

# Segmentation

## What is Segmentation?

*Segmentation* is an image processing topic which focuses on dividing an image in parts which have the *same properties* (i.e. the same textures etc..).

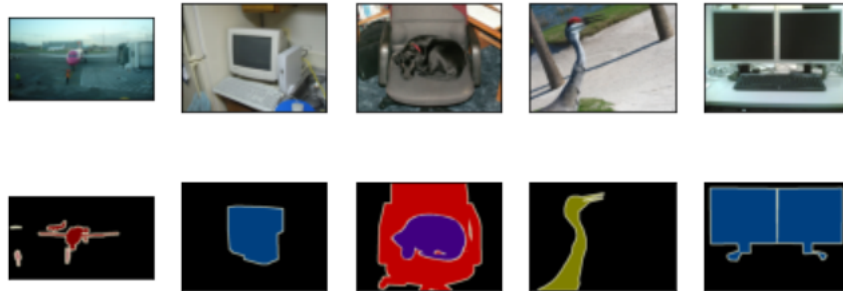
## Semantic Segmentation

**Semantic segmentation:** classify each pixel in an image according to the ob-



ject category it belongs to.

Building supervised training set is expensive, since it requires a complex human operation. The *label is itself an image*, with a different color for each category:



For this reason, semantic segmentation can be regarded as a special case of Image-to-image transformation.

## Convolutionalization

Composing convolutions *we still get a convolution*. Specifically, the composition of convolutional layers essentially behaves as a convolutional layer. The stride of the compound convolution is the *product of the strides of the components*.

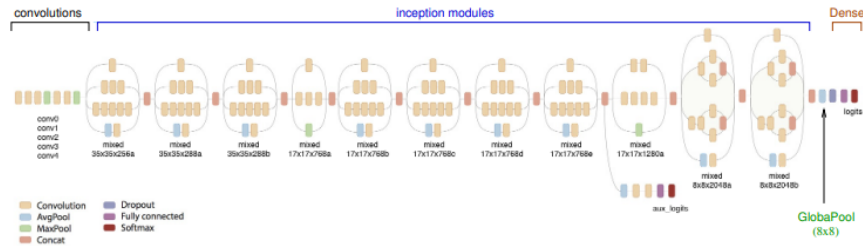
## Dimensions

As we know,  $\frac{D_{in} + P - K}{S} + 1 = D_{out}$ , or equivalently  $D_{in} = S * (D_{out} - 1) + K$ .  
 Suppose to compose two kernels with dimension 3 and stride 1. Then, the intermediate dimension is  $(1 - 1) * 1 + 3 = 3$  and the initial dimension must be  $(3 - 1) * 1 + 3 = 5$ .

Suppose to compose a kernel of dimension  $K_1 = 5$  and stride  $S_1 = 3$  with another kernel of dimension  $K_2 = 3$  and stride  $S_2 = 2$ . Then, applying the rule  $D_{in} = S * (D_{out} - 1) + K$  we get, for  $D_2 = 1$ : -  $D_1 = S_2 * (D_2 - 1) + K_2 = 3 - D_0 = S_1 * (D_1 - 1) + K_1 = 11$   $D_0 = 11$  is the dimension of the compound kernel, aka its “receptive fields”.

## What breaks convolutionality

Let us consider a typical architecture for image classification such as Inception



V3:

Composing convolutional layers we still get a convolutional network. What breaks convolutionality are the *dense layers* at the end of networks (if maxpooling has a fixed pooling dimension).