

Fully Convolutional Networks



Pattern Recognition & Machine Learning Laboratory

Sangho Kim

Aug 10, 2021



Introduction

▪ Classification

- Determine which objects are in the image and assign class labels
 - AlexNet, VGGNet, GoogleNet

▪ Detection

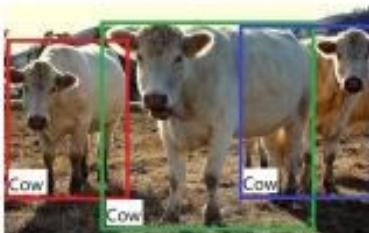
- Determine what objects are in the image and specify where they are in the image
 - R-CNN, Fast R-CNN, Faster R-CNN

▪ Segmentation

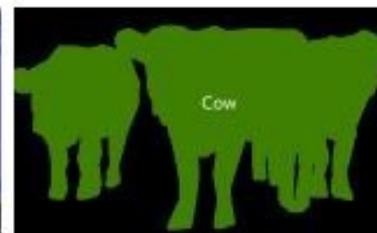
- Separate meaningful objects in pixels from the image
 - Fully Convolutional Networks (FCN)



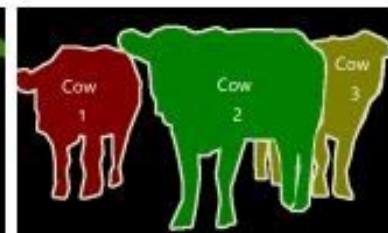
(a) Image Classification



(b) Object Detection



(c) Semantic Segmentation



(d) Instance Segmentation

Comparison of different visual recognition tasks

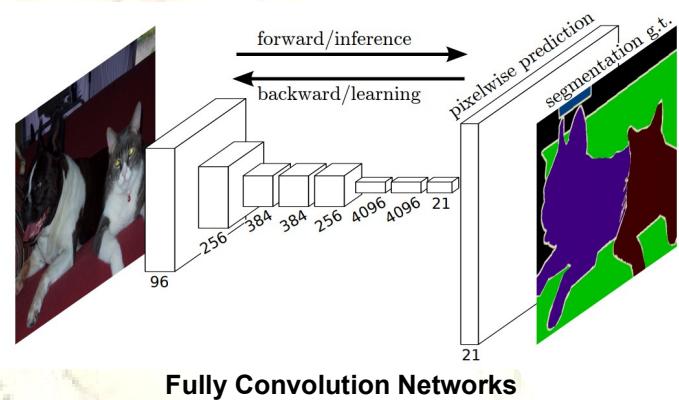




Fully Convolutional Networks (1/3)

▪ Segmentation networks

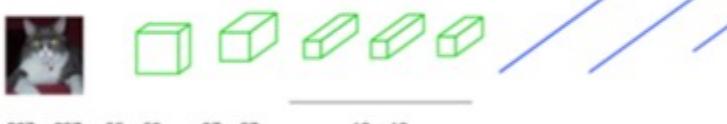
- Transform image pixels to pixel categories
- 2 parts of networks
 - Downsampling
 - Extract contextual information
 - Upsampling
 - Recover spatial information



▪ Fully convolutional model

- Fully Convolutional Networks using classification model
- Transforming fully connected layers to convolution layers
 - Fully connected layers have restrictions when performing segmentation
 - Accept only fixed size inputs
 - Location information disappeared

convolution fully connected



Example of classification model

convolution



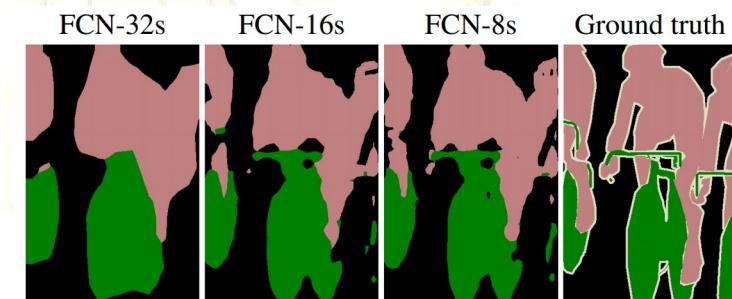
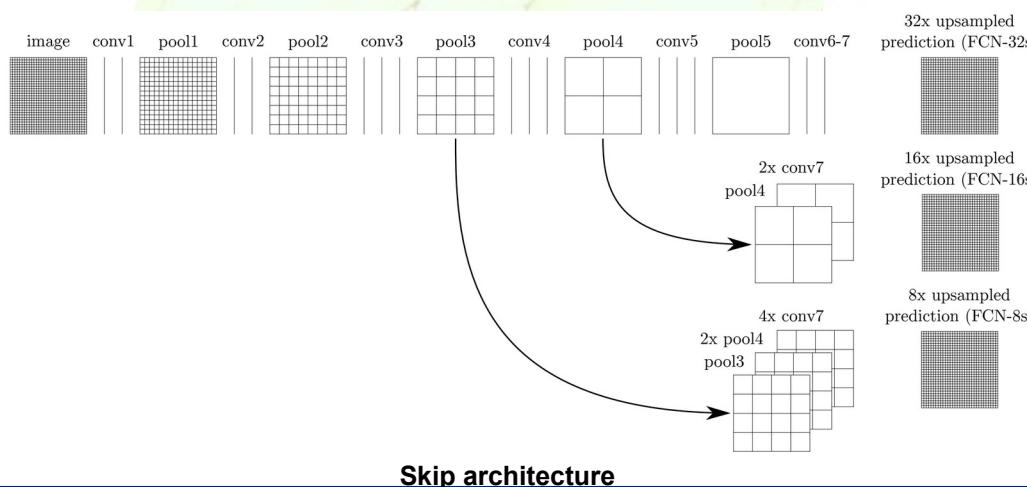
Example of fully convolutional model



Fully Convolutional Networks (2/3)

Upsampling

- Magnify feature maps to input size for pixel-by-pixel prediction
- Using backward convolution
 - Determine the filter's parameters through learning
 - Bilinear filters can be learned
 - Non-linear upsampling enabled
- Using skip architecture
 - Reinforce detail of feature map
 - Combine upsampling feature maps with downsampling feature maps
 - Upsampling feature maps have context information
 - Downsampling feature maps have spatial information





Fully Convolutional Networks (3/3)

Experiments

Metrics

- Pixel accuracy :
- Mean accuracy :
- Mean IU :
- Frequency weighted IU :

	pixel acc.	mean acc.	mean IU	f.w. IU
FCN-32s-fixed	83.0	59.7	45.4	72.0
FCN-32s	89.1	73.3	59.4	81.4
FCN-16s	90.0	75.7	62.4	83.0
FCN-8s	90.3	75.9	62.7	83.2

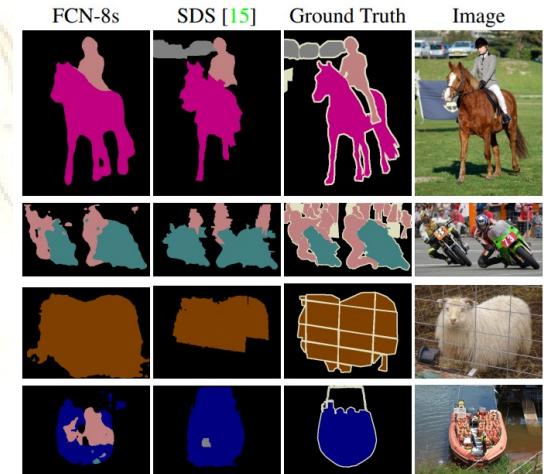
Comparison of skip FCNs on a subset of PASCAL VOC 2011

PASCAL VOC

- Use the sets of PASCAL VOC 2011 and 2012
- FCN gives a 20% relative improvement over the SOTA
- Reduce inference time

	mean IU VOC2011 test	mean IU VOC2012 test	inference time
R-CNN [10]	47.9	-	-
SDS [15]	52.6	51.6	~ 50 s
FCN-8s	62.7	62.2	~ 175 ms

FCN-8 performance over previous SOTA



Results of FCN-8 compared to previous SOTA

