SynapCountJ–An ImageJ Plugin to Analyze Synaptical Densities in Neurons

Gadea Mata Martínez[1], Miguel Morales Fuciños[1], Germán Cuesto Gil[1], Julio Rubio García[2], Jónathan Heras Vicente[2]

1. Structural Synaptic Plasticity, CIBIR Logroño, Spain
2. Dept. of Mathematics and Computer Science, University of La Rioja, Spain

gadea.mata@gmail.com http://www.cibir.es/structure-a-investigation/neurodegenerative-diseases

Abstract

Synapses are dynamic structures subject to changes depending on their development and activity. There are direct relationships among the number of synapses, memory processes and some neuropathologies such as Alzheimer. Quantification of synapses in both, neuronal cultures and tissue is based on morphological or immunocytochemical criteria. The procedure to identify and quantify synapses needs a huge time effort, it is a task performed, mainly, manually by the researcher.

The aim of our work is the development of a software system that allows determining the synaptic density from immunofluorescence images. To achieve this goal, we have implemented SynapCountJ, an ImageJ plug-in, based on topological and geometric algorithms. The main hindrance in automating such a process consists in discriminating between the actual synapses and irrelevant information; for instance, the background or other structures such as axonal vesicle transport. In order to only count the synapses into neuronal dendrites, the plug-in uses a triple criterion: two images with two different synaptic markers and the identification of the neuronal structure by immunostaining or by manual tracing. The analysis of big data volumes can be performed, without external interaction, by a batch job subroutine.

The comparative study using cultured rat hippocampal neurons, after manually and automatically counting, indicates a high reliability obtaining a counting error of less than 2% and a time saving among 90%.

Keywords

Synaptic density, algebraic topology