MatCNN In-Class Tutorial

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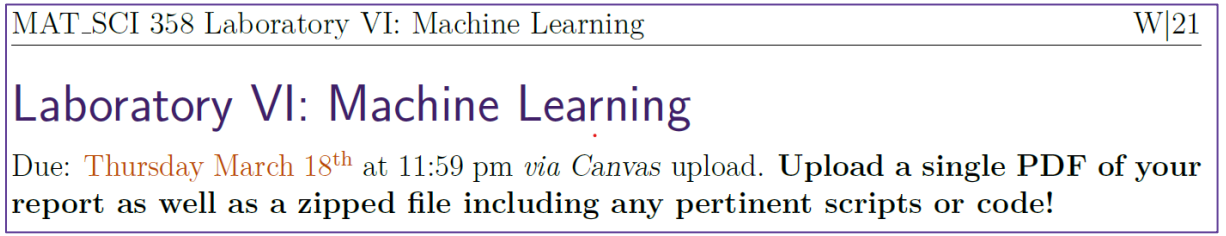
MatSci 395 – ML Lecture 5 – March 10, 2021

Introduction

Announcements

- My email: tiberiu.stan@northwestern.edu



MAT_SCI 358 Laboratory VI: Machine Learning W|21

Laboratory VI: Machine Learning

Due: Thursday March 18th at 11:59 pm *via Canvas* upload. **Upload a single PDF of your report as well as a zipped file including any pertinent scripts or code!**

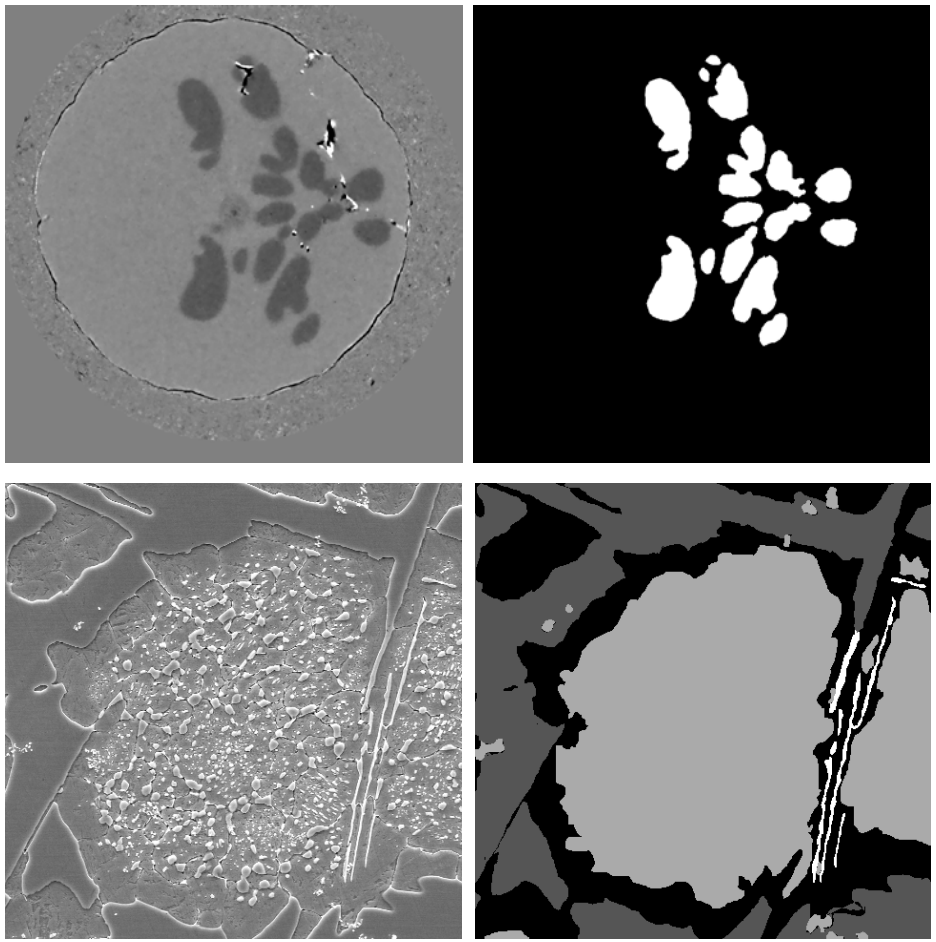
Tentative Schedule

Monday	Wednesday	Friday
~~L1 – Introduction to machine learning, imaging, and segmentation~~	~~L2 – **In-class activity: segmentation using GIMP**~~	~~L3 – Neural network basics~~
~~L4 – Neural network training~~	L5 – **In-class activity: segmentation using MatCNN**	L6 – Convolutional Neural Networks

Introduction

At the end of this lesson you should be able to:

- Access the latest version of MatCNN on Google Colab
- Understand some of the fundamental neural network training parameters
- Train a neural network that segments tomography images

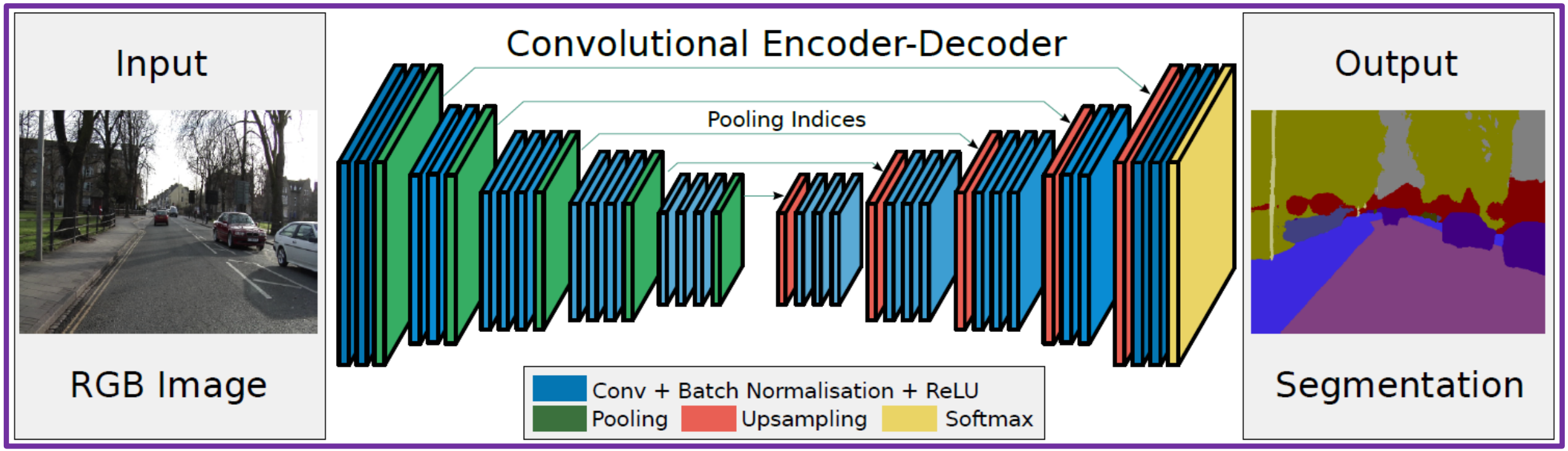


Special thanks to:

- Nathan Pruyne, Jim James, Marcus Schwarting, and Jiwon Yeom

Machine Learning

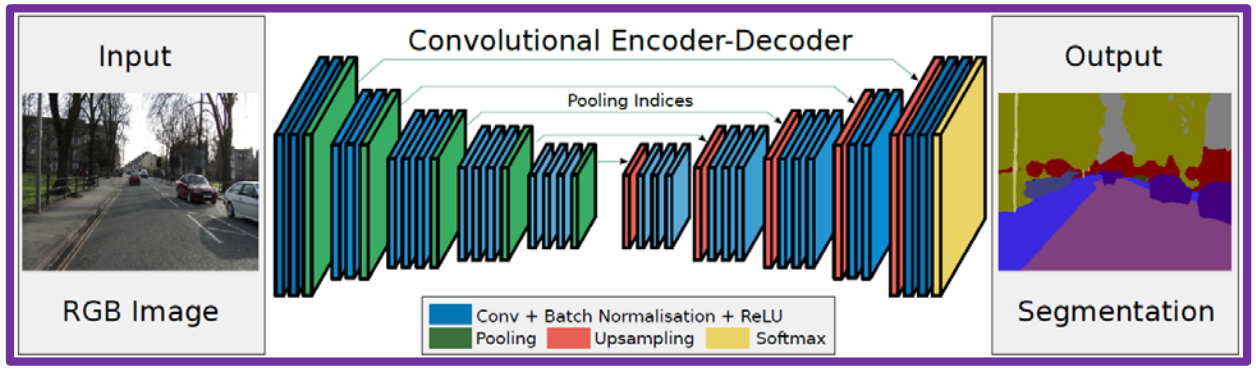
- Semantic segmentation is the process of assigning a class label to each pixel of an image, usually using Convolutional Neural Networks (CNNs)
- **SegNet** architecture consists of an encoder network (13 convolutional layers from VGG-16), a decoder network, and a pixel-wise softmax classification layer



V. Badrinarayan et al. *IEEE Trans Pattern Analysis Mach Intell.* 2017

Machine Learning Architectures

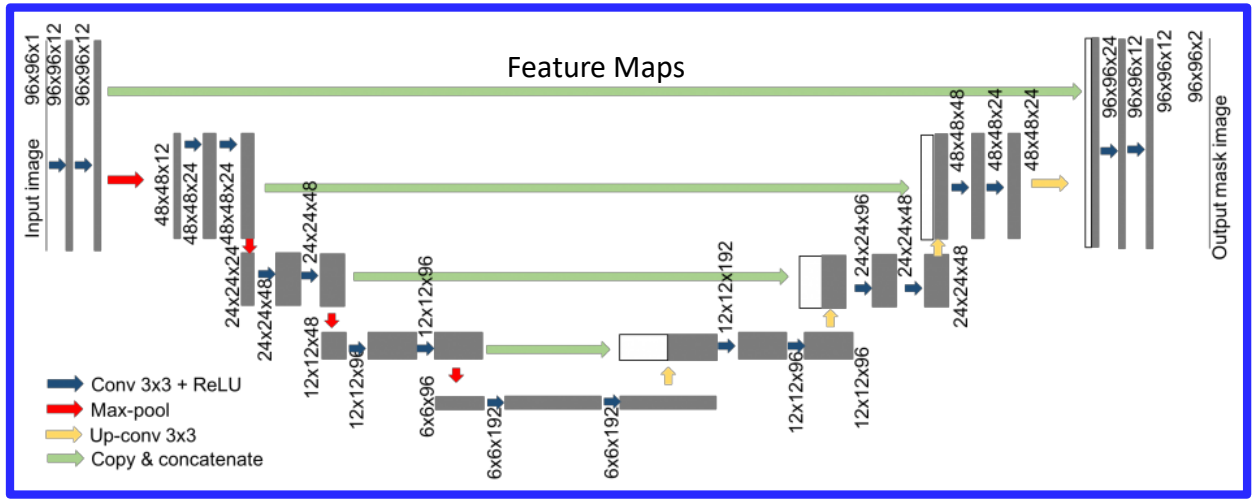
SegNet



V. Badrinarayan et al. *IEEE Trans Pattern Analysis Mach Intell.* 2017

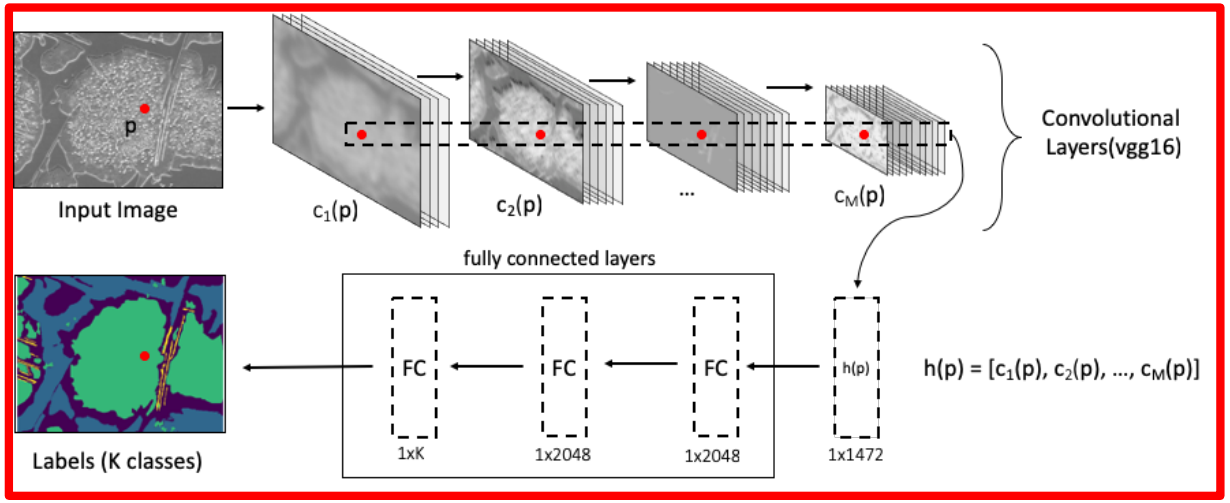
- **U-Net** is similar to **SegNet** but transfers feature maps instead of pooling indices
- **PixelNet** uses hypercolumn descriptors of several pixels from convolutional layers

U-Net



O. Ronneberger et al. *MICCAI* 2015

PixelNet



A. Bansal et al. *arXiv:1702.06506* 2015

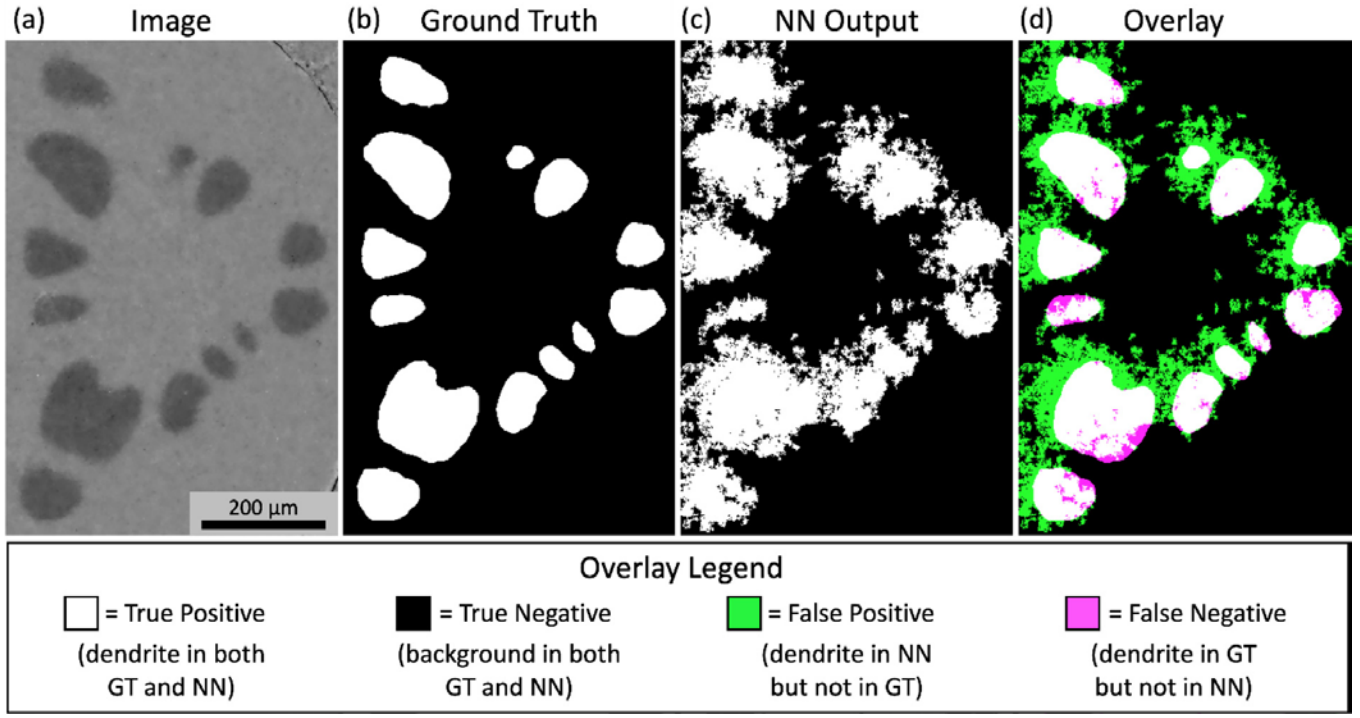
Segmentation Metrics

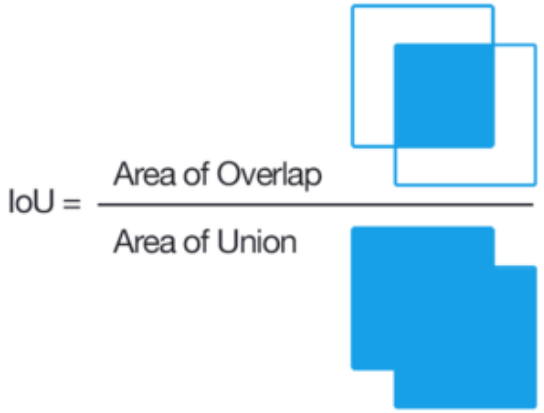
Accuracy (Acc)

- Number of correctly classified pixels / total number of pixels
- Total Acc = $\frac{white+black}{white+black+green+pink}$
- Dendrite Acc = $\frac{white}{white+pink}$

Intersection over Union (IoU)

- Size of overlap / size of union
- Dendrite IoU = $\frac{white}{white+green+pink}$
- Background IoU = $\frac{black}{black+green+pink}$
- Mean IoU = $\frac{Dendrite\ IoU+Background\ IoU}{2}$

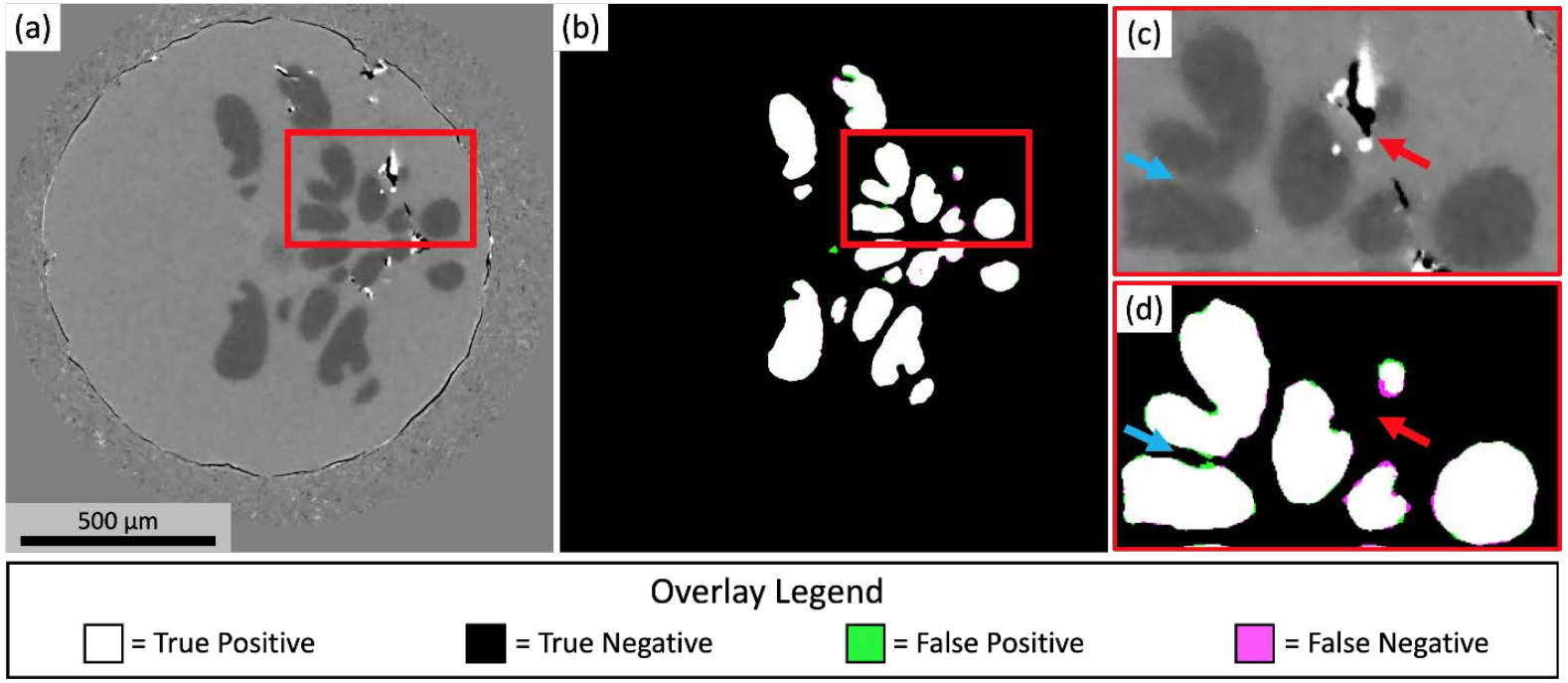




Segmentation Metrics

Boundary F1 Score (BF1)

- Fraction of boundary in the NN segmentation that is within some specified number of pixels to a boundary in the ground truth
- Example: BF1 score of 0.981 with a tolerance of 4 means that 98.1% of the dendrite boundaries in the NN segmentation are within 4 pixels of dendrite boundaries in the ground truth
- More details: G. Csurka, D. Larlus, F. Perronnnin, “What is a good evaluation measure for semantic segmentation”?



Segmentation Metrics for the Overlay in (b)

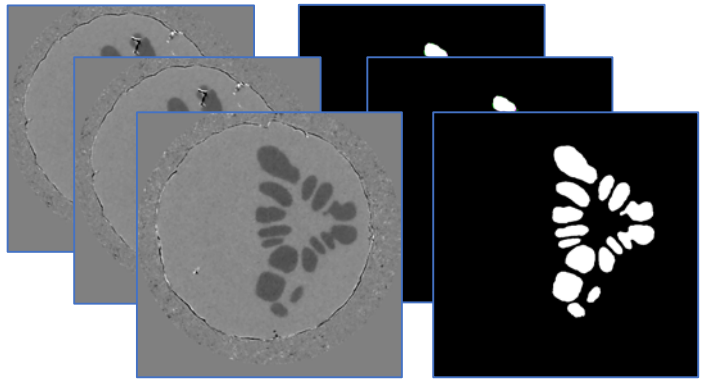
- 99.9% Acc
- 96.9% IoU for the dendrite class
- 98.1% BF1 with tolerance of 4 pixels

MatCNN

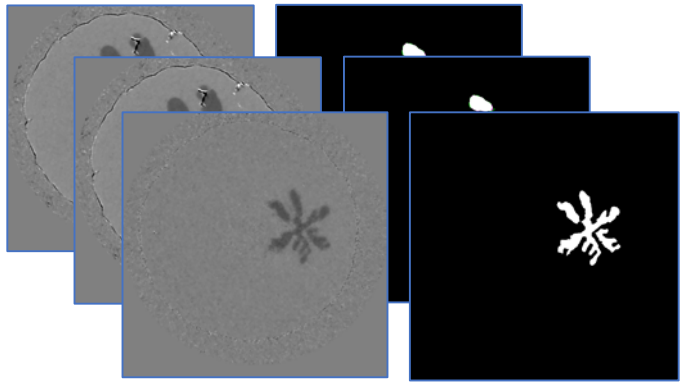
Requires ~500 MB of Google Drive storage for:

- Google Colab script (~few kbs)
- Python codes (~few MBs)
- Pre-trained CNN (~185 MB per CNN)
- 42 Image Tomography dataset (~50 MB)

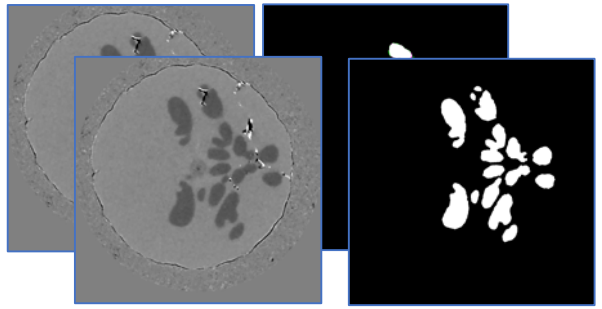
30 Training Pairs



10 Validation Pairs



2 Test Pairs



Create New Google Account?

New Google account steps:

- Chrome – New Incognito Widow
- Google.com – Sign in – Create Account – For Myself
- Create username
- Create Password

When Google Account is ready, go to this link to access MatCNN:
https://colab.research.google.com/drive/1VzV95t9y52ut3IzYwh1ir5S5mQhSBb38?usp=sharing