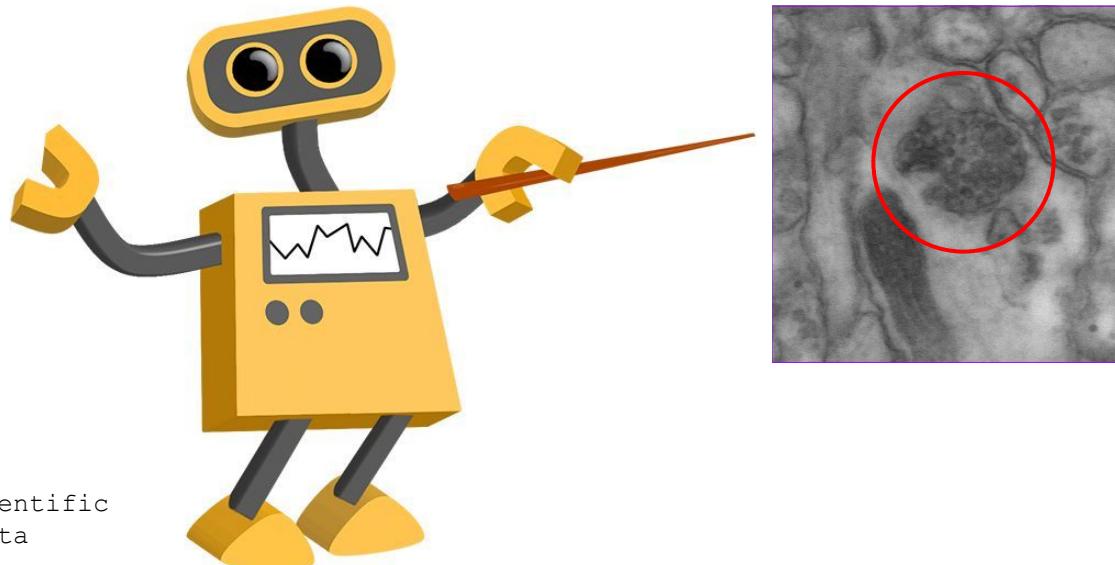
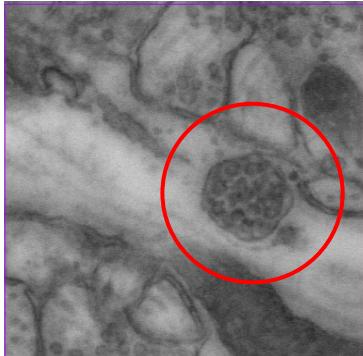
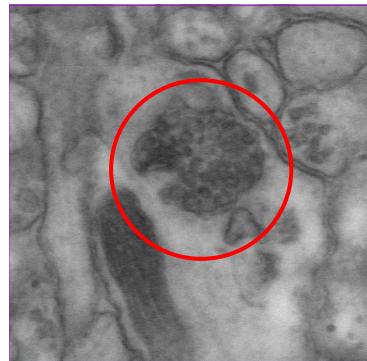


Multivesicular Body Detection Using Machine Learning



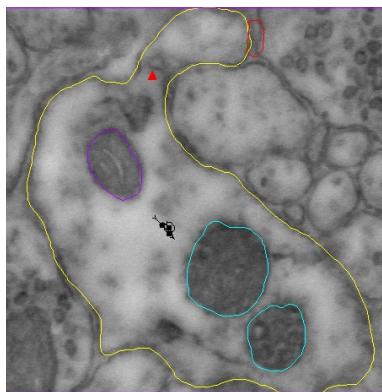
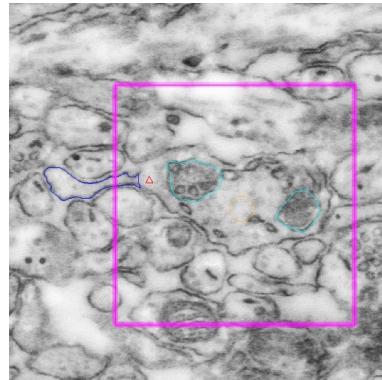
Nicholas Calzada
Harris Lab
Certificate in Scientific
Computation and Data
Sciences

What is a Multivesicular Body (MVB) ?

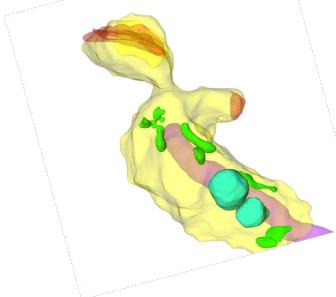
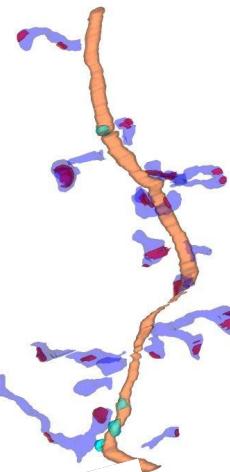


- Organelles containing vesicles with a single limiting membrane.
- Endocytotic, intracellular degradation, and protein sorting pathways.
- Relation in pathogenesis in diseases such as Alzheimer's (Filiomenko et al., 2007).

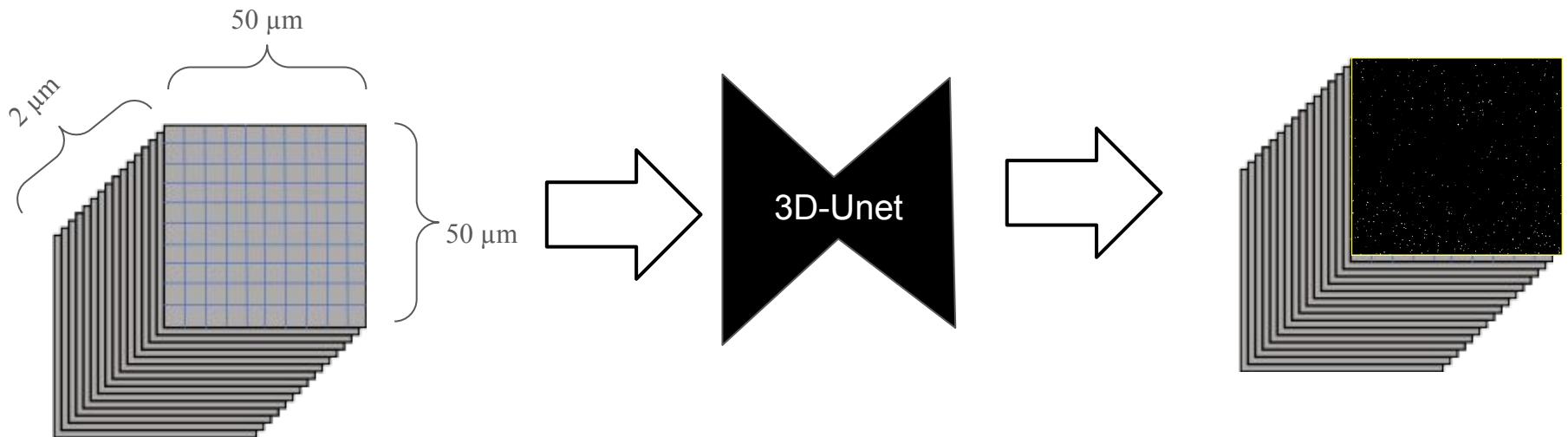
The Goal



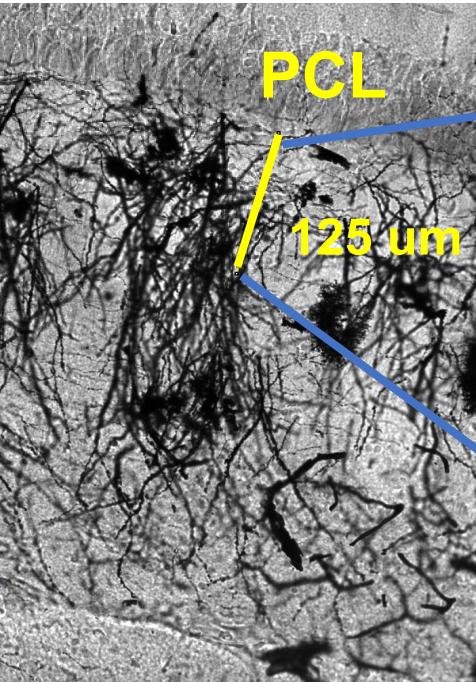
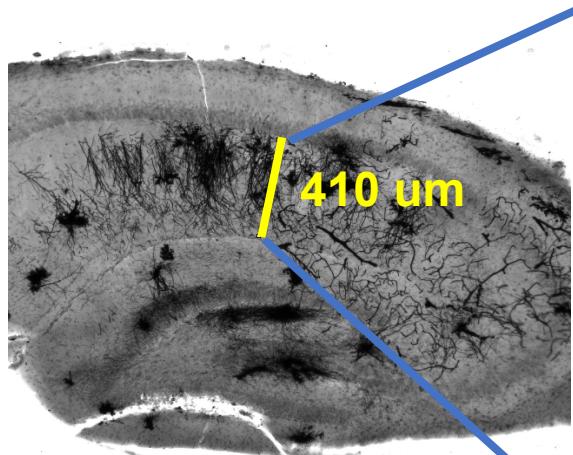
3D
Reconstruction



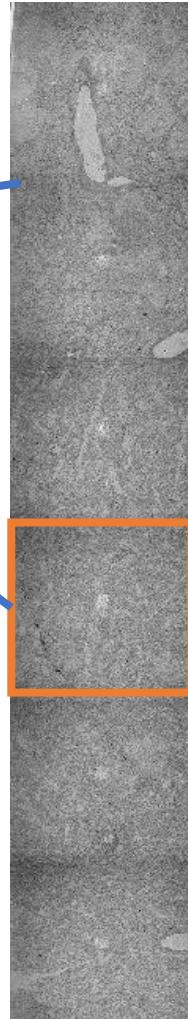
Instead, let's construct a model by feeding our raw data with associated labels into a 3D-Unet, which can be used to output predicted MVBs.



Light Microscopy (LM) *



Golgi stain shows apical dendrites of hippocampal CA1 pyramidal neurons of a PSD20 rat.



CA1
PCL

Transmitted Scanning Electron Microscopy (tSEM)

ROI 50 um
by 50 um,
125 um from
PCL in
S. radiatum

What is a Signed Distance Transform (SDT) ?

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

0	0	0	0	0	0	0	0	0
0	1	1	1	1	1	1	1	0
0	1	1	1	1	1	1	1	0
0	1	1	1	1	1	1	1	0
0	1	1	1	1	1	1	1	0
0	1	1	1	1	1	1	1	0
0	0	0	0	0	0	0	0	0



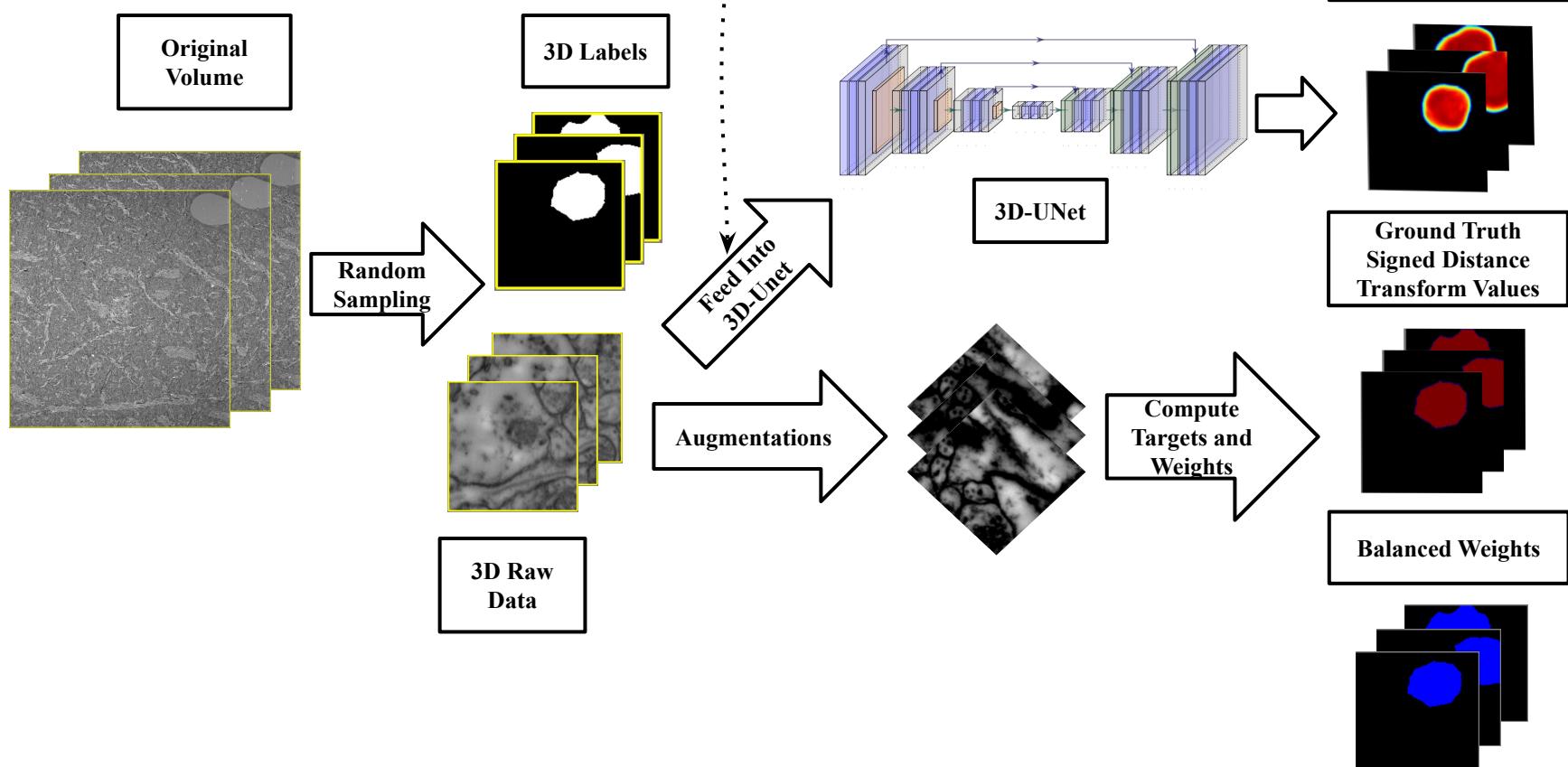
0	0	0	0	0	0	0	0	0
0	1	1	1	1	1	1	1	0
0	1	2	2	2	2	2	1	0
0	1	2	3	3	2	1	0	
0	1	2	2	2	2	2	1	0
0	1	1	1	1	1	1	1	0
0	0	0	0	0	0	0	0	0



<https://homepages.inf.ed.ac.uk/rbf/HIPR2/distance.htm>

<https://medium.com/on-coding/euclidean-distance-transform-d37e06958216>

$$WMSE = \frac{1}{n} \sum_{i=1}^n \text{weights}_i (\widehat{\text{predicted}}_i - \text{actual}_i)^2$$

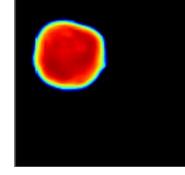
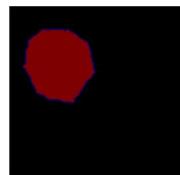
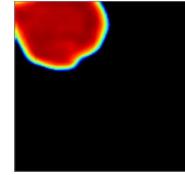
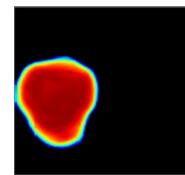
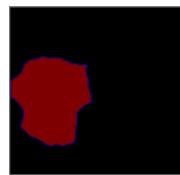
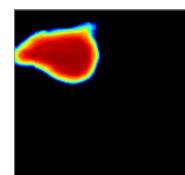


Qualitative Analysis

Ground Truth



Predicted



Model Evaluations

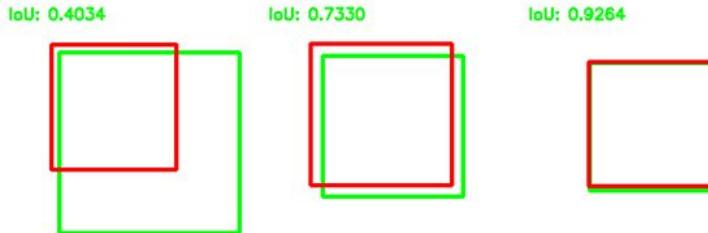
Model Iteration (Uneroded GT labels)	Mean Intersection over Union (IoU)
Model 100,000	0.337
Model 200,000	0.492
Model 300,000	0.471

Model Iteration (Dilated + Eroded GT labels)	Mean Intersection over Union (IoU)
Model 100,000	0.336
Model 200,000	0.493
Model 300,000	0.471

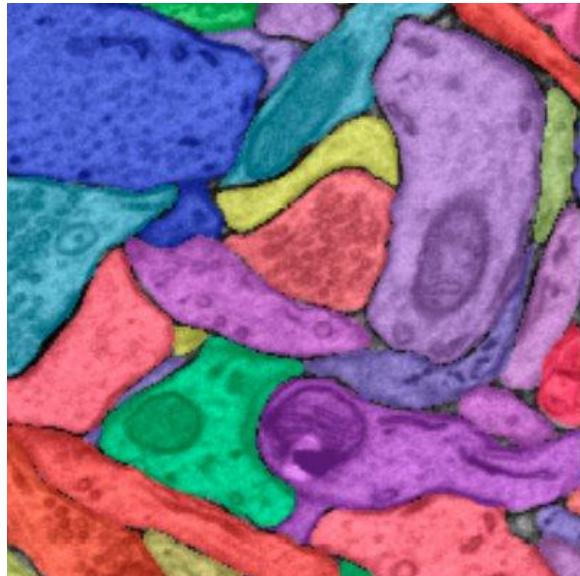
Model Iteration (Uneroded GT labels + removed dust*)	Mean Intersection over Union (IoU)
Model 100,000	0.336
Model 200,000	0.493
Model 300,000	0.470

*Predicted masks less than 100 pixels were removed

Model accuracy metric:
Intersection Over Union (IoU)



Future Direction



- Use a successful model to compare density of MVBs in LTP and control experiments.
- Principal Component Analysis (PCA) to classify MVBs based on quantitative information.
- Multiple organelle segmentation.