Identification of Neuronal Polarity by Node-based Machine Learning

Chen-Zhi Su[1,2*], Kuan-Ting Chou[1,3], Hsuan-Pei Huang[1,4], Chiau-Jou Li[1,3], Ching-Che Charng[1,4], Chung-Chuan Lo[1,4], Daw-Wei Wang[2,3,5]

[1]*Brain Research Center, National Tsing Hua University, Hsinchu, Taiwan*
[2]*Physics Division, National Center for Theoretical Sciences, Hsinchu, Taiwan*
[3]*Department of Physics, National Tsing Hua University, Hsinchu, Taiwan*
[4]*Institute of Systems Neuroscience, National Tsing Hua University, Hsinchu, Taiwan*
[5]*Center for Quantum Technology, National Tsing Hua University, Hsinchu, Taiwan*

Identifying the directions of signal flows in neural networks is one of the most important stages for understanding the intricate information dynamics of a living brain. Using a dataset of 213 projection neurons distributed in more than 15 neuropils of a Drosophila brain, we develop a powerful machine learning algorithm: node-based polarity identifier of neurons (NPIN). The proposed model is trained by nodal information only and includes both Soma Features (which contain spatial information from a given node to a soma) and Local Features (which contain morphological information of a given node). After including the spatial correlations between nodal polarities, our NPIN provided extremely high accuracy (>96.0%) for the classification of neuronal polarity, even for complex neurons with more than two dendrite/axon clusters. Finally, we further apply NPIN to classify the neuronal polarity of neurons in other species (Blowfly and Moth), which have much less neuronal data available. Our results demonstrate that NPIN is a powerful tool to identify the neuronal polarity of insects and to map out the signal flows in the brain's neural networks if collecting more data for training in the future.

Keywords: Neuronal Polarity, Machine Learning, Drosophila, Connectome, Axon, Dendrite

Email:czsu32@gmail.com