Dilation and Upconvolution
Receptive Field – Striding

Conv 3, Stride 2

Receptive Field: 3

Conv 3, Stride 2

Receptive Field: 7

Conv 3, Stride 2

Receptive Field: 15
Segmentation

Instead of classifying the whole image, classify each pixel

Not Cat

Cat

We need to keep all of the spatial resolution
Dilation

Increase the receptive field without increasing kernel size or losing resolution

Holes
A trous
Receptive Field – Dilation

Conv 3, Dilation 1
Receptive Field: 3

Conv 3, Dilation 2
Receptive Field: 7

Conv 3, Dilation 4
Receptive Field: 15
Upconvolution

Dilate the input

Transpose convolution

“Deconvolution”

Fractionally strided convolution
Upconvolution

Conv
Conv
Conv
Up Conv
Up Conv
Up Conv

Spatial resolution decreasing, Channels increasing
Spatial resolution increasing, Channels decreasing
Residual Connections
Deep Networks are Hard to Train

- We can train maybe 10-15 layers with the techniques we have seen so far.
- 20-30 with some other techniques we will see next week.
Deep Networks are Hard to Train

Accuracy

Loss

- **8 layer network**
- **12 layer network**
Residual Connections

$C_o \neq C_i$ or stride $\neq 1$: Conv 1x1, stride=stride
Residual Connections – Gradient

Forward Pass

Conv
ReLU
+

Backward Pass

Conv'
ReLU'
+

Training networks with up to 1000 layers
Upconvolution – Residual Connections

Spatial resolution decreasing, Channels increasing

Spatial resolution increasing, Channels decreasing