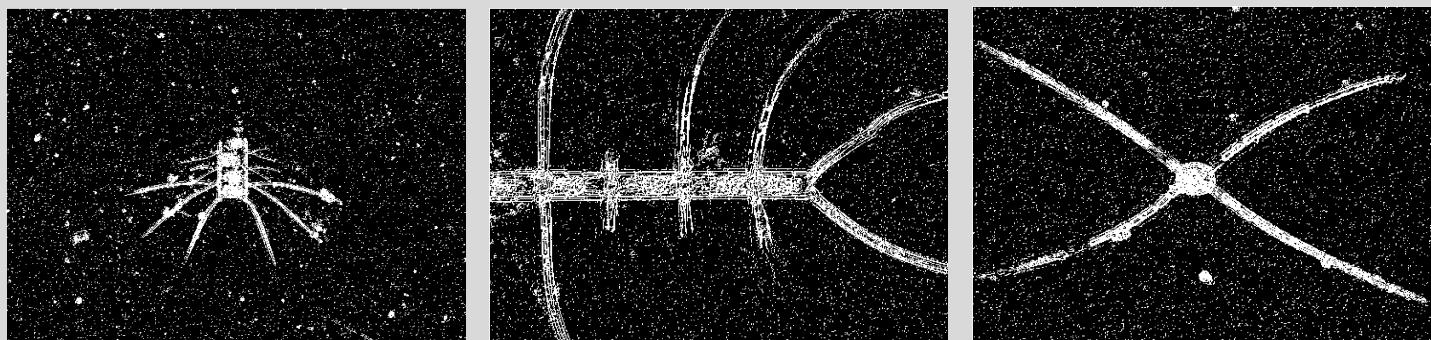
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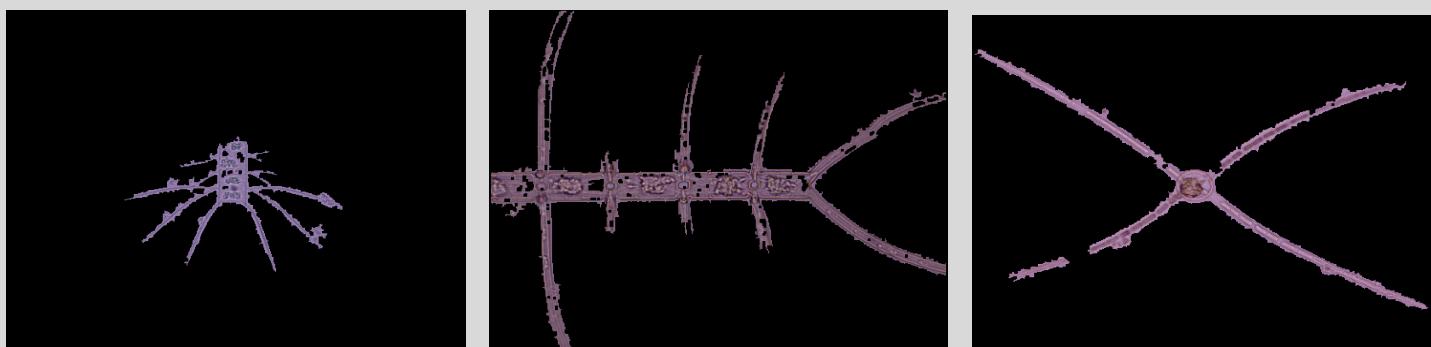
(a)
Original image



(b)
SVM
classification
results



(c)
Final
segmentation
results



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Conclusion

- 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 !