Extraction of Novel Biological Priors from Skeletal Neuronal Images for the Classification of (EM) Connectomics Data

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January 11, 2016

1 Introduction

Producing a connectome from electron microscopy (EM) images provides an incredibly informative graph of connections on the individual neuron level. However, the enormous amount of data, the time it takes to manually annotate it, and the many errors automated parsing software produces are major challenges facing the continued growth of the burgeoning field of connectomics. [1][2] In this proposal, we present a project that attempts to use existing skeletal and EM data for analysis and classification of new biological priors, such as dendrite branching angles. Building off work presented in Roncal et al.'s 2014 Society for Neuroscience poster, [3] this project will be accomplished using recently developed software such as the TREES software for MATLAB [4] and analyzing neuronal skeletal data from NeuroMorpho.org [5] as well as ground truth data for comparison. These priors will be meaningful to improve accuracy and speed of parsing neurons in EM data after being implemented in future automatic annotation and proofreading software by computer vision scientists.

2 Project Outline

2.1 Methods

Structural trees are available publicly on NeuroMorpho.org [5] and will provide a starting point for data collection. We will try to distinguish between interneurons and pyramidal neurons in the neocortex of mice using the TREES program. [4] We will compare the priors found by analyzing the neurons from NeuroMorpho.org to the gold standard for EM data on the neocortex. This way we can test whether these priors are valid. Then we will compare these types of neurons between different parts of the brain, for instance, between the neocortex and hippocampus.

2.2 Schedule

Monday, January 11th
Each team member will have MATLAB and the TREES toolbox [4] up and running
with some sample data from NeuroMorpho.org [5]. There will be a possible meeting on
Sunday, January 10th to go over any remaining problems.

Wednesday, January 13th
After working with the NeuroMorpho.org and other data for a few days now, we will
have identified at least four biological priors learned from the data that we will intend
to pursue. We will delegate a prior to each team member by this time.

Friday, January 15th
By this date, we should have preliminary results for most of the skeletal data, which
will be compiled in the progress report. Any preliminary successes and problems will be
included. We will also begin comparing the these priors with gold standard data.

Monday, January 18th
Over the weekend, we will work through any remaining problems individually and as a
group. An outline of our final presentation and report will be collaborated on over the
weekend and produced by Monday.

Wednesday, January 20th
By the end of this date, the final poster and presentation will be finished as a collabo-
rative effort by all team members.

2.3 Allocation of Tasks

All team members will try to distinguish between the inter-neurons and pyramidal cells
in the mouse cortex by applying the templates on NeuroMorpho.org [5] to the TREES
toolbox in MATLAB and find priors, which will then be compared to the gold standard.
Afterwards, each member will be allocated a prior to compare cells between different
regions of the brain. The entire group will come together frequently to solve any emerging
problems or make sure everyone is on task.

3   References

1. Jurrus, Elizabeth, et al. "Detection of neuron membranes in electron microscopy
images using a serial neural network architecture." Medical image analysis 14.6 (2010):
770-783.

2. Plaza, Stephen M. "Focused Proofreading: Efficiently Extracting Connectomes from
Segmented EM Images." arXiv preprint arXiv:1409.1199 (2014).

3. Roncal, William Gray, et al. "A Semantic Framework to Guide Computer Vision in (EM) Connectomics." Society for Neuroscience. Washington, DC. 11-15 Nov. 2014.

4. Cuntz, Hermann, et al. "The TREES toolbox—probing the basis of axonal and dendritic branching." Neuroinformatics 9.1 (2011): 91-96.

5. Ascoli, Giorgio A., Duncan E. Donohue, and Maryam Halavi. "NeuroMorpho.Org: a central resource for neuronal morphologies." The Journal of Neuroscience 27.35 (2007): 9247-9251.