Intra- and Inter-Cellular Awareness for 3D Neuron Tracking and Segmentation in Large-Scale Connectomics

Editors: Under Review for MIDL 2022

Abstract

Currently, most state-of-the-art pipelines for 3D connectomic reconstruction deal with neuron over-segmentation, agglomeration and subcellular compartment (nuclei, mitochondria, synapses, *etc.*) detection separately. Inspired by the proofreading consensus of experts, we established a paradigm to simultaneously acquire prior knowledge of cellular characteristics and ultrastructures, as well as discriminate the posterior connectivity of neural circuits. Following this novel paradigm, we were keen to bring the **I**ntra- and **I**nter-**C**ellular **A**wareness back when **T**racking and **S**egmenting neurons in connectomics. Our proposed method (II-CATS) utilizes few-shot learning techniques to encode the intermediate neuron representation and its key components, which could significantly impact tracings. We further go beyond the original **e**xpected **r**un **l**ength (ERL) metric by focusing on **b**iological constraints (bERL) and spanning from the **n**ucleus to spines (nERL). With the evaluation of these metrics, we perform typical experiments on multiple electron microscopy datasets on diverse animals and scales. In particular, our proposed method is naturally suitable for tracking neurons that have been identified by staining.

Keywords: Connectomics, Tracking, Segmentation, Few-shot Learning

1. Introduction

This is where the content of your paper goes. Some random notes[1]:

- You should use LaTeX(Lamport, 1986).
- JMLR/PMLR uses natbib for references. For simplicity, here, `\cite` defaults to parenthetical citations, i.e. `\citep`. You can of course also use `\citet` for textual citations.
- Eprints such as arXiv papers can of course be cited (Hinton et al., 2015). We recomend using a `@misc` bibtex entry for these as shown in the sample bibliography.
- You should follow the guidelines provided by the conference.
- Read through the JMLR template documentation for specific LaTeXusage questions.
- Note that the JMLR template provides many handy functionalities such as `\figureref` to refer to a figure, e.g. Figure 1, `\tableref` to refer to a table, e.g. Table 1 and `\equationref` to refer to an equation, e.g. Equation (1).

1. Random footnote are discouraged

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Table 1: An Example Table

Dataset	**Result**
Data1	0.12345
Data2	0.67890
Data3	0.54321
Data4	0.09876

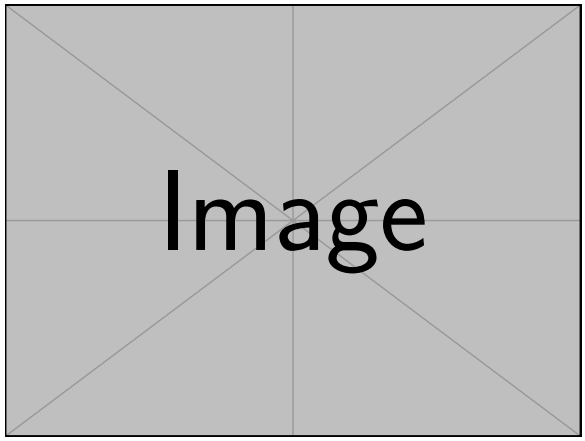

Figure 1: Example Image

Algorithm 1: Computing Net Activation

Input: $x_1, \ldots, x_n, w_1, \ldots, w_n$
Output: y, the net activation
$y \leftarrow 0$;
for $i \leftarrow 1$ **to** n **do**
  $y \leftarrow y + w_i * x_i$;
end

Acknowledgments

We thank a bunch of people.

References

Geoffrey Hinton, Oriol Vinyals, and Jeff Dean. Distilling the knowledge in a neural network. Eprint arXiv:1503.02531, 2015.

Leslie Lamport. *Latex: A Document Preparation System.* Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA, 1986. ISBN 0-201-15790-X.

Appendix A. Proof of Theorem 1

This is a boring technical proof of

$$\cos^2\theta + \sin^2\theta \equiv 1. \tag{1}$$

Appendix B. Proof of Theorem 2

This is a complete version of a proof sketched in the main text.