Strahler Order Reveals Hidden Features in Neuronal Morphology

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Neurons exhibit diverse morphology which is critical for their functionality and connectivity. Therefore, the shape of a neuron becomes an ideal descriptor for classification and identification of neurons. Although neuronal morphology has intrinsic confinement instead of full randomness, how a neuron forms appropriate shape and what the confinement is remain elusive. To investigate the anatomical restriction, we first quantitatively characterize the topological features using the big data approach on the whole dataset from the FlyCircuit database. Specifically, we use Strahler order (SO), which is commonly used in potamology, to analyze the morphology of the fruit fly neurons. We define the Balancing Factor based on SO and discover that the Balancing Factor of the neurons distribute in a small range, suggesting that the neuronal morphology maintains certain symmetry which cannot be easily observed with traditional measures used in neuroscience. We further compare the neuronal morphology across different neuropils and found that the local neurons in the antennal lobe exhibiting prominent specific features. Our preliminary sheds lights on the hidden features in neuronal morphology and provides a novel measure for classification of neurons in large-scale image databases.

Keywords: Strahler order, neuronal morphology, Balancing factor, neuronal classification

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