



**IEEE ISBI 2020**  
International Symposium on  
Biomedical Imaging



# **DiskMask: Focusing Object Features for Accurate Instance Segmentation of Elongated or Overlapping Objects**

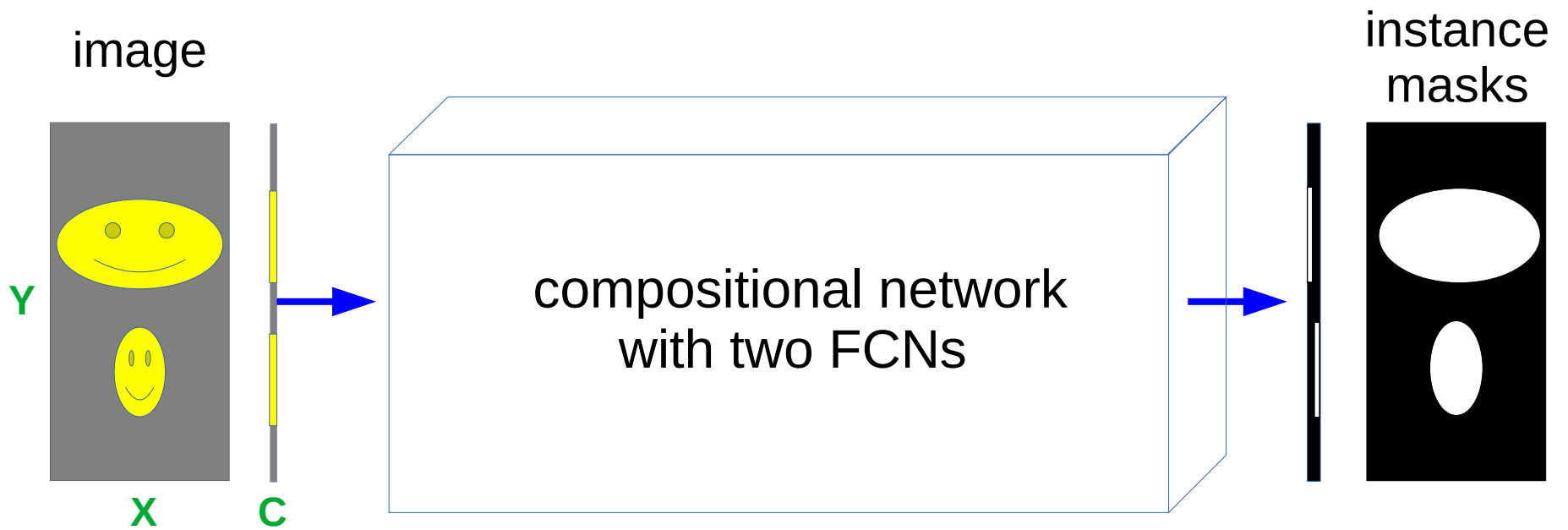
Anton Böhm, Nikolaus Mayer, Thomas Brox

This study was supported by German Research Foundation (DFG) under Germany's Excellence Strategy (CIBSS-EXC-2189- Project ID 390939984)

# DiskMask

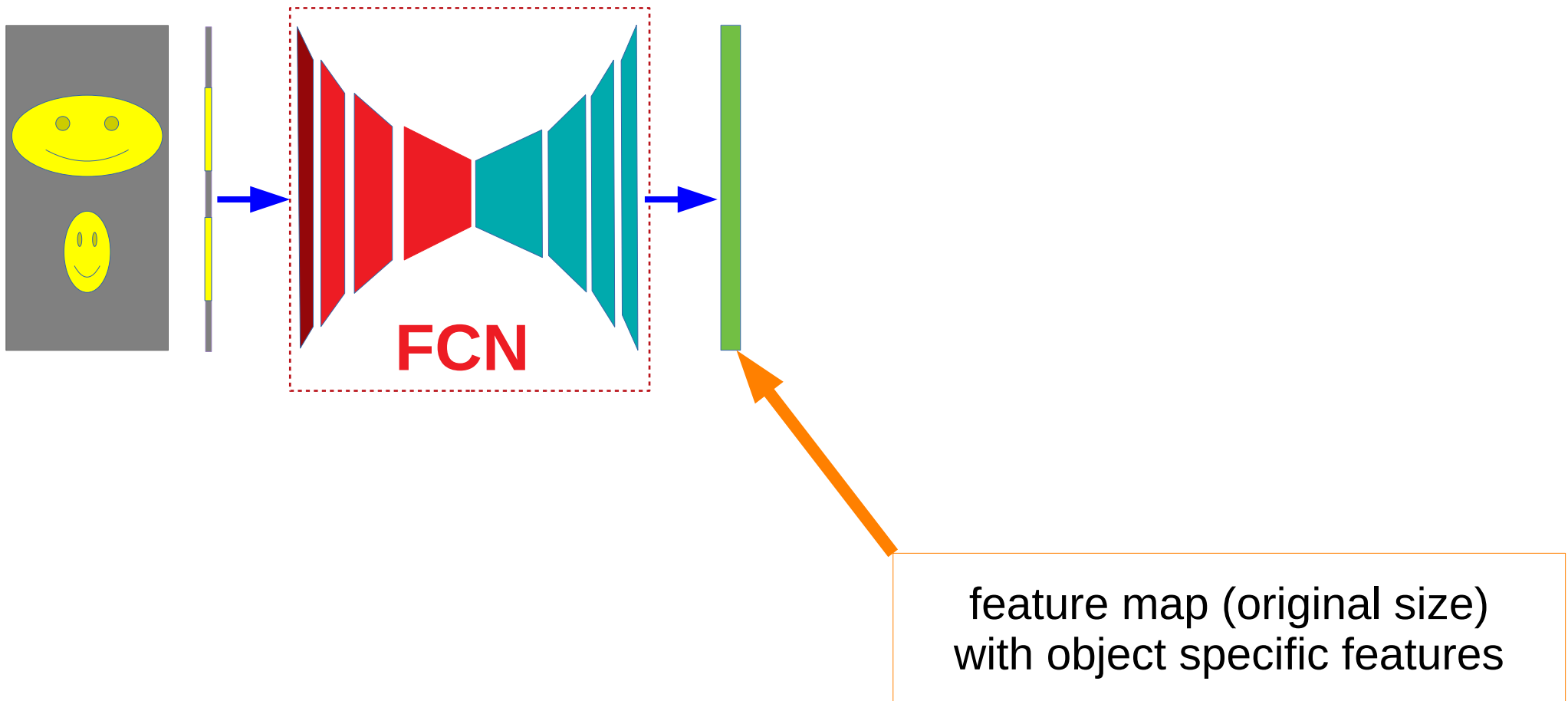
- bounding box free approach
- feature pool from entire image
- high-resolution masks

# DiskMask: Input / Output

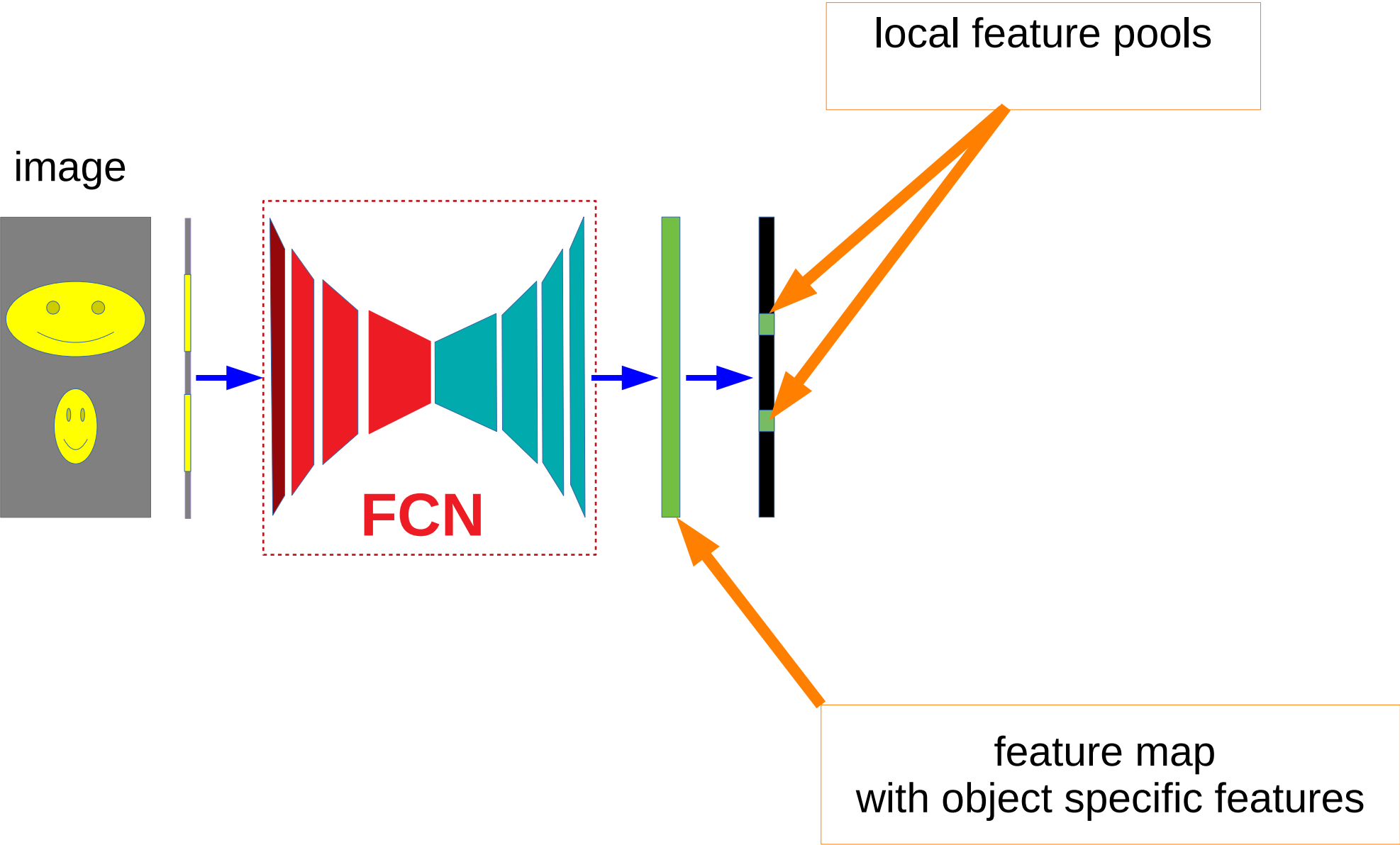


# DiskMask: Pipeline

image

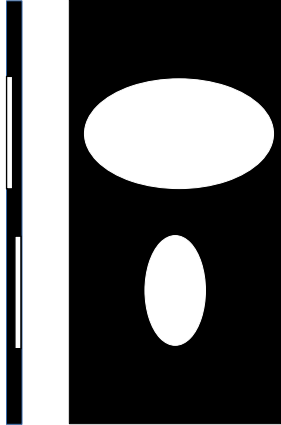
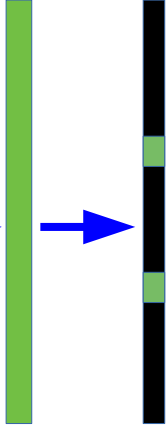
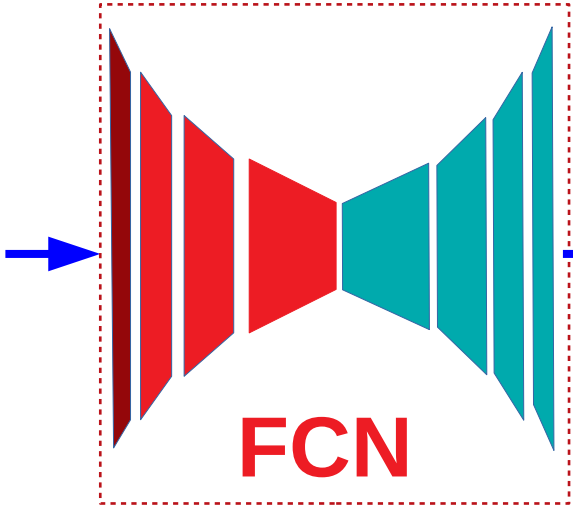
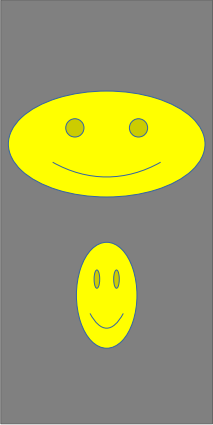


# DiskMask: Pipeline

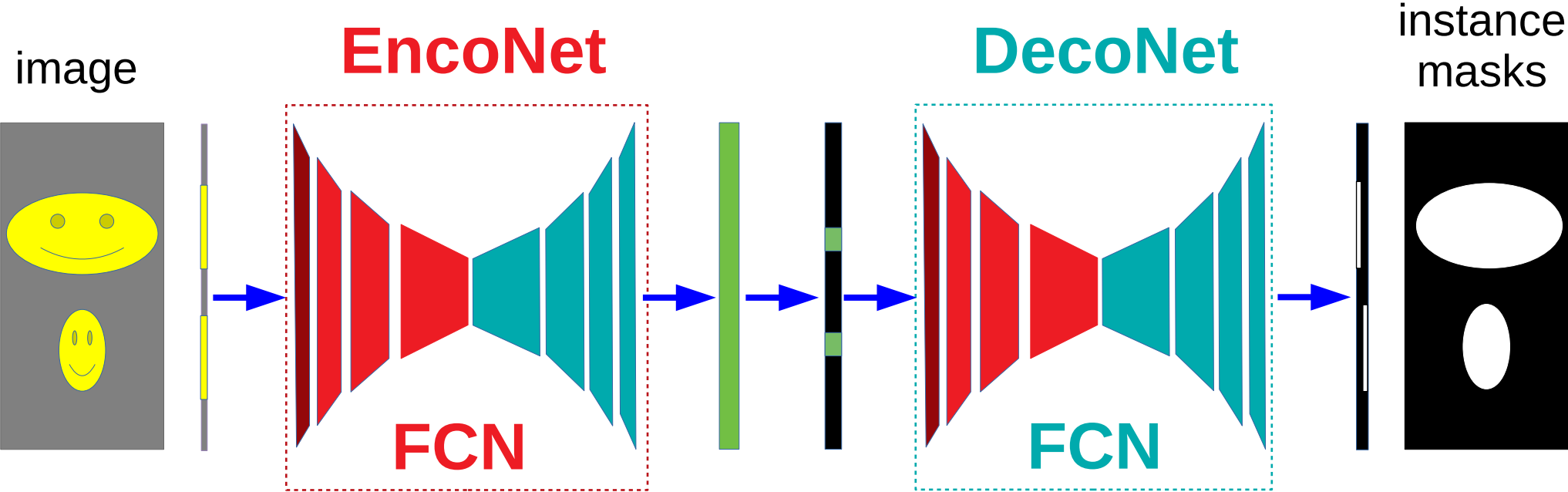


# DiskMask: Pipeline

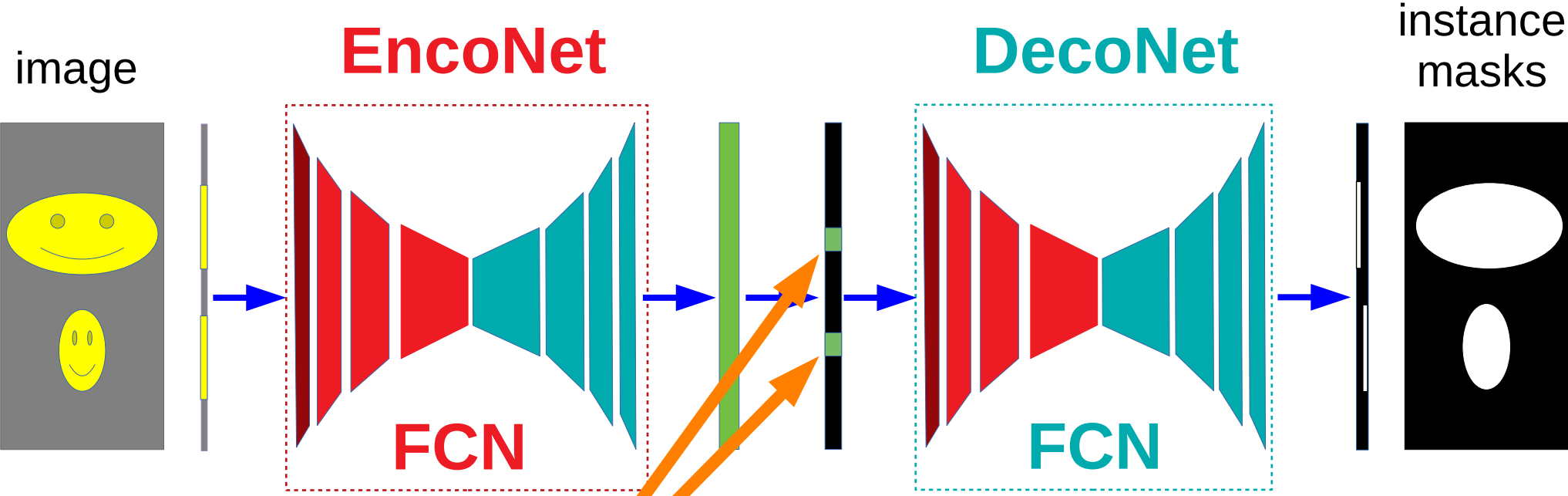
image



# DiskMask: Pipeline



# DiskMask: Pipeline

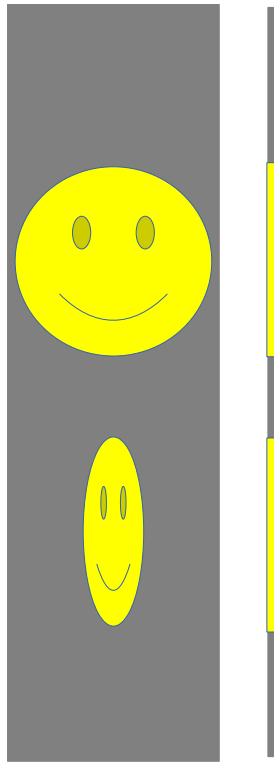


what is the pools' position in image?

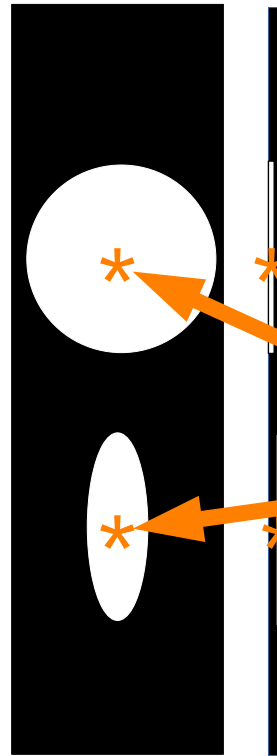


# DiskMask: Feature Pool's Position

image

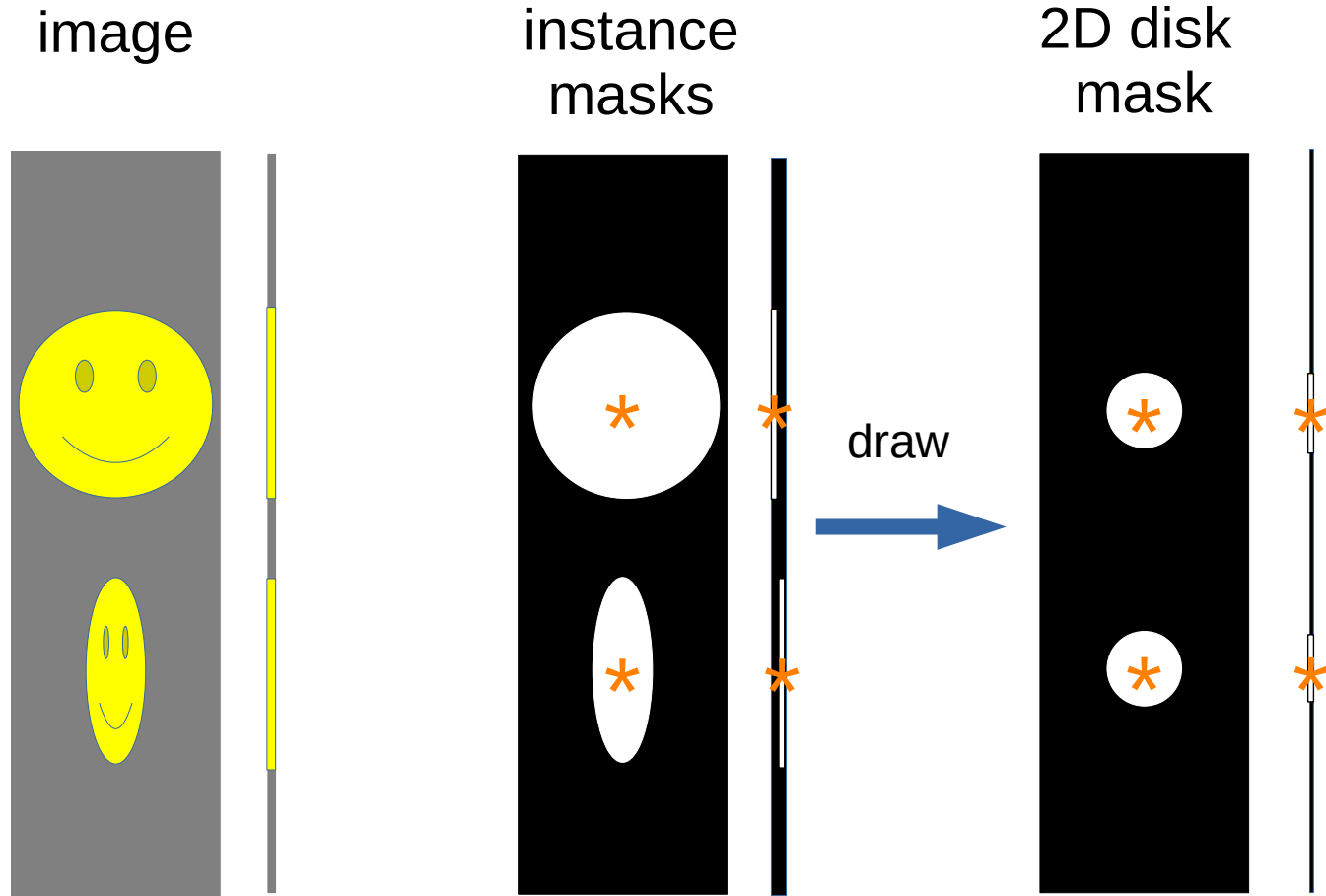


instance  
masks



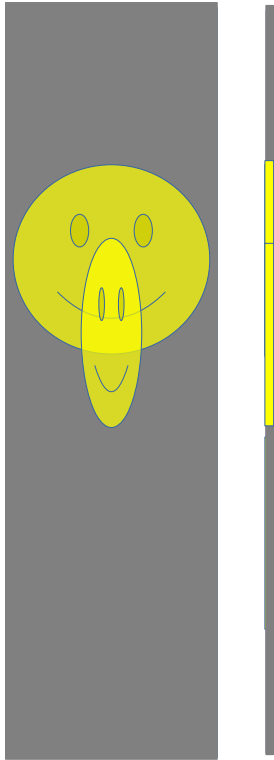
reference points  
(here centroids)

# DiskMask: Feature Pools

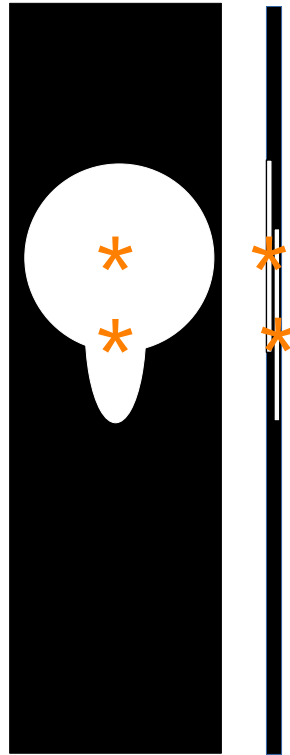


# DiskMask: Feature Pools

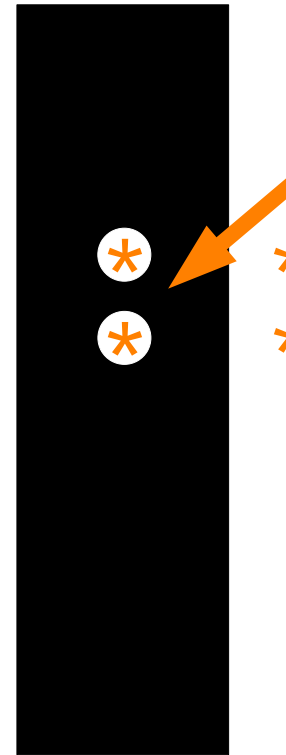
image



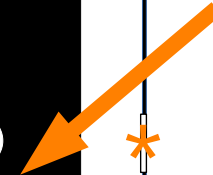
instance masks



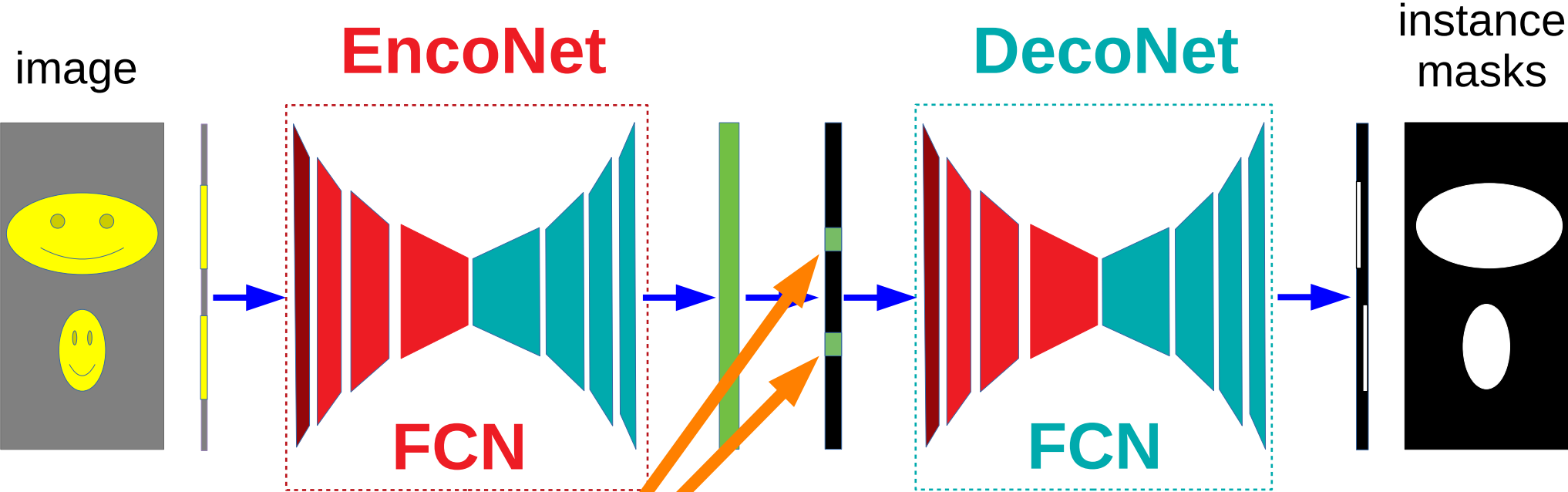
2D disk mask



must stay disconnected

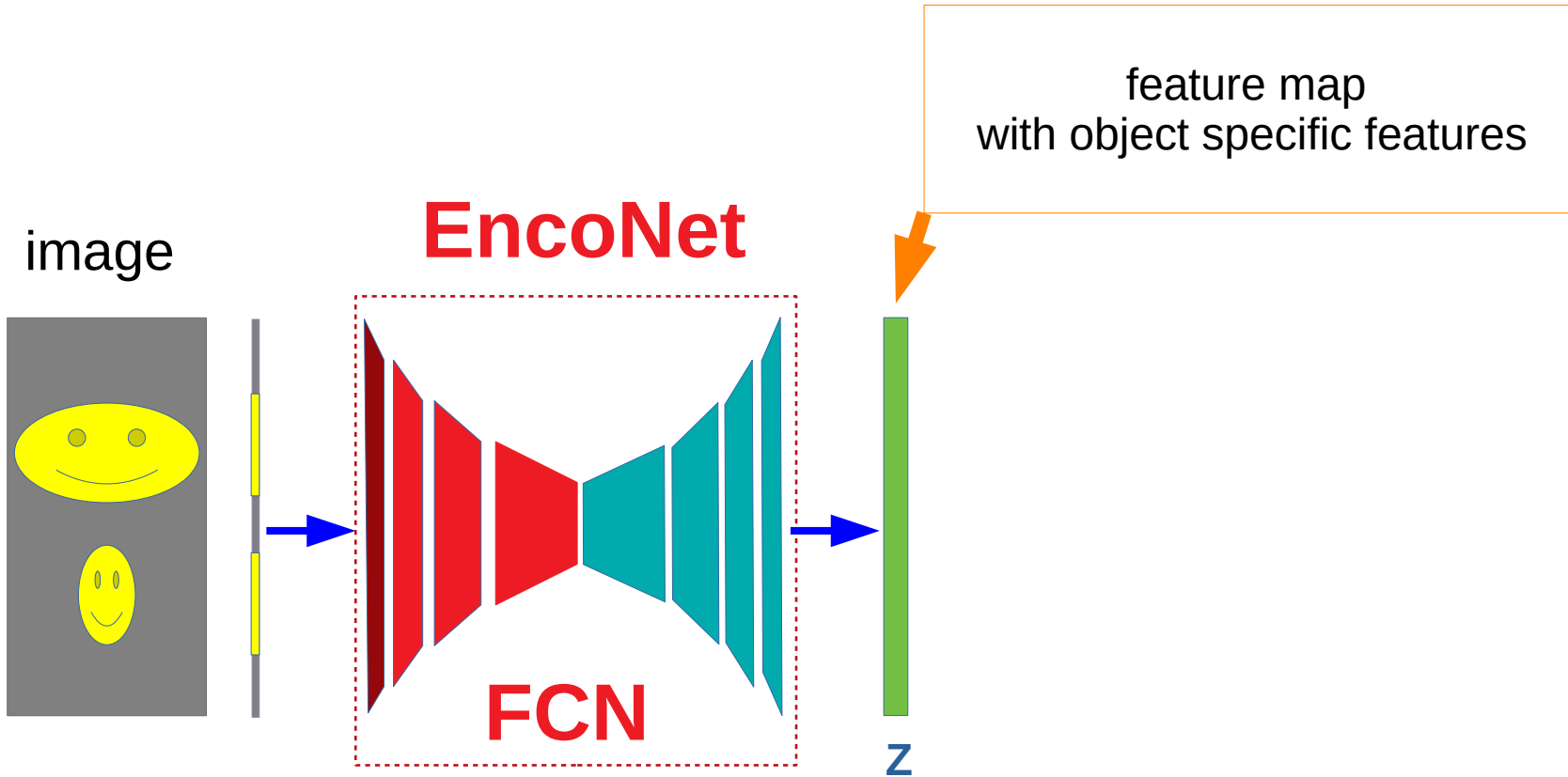


# DiskMask: Pipeline

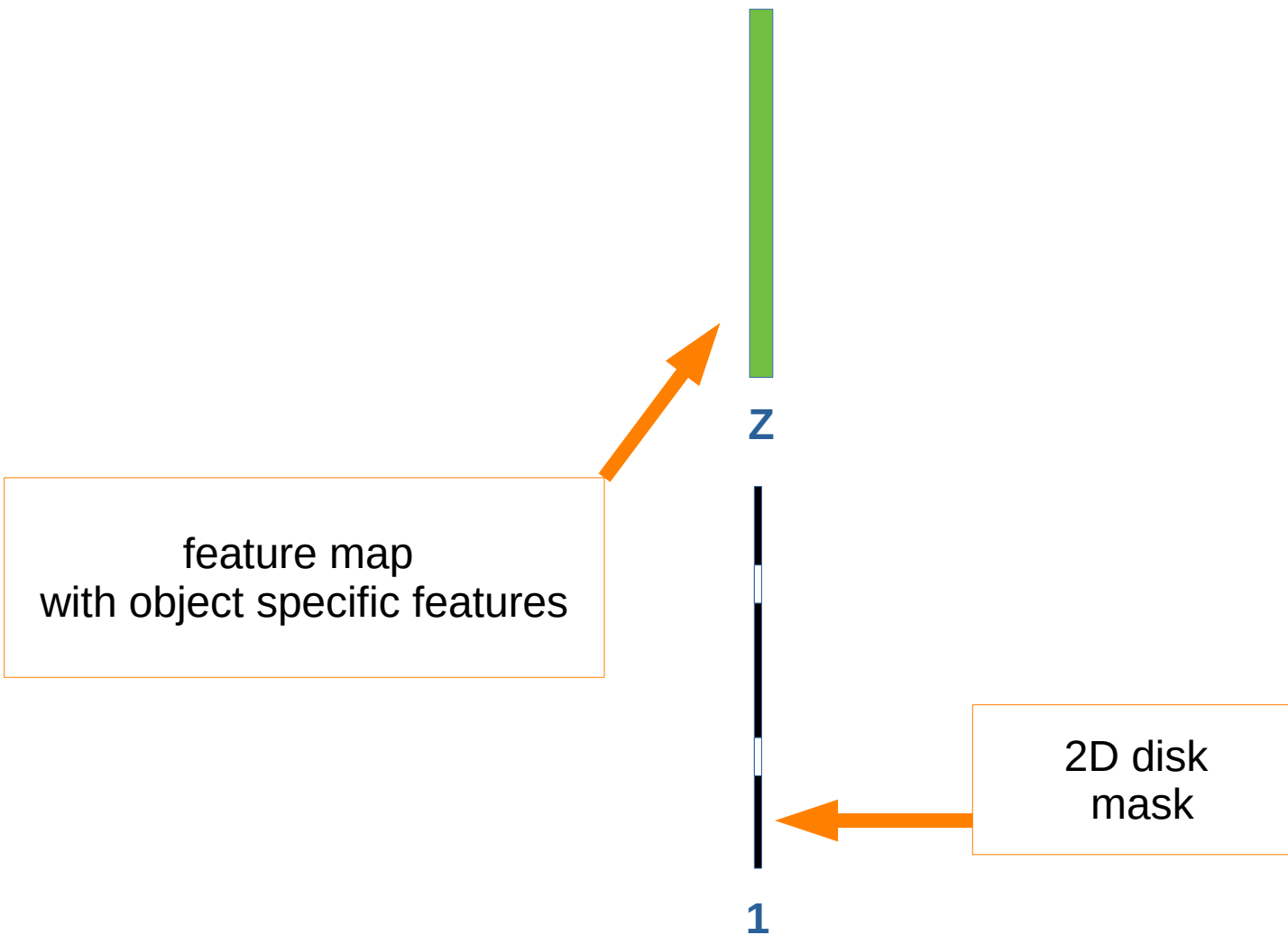


how to create the pools?

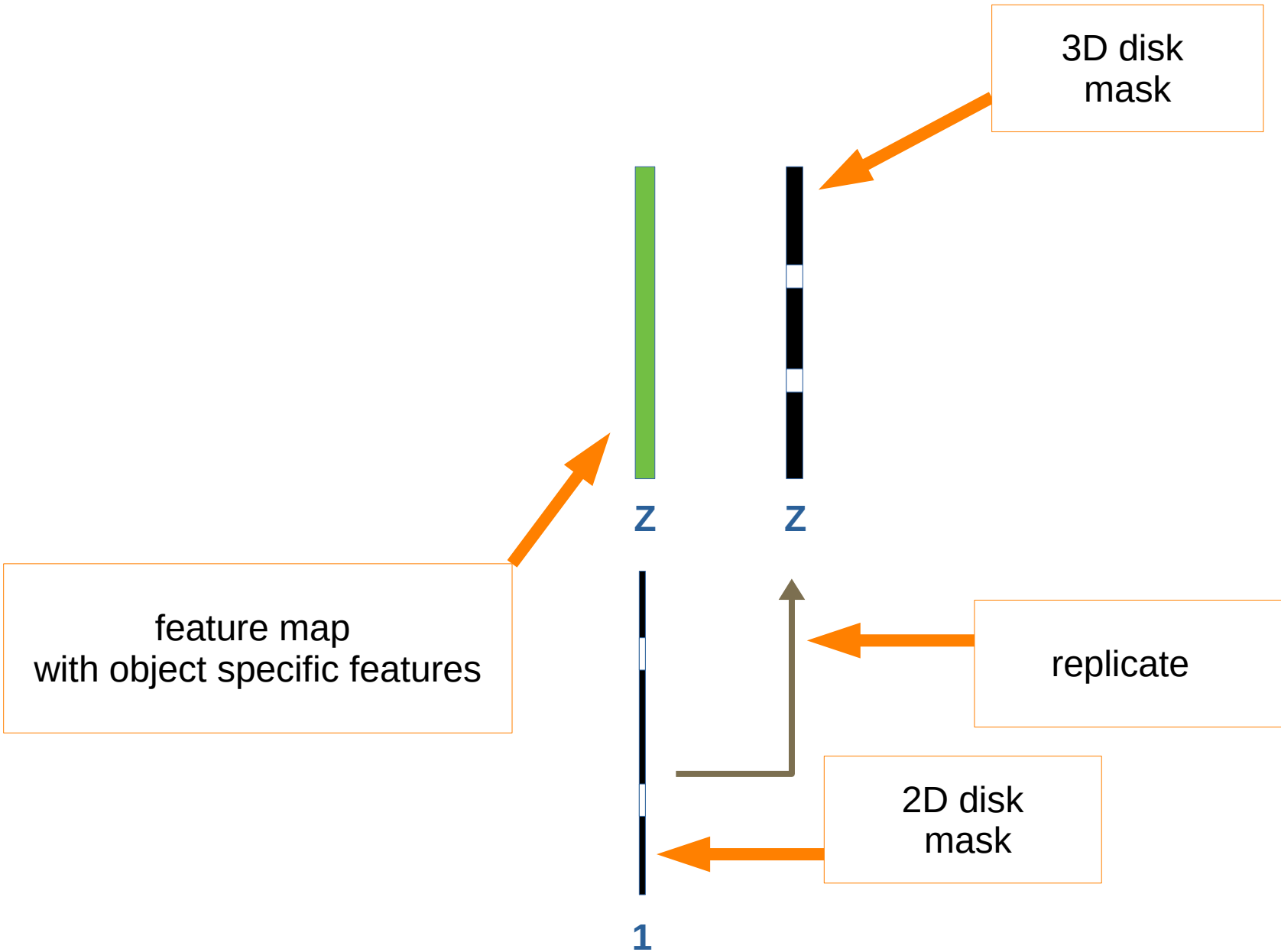
# DiskMask: Feature Pools



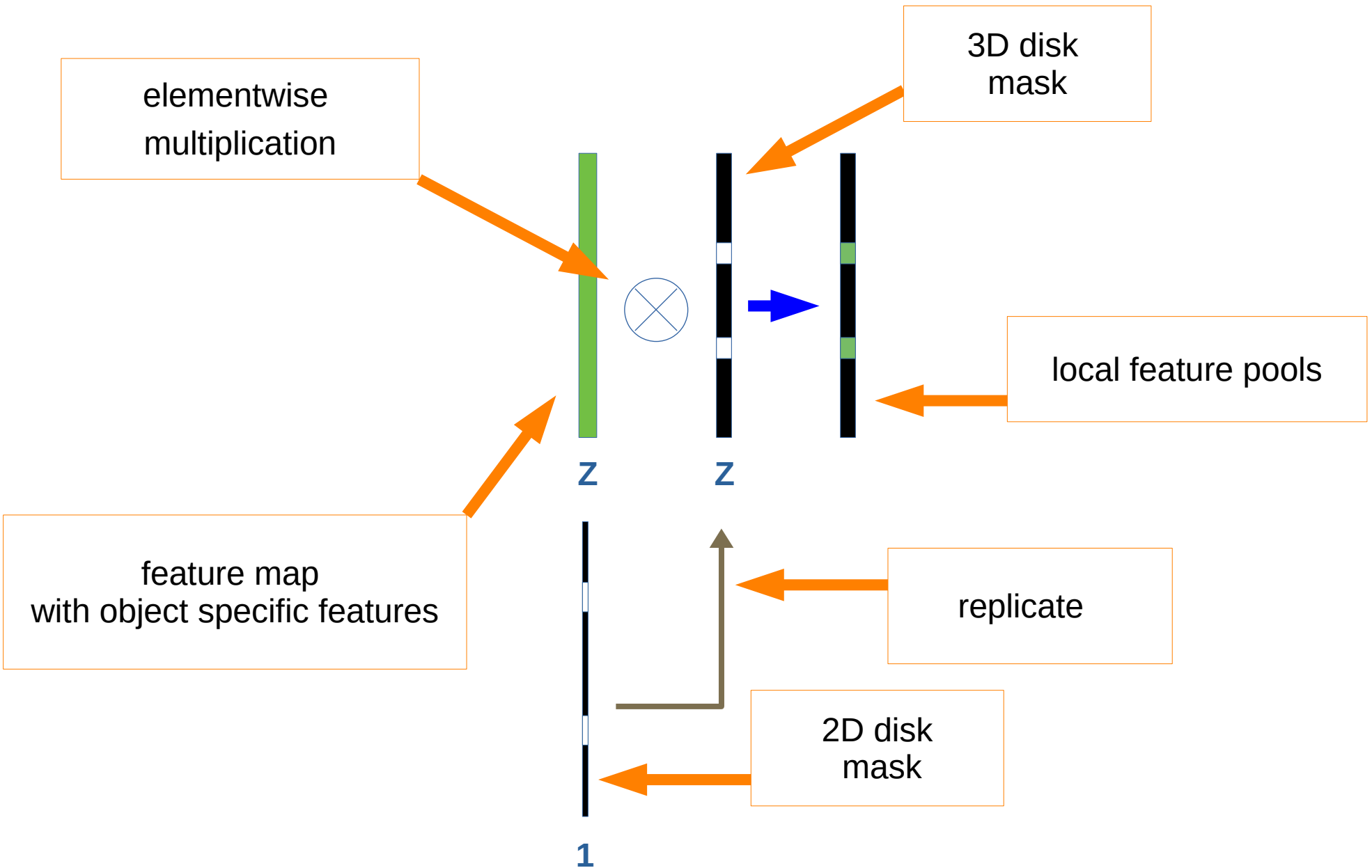
# DiskMask: Local Feature Pools



# DiskMask: Local Feature Pools

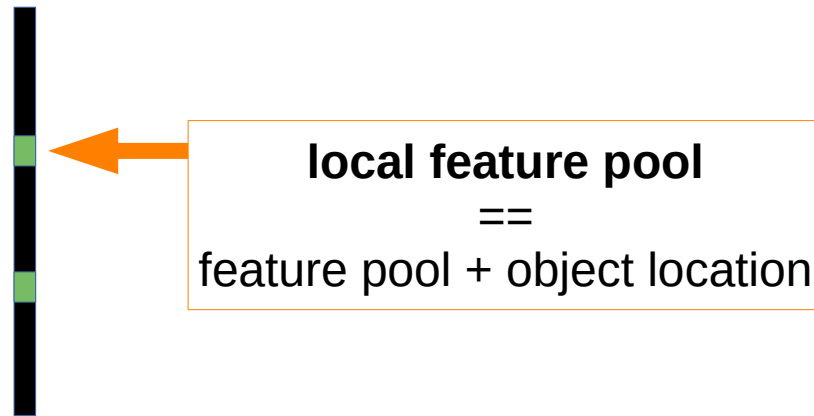


# DiskMask: Local Feature Pools

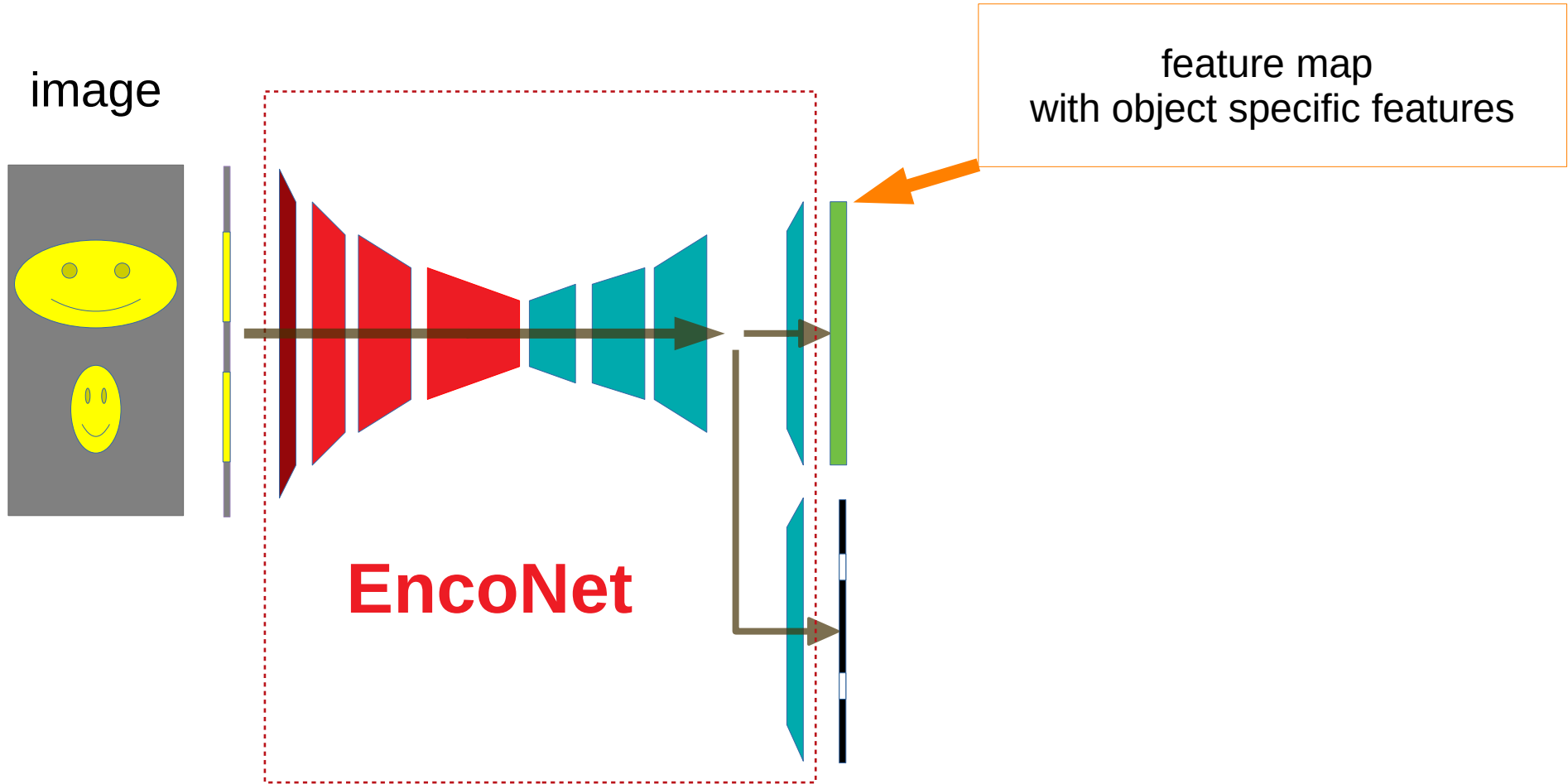




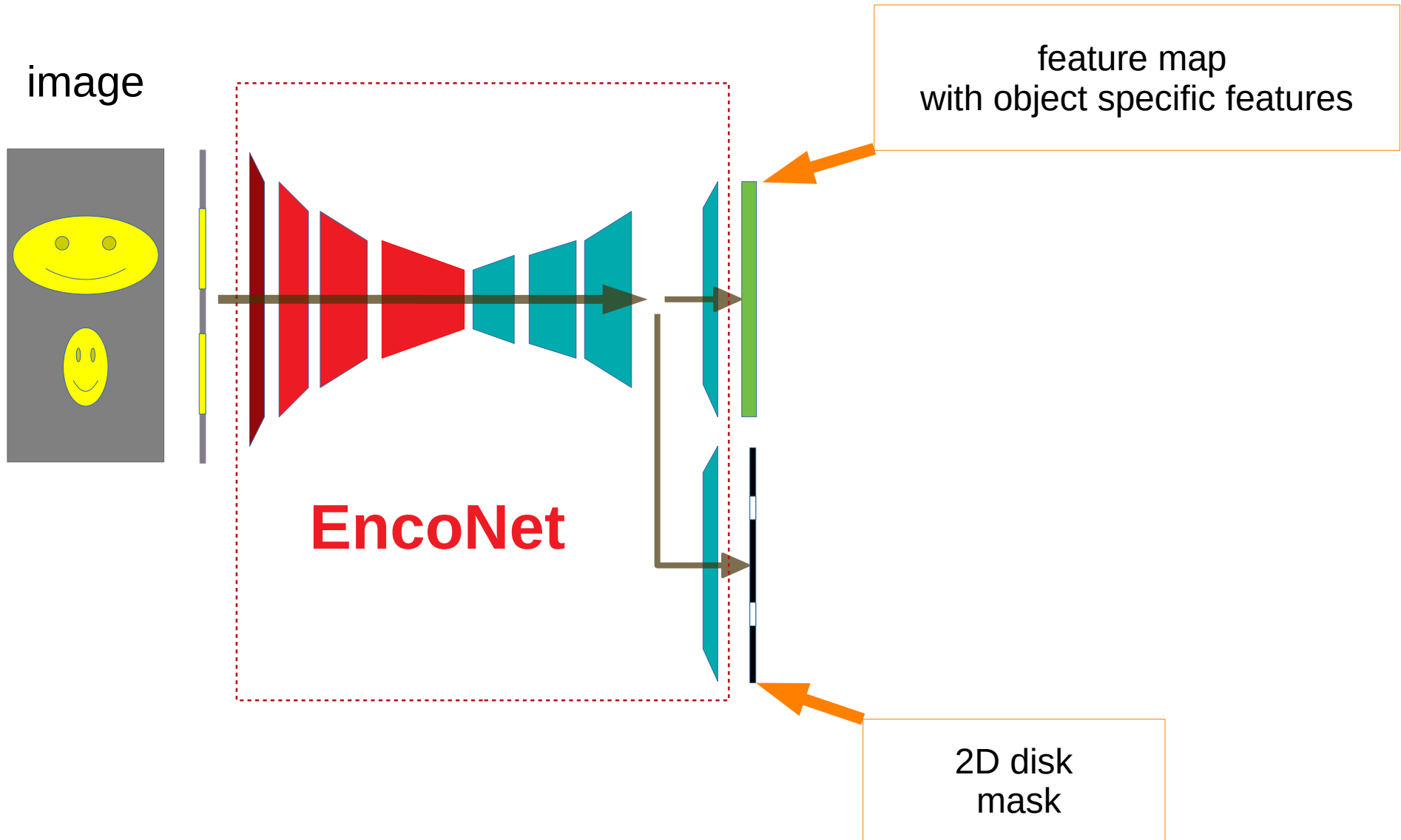
# DiskMask: Local Feature Pool



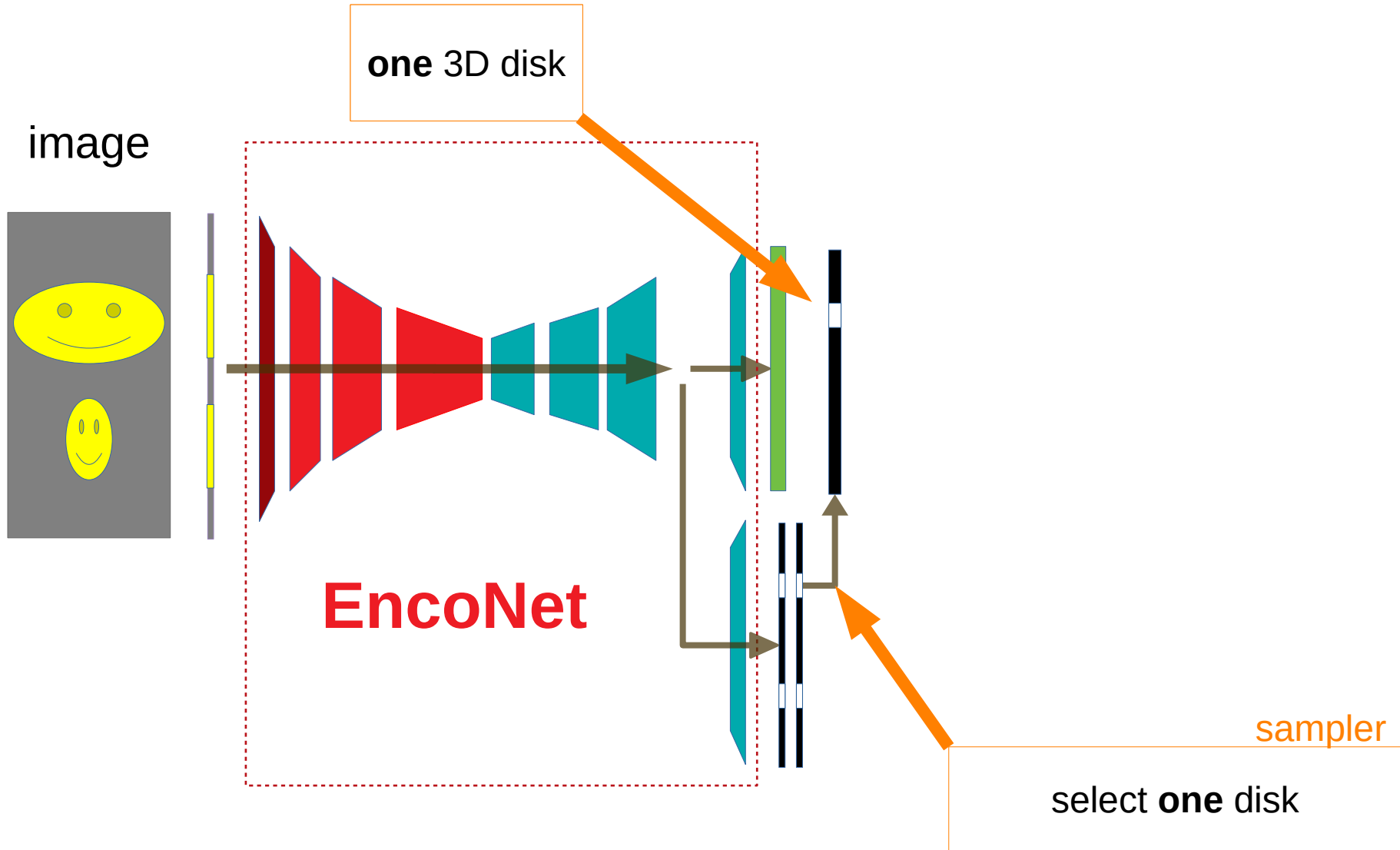
# DiskMask: Forward Pass



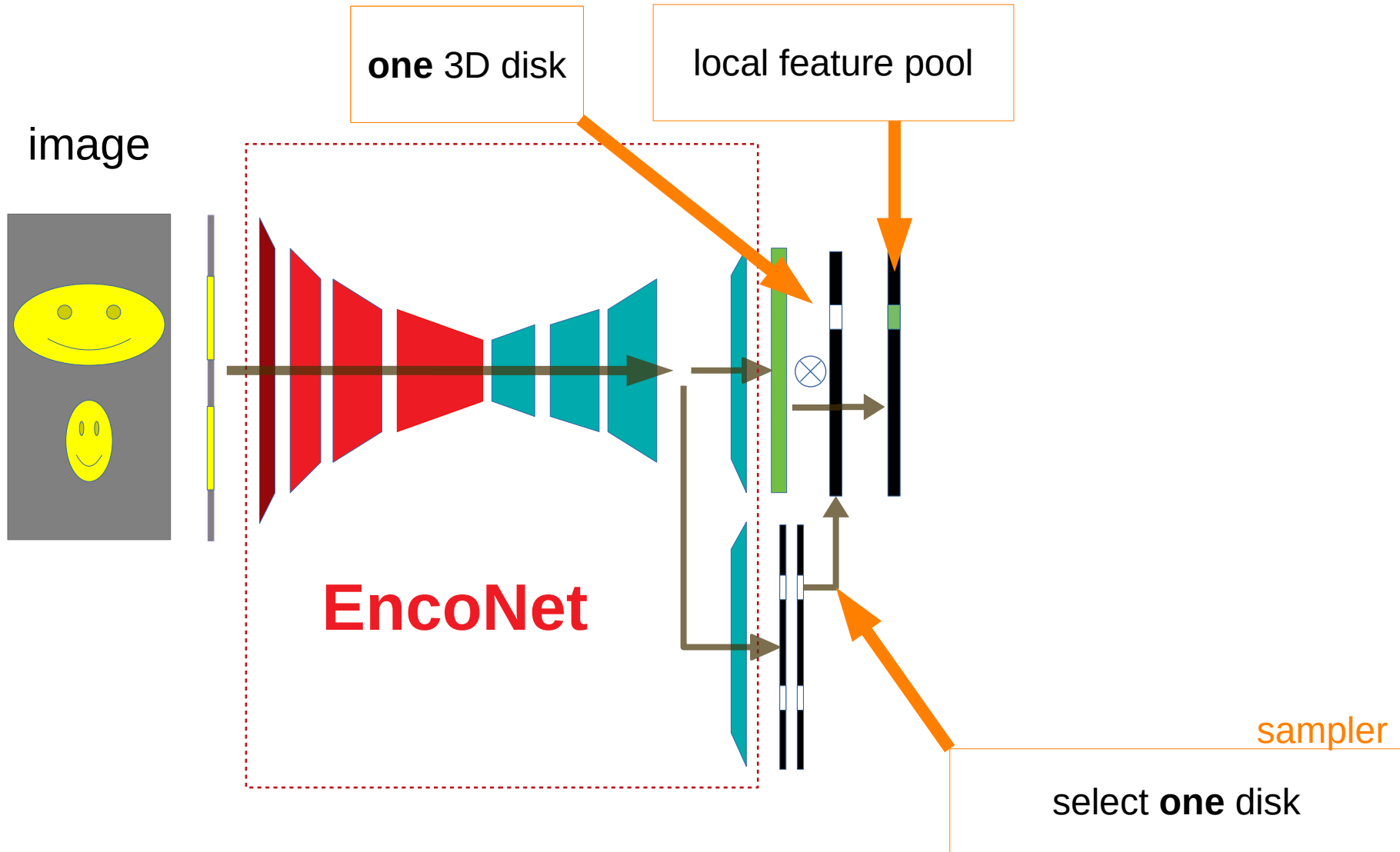
# DiskMask: Forward Pass



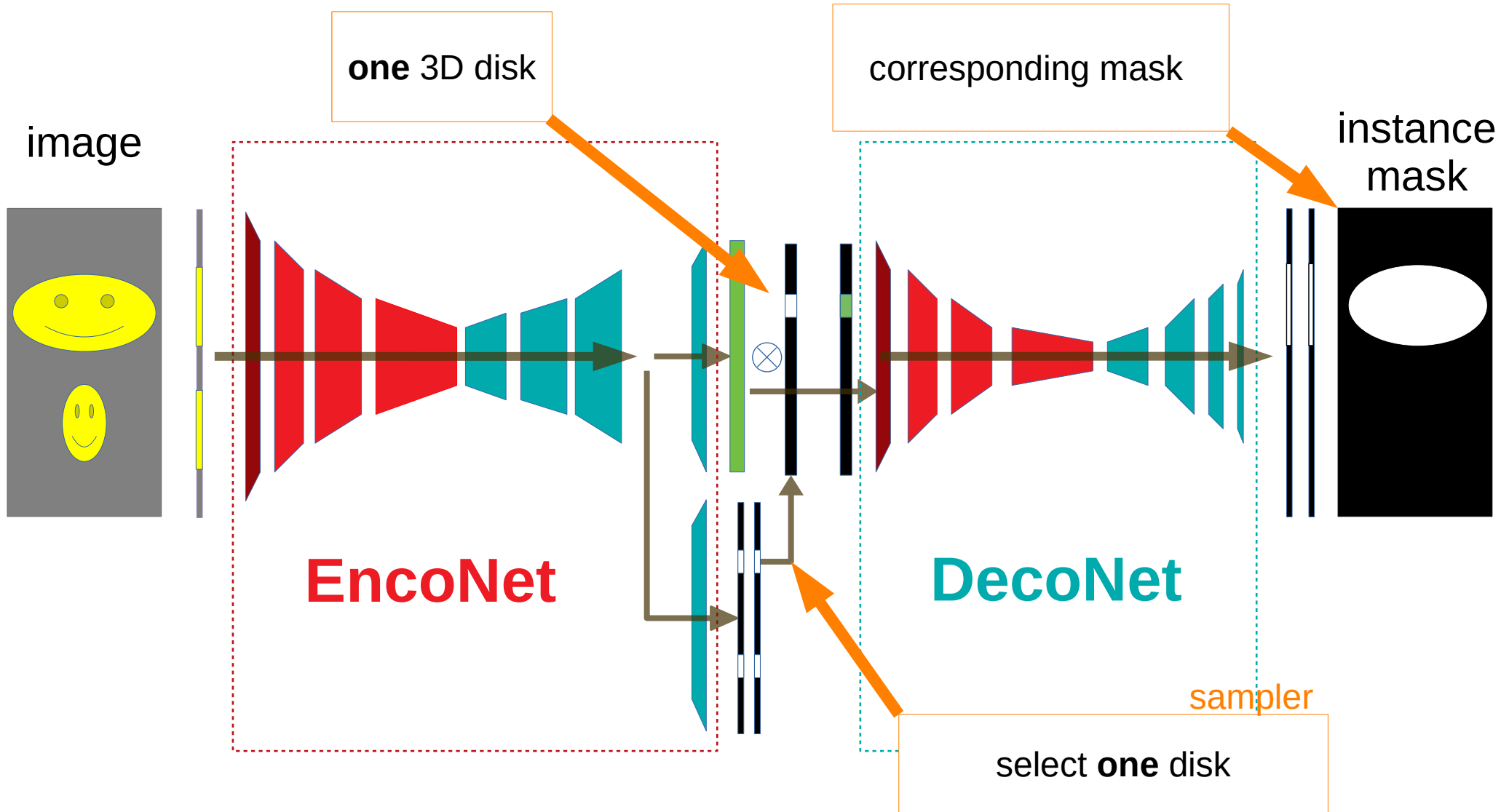
# DiskMask: Forward Pass



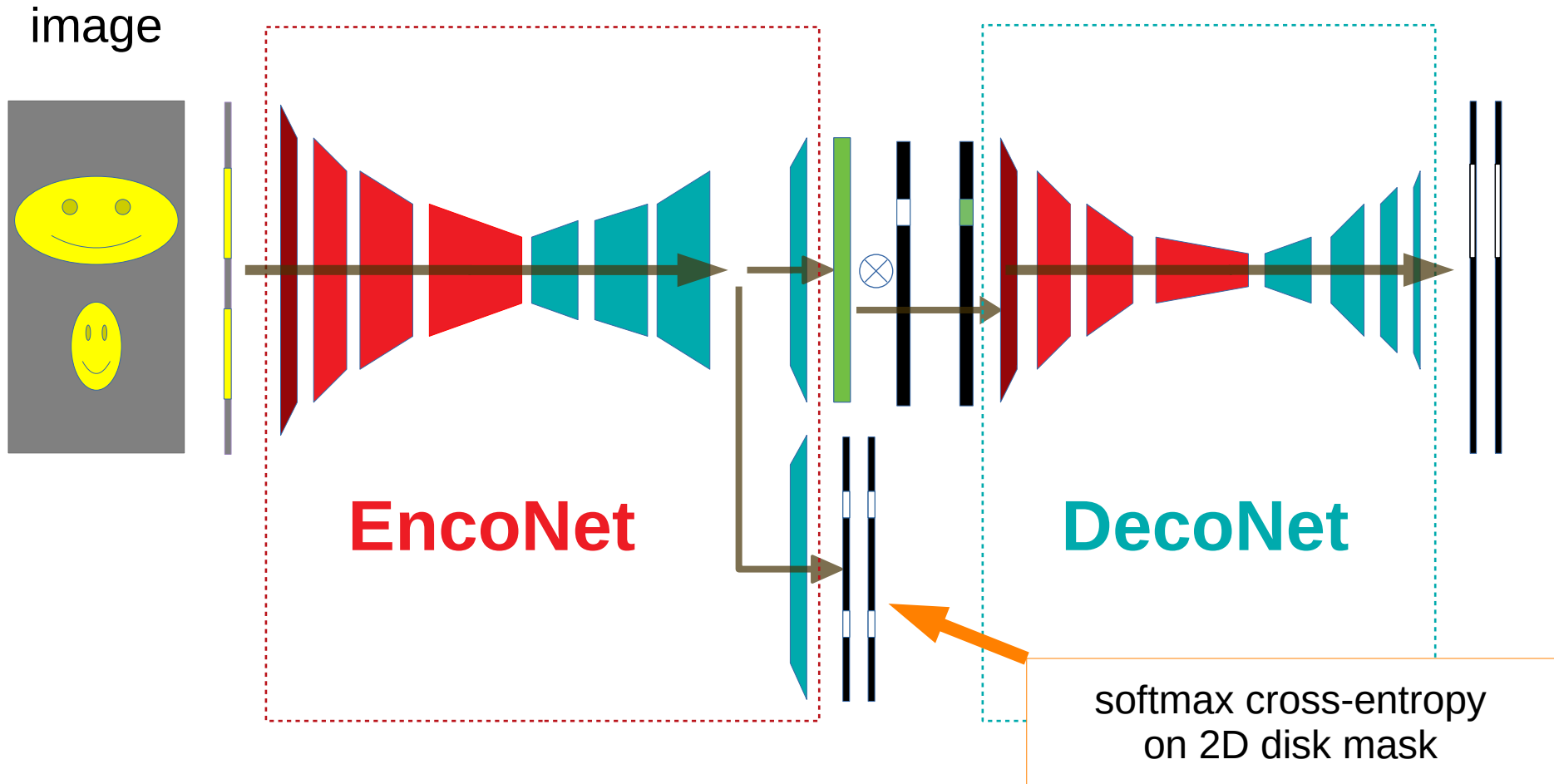
# DiskMask: Forward Pass



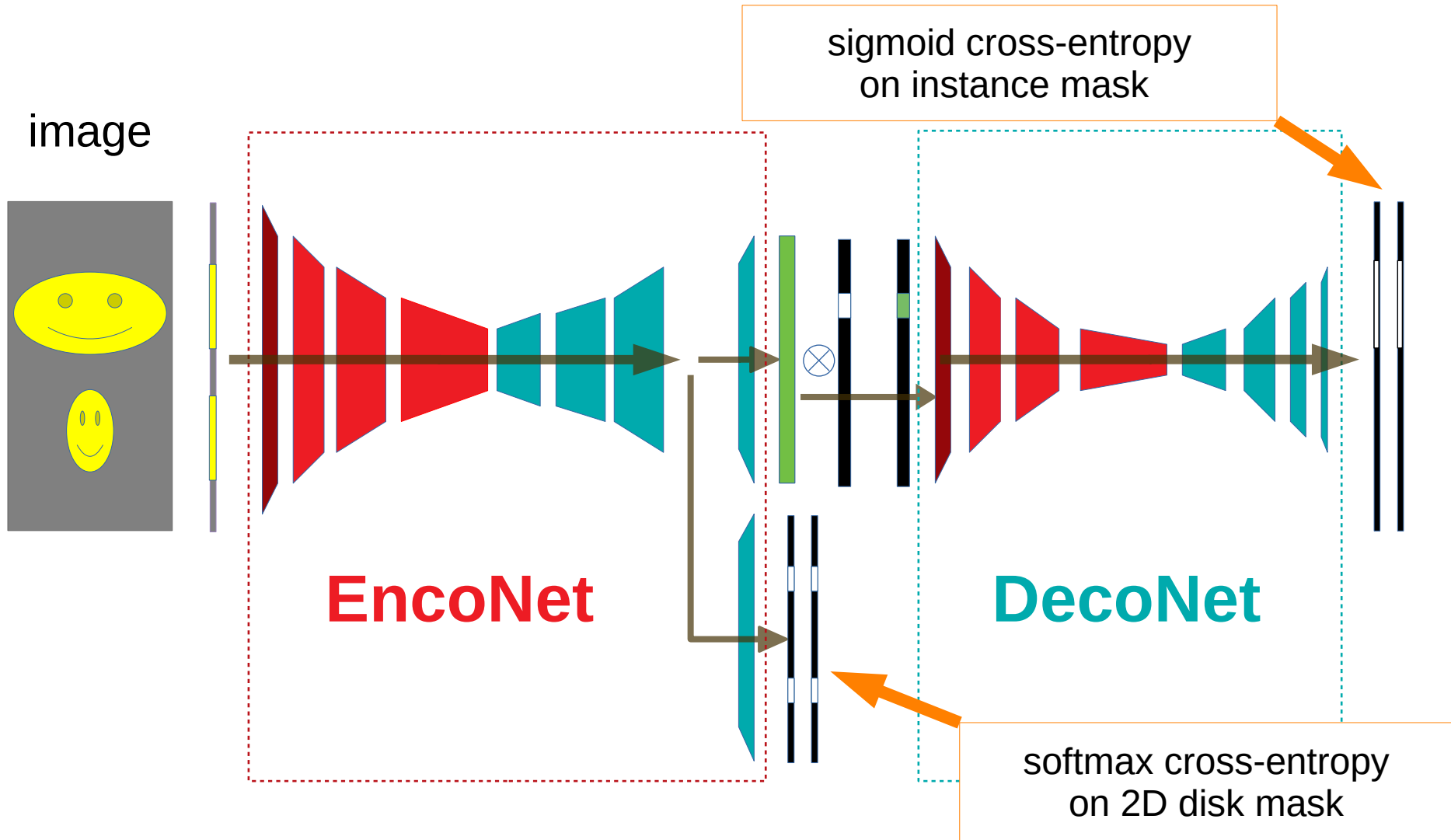
# DiskMask: Forward Pass



# DiskMask: Loss Functions

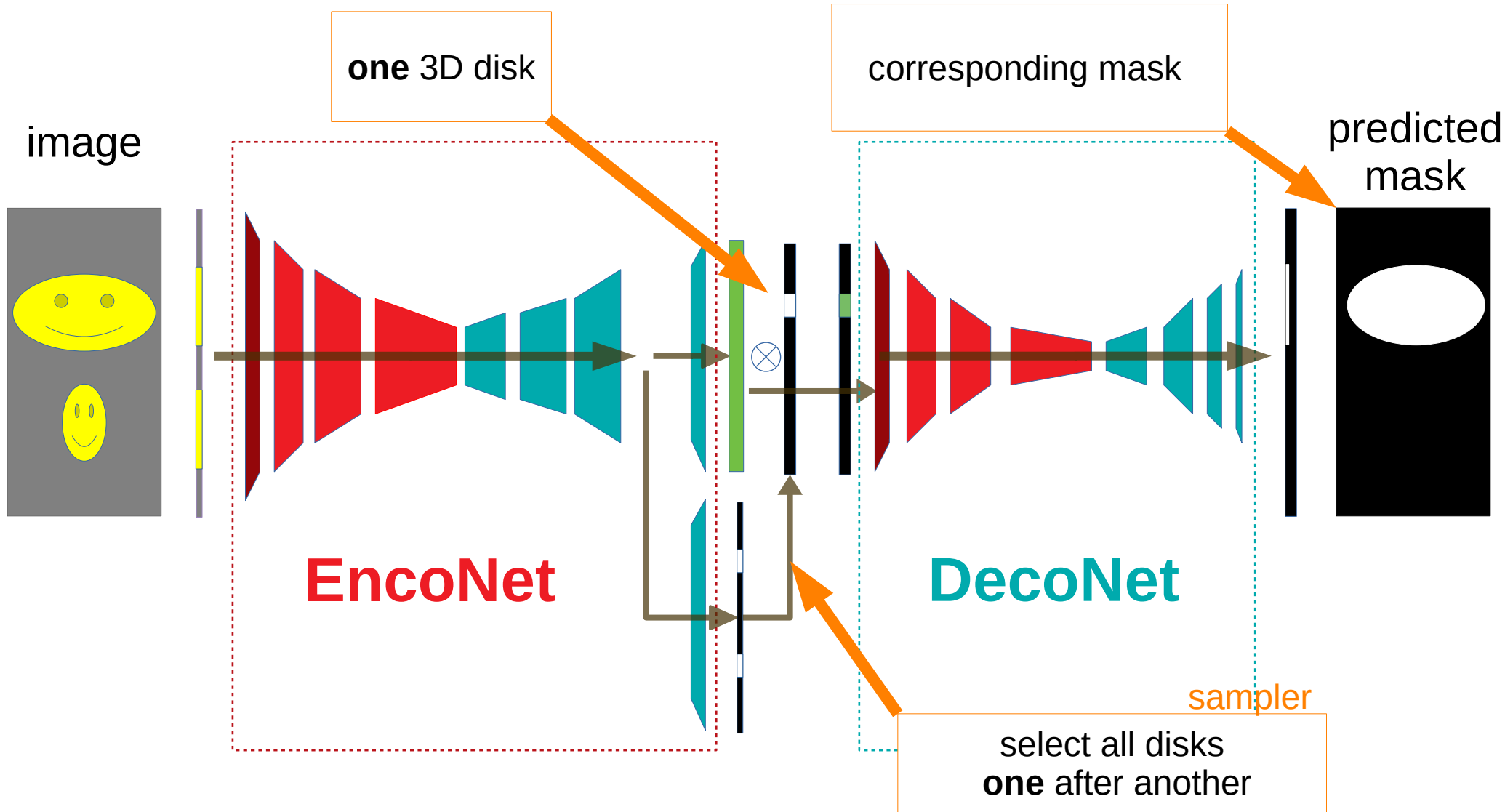


# DiskMask: Loss Functions

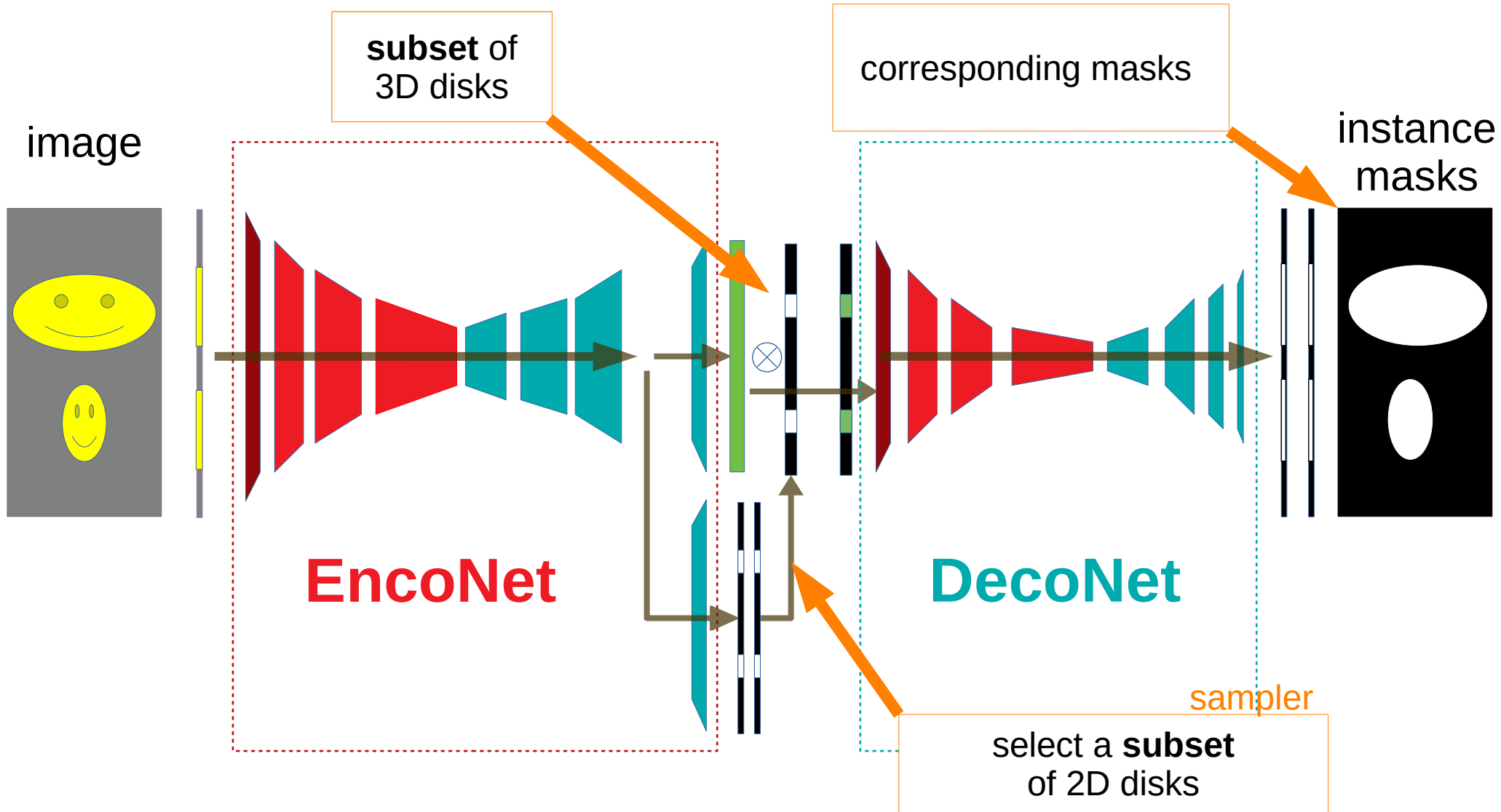




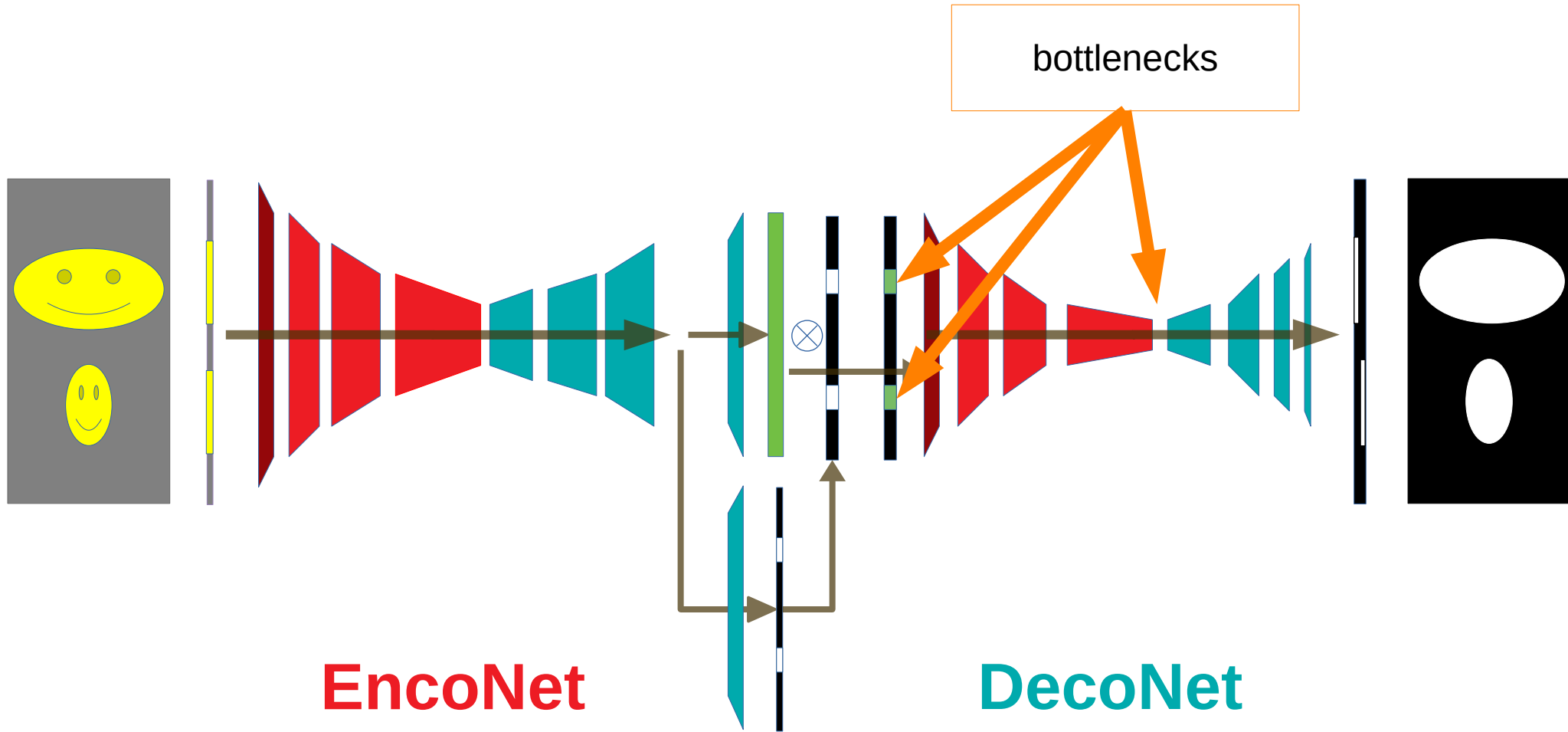
# DiskMask: Forward Pass (Inference)



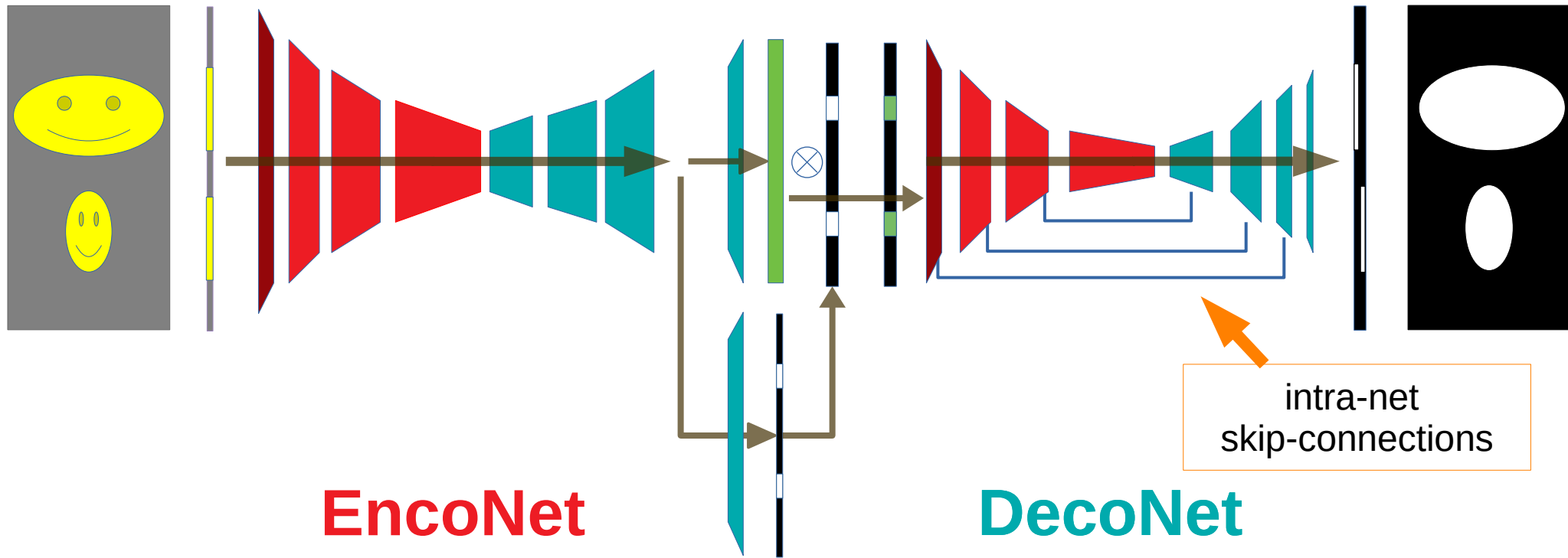
# DiskMask: Forward Pass (Training)



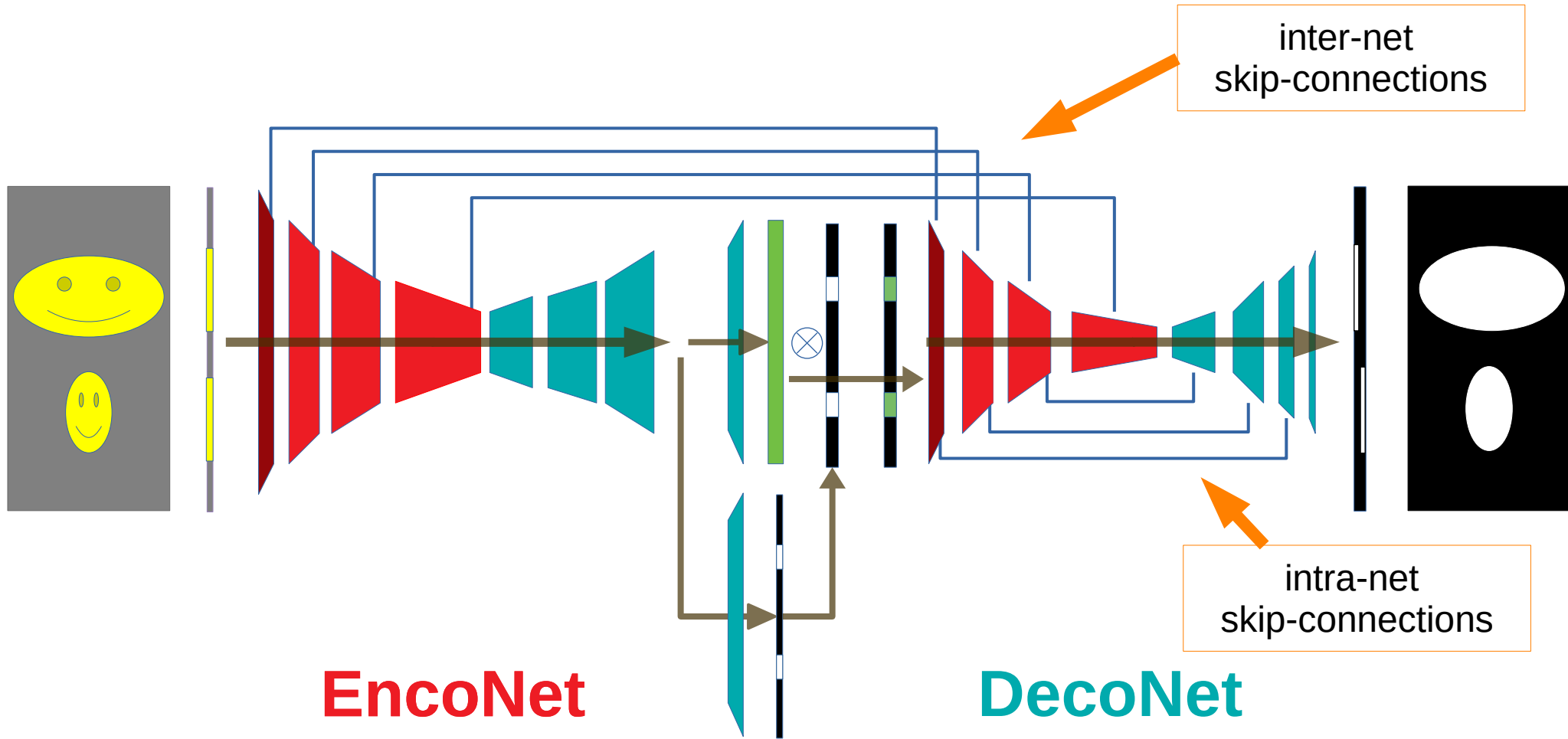
# DiskMask: Skip-Connections



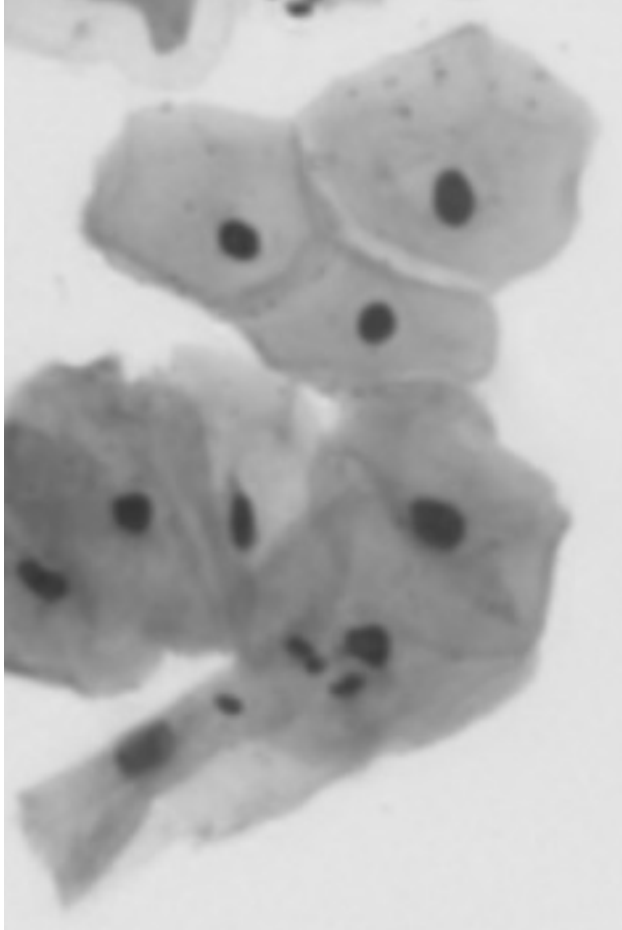
# DiskMask: Skip-Connections



# DiskMask: Skip-Connections



# Datasets



Cervical Cells

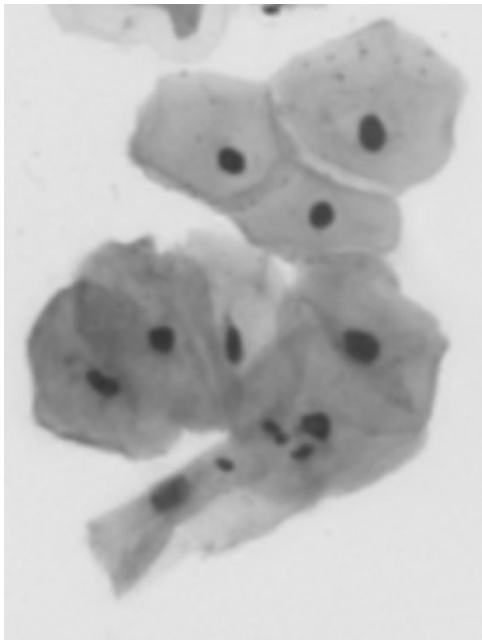


C. Elegans

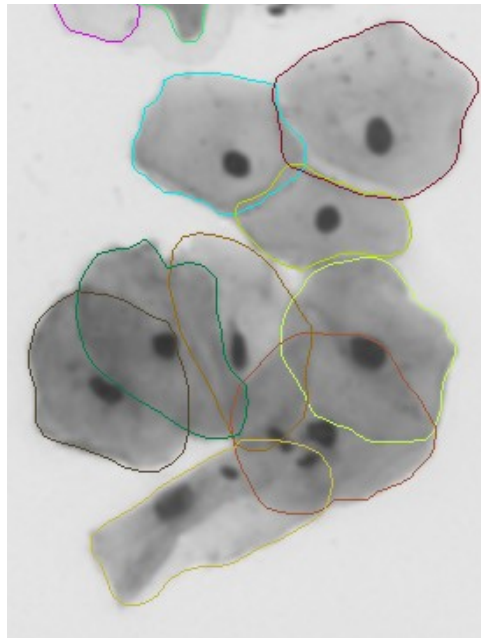


Leaf Segmentation  
Challenge (LSC)

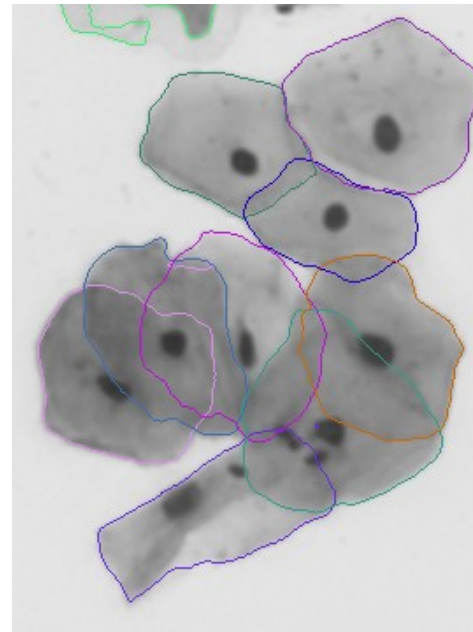
# Results: Cervical Cells



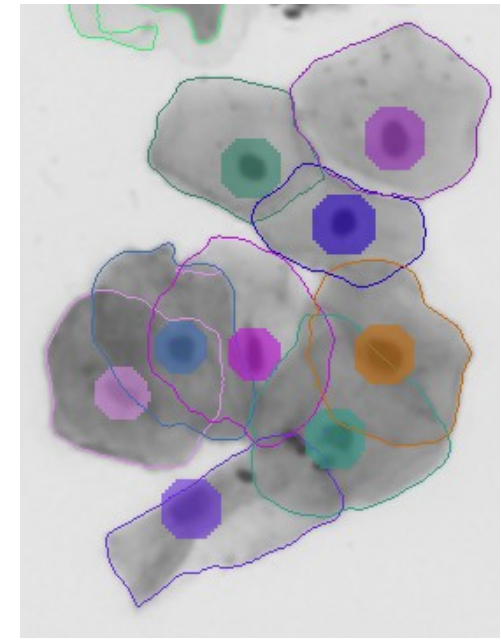
image



ground truth:  
masks as contours

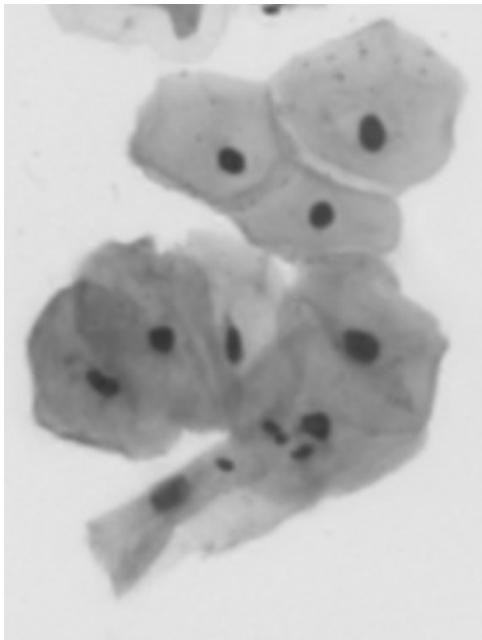


prediction:  
masks

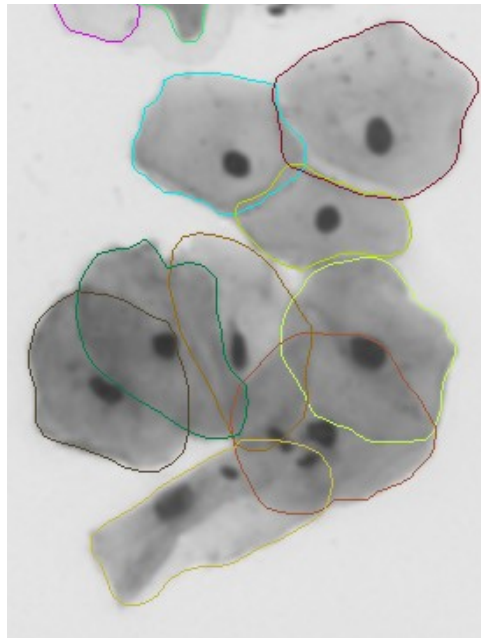


prediction:  
masks and disks

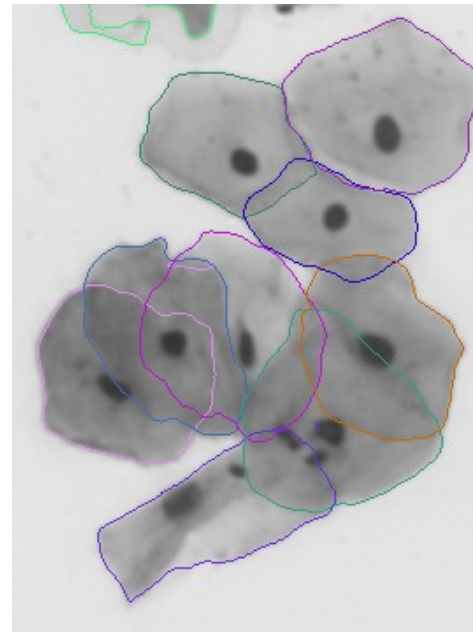
# Results: Cervical Cells



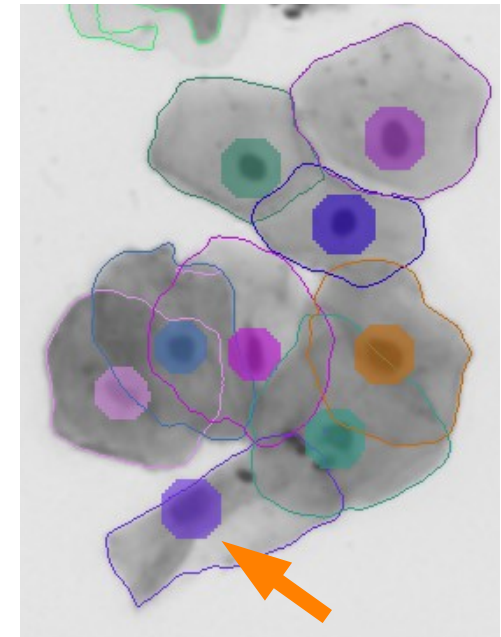
image



ground truth:  
masks as contours



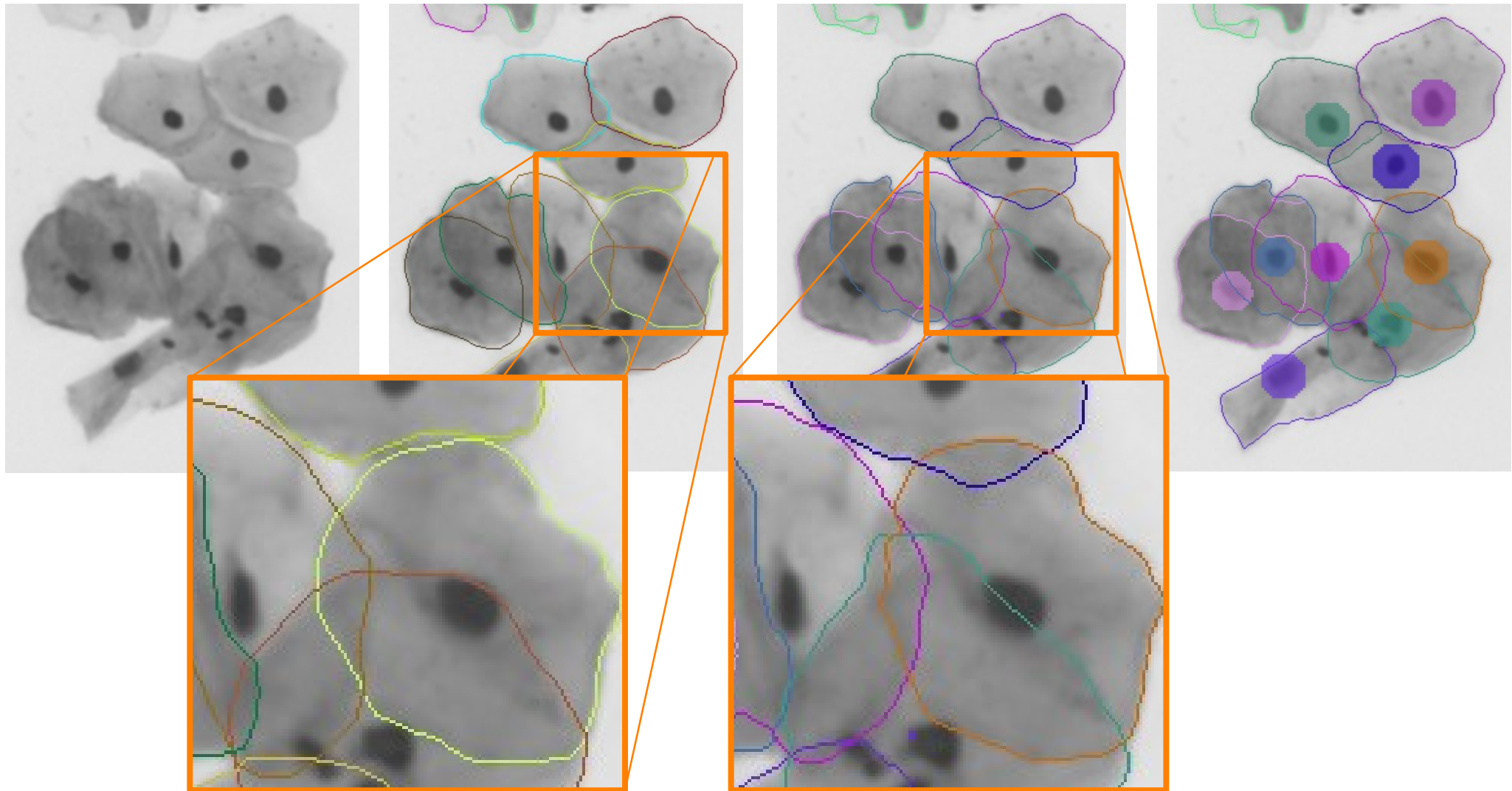
prediction:  
masks



prediction:  
masks and disks



# Results: Cervical Cells



# Results: Cervical Cells

	<b>DC</b>	<b>FNo</b>	<b>TPp</b>	<b>FPp</b>
Phoulady <i>et al.</i>	.831±.079	.408±.163	.927±.098	.003±.002
Ramalho <i>et al.</i>	.856±.078	.501±.180	.899±.113	.002±.001
Lee <i>et al.</i>	.879±.087	.434±.168	.877±.123	.001±.001
ISOOv	.863±.074	.370±.141	.895±.107	.001±.001
ISOOv2	.895±.079	.290±.151	.901±.108	.001±.001
<b>ours</b>	<b>.899±.082</b>	<b>.221±.125</b>	<b>.904±.105</b>	.001±.001

**DC** - Dice Coefficient; **FN** - False Negative; **TP** - True Positive; **FP** - False Positive

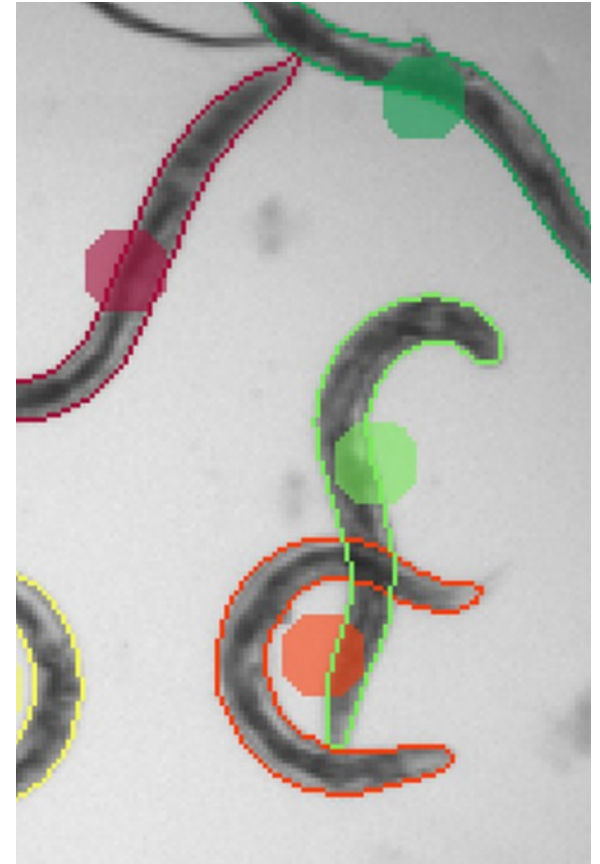
# Results: C. Elegans



image



ground truth:  
masks as contours



prediction:  
masks and disks

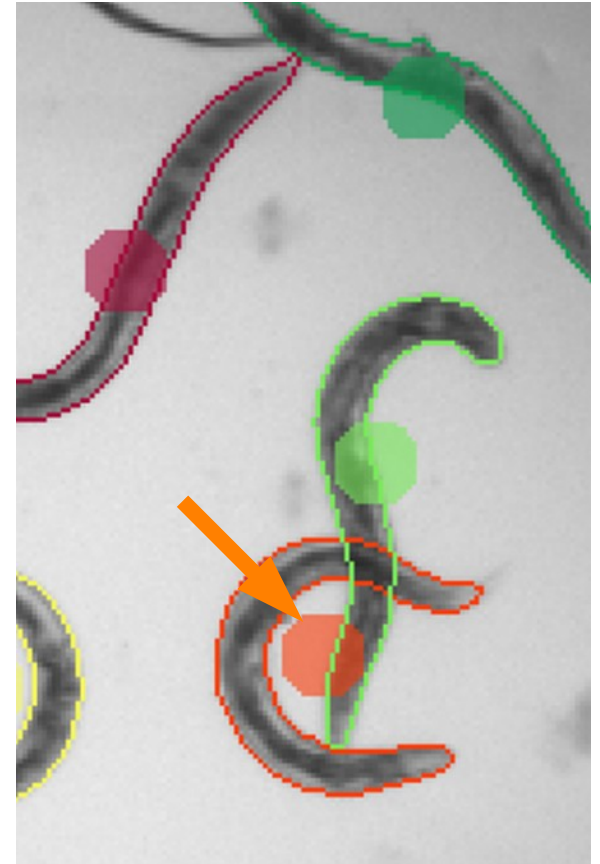
# Results: C. Elegans



image



ground truth:  
masks as contours



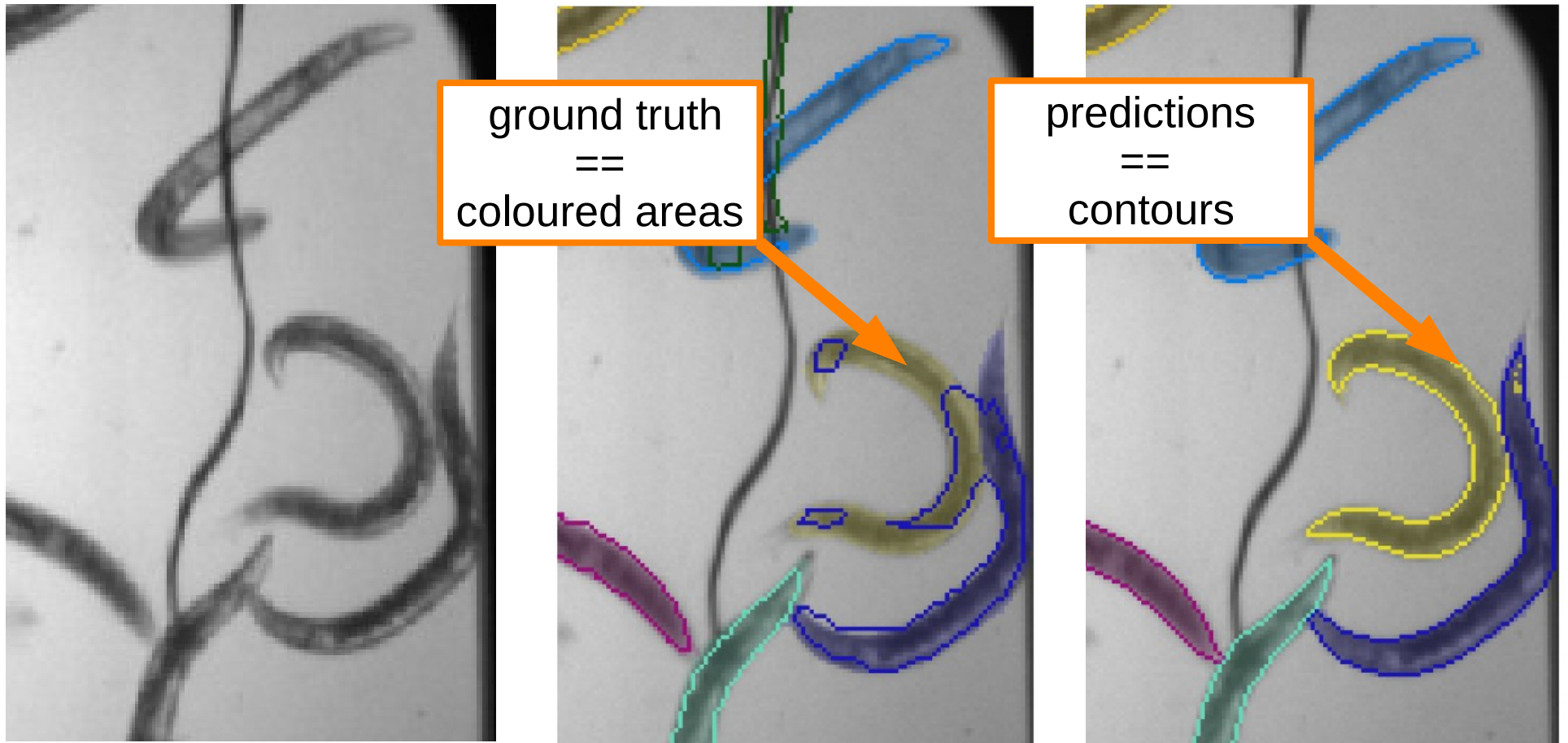
prediction:  
masks and disks

# Results: C. Elegans



image

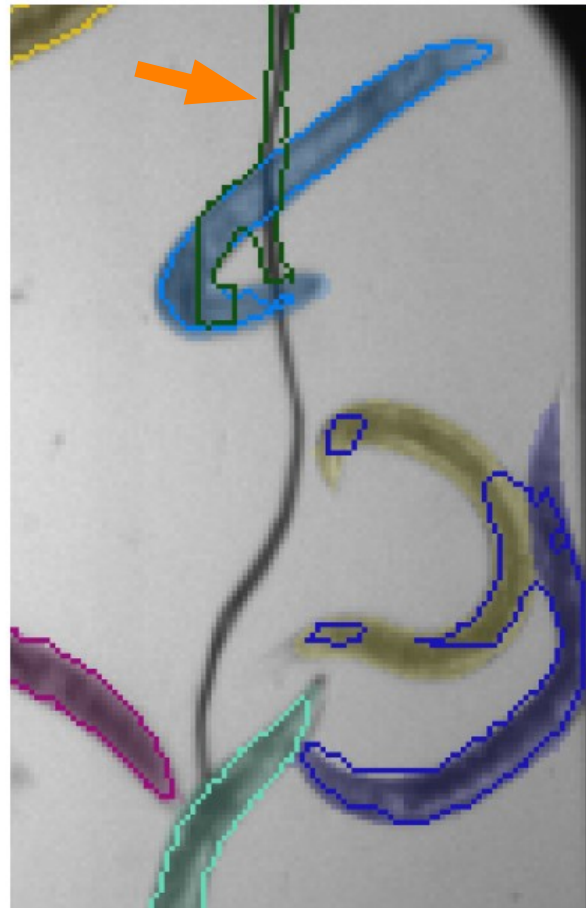
# Results: C. Elegans



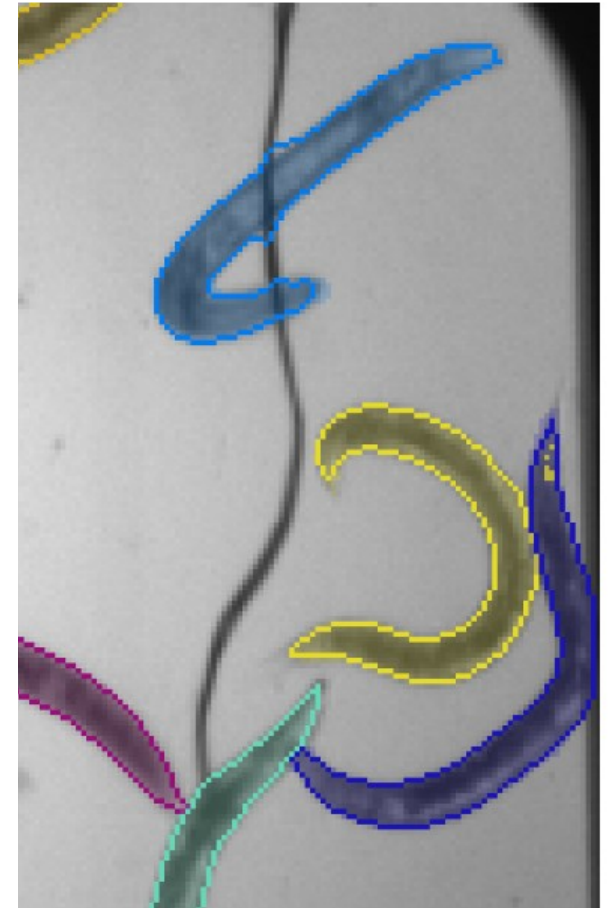
Mask R-CNN

DiskMask

# Results: C. Elegans

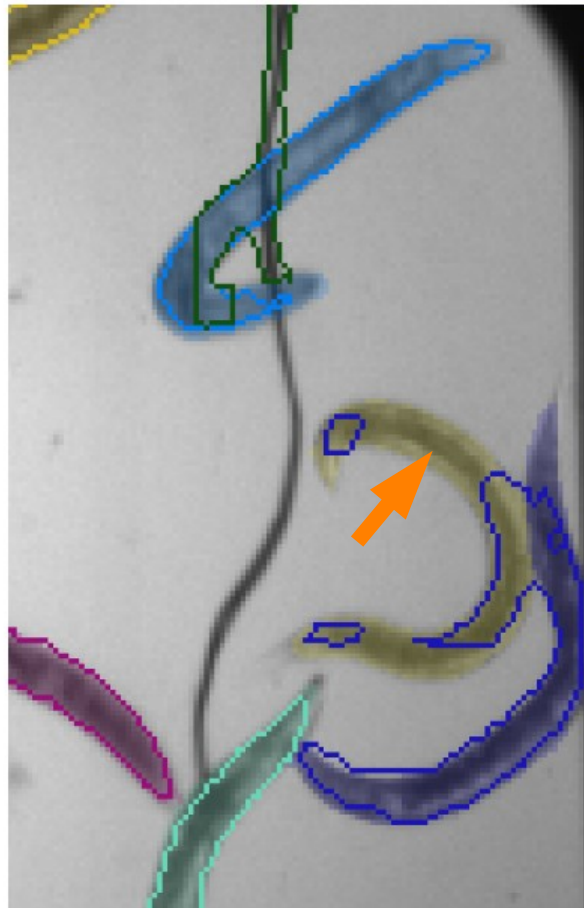


Mask R-CNN

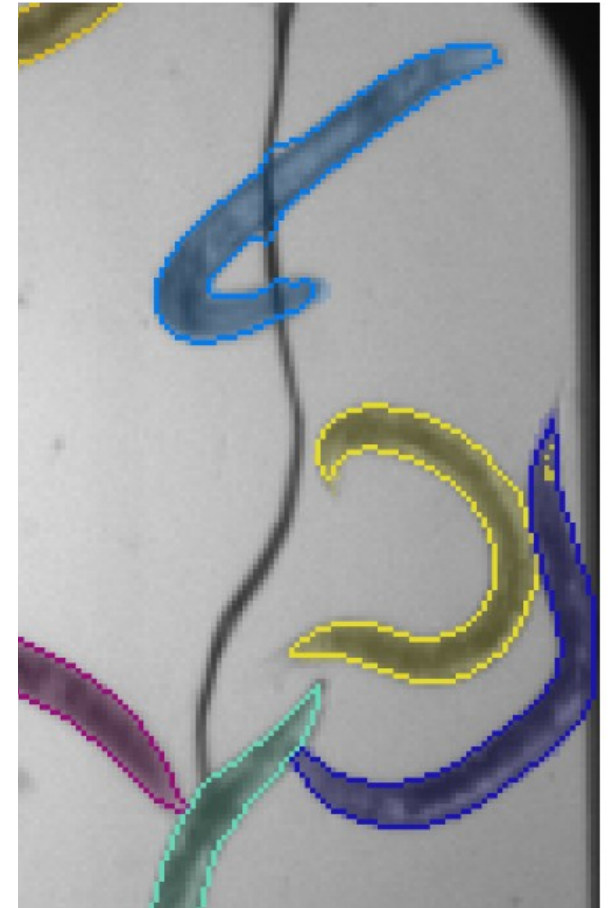


DiskMask

# Results: C. Elegans



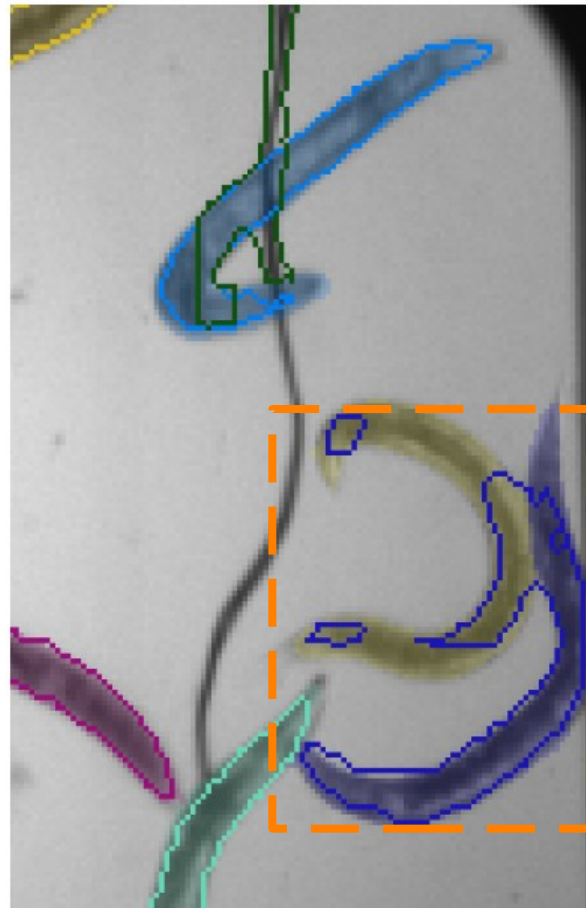
Mask R-CNN



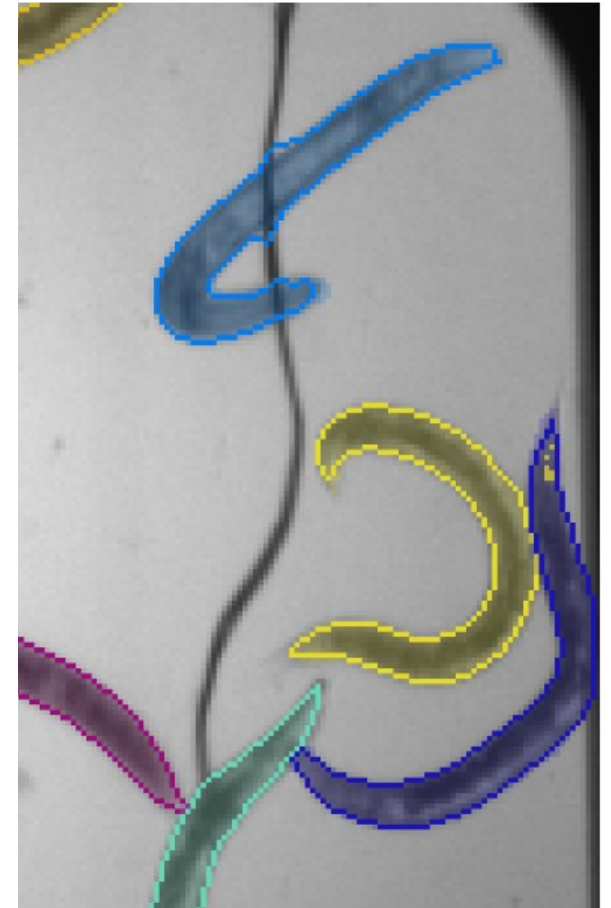
DiskMask



# Results: C. Elegans

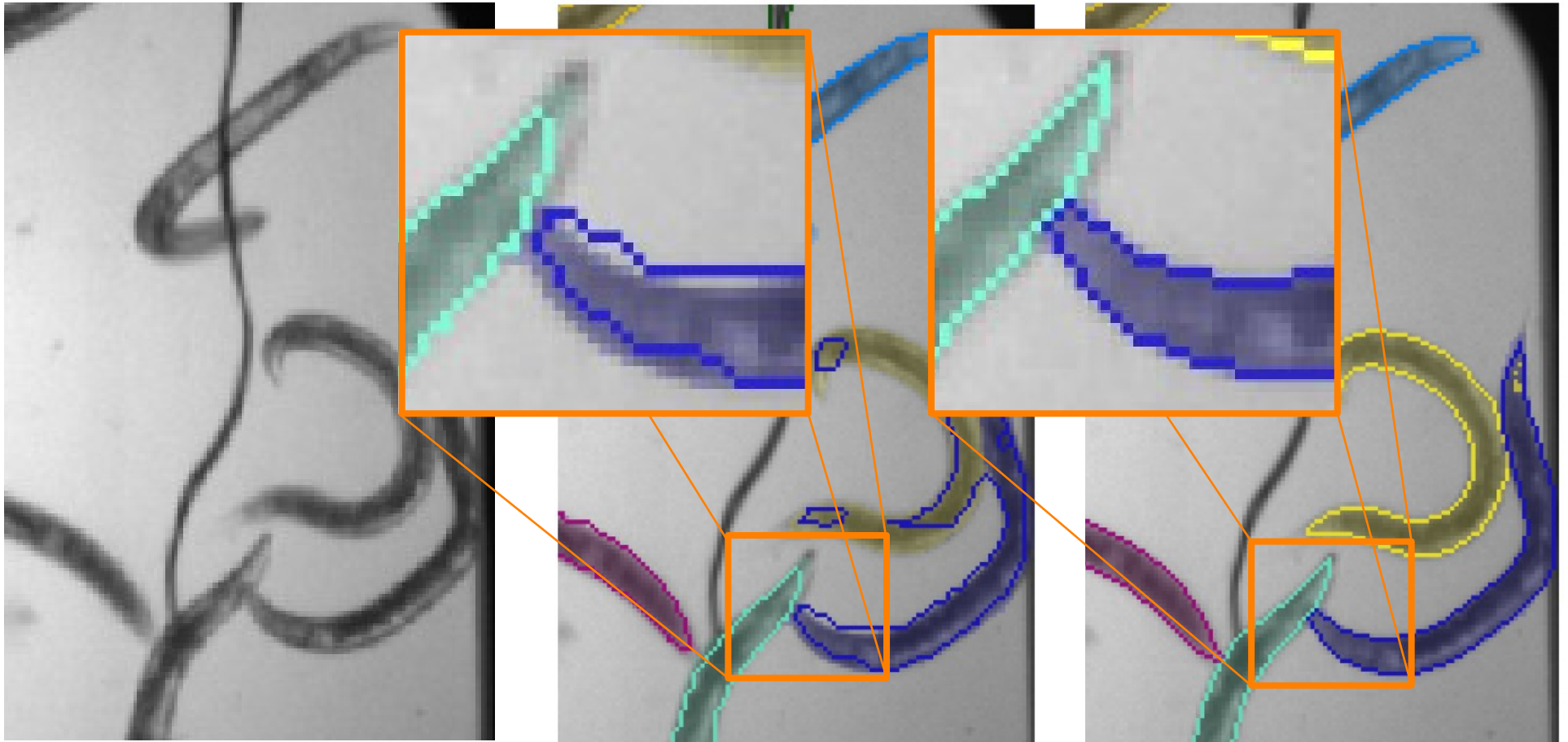


Mask R-CNN



DiskMask

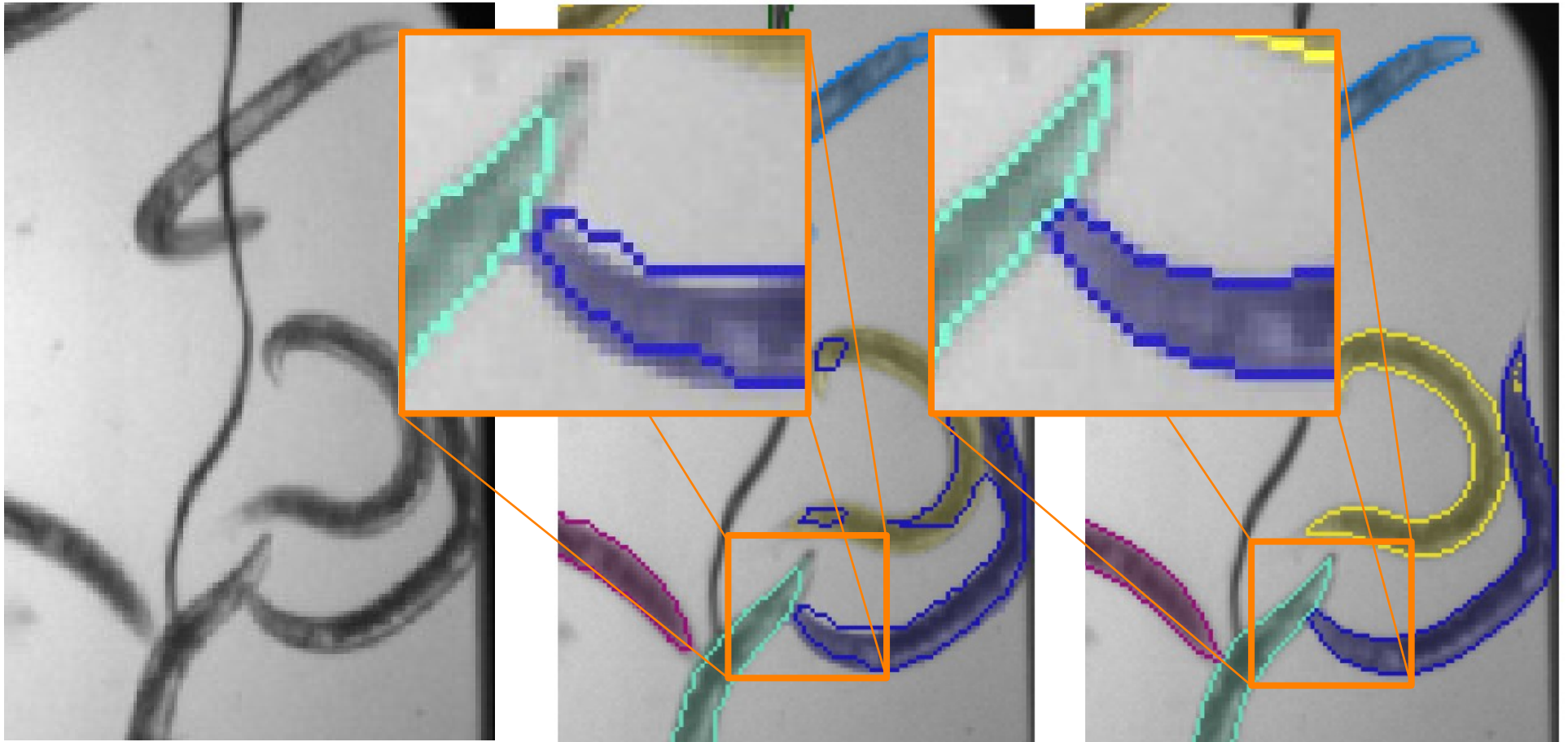
# Results: C. Elegans



Mask R-CNN

DiskMask

# Results: C. Elegans



AP	Mask R-CNN	DiskMask
IoU = 75	.790	.916
IoU = 90	.019	.592

# Results: Leaf Segmentation Challenge (LSC)



image



prediction:  
masks as contours



prediction:  
masks and disks

# Results: LSC



image



prediction:  
masks as contours

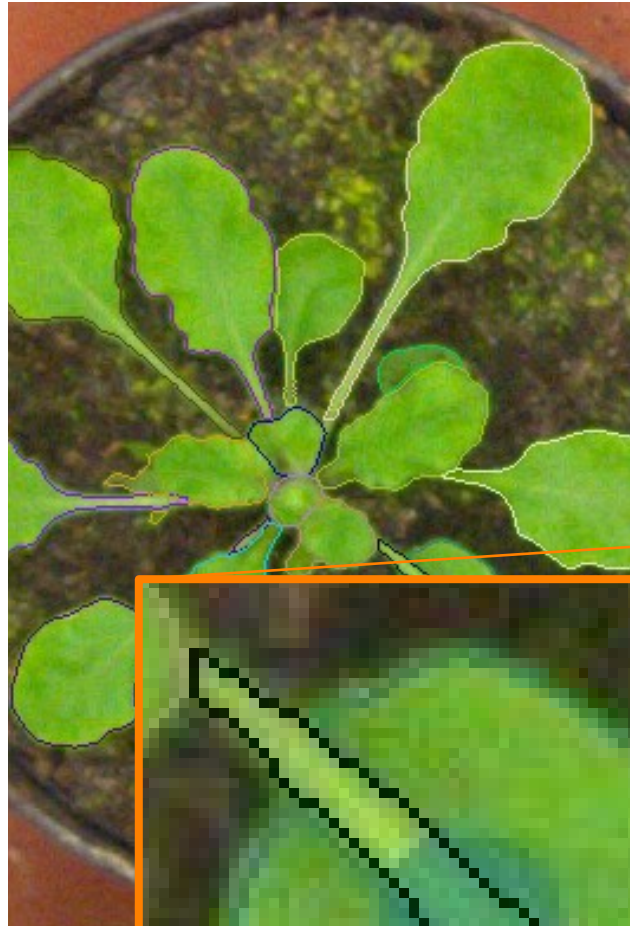


prediction:  
masks and disks

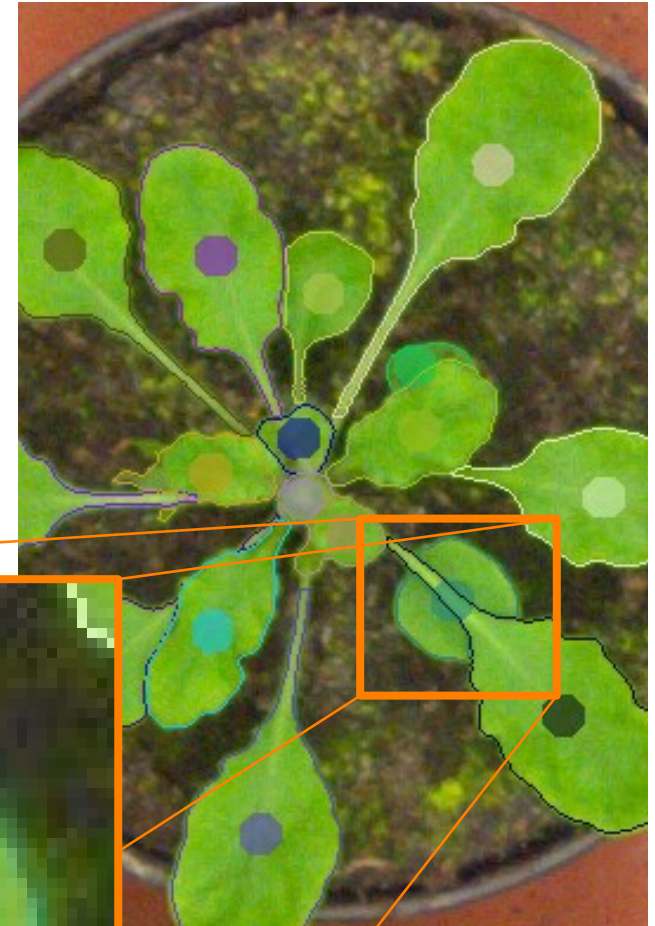
# Results: LSC



image



m



prediction:  
masks and disks



# Results: LSC

	SBD↑	DiC   ↓
Wageningen	71.1±6.2	2.2±1.6
IPK	74.4±4.3	2.2±1.3
Salvador <i>et al.</i>	74.7±5.9	1.1±0.9
Brabandere <i>et al.</i>	84.2	1.0
Ren <i>et al.</i>	84.9±4.8	<b>0.8±1.0</b>
Kuznichov <i>et al.</i>	88.7	5.3
Ward <i>et al.</i>	90.0	—
<b>ours*</b>	<b>91.7±4.1</b>	1.0±1.1

**SBD**: symmetric best dice , **|DiC|**: absolute difference in count

\*evaluated by:

<https://competitions.codalab.org/competitions/18405>

# DiskMask

