

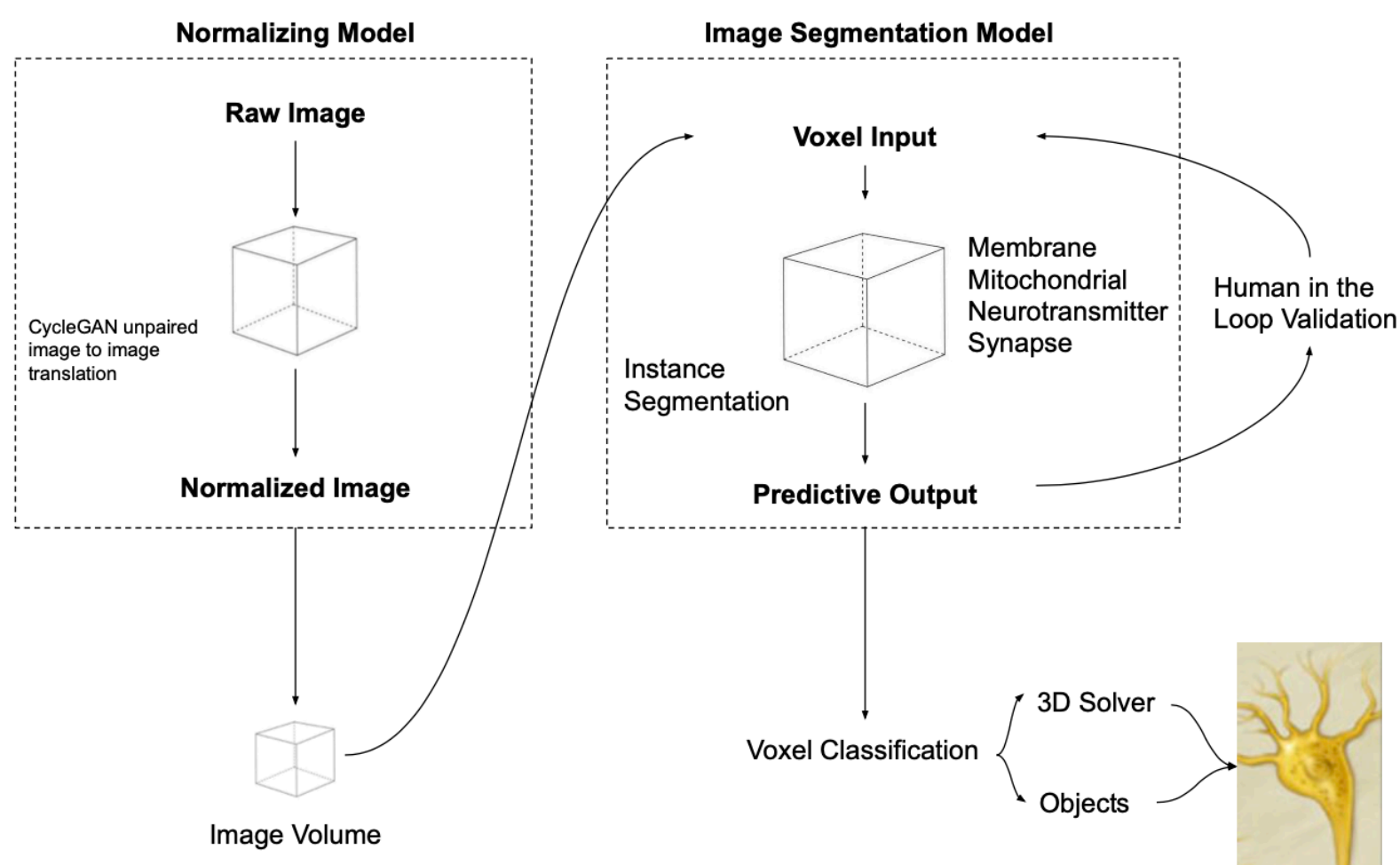
Project Overview

Alzheimer's disease is a type of brain disease, just as coronary artery disease is a type of heart disease. Data imaging of Alzheimer's affected brain cells started in the 1960's. In the 1980's advancements in technology and renewed interest led to pioneering research into 3D modeling of brain cells.

Early 3D rendering of cells were groundbreaking but extremely computationally expensive. And there is additional differences in techniques and non-standardized procedures/SOPs can result in diverging results in terms of resolution, clarity and contrast.

We focus on improving original image quality to enhance existing model efficiency so that we can achieve better output visualizations of brain organelles.

Pipeline



Data Preparation



Issue in Image Quality

- Low resolution microscopic image
- Images with different sizes
- Low image volume



Improve Image Quality

- Thru CycleGan process
- Simulate higher volume data with different scale size
- Windowing CycleGan to get better edge resolutions
- Tuning hyperparameters



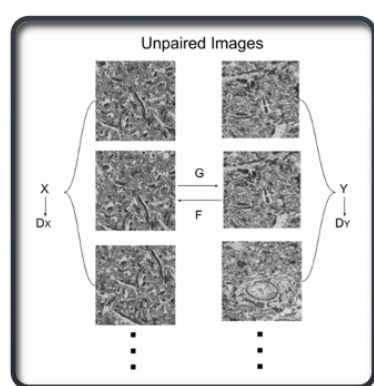
Validate Pre-processed Image

- Subjective comparison between original image with generated image

Modeling

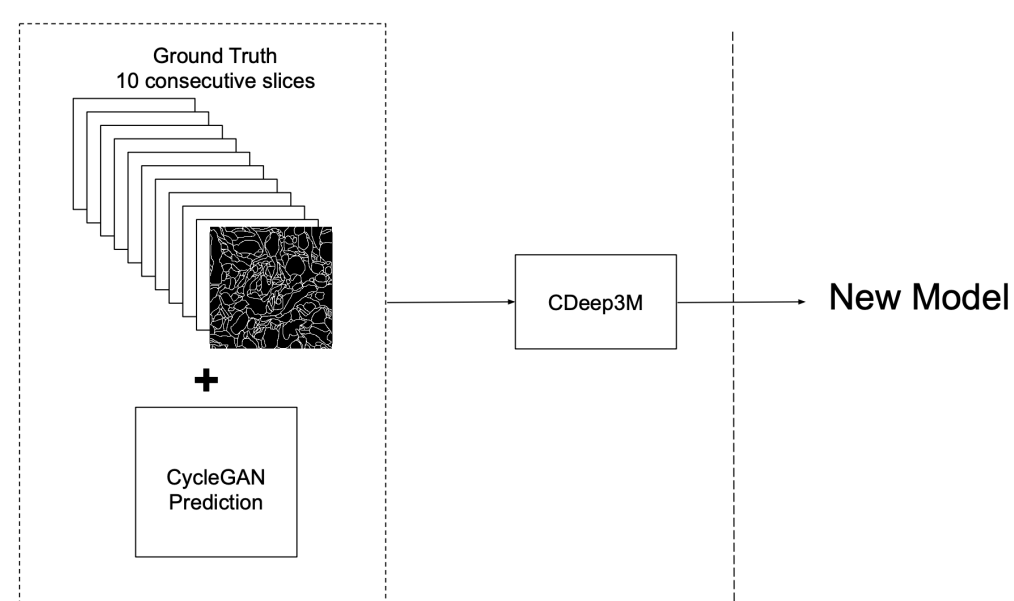
CycleGAN

- Learn a mapping $G : X \rightarrow Y$ and couple it with an inverse mapping $F : Y \rightarrow X$ and introduce a cycle consistency loss to push $F(G(X)) \approx X$ (and vice versa)
- Loss function a measure of reproducibility of model output



Normalization Model

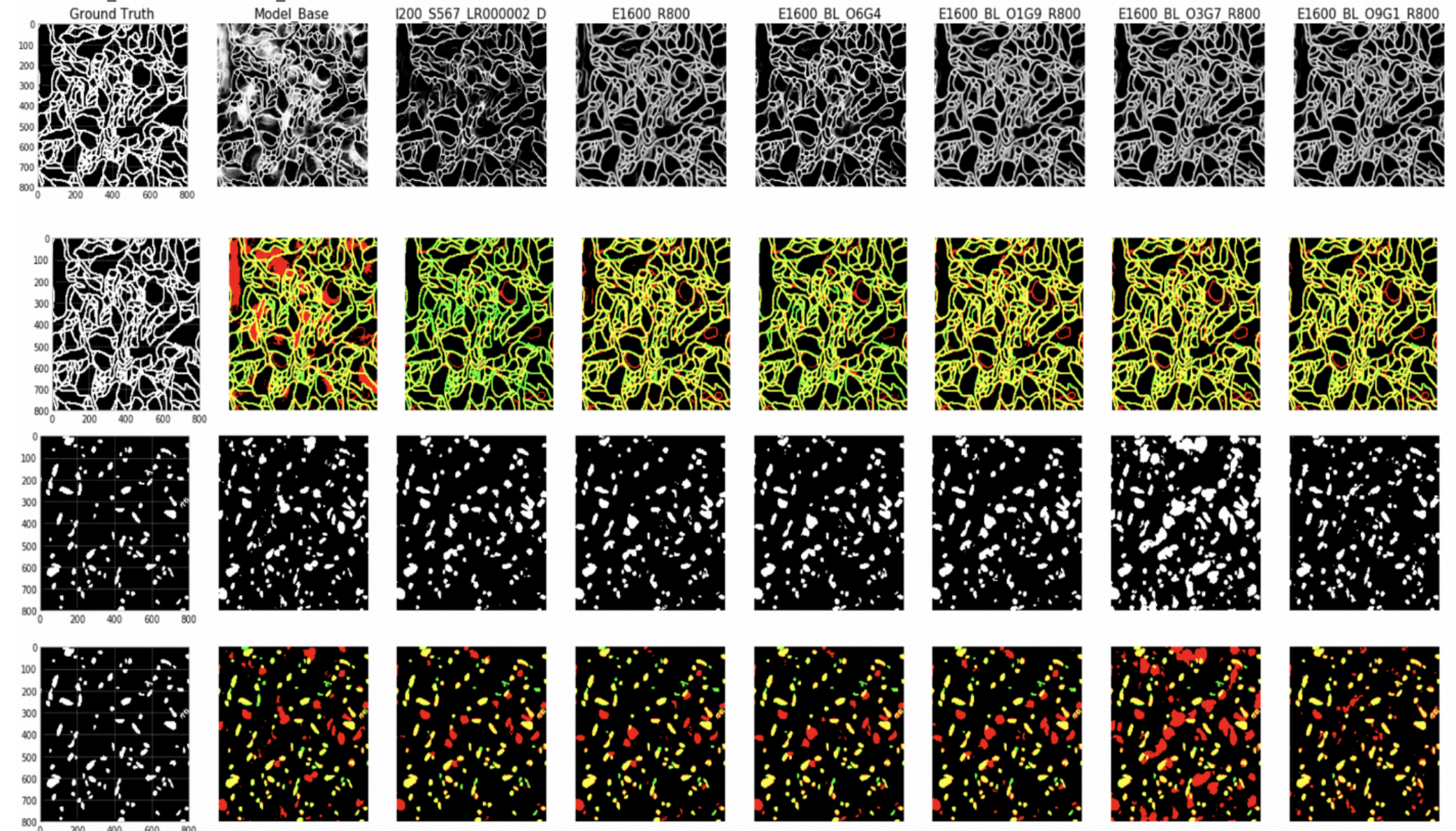
Image Segmentation Model



Performance Evaluation

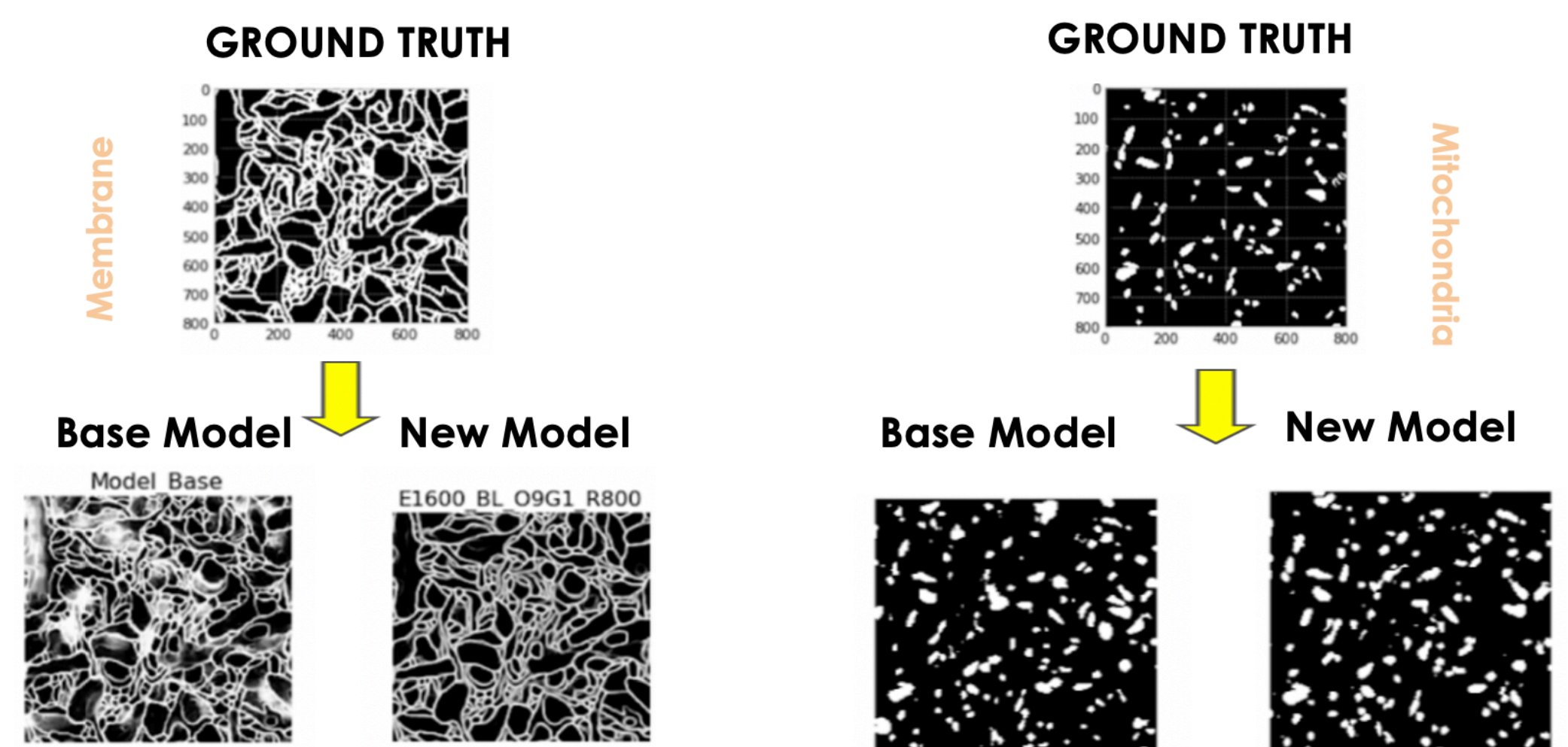
Model	Threshold	Images	Scale	Epoch	Denoise	Learning Rate	Retrained	Blended	Original(%)	Generated(%)	Precision	Recall	Specificity	F1	Accuracy	F_Beta
I200_S567_LR000002_D_E1600_BL_O6G4: Base Model, prediction on blended(60% Original 40% Generated) images and tuned hyperparameters	125	200	Multi	200	Yes	0.000002	No	Yes	60.0	40.0	0.8429	0.6137	0.9227	0.7103	0.798	0.831
I200_S567_LR000002_D_E1600_BL_O9G1_R800: Re-trained Model (+800 iterations) with generated & groundtruth data, prediction on blended(90% Original 10% Generated) images, and tuned hyperparameters	125	200	Multi	200	Yes	0.000002	Yes	Yes	90.0	10.0	0.8297	0.7445	0.8967	0.7848	0.8353	0.8261
I200_S567_LR000002_D: Base Model, prediction on generated images by GAN, and tuned hyperparameters	125	200	Multi	200	Yes	0.000002	No	No	100.0	0.0	0.8492	0.4817	0.9422	0.6147	0.7564	0.825
I200_S567_LR000002_D_E1600_BL_O3G7_R800: Re-trained Model (+800 iterations) with generated & groundtruth data, prediction on blended(30% Original 70% Generated) images, and tuned hyperparameters	125	200	Multi	200	Yes	0.000002	Yes	Yes	30.0	70.0	0.8259	0.7417	0.8943	0.7815	0.8327	0.8223
I200_S567_LR000002_D_E1600_BL_O1G9_R800: Re-trained Model (+800 iterations) with generated & groundtruth data, prediction on blended(10% Original 90% Generated) images, and tuned hyperparameters	125	200	Multi	200	Yes	0.000002	Yes	Yes	10.0	90.0	0.8233	0.7517	0.8919	0.7859	0.8348	0.8203
I200_S567_LR000002_D_E1600_R800: Re-trained Model (+800 iterations) with generated & groundtruth data; prediction on generated images by GAN, and tuned hyperparameters	125	200	Multi	200	Yes	0.000002	Yes	No	100.0	0.0	0.8232	0.7387	0.8927	0.7787	0.8336	0.8196
Base Model, prediction on original images	125	Single	200	No	0.0002	No	No	No	100.0	0.0	0.6506	0.6964	0.7471	0.6727	0.7286	0.6522

Ground Image vs Predicted Images from different model:

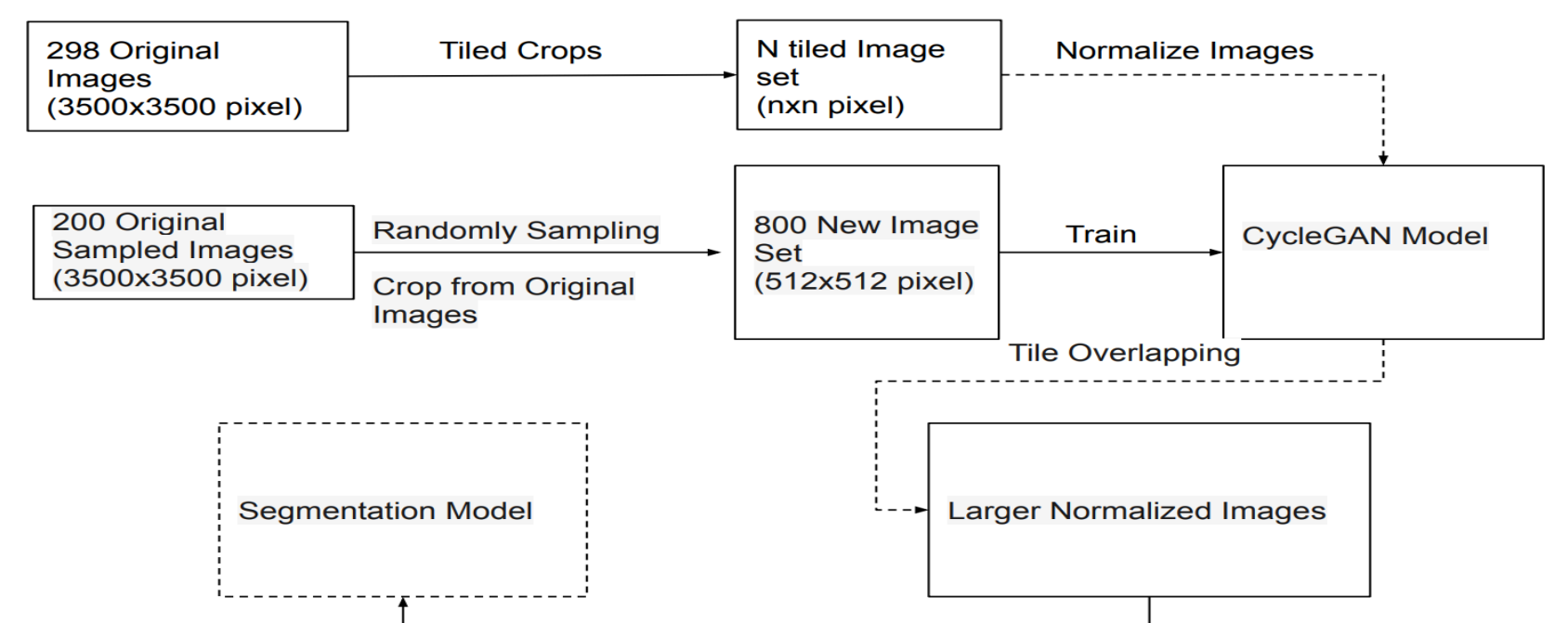


Yellow: True Positive Green: False Negative
Red: False Positive Black: True Negative

Model Selection



Scalability



Key Findings

- **Measured Improvement in Membrane Detection**
 - Over 26% through tuning
- **Subjective Improvement in Mitochondria Predictions**
 - High Epoch model increases Mitochondria Selection
- **Retraining leads to thicker Membrane Predictions**
 - Cleaner predictions with good boundary
- **Interactive Volume Rendering**
 - End user has more control

