COSE474 Deep Learning

Project #3: Encoder-Decoder Implementation

Seungryong Kim

Computer Vision Lab. (CVLAB)

Department of Computer Science and Engineering

Korea University

Pascal VOC

- **Download Pascal VOC 2012 Dataset**
  - http://host.robots.ox.ac.uk/pascal/VOC/voc2012/

Development Kit

The development kit consists of the training/validation data, MATLAB code for reading the annotation data, support files, and example implementations for each competition.

The development kit is now available:

- Download the training/validation data (2GB tar file)
- Download the development kit code and documentation (500KB tar file)
- Download the PDF documentation (500KB PDF)
- Browse the HTML documentation
- View the guidelines used for annotating the database (VOC2011)
- View the action guidelines used for annotating the action task images

- Latest version (2012)

2012	20 classes. The train/val data has 11,530 images containing 27,450 ROI annotated objects and 6,929 segmentations.	• Size of segmentation dataset substantially increased. • People in action classification dataset are additionally annotated with a reference point on the body.	• Datasets for classification, detection and person layout are the same as VOC2011.

Pascal VOC

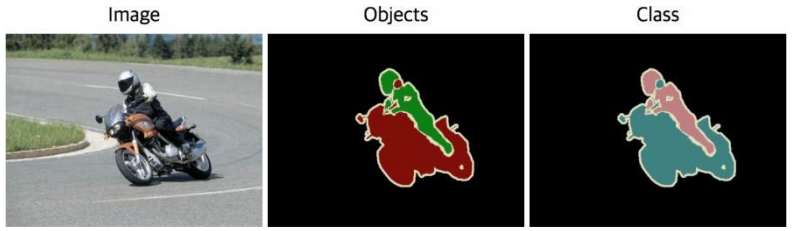
- **Pascal VOC 2012 Dataset**

  - Pascal VOC 2012 has 20 classes. The train/validation data has 11,530 images containing 27,450 ROI annotated objects and 6,929 segmentations.
  - **Classes**
    - Person : person
    - Animal : bird, cat, cow, dog, horse, sheep
    - Vehicle : aeroplane, bicyble, boat, bus, car, motorbike, train
    - Indoor : bottle, chair, dining table, potted plant, sofa, tv/monitor

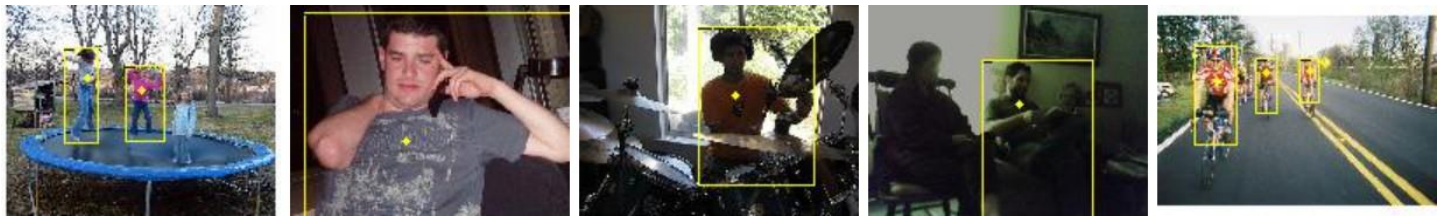
Pascal VOC

- **Pascal VOC 2012 Dataset**
  - There are main object recognition competitions: classification, detection, segmentation, action classification, and a competition on large scale recognition run by ImageNet.
  - Classification/Detection Competitions

  - Segmentation Competition

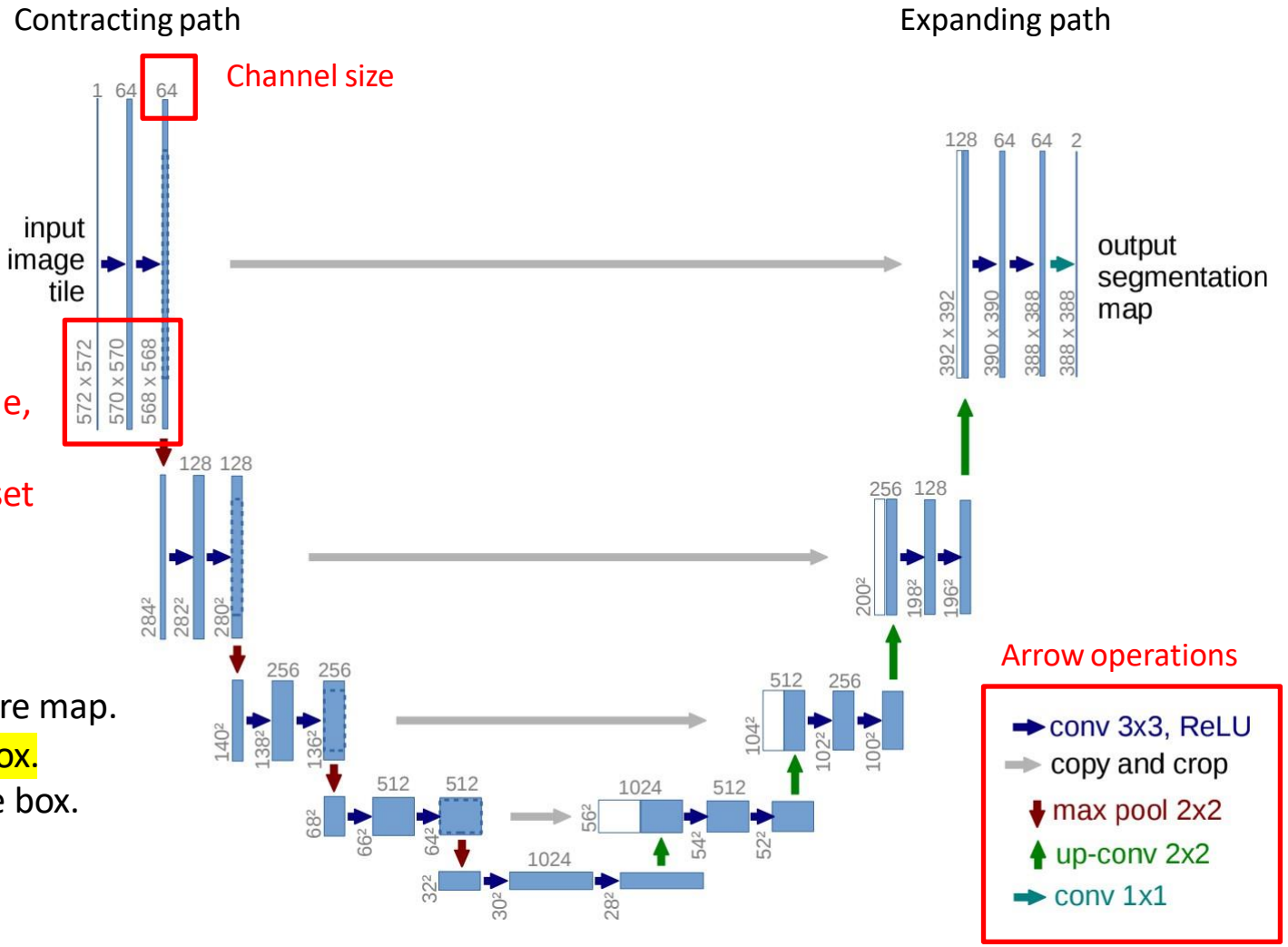


  - Action Classification Competition



Original U-Net

- **Train "*UNet*"**
  - Network Architecture



Compared to the skeleton code, image size changed because we are using pascal VOC dataset

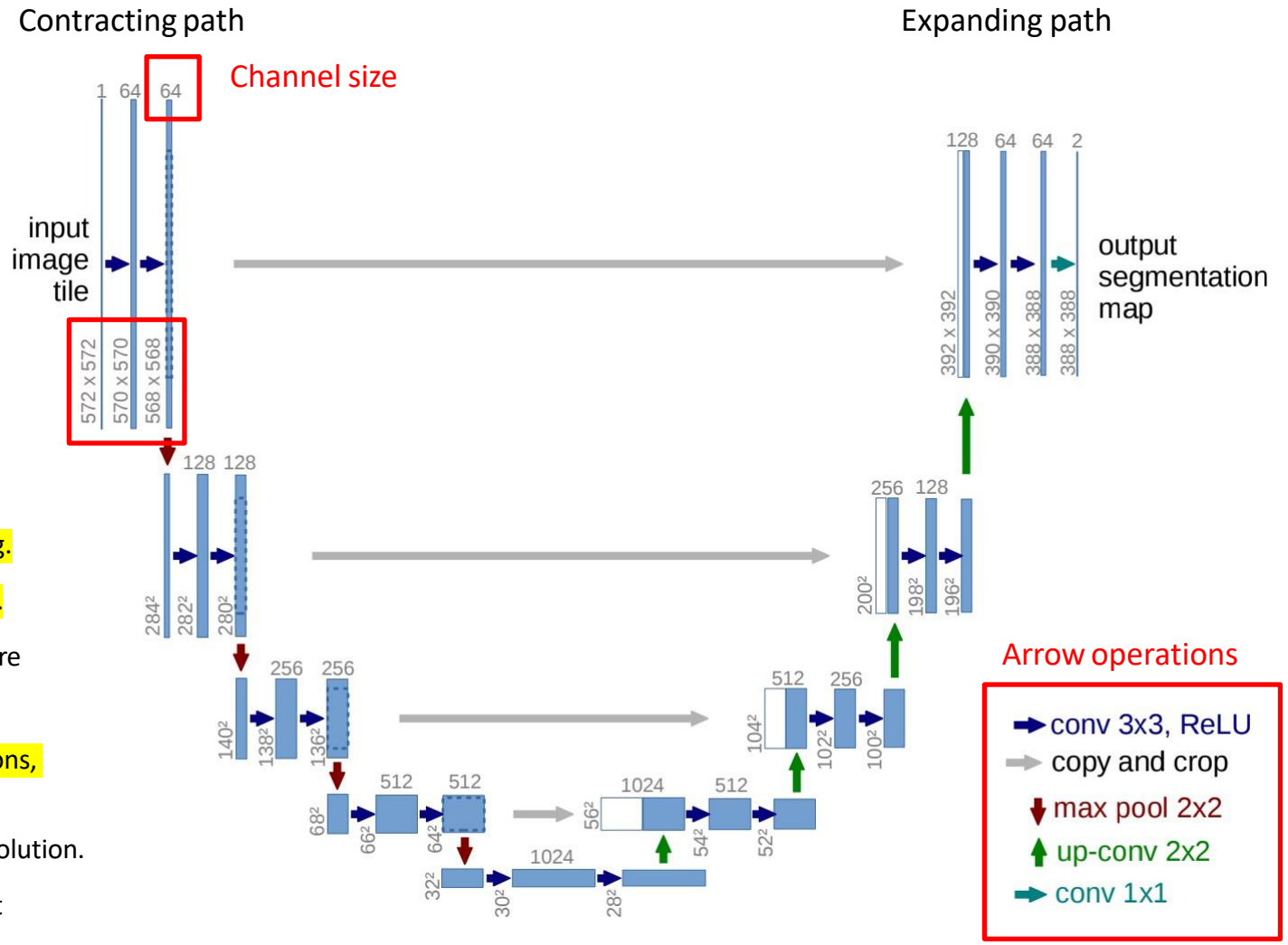
1. U-net architecture (example for 32x32 pixels in the lowest resolution)
2. Each blue box corresponds to a multi-channel feature map.
3. The number of channels is denoted on top of the box.
4. The x-y-size is provided at the lower left edge of the box.
5. White boxes represent copied feature maps.
6. The arrows denote the different operations.

Olaf Ronneberger, Philipp Fischer, and Thomas Brox, "U-Net: Convolutional Networks for Biomedical Image Segmentation," MICCAI, 2015

Original U-Net

- **Train "*UNet*"**
  - Network Architecture

- It consists of a contracting path (left side) and an expansive path (right side).
- The contracting path follows the typical architecture of a convolutional network.
- It consists of the repeated application of two 3x3 convolutions (unpadded convolutions), each followed by a rectified linear unit (ReLU) and a 2x2 max pooling operation with stride 2 for downsampling.
- At each downsampling step we double the number of feature channels.
- Every step in the expansive path consists of an upsampling of the feature map followed by a 2x2 convolution (up-convolution) that halves the number of feature channels, a concatenation with the correspondingly cropped feature map from the contracting path, and two 3x3 convolutions, each followed by a ReLU.
- The cropping is necessary due to the loss of border pixels in every convolution.
- At the final layer a 1x1 convolution is used to map each 64- component feature vector to the desired number of classes.
- In total the network has 23 convolutional layers.



Olaf Ronneberger, Philipp Fischer, and Thomas Brox, "U-Net: Convolutional Networks for Biomedical Image Segmentation," MICCAI, 2015

Original U-Net

- **Train "*UNet*"**
  - Train "UNet" model with "Pascal VOC 2012" datasets, and conduct image segmentation
    - Optimize parameters with *Adam optimizer* and *cross Entropy Loss*
      - Get "Pascal VOC 2012" Dataset using previous ppt slides.
        (*Tip : If data processing process takes too long, try using only 20 images first.)
    - Procedure

      1) Download Pascal VOC 2012 Dataset using page 2 in this slide.

      2)Fill in the blanks of the skeleton codes ('main_skeleton.py', 'modules_skeleton.py', 'Unet_skeleton.py')

      'main_skeleton.py', 'modules_skeleton.py': Refer to p2-7 of 'Project2_COSE474_SeungryongKim.pdf'

      'Unet_skeleton.py': Refer to p5-6 of 'Project3_COSE474_SeungryongKim.pdf'

      3) Load the trained model, which is given as 'UNet_trained_model.pth'

      4) Train it with CPU or GPU, and screen capture the test accuracy.

      Note) As the trained checkpoint parameters are used, you will train model only 1 epoch.

Olaf Ronneberger, Philipp Fischer, and Thomas Brox, "U-Net: Convolutional Networks for Biomedical Image Segmentation," MICCAI, 2015

Original U-Net

- **Train "*UNet*"**
  - Train "UNet" model with "Pascal VOC 2012" datasets, and conduct image segmentation
    - (30 points) Unet model code: 'Unet_skeleton.py'
      - Check out the channel size and fill in the blanks of the convolutional layers
    - (30 points) train/test module: 'modules_skeleton.py'
      - Please understand train/test codes, fill out the blanks that get output out of model, loss, optimizer, and backpropagation.
    - (20 points) main code: 'main_skeleton.py'
      - Please understand the loading model, saving model, model initialization, setting optimizer and loss in 'Project2_COSE474_SeungryongKim.pdf'.

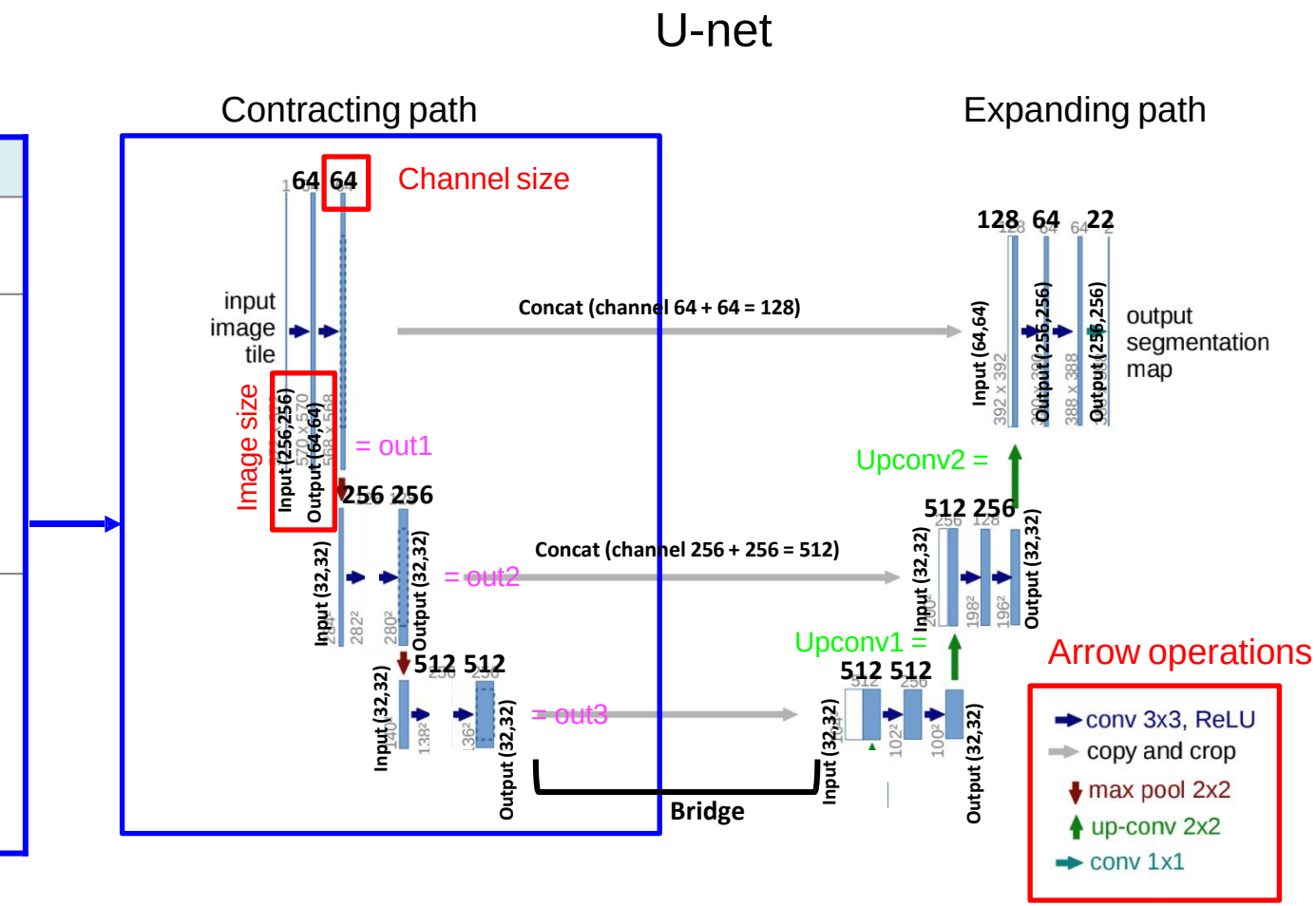
Olaf Ronneberger, Philipp Fischer, and Thomas Brox, "U-Net: Convolutional Networks for Biomedical Image Segmentation," MICCAI, 2015

Original U-Net

- **Implement "*ResNet-encoder-Unet*"**
  - Replace the encoder of original U-net with ResNet-50

ResNet-50

Layer number	Network
Layer 1	7x7 conv, channel = 64, stride = 2 3x3 max pool, stride = 2
Layer 2	[1x1 conv, channel = 64, 3x3 conv, channel = 64, 1x1 conv, channel = 256] x 2 [1x1 conv, channel = 64, stride = 2 3x3 conv, channel = 64, 1x1 conv, channel = 256] x 1
Layer 3	[1x1 conv, channel = 128, 3x3 conv, channel = 128, 1x1 conv, channel = 512] x 3 [1x1 conv, channel = 128, stride = 2 3x3 conv, channel = 128, 1x1 conv, channel = 512] x 1



Note) In layer 2 and 3, reduce an activation map in half by using the strided convolution (stride = 2) at the last Residual block.

Original U-Net

- **Implement "*ResNet-encoder-Unet*"**
  - Train "ResNet-encoder-Unet" model with "Pascal VOC 2012" datasets, and conduct image segmentation

    Tip) If a data processing step takes too long, try using only 20 images first

    - Optimize parameters with *Adam optimizer* and *cross Entropy Loss*
    - Procedure

      1) Download Pascal VOC 2012 Dataset using page 2 in this slide.

      2) Fill in the blanks of the skeleton code ('resnet_encoder_unet_skeleton.py')

      Refer to the page 5, 6, and 9 in this slide and Resnet-50 code ('resnet50_skeleton.py') of the previous assignment

      3) Load the trained model , which is given as 'resnet_unet_trained_model.pth'

      4) Train it with CPU or GPU, and screen capture the test accuracy.

      Note) As the trained checkpoint parameters are used, you will train model only 1 epoch.

Original U-Net

- **Implement "*ResNet-encoder-Unet*"**
  - Train "ResNet-encoder-Unet" model with "Pascal VOC 2012" datasets, and conduct image segmentation
    - (20 points) ResNet-encoder-Unet model code: 'resnet_encoder_unet_skeleton.py'
      - Please understand the architecture of the Unet in page 5, 6, and 9.
      - Check out the concatenation functions in pytorch.

- (30 points) train/test module: 'modules_skeleton.py'
  - Please understand train/test codes, fill out the blanks that get output out of model, loss, optimizer, and backpropagation.

This is the same as the codes in p8

- (20 points) main code: 'main_skeleton.py'
  - Please understand the loading model, saving model, model initialization, setting optimizer and loss in 'Project2_COSE474_SeungryongKim.pdf'.

Encoder-Decoder Implementation

Due on Dec. 7 (Thu.), 1:29 pm (in Blackboard)

(late policy: 25% off per a day late)

You must submit the **code** with the **report**.

(1 page with free format, including the description of your code, results, and discussions)

The report should be written in **English**.

Please do NOT copy your friends' and internet sources.

Please start your project EARLY.

Thank you!
Q & A