COBALT Deliverables

Mission

- To drive breakthrough neuroscience discoveries by enabling terabyte-scale, cleared brain tissue analysis through the use of a comprehensive and well-documented software package and web interface

Sprint 1 deliverables

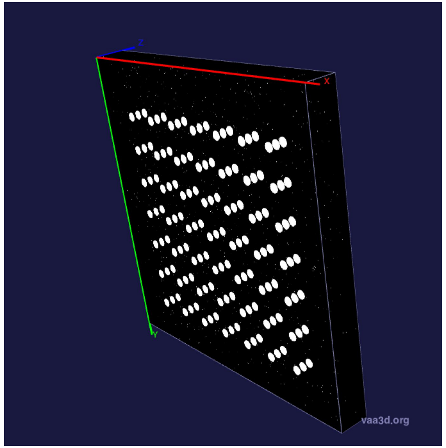
Sprint	Date Due	Requirements: Portion of manuscript (and package) corresponding to...
Sprint 1: Registration and Cell Detection	11/6	• Obtain/Label up to 10 subvolumes of interest with manual annotations for cell detection • Tool for generating simulated validation data • Implement & quantitatively compare 2-3 unsupervised cell detection methods • Quantitative evaluation of 25 and 50 um registration on 4 control brains from ailey with manual fiducials

10 subvolumes of data fully annotated!

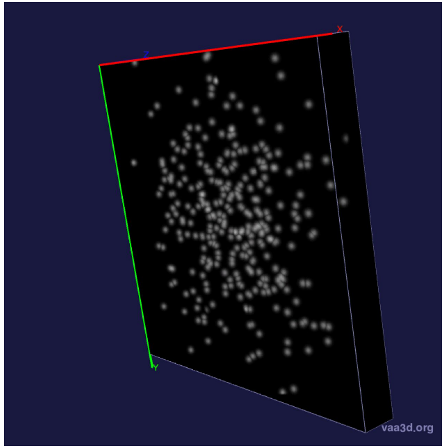
- Cell Detection Subvolumes Spreadsheet
- Subvolumes obtained from Boss
- Used orthogonal views to differentiate actual cells from noise
- Talked with collaborators to improve annotation accuracy (learning more about what is and what isn’t a cell)
- Viz links
  - s3617
  - 170726_Insula-vCapture-Atenolol2_00-56-01
  - 170728_Insula-vCapture-Iso1_12-42-27

Simulated validation data allows for rapid prototyping

- Developed a tool for generating synthetic blob images.
  - Specify how many blobs, intensity, distribution, size
- Allows us to test our code, algorithm fast and will allow for unit testing
- To run the data generating tool: import `ImageGenerator.py` and run `make_ellipsoidal_image`



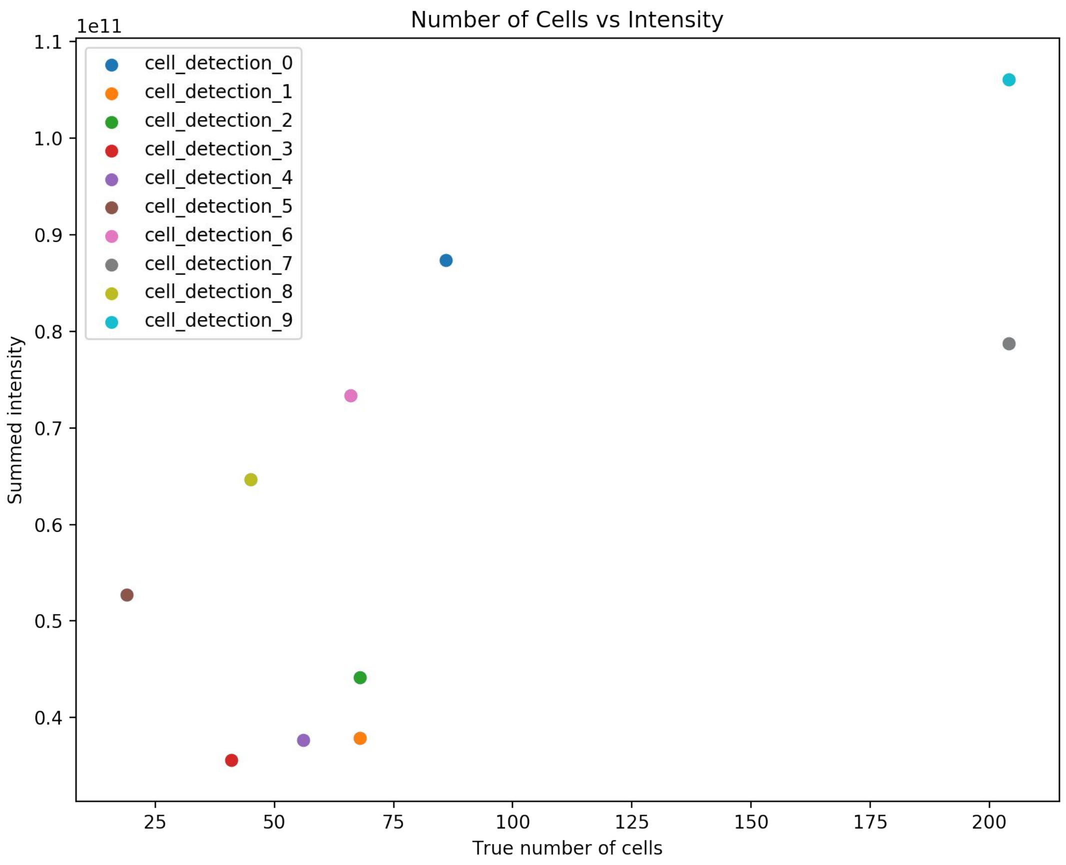
Dataset number	Dataset name	cell count	noisy	center distribution	cell intensity	source of data
1	solid_45_cells	45	No	fixed array	solid	generated
2	solid_45_cells_noise_random_intensity	45	Yes	fixed array	solid	generated
3	solid_147_cells_img_noise	147	Yes	fixed array	solid	generated
4	blurred_147_cells	147	No	fixed array	gauss blurred	generated
5	blurred_147_randomized_gauss_cells	147	No	gaussian	gauss blurred	generated
6	faded_147_randomized_cells_random_intensity	147	No	uniform	faded	generated
7	faded_147_randomized_cells	147	No	uniform	faded	generated
8	faded_147_randomized_gauss_cells	147	No	gaussian	faded	generated
9	s3617_cutout	??	artifacts	random	??	real



Top: Table of characteristics of each synthetic data set
Right: Examples of simulated data

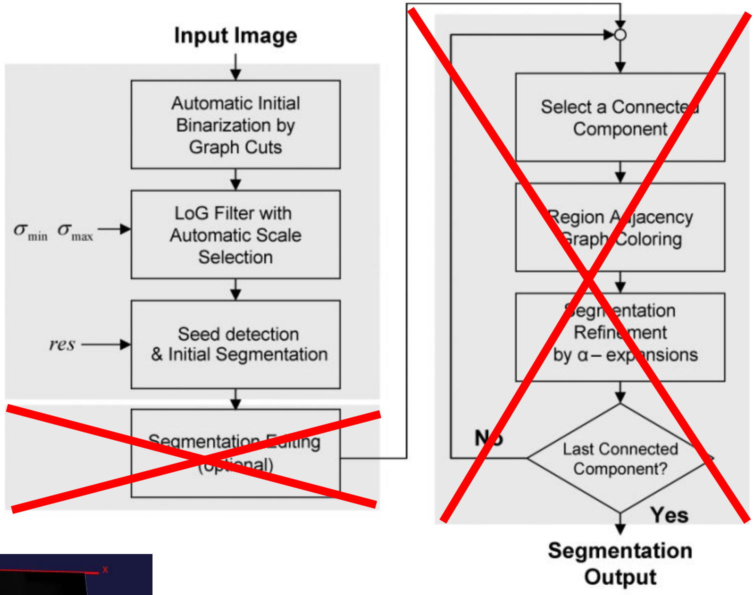
Simple intensity summing can act as a sanity check

- Jupyter notebook
- Simply summing voxels

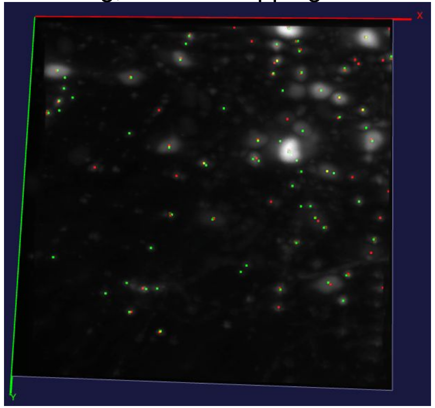


FARSIGHT works better than intensity summing

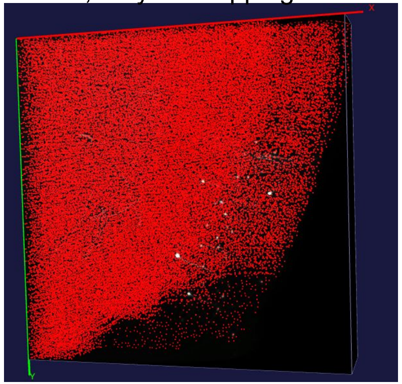
- Best performing unsupervised cell detection algorithm as stated in a 2014 review of unsupervised cell detection algorithms
- Uses very basic methods:
  - Binarization
  - LoG
  - Local maxima filtering of LoG features to find seeds
- We only care about cell detection so we cut out the segmentation portion of the pipeline (Big red X)
- Performs well on synthetic data. Fairly well on some of the real data.

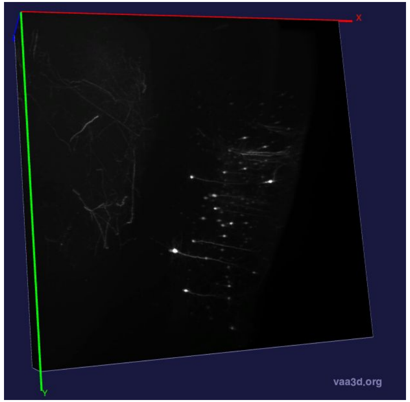


Decent results on subvolumes with big, less overlapping blobs



Terrible on subvolumes with small, very overlapping blobs





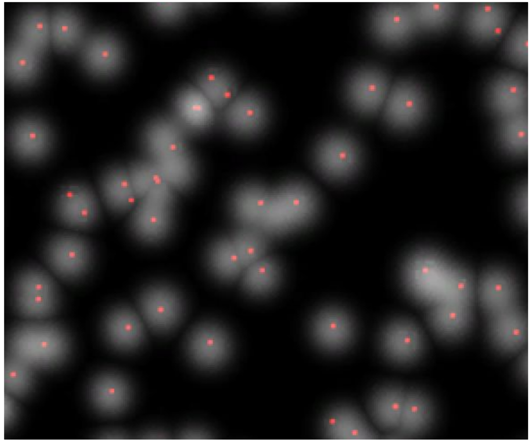
Original subvolume with small, overlapping blobs for comparison. (Hard to see but there is a thin light film of low intensity going across image)

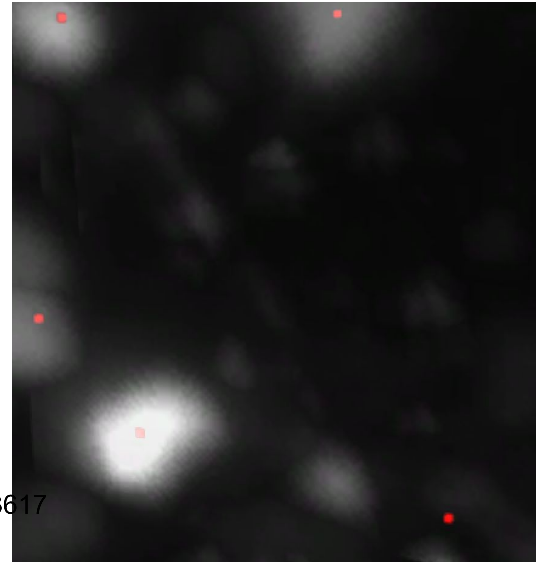
HDoG algorithm outperforms summing and FARSIGHT

- [Notebook]

		Accuracy (%)	Precision	Recall	F-Measure	Mean Squared Error
S3617	cell_detection_0	64.7	0.32	0.38	0.35	56.33
	cell_detection_1	76.4	0.33	0.36	0.34	59.19
	cell_detection_2	75.6	0.25	0.28	0.26	55.09
	cell_detection_3	84	0.22	0.23	0.23	57.62
Atenolol2	cell_detection_4	52.6	0.45	0.77	0.57	559.76
	cell_detection_5	85	0.23	0.24	0.24	70.08
	cell_detection_6	51	0.53	0.9	0.67	49.23
	cell_detection_7	51	0.58	0.8	0.67	44.75
ISO1	cell_detection_8	25	0.96	0.25	0.4	885.33
	cell_detection_9	31	0.81	0.33	0.47	507.515

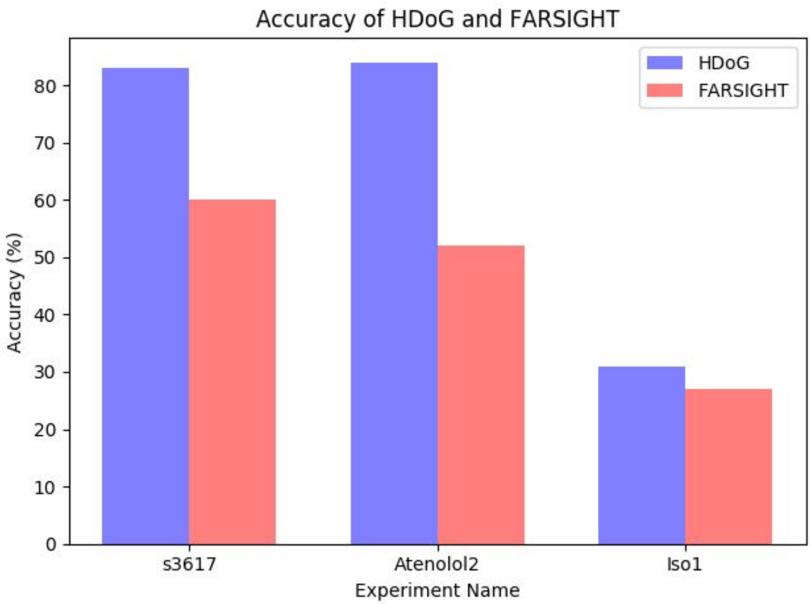
Simulated Data

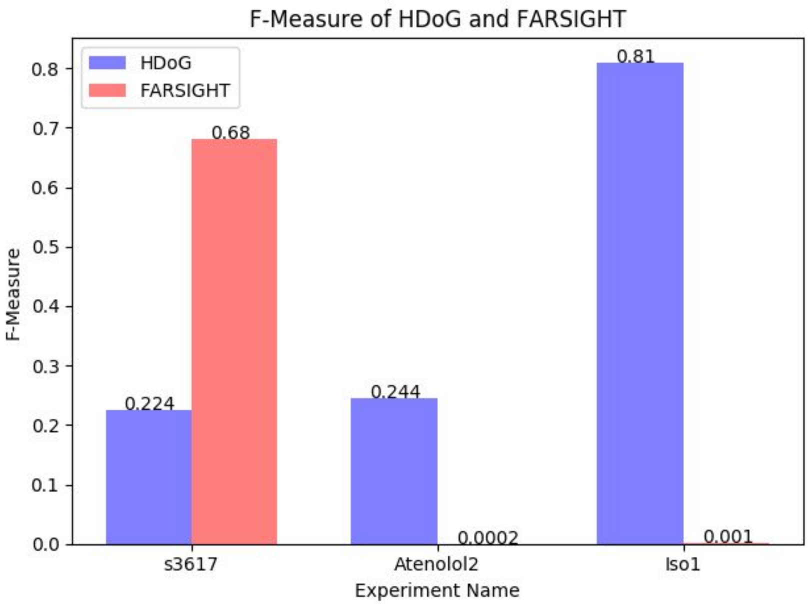




Snippet of s3617

HDoG algorithm outperforms summing and FARSIGHT





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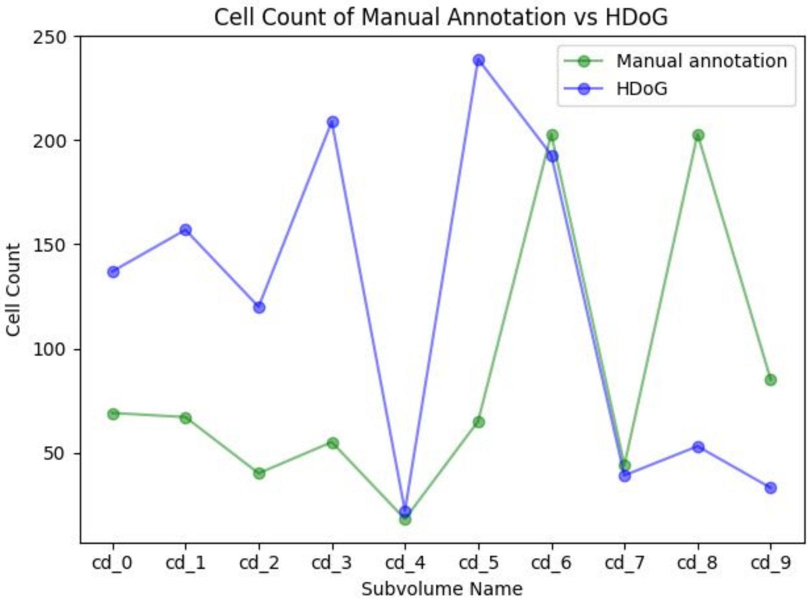

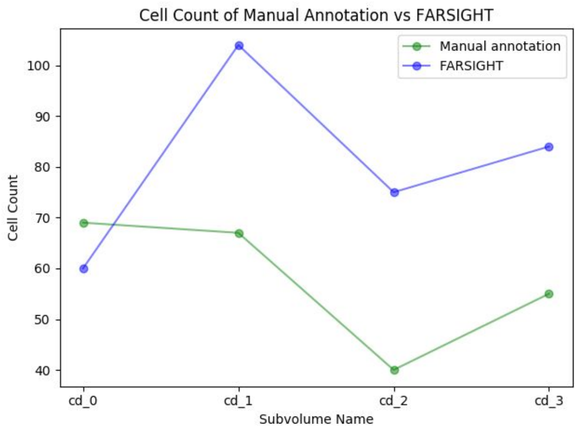

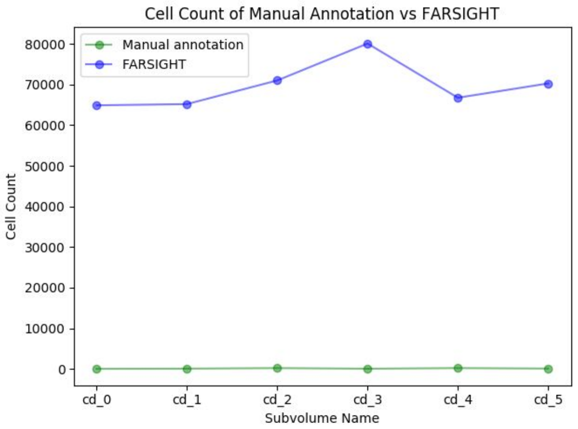

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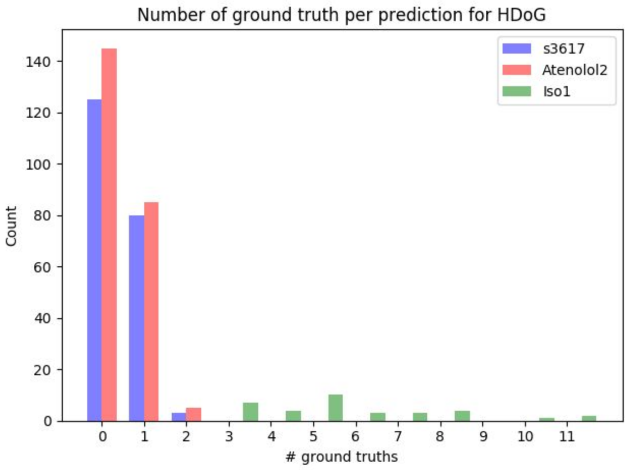

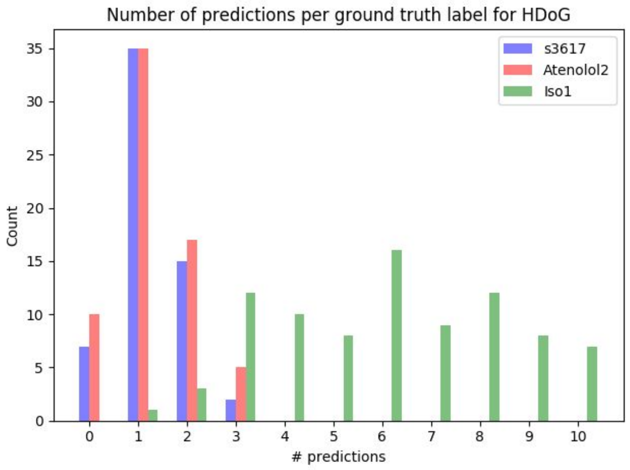

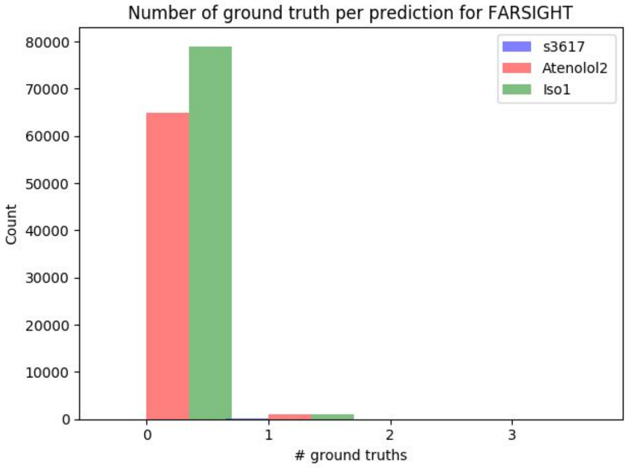

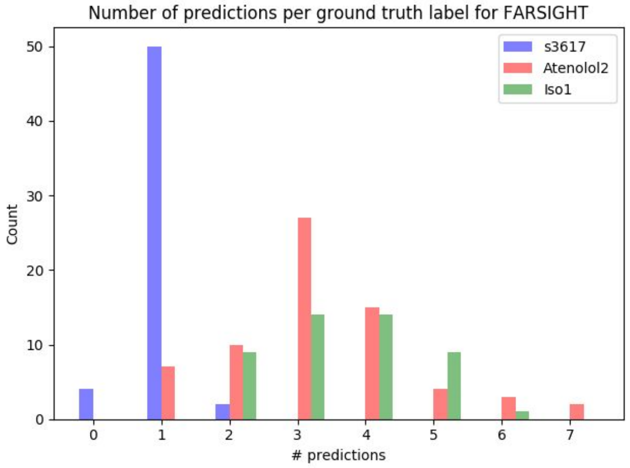

Annotations and predictions uploaded to BOSS

- Manual annotations and predictions from HDoG and FARSIGHT uploaded to BOSS as separate channels for the 10 subvolumes as separate experiments
  - "annotations"
  - "hdog_predictions"
  - "farsight_predictions"
- View it on boss

Cell detection demo!

Registration evaluation indicates high degree of accuracy

- Registration package
  - Docker Hub: https://hub.docker.com/r/vikramc/simple-elastix/
  - Source code: https://github.com/vikramc1/clareg
- Evaluate 3 brains with fiducials: Control9, Contol10, Control11
  - Control9 mean fiducial distance: **0.875 mm**
  - Control10 mean fiducial distance: **0.745 mm**
  - Control11 mean fiducial distance: **1.137 mm**
- Jupyter notebook

Progressing as planned

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Sprint 2:	12/8	• Well-documented cell detection python package (w/ 1-2 algorithms for cell detection) • Region-based analysis in package • Object-based statistics • Create a well-documented python package on pip for registration. • work with nomads to create code to merge annotations from each processed chunk