Day 4 Lecture 2

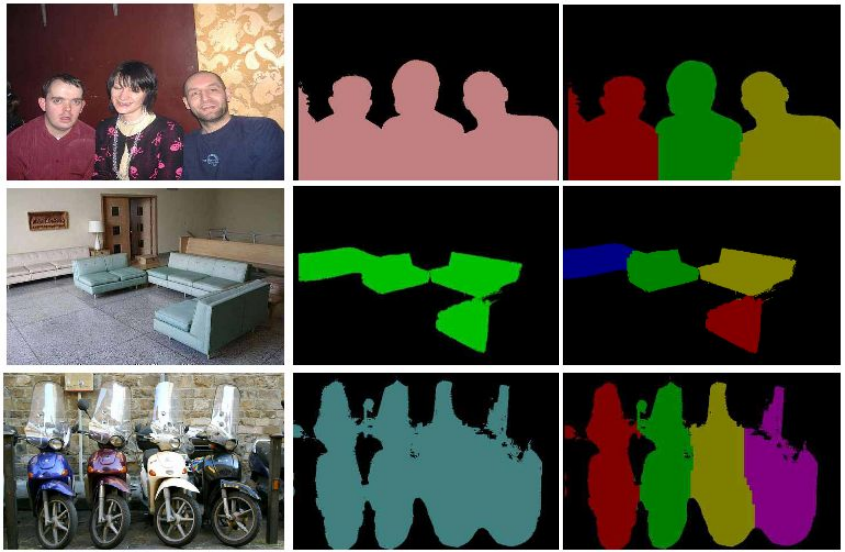
Segmentation

Segmentation

Segmentation

Define the accurate boundaries of all objects in an image

Segmentation: Datasets



Pascal Visual Object Classes
20 Classes
~ 5.000 images

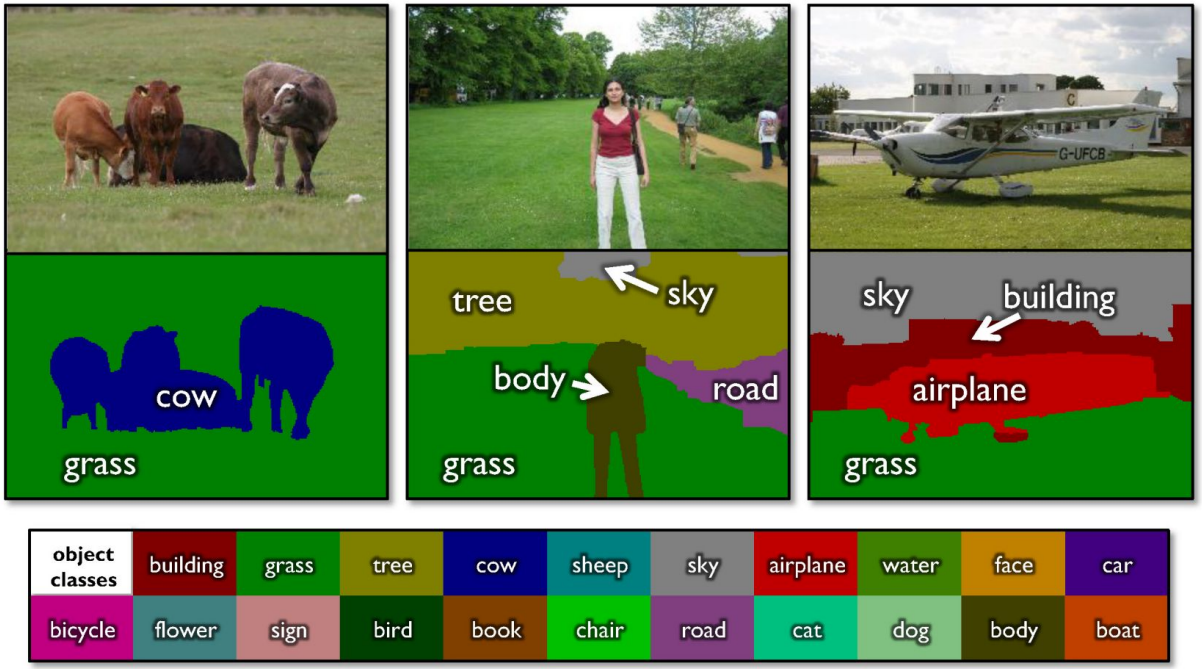
Microsoft COCO
80 Classes
~ 300.000 images

Semantic Segmentation

Label every pixel!

Don’t differentiate instances (cows)

Classic computer vision problem

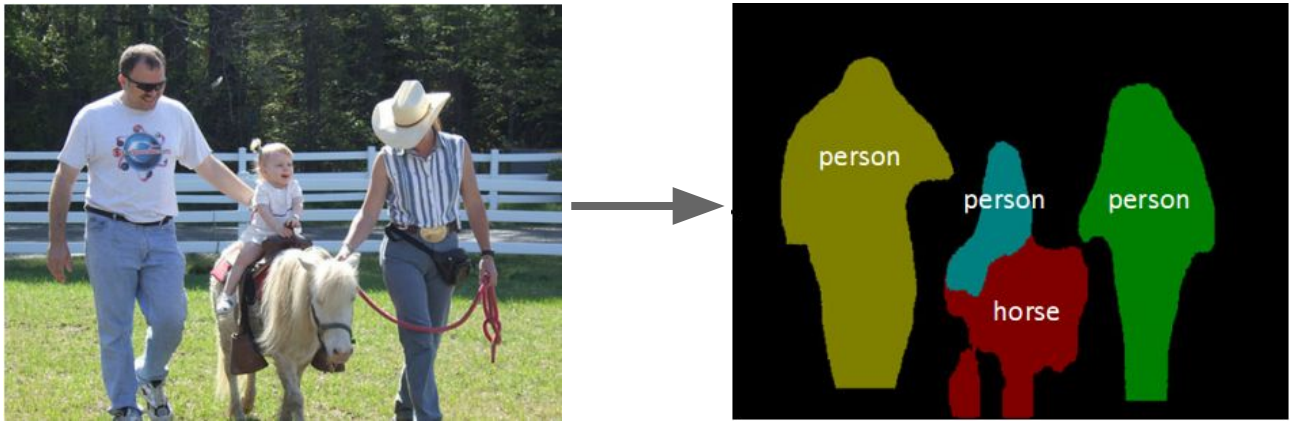


Slide Credit: CS231n

Instance Segmentation

Detect instances, give category, label pixels

“simultaneous detection and segmentation” (SDS)



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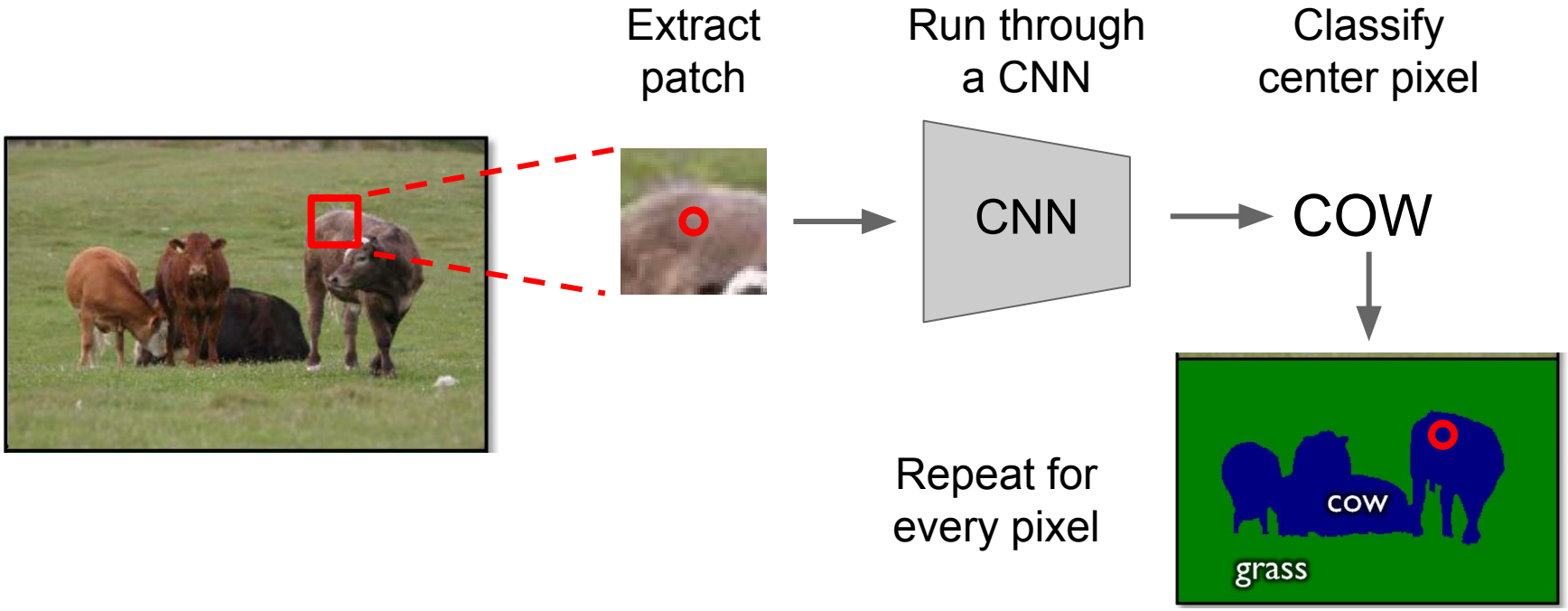
Semantic Segmentation



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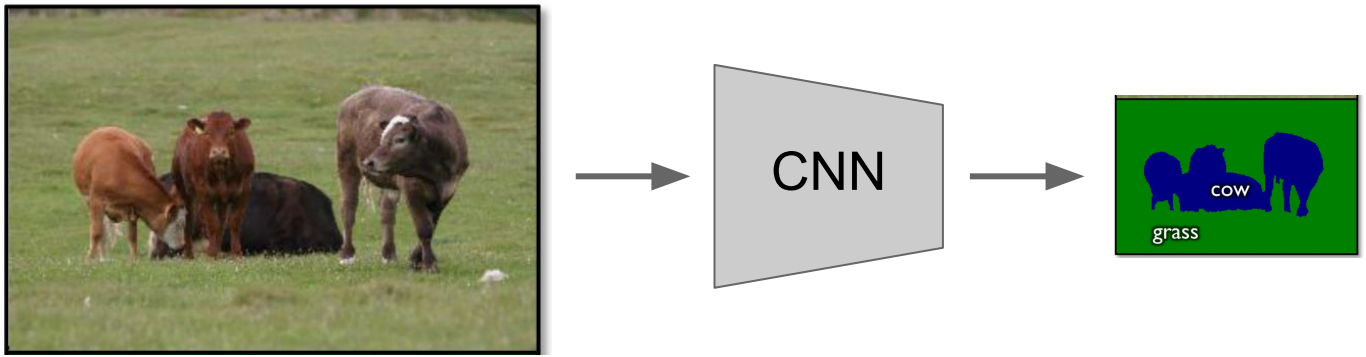
Semantic Segmentation

Run “fully convolutional” network
to get all pixels at once



Smaller output
due to pooling

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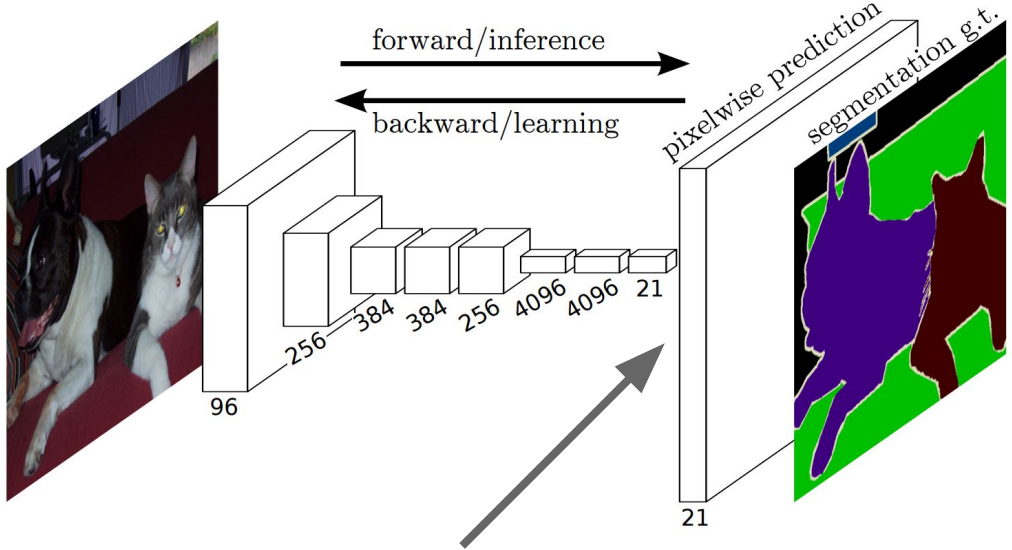
Semantic Segmentation



Learnable upsampling!

Long et al. Fully Convolutional Networks for Semantic Segmentation. CVPR 2015

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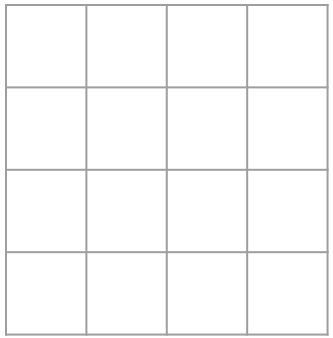
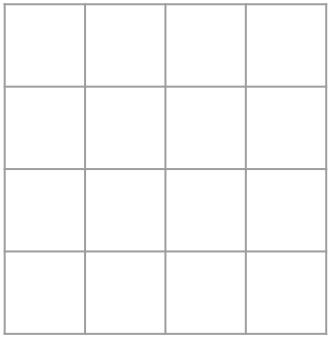
Convolutional Layer

Typical 3 x 3 convolution, stride 1 pad 1



Input: 4 x 4



Output: 4 x 4

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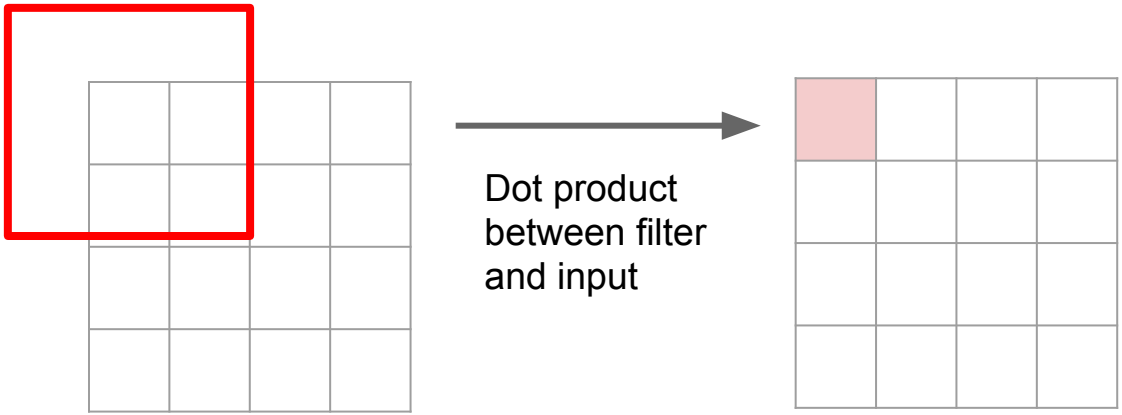
Convolutional Layer

Typical 3 x 3 convolution, stride 1 pad 1



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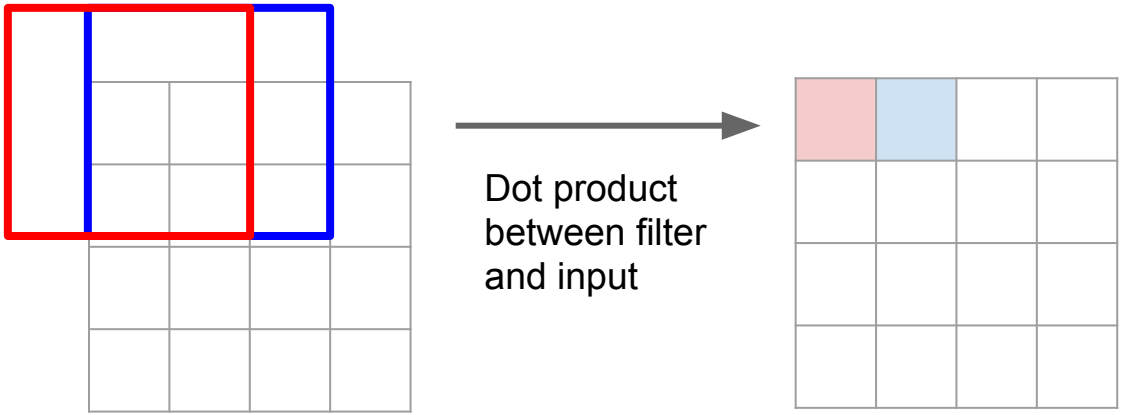
Convolutional Layer

Typical 3 x 3 convolution, stride 1 pad 1



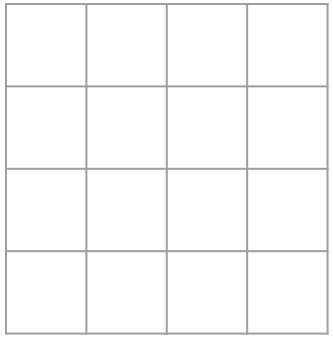
Input: 4 x 4

Output: 4 x 4

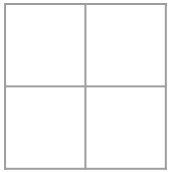
Slide Credit: CS231n

Convolutional Layer

Typical 3 x 3 convolution, **stride 2** pad 1



Input: 4 x 4



Output: 2 x 2

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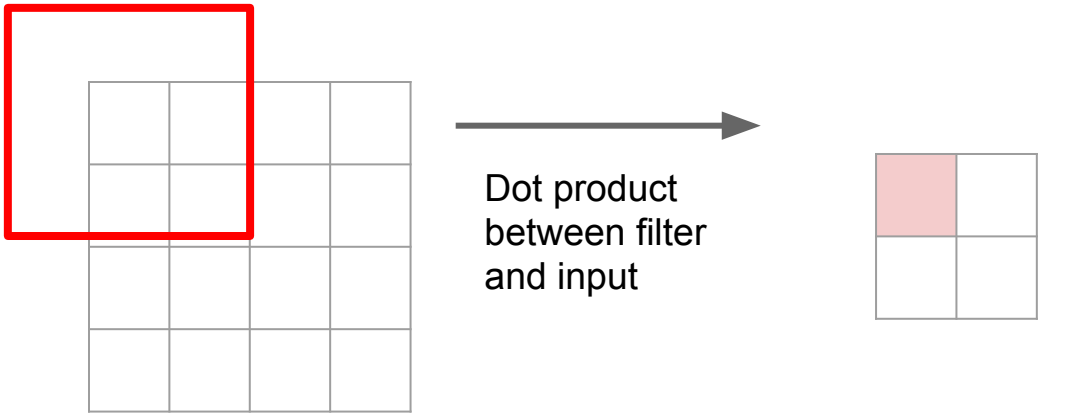
Convolutional Layer

Typical 3 x 3 convolution, stride 2 pad 1



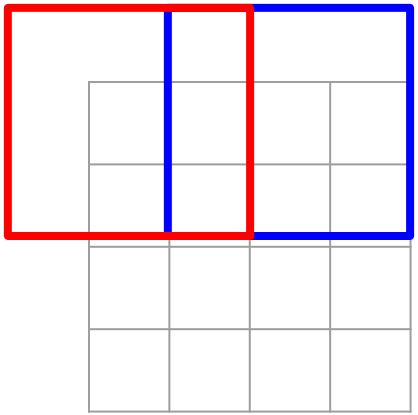
Input: 4 x 4

Output: 2 x 2

Slide Credit: CS231n

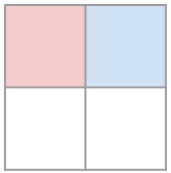
Convolutional Layer

Typical 3 x 3 convolution, stride 2 pad 1



Input: 4 x 4

Dot product
between filter
and input

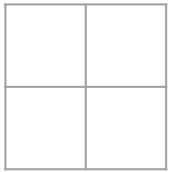


Output: 2 x 2

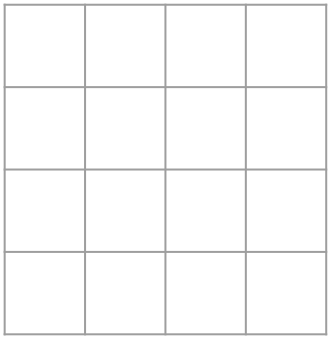
Slide Credit: CS231n

Deconvolutional Layer

3 x 3 “deconvolution”, stride 2 pad 1



Input: 2 x 2

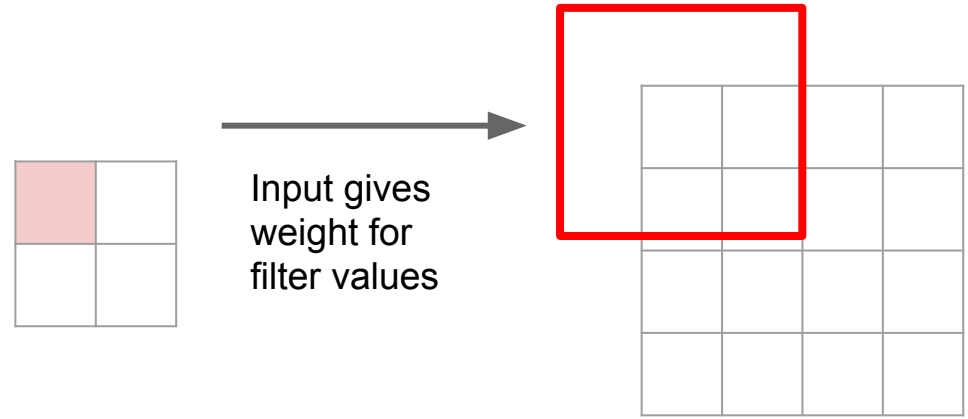


Output: 4 x 4

Slide Credit: CS231n

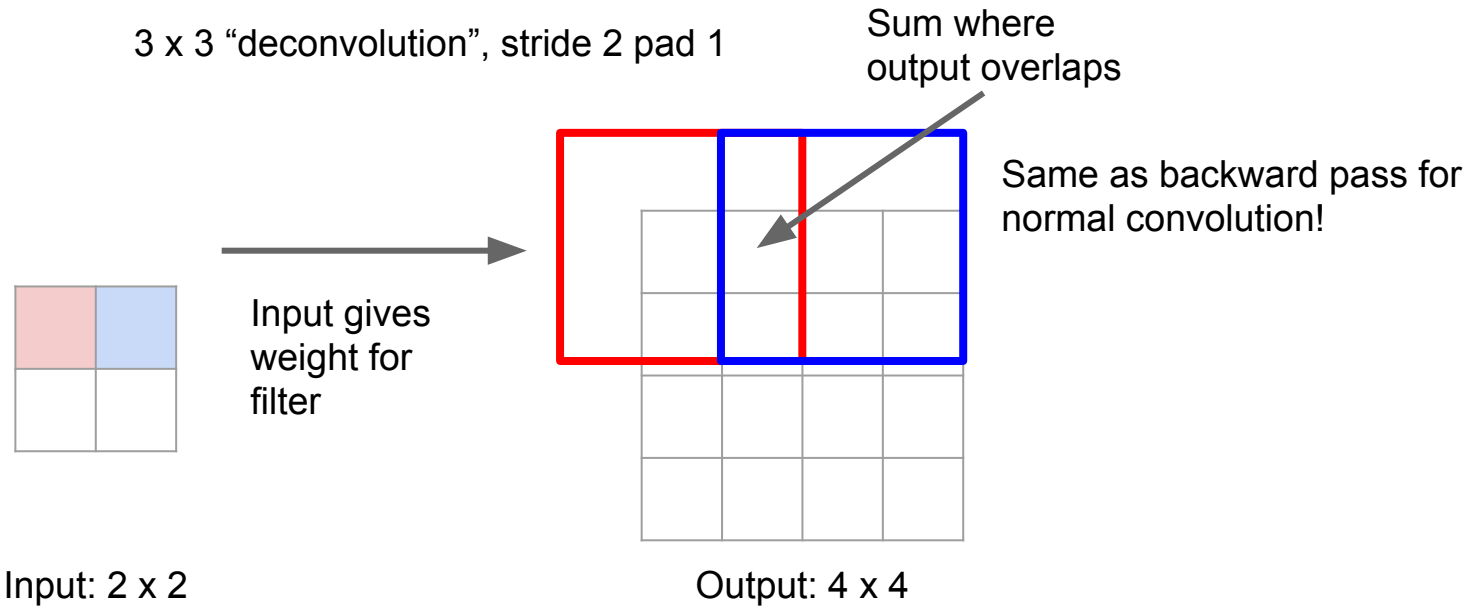
Deconvolutional Layer

3 x 3 “deconvolution”, stride 2 pad 1



Slide Credit: CS231n

Deconvolutional Layer



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Deconvolutional Layer

[1]It is more proper to say "convolutional transpose operation" rather than "deconvolutional" operation. Hence, we will be using the term "convolutional transpose" from now.

Im et al. Generating images with recurrent adversarial networks. arXiv 2016

A series of four fractionally-strided convolutions (in some recent papers, these are wrongly called deconvolutions)

Radford et al. Unsupervised Representation Learning with Deep Convolutional Generative Adversarial Networks. ICLR 2016

"Deconvolution" is a bad name, already defined as "inverse of convolution"

Better names:
convolution transpose,
backward strided convolution,
1/2 strided convolution, upconvolution

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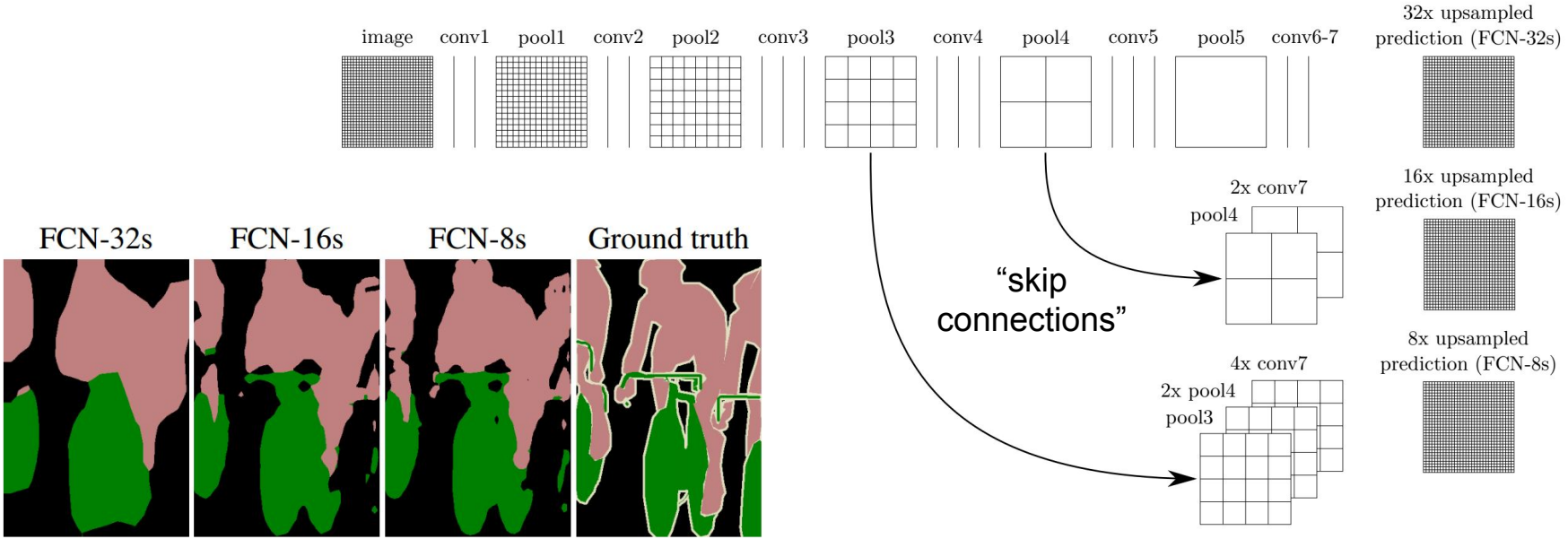
Skip Connections

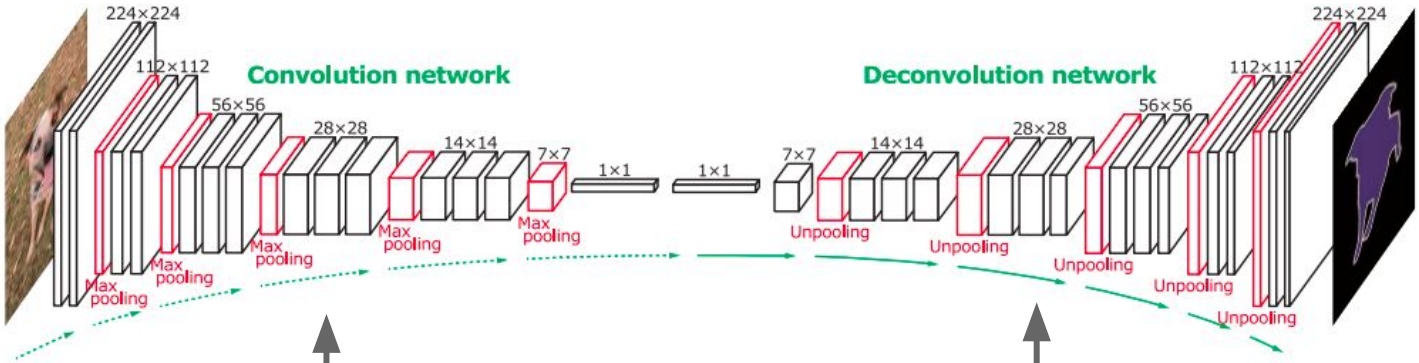


Skip connections = Better results

Long et al. Fully Convolutional Networks for Semantic Segmentation. CVPR 2015

Slide Credit: CS231n

Semantic Segmentation



Normal VGG

“Upside down” VGG

Noh et al. Learning Deconvolution Network for Semantic Segmentation. ICCV 2015

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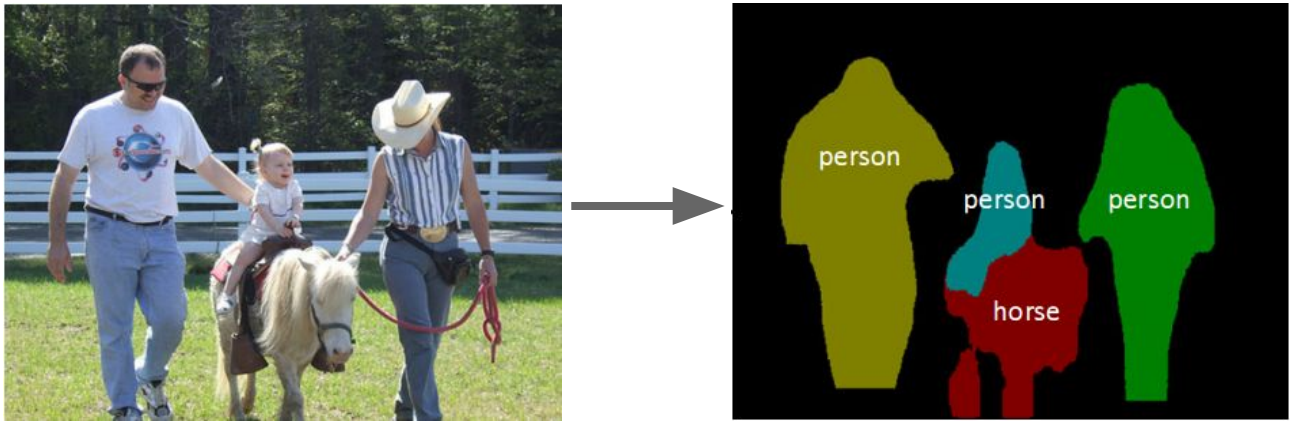
Instance Segmentation

Detect instances, give category, label pixels

“simultaneous detection and segmentation” (SDS)



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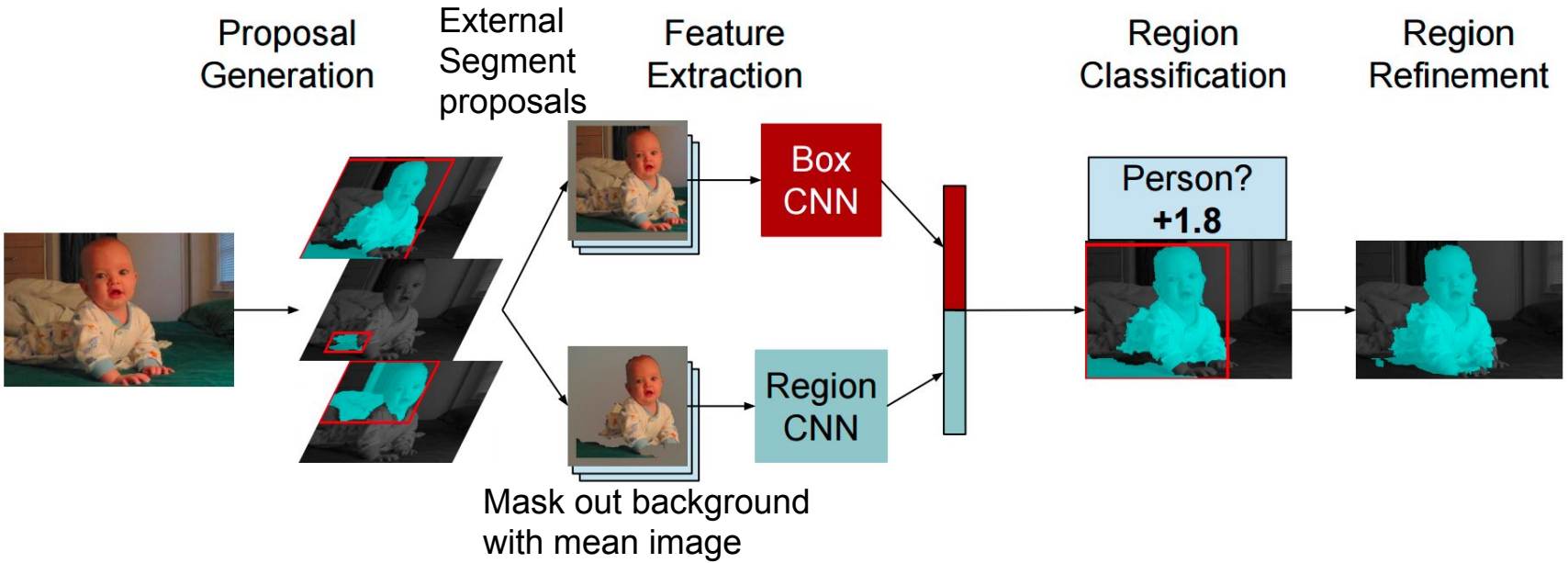
Instance Segmentation

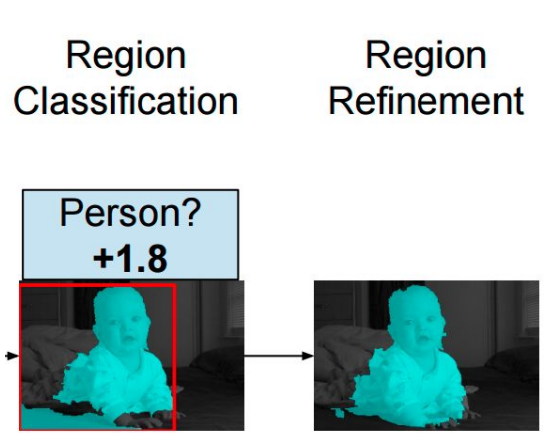
Similar to R-CNN, but with segments

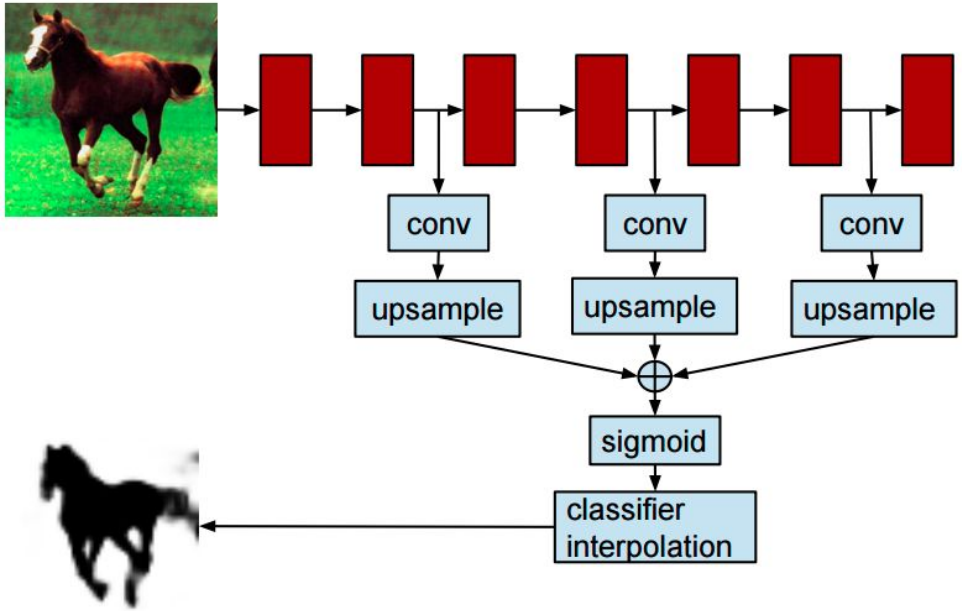


Hariharan et al. Simultaneous Detection and Segmentation. ECCV 2014

Slide Credit: CS231n

Instance Segmentation





Hariharan et al. Hypercolumns for Object Segmentation and Fine-grained Localization. CVPR 2015

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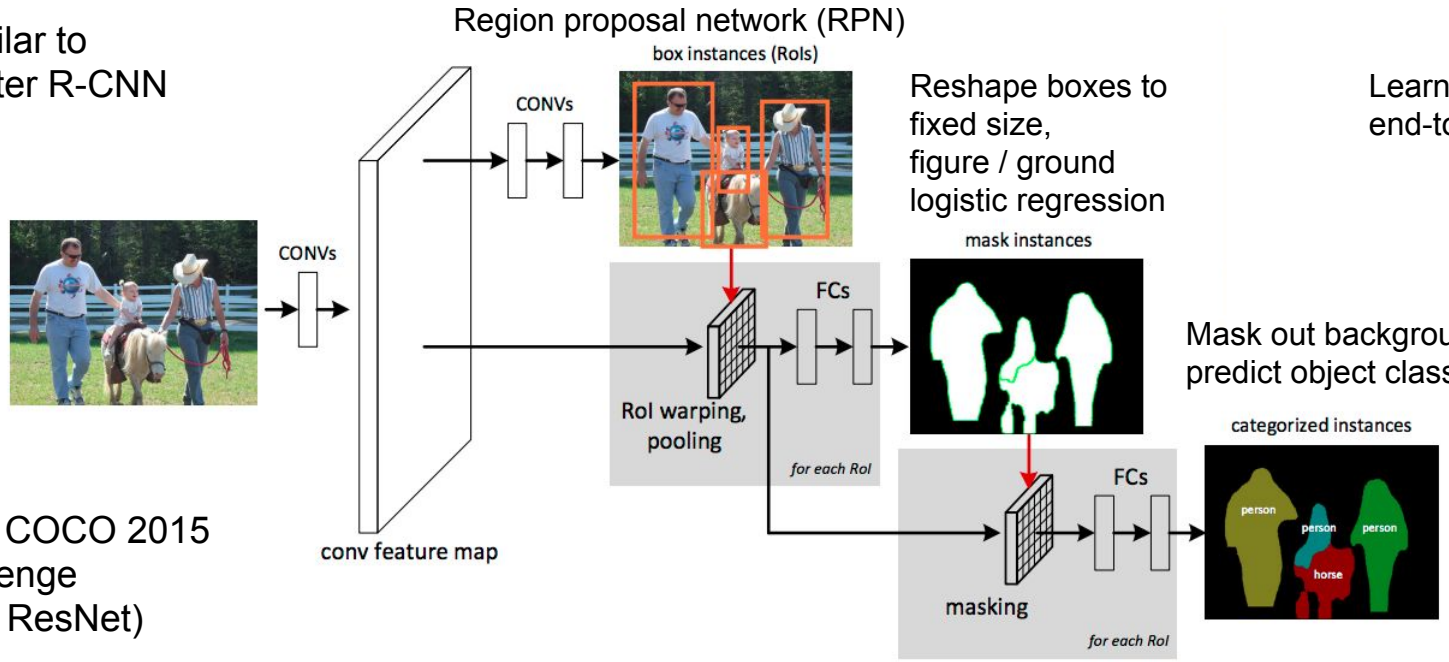
Instance Segmentation

Similar to
Faster R-CNN



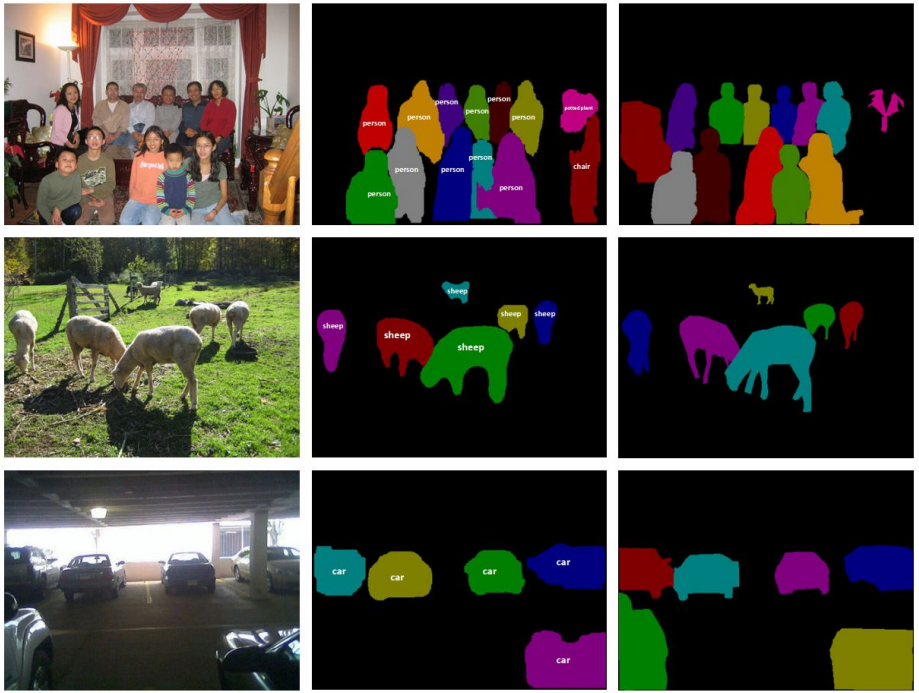
Learn entire model
end-to-end!

Won COCO 2015
challenge
(with ResNet)

Dai et al. Instance-aware Semantic Segmentation via Multi-task Network Cascades. arXiv 2015

Slide Credit: CS231n

Instance Segmentation



Dai et al. Instance-aware Semantic Segmentation via Multi-task Network Cascades. arXiv 2015

Slide Credit: CS231n

Resources

- CS231n Lecture @ Stanford [slides][video]
- Code for Semantic Segmentation
  - FCN (Caffe)
- Code for Instance Segmentation
  - SDS (Caffe)
  - SDS using Hypercolumns & sharing conv computations (Caffe)
  - Instance-aware Semantic Segmentation via Multi-task Network Cascades (Caffe)