

## Course: Image Segmentation with Python

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### Python Technology stack

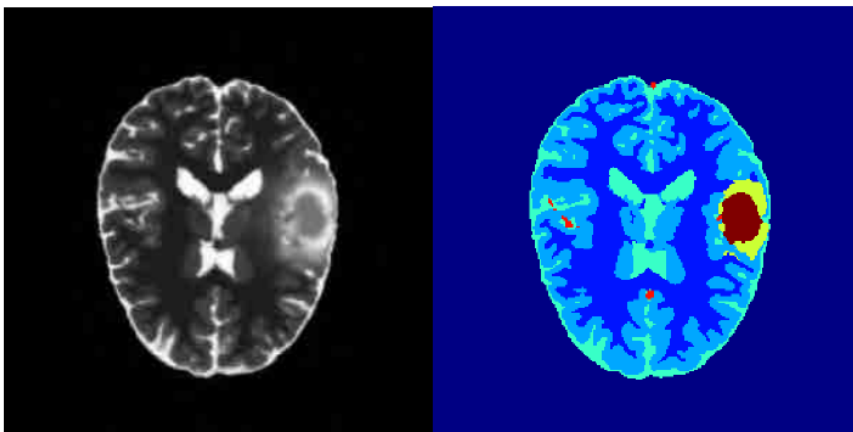
- NumPy
- TensorFlow and Keras
- Sckit-image
- OpenCV
- Google's Colaboratory

### Related courses

- [Deep Learning in Python](#)
- [Convolutional Neural Networks for Image Processing](#)

## Part 1: Image Segmentation Basics

- Intro video explaining what image segmentation is (5-10 min)

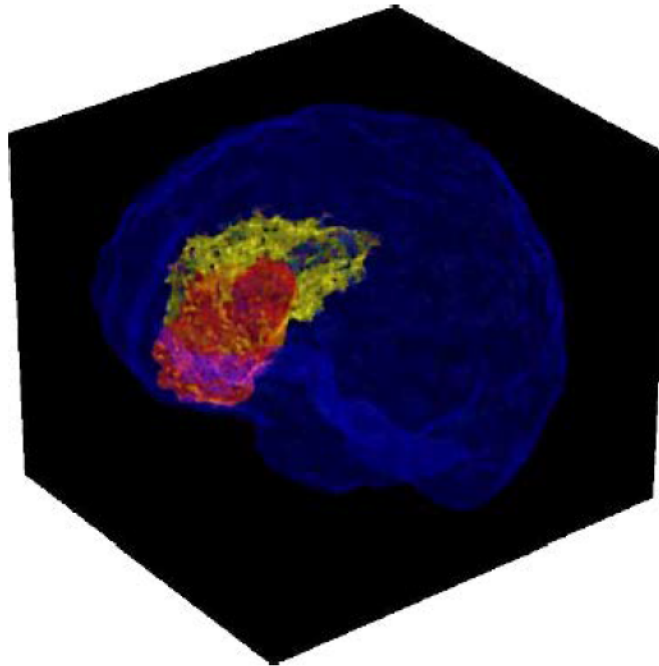


Synthetic MRI slice generated by TumorSim

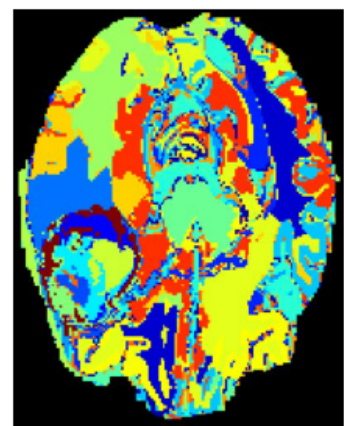
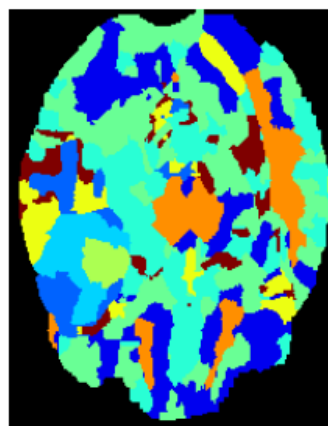
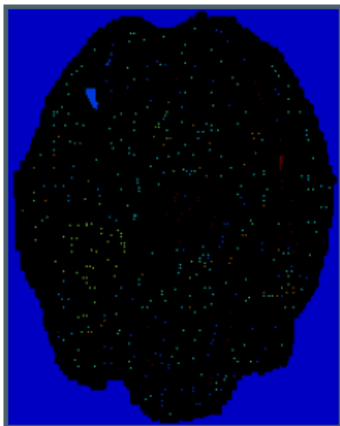
Ground truth for 10 tissue classes, including tumor and edema

- Loading an image with OpenCV
  - Importing medical image data with PyDICOM
- Using a mask to select regions of an image

- Select the tumor region in brain MRI



- Visualizing the tumor region in 3D
- Quick multiple choice quiz about image segmentation (purpose of segmentation, use of masks)
- Intro video explaining segmentation with the GrowCut cellular automaton (5-10 min)
- Seeded segmentation with the GrowCut cellular automaton
  - Complete a Numpy implementation of the GrowCut cellular automaton
  - Using entropy minima as segmentation seeds
  - Labeling entropy minima with k-medoids
  - Defining minima area for segments to avoid oversegmentation

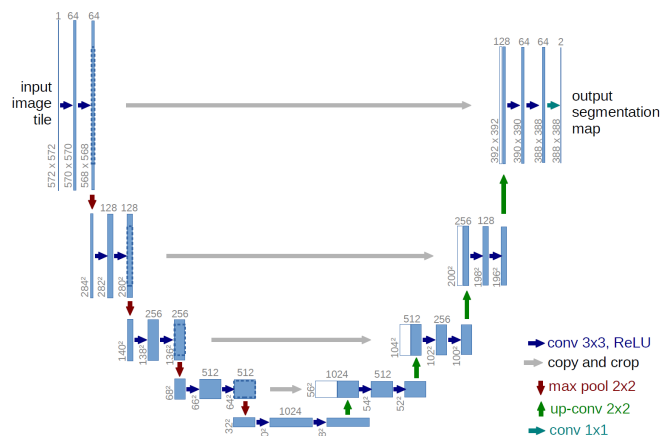


- Evaluating the quality of a segmentation
  - Counting true positives, true negatives, false positives, and false negatives
  - Computing precision
  - Computing recall
  - Computing the f1-measure
  - Computing Intersection over Union (IoU)
  - Computing the warping error
  - Computing the Rand error

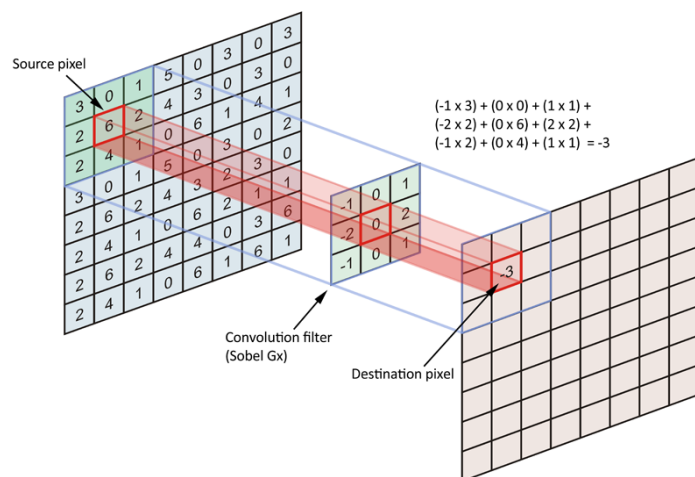
## Part 2: Understanding U-net part 1

### Segmenting biomedical images

- Intro video explaining what U-net is and how does deep learning enables automatic image segmentation (5-10 min)
  - The intro video mentions the encoder-decoder architecture of U-net and how part 2 focuses on the encoder, part 3 on the decoder, and part 4 on the final layers of U-net and its optimization

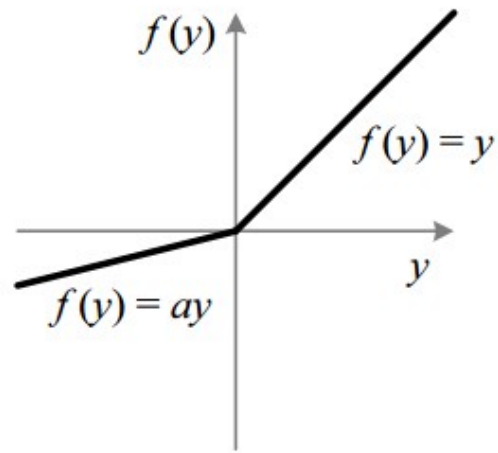
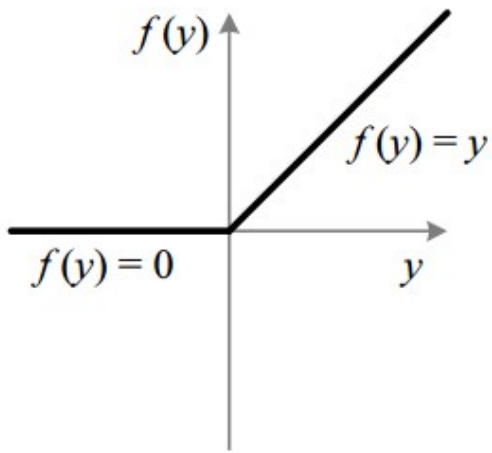


- U-net architecture
  - Quick multiple choice quiz about U-net's architecture (purpose of U-net, contents of layers, what convolution is, what upsampling is)



- Understanding image convolutions
  - Applying a convolution filter
  - Changing the weights of a convolution filter
- Video explaining the need of image cropping and data augmentation in U-net (5 min)
- Doing image cropping
- Doing data augmentation
  - Mirroring
  - Rotation
  - Vertical/horizontal flips
  - Deformations

- Video explaining the use of pooling (3 min)
- Understanding pooling
  - Implement max pooling
- Video explaining activation functions in U-net (3 min)



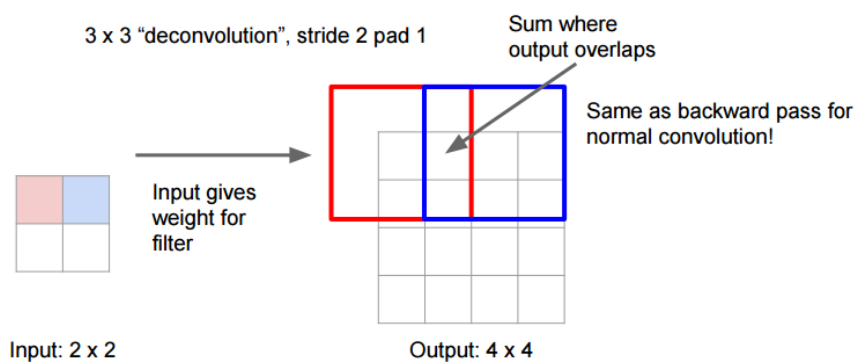
- Understanding ReLU
  - Implement Regular ReLU
  - Implement Leaky ReLU

## Part 3: Understanding U-net part 2

### Segmenting road images



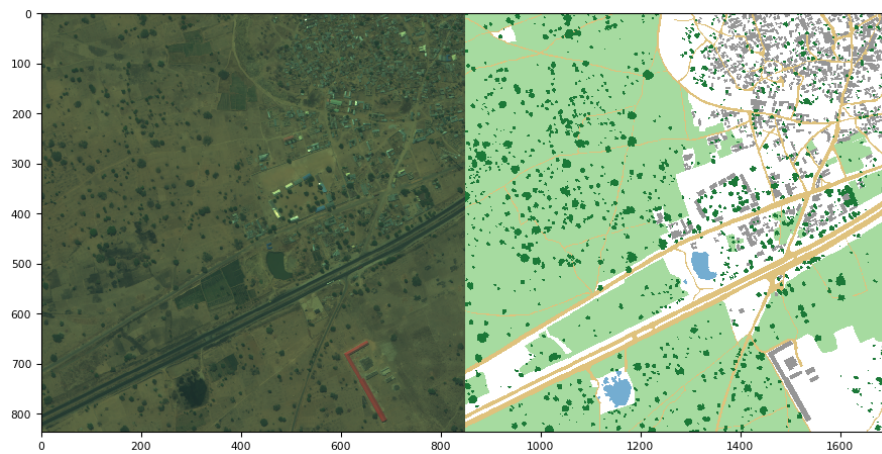
- Video explaining the decoder part of the U-net learning architecture, explains upsampling, mentions what unpooling and transposed convolutions are and their purpose (5-10 min)
- Understanding unpooling
  - Replacing each entry with an  $n \times n$  matrix filled with the original entry (NumPy drill).
  - Replacing each entry with an  $n \times n$  matrix with the original entry in the upper left and the other squares set to 0. [1506.02753] (NumPy drill)



- Computing a transposed convolution with `tf.nn.conv2d_transpose`

## Part 4: Understanding U-net part 3

### Segmenting satellite images



## Understanding the final layers and the loss function

- Video explaining loss functions (5 min)
- Quiz on loss functions
- Understanding loss functions:
  - Computing Cross entropy
  - Computing Mean squared error
  - Computing Mean absolute error
  - Using the Dice similarity coefficient as an error metric
- Video explaining optimizers (5 min)
- Choosing an optimizer:
  - Training a net with Stochastic Gradient Descent (`tf.train.GradientDescentOptimizer`)
  - Training a net with ADAM (`tf.train.AdamOptimizer`)
- Video introduction to regularization and dropout (2-3 min)
- Regularization with Dropout
  - Regularization with `tf.nn.dropout`
- Video introduction to mathematical morphology operations (2-3 min)
- Mathematical morphology to define borders of the final segmentation mask
  - Eroding an image
  - Dilating an image
  - Finding borders on image by the composition of dilation and erosion
- Putting it all together
  - Comparing the performance of networks with different hyperparameters

