

N.O.M.A.D.S.

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NOvel **M**ethod of **A**utonomous **D**etection for **S**ynapses

Mission

To accelerate brain research by autonomously detecting and characterizing synapses, and to provide software that is readily useable for neuroscientists and computer scientists.

Motivation

- Central nervous system (CNS) synapses are poorly understood due to their diverse functions and patterns in gene expression, making identification and characterization difficult.
- Understanding synapses on individual level can elucidate pathology of neurological disorders.
- Conjugate array tomography (cAT) allows collection of high dimensional proteomic data and structural data with single synapse precision.
- Many well-developed image processing and machine learning frameworks can be leveraged for synapse analysis using data obtained through cAT.

Problem

- No standardized pipelines exist for autonomous synapse detection that are useable for neuroscientists who do not have expert knowledge in image processing and machine learning.
- Current state of the art algorithms developed by researchers are not readily accessible or available for use.

Causes

- **Neuroscientists are not Computer Scientists**
 - They don't know what computational resources they need
 - They don't know how to use the computational resources that others build
- **Computer Scientists are not Neuroscientists**
 - They don't know what kind of capabilities neuroscientists want
 - They don't know how to structure their resources so neuroscientists can use them

Current Best Practices

- Manual annotation of synapses via EM, IF, and conjugated EM-AT
 - Why it's useful:
 - Allows for detection/visualization of individual synapses
 - Reliable methodology
 - Why it isn't useful:
 - Time-consuming and labor-intensive
 - Requires significant expertise in identifying synapses just by looking at them
- openneuro.org
 - Why it's useful:
 - One click pipeline deployment
 - Multiple datasets
 - Why it isn't useful:
 - Currently has very few implemented pipelines
 - Specifically, no synapse pipelines

What's Missing?

A team of Neuroscientists and
Computer Scientists working
together to bridge the gap
between the two disciplines.

Solution

- An end to end cAT analysis pipeline
 - Interfaces with openneuro.org for deployment
 - Performs both supervised and unsupervised synapse detection
 - Reduce reliance on manual annotations
 - Performs unsupervised synapse clustering
 - Assists in identification of synapse types
- A partial set of annotations for the Collman 15 data set:
 - Allows both our team and other teams to train supervised detection algorithms
 - Can be uploaded to openneuro.org as an additional dataset

Impact

- **Neuroscientists**
 - Readily usable pipeline that enables the autonomous detection of synapses without the need for an extensive background in computer science
 - Provides a benchmark for which future algorithms can be judged against
 - Decreases reliance on manual annotations
- **Computer Scientists**
 - Open source & well documented code base make extensibility easy
 - Developed openneuro.org interface code lowers barrier for other computer scientists who want to write and deploy pipelines
- **Both**
 - Fosters a collaborative environment for reproducible science!