



*Not All Pixels are Equal:*  
Difficulty-aware Semantic Segmentation  
via Deep Layer Cascade

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# Problem



Input Video



State-of-the-art Method (4 FPS)



Deep Layer Cascade (17 FPS)

# State-of-the-art



State-of-the-art Method (4 FPS)

- Why Slow?

- Very Deep Backbone Network
- High Resolution Feature Map

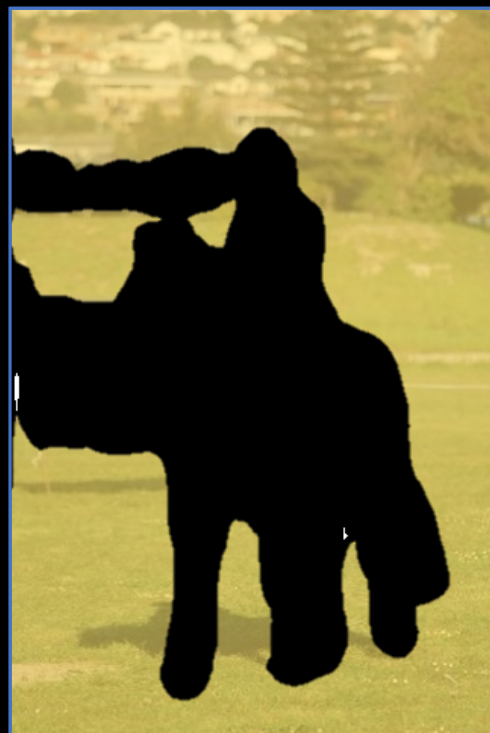


Fully Convolutional Network

# Motivation



**Image**



**Easy Region**

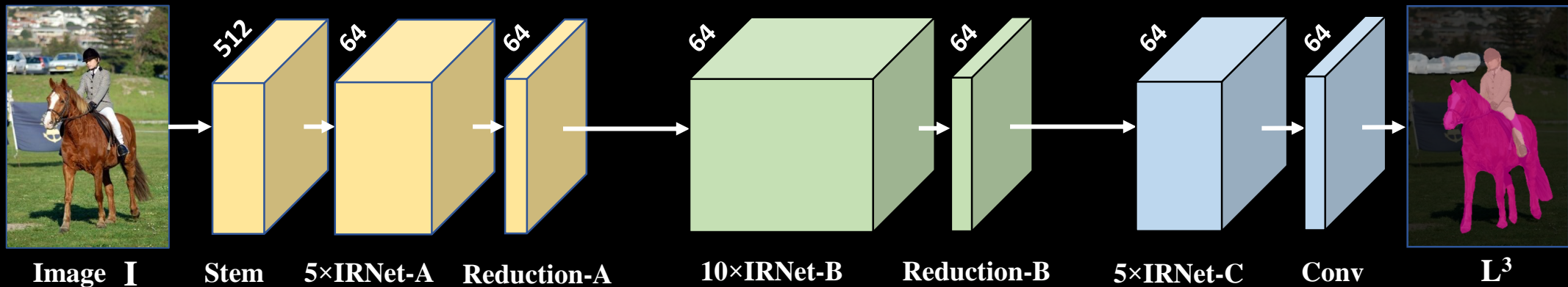
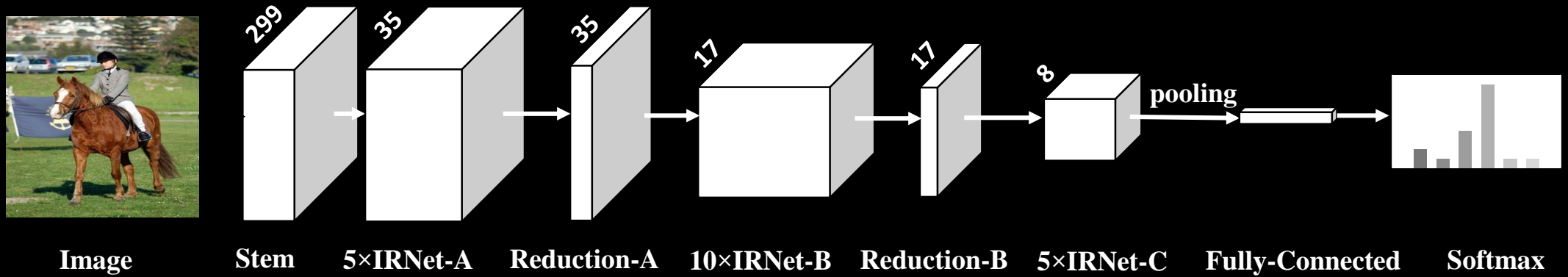


**Moderate Region**

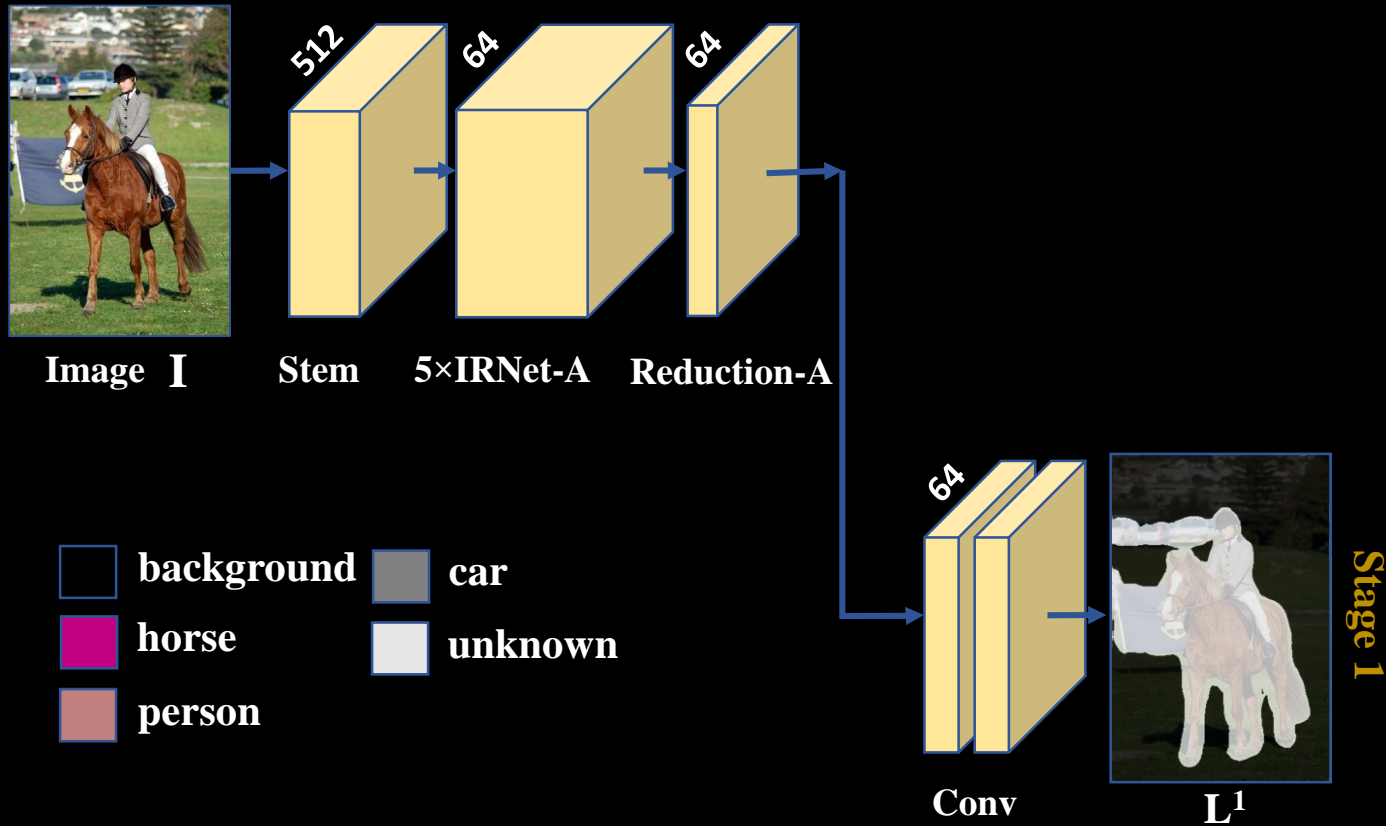


**Hard Region**

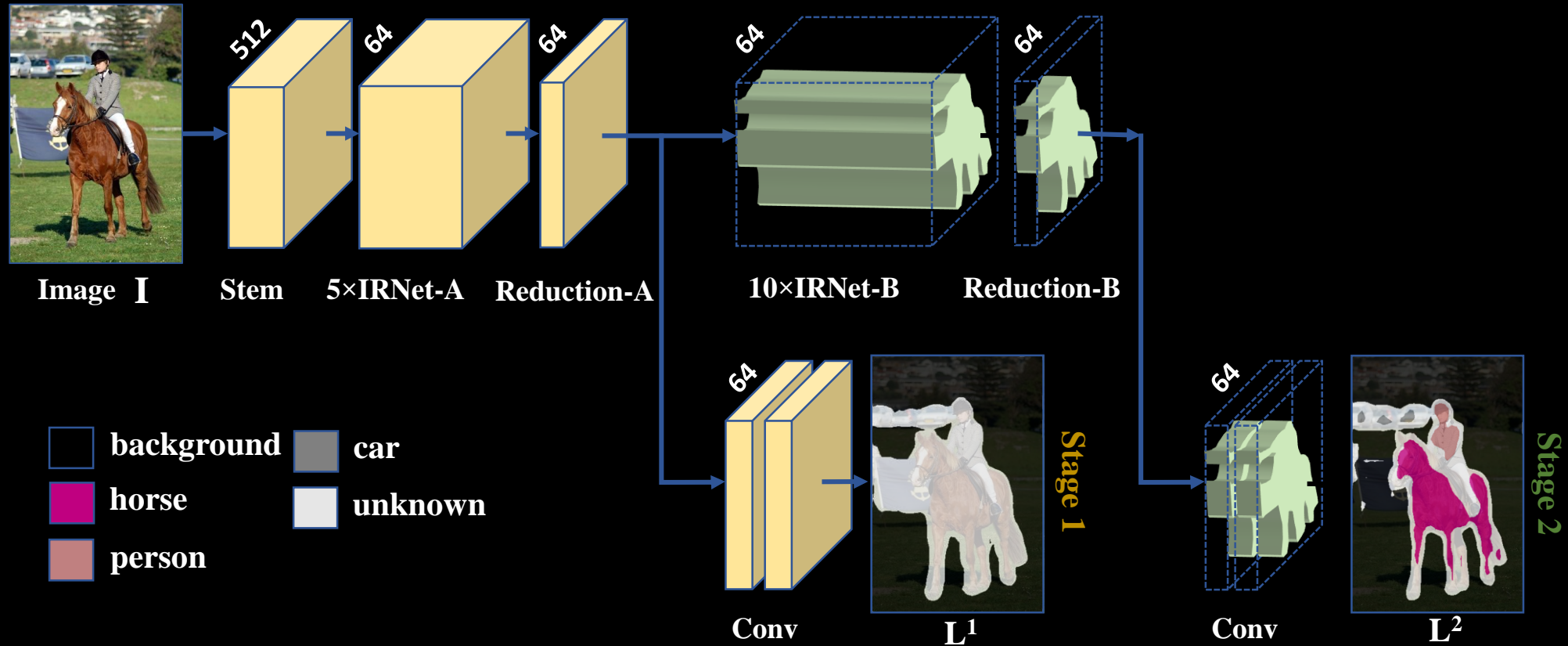
# Contemporary Model



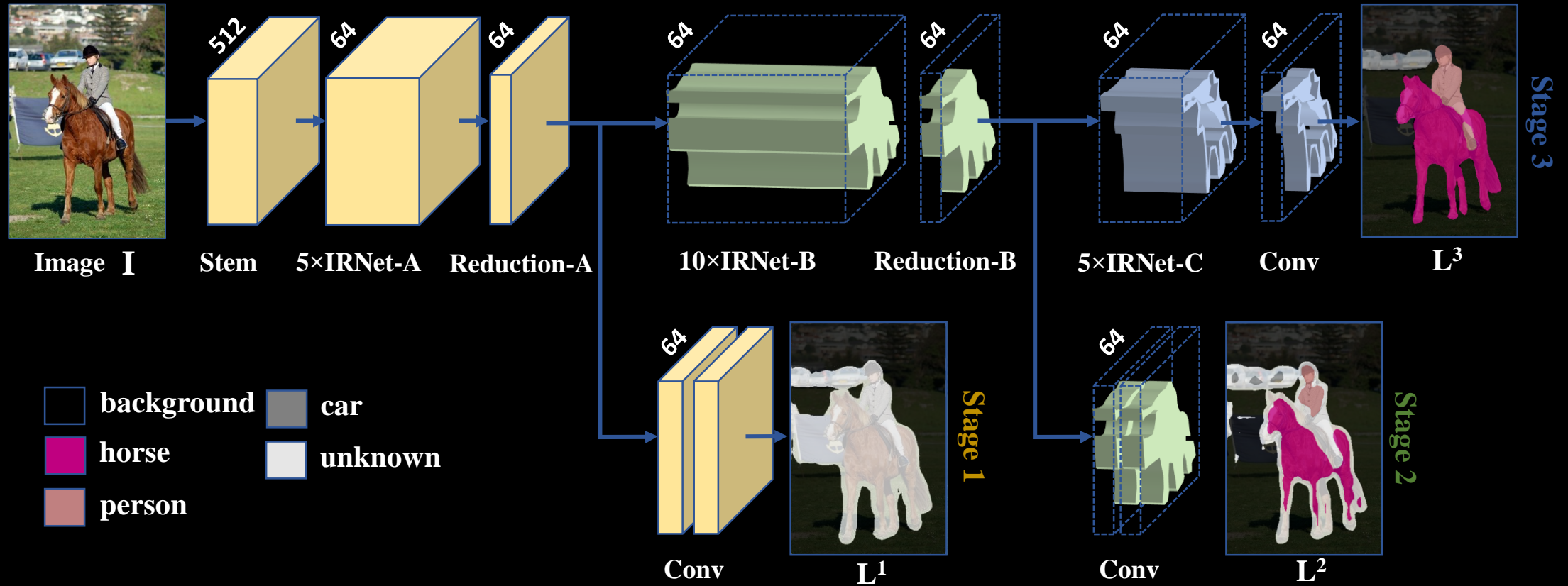
# Deep Layer Cascade



# Deep Layer Cascade

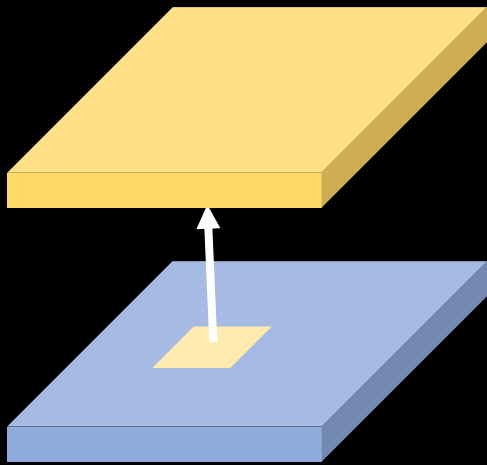


# Deep Layer Cascade

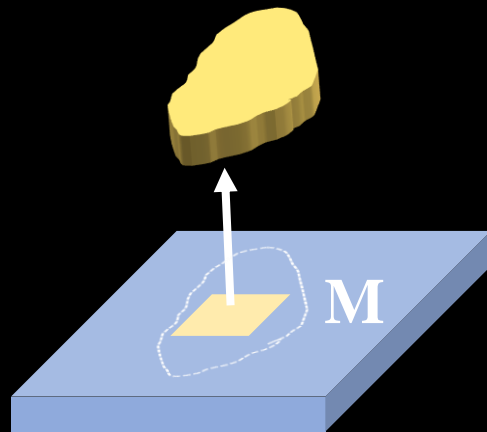




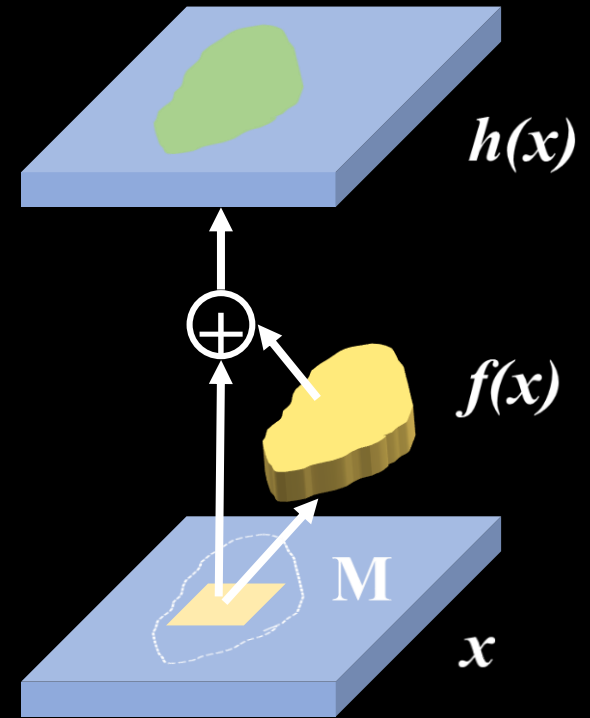
# Region Convolution



**Convolution**



**Region Convolution**



**Region Convolution with Residual**

# Performance

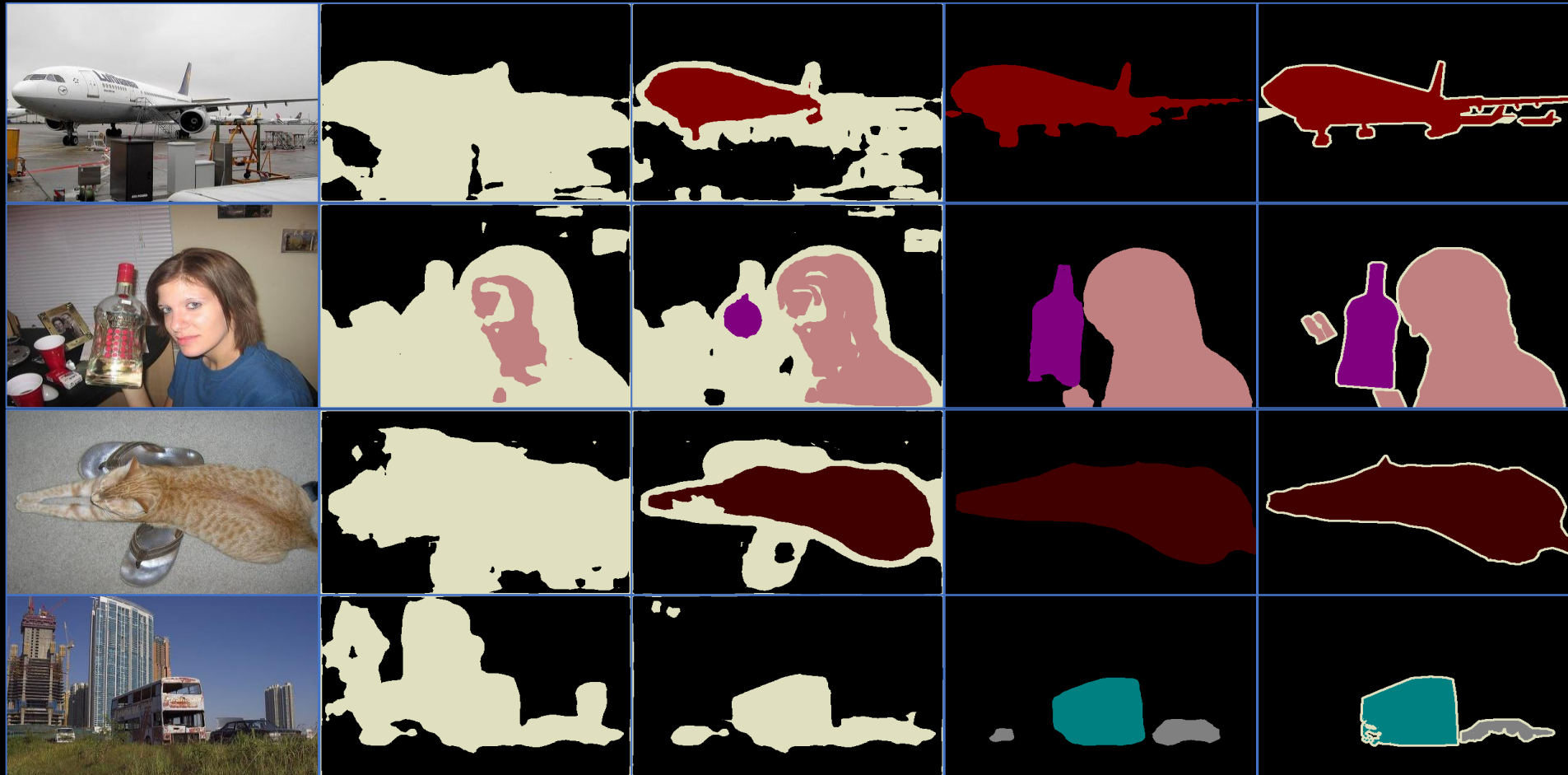
## PASCAL VOC 2012

	<b>mIoU</b>	<b>FPS</b> (Backbone Network)
DPN	77.5	5.7
Adelaide	79.1	-
Deeplab-v2	79.7	7.1
<b>LC(w/o COCO)</b>	<b>80.3</b>	<b>14.7</b>
<b>LC(with COCO)</b>	<b>82.7</b>	

(PASCAL VOC 2012 Challenge test set)

# Stage Visualization

background unknown aeroplane person bottle cat bus car



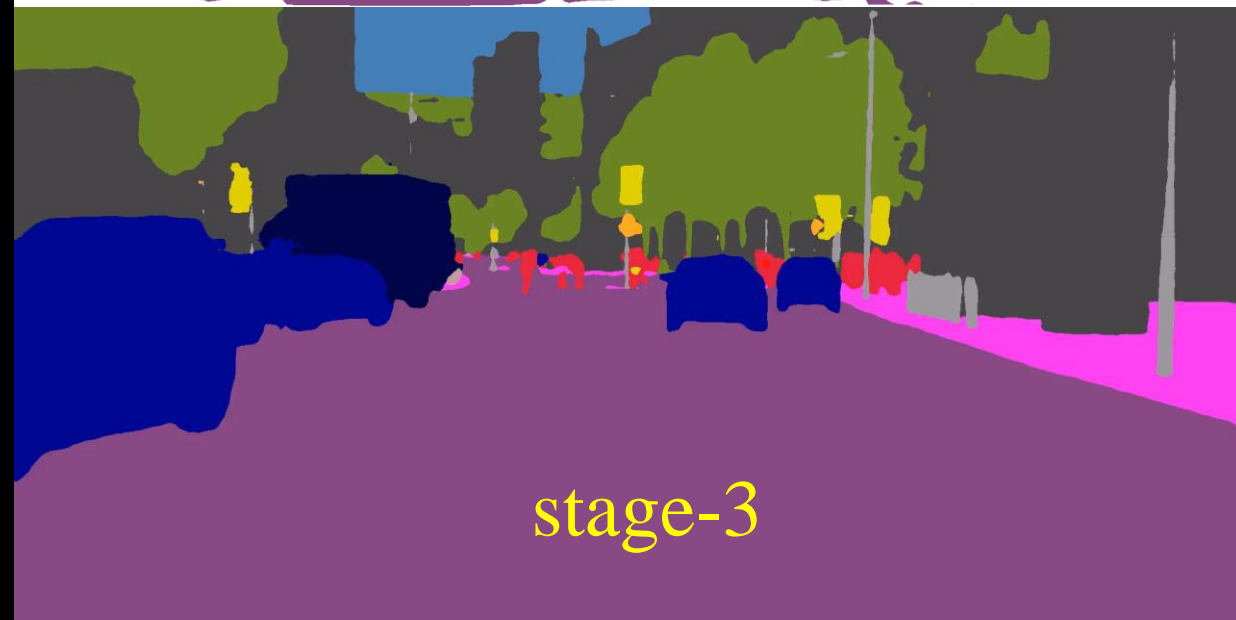
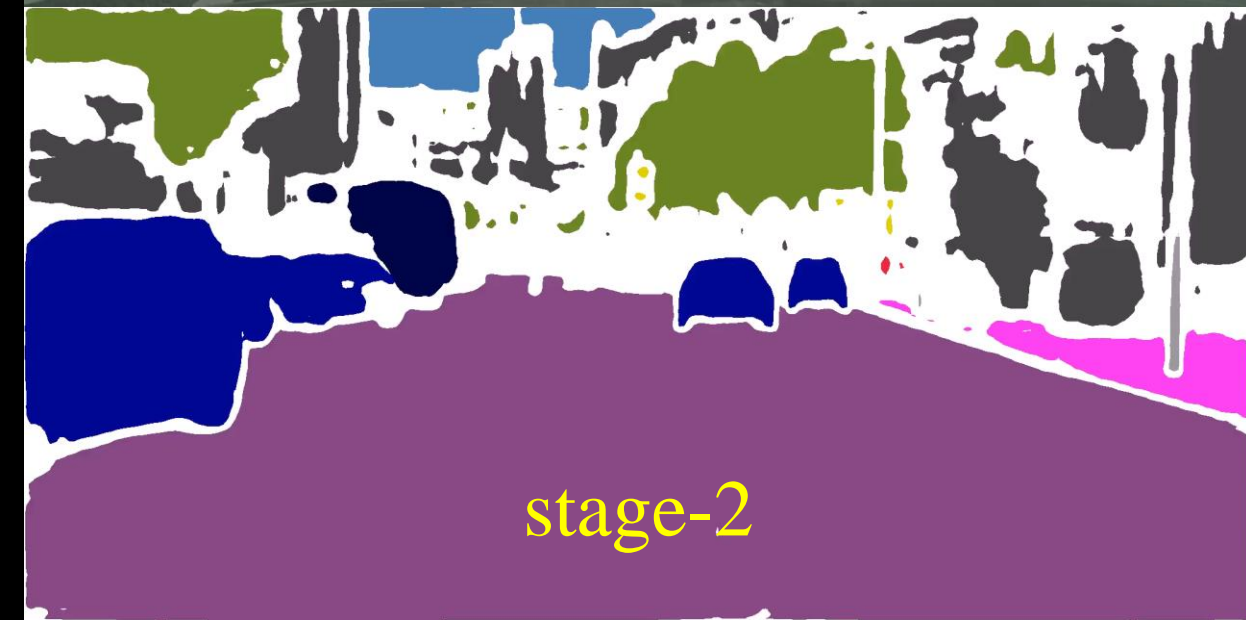
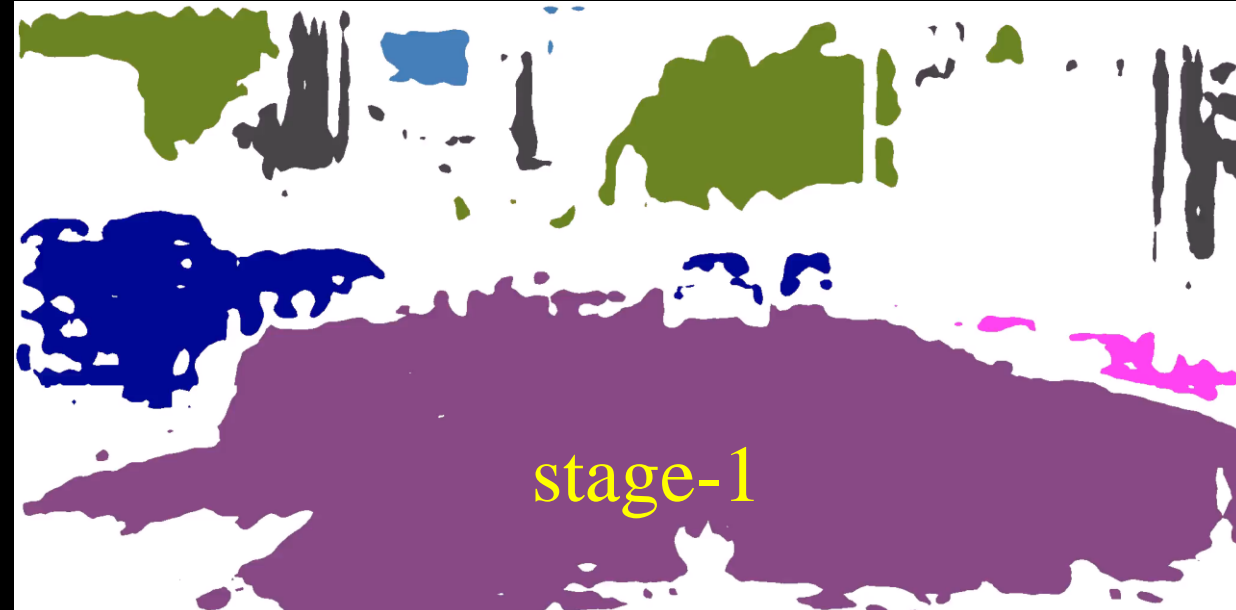
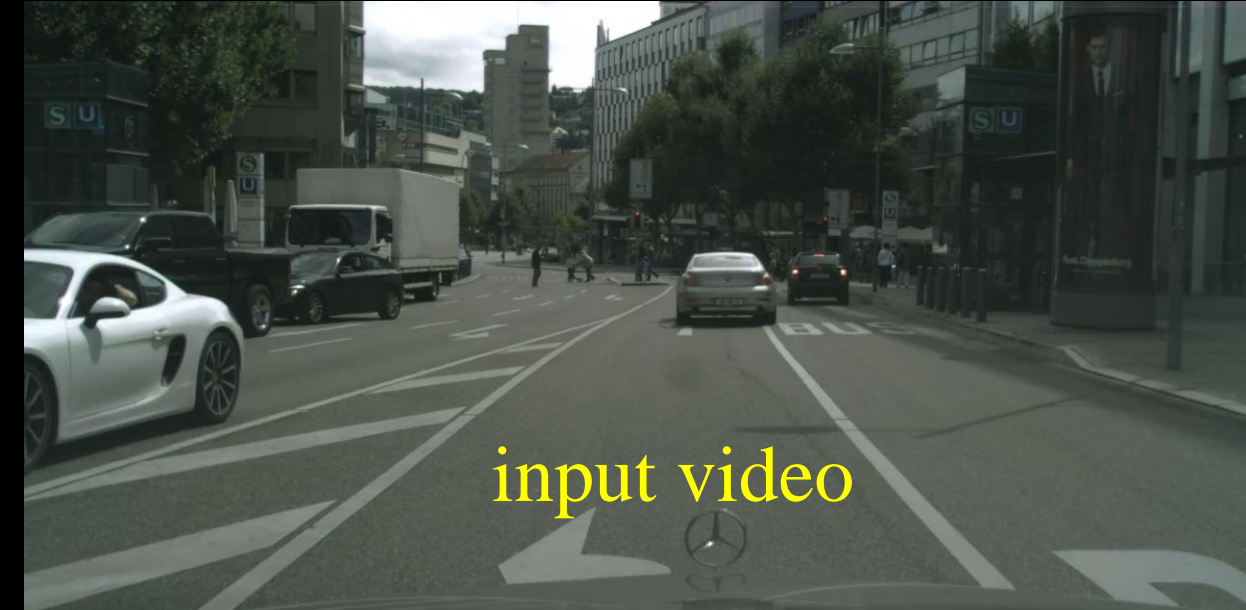
(a) input image

(b) stage-1

(c) stage-2

(d) stage-3

(e) ground truth



• Difficulty-Aware Learning Paradigm

• Region Convolution → Real-Time

• End-To-End Trainable Framework

# Thanks!

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Code and models are available @

Project Page: <http://personal.ie.cuhk.edu.hk/~lz013/projects/LayerCascade.html>