TITLE:

Present and Future of Artificial NeuroAstrocytic Networks

ABSTRACT:

Since the dawn of neuroscience, and for almost 100 years, information processing in the brain was attributed to neurons. Thanks to advances in imaging techniques and fluorescent markers, it was possible to prove that astrocytes, a type of glial cell, are also relevant for information processing [Araque, Parpura, Sanzgiri, & Haydon, 1999]. It is not yet known exactly what the interactions between neurons and astrocytes look like, nor when they take place, or through what mechanisms. What is known is that in areas of the brain where complex cognitive processes take place, such as the hippocampus or the cortex, "tripartite synapses" occur to process information, involving two neurons and an astrocyte.

From the point of view of Artificial Intelligence we have studied for the first time the influence of artificial astrocytes on information processing, through the construction of Artificial NeuroAstrocyte Networks that include artificial astrocyte modulation algorithms [Porto, Araque, Rabuñal, Dorado, & Pazos, 2007; Porto-Pazos et al., 2011; Pastur-Romay, Porto-Pazos, Cedron, & Pazos, 2015, Mesejo et al., 2015; Pastur-Romay, 2018]. In this way, Neuroscience and Artificial Intelligence come together, collaborating in their study and prospecting for progress. The confluence of both specialties takes place by extracting information on mechanisms of astrocytic modulation tested in laboratories in a replicable and refutable manner [http://www.cajal.csic.es/departamentos/araque-almendros/araque-almendros.html] as have been shown to be phenomena of potentiation, depression or effects on cannabinoid receptors induced by this type of glial cell for regulation of synapses. With each phenomenon to be simulated, a mathematical and computational model implemented in silico has been proposed, which has allowed to solve classification and regression problems.

ANAN (Artificial Neuron-Astrocytic Networks) have been compared with multi-layer artificial neuron networks (ANN). To carry out these tests, we have developed an opensource simulation tool for high performance computers, called Energlia [Cedron, 2019]. This tool allows, through a web access, to be used from any place and to optimize the memory management and increase the speed of execution and training, besides a simple interface that allows to introduce the data in a very intuitive way and without using complex commands.

In addition to the design of neuroglial algorithms that model different possibilities of astrocyte-neuron interaction/modulation, parallel networks of astrocytes and neurons such as those existing in the biological brain have also been designed [Blanco, 2015]. So far, significant improvements have been found in the accuracy of ANAN results with respect to NNAs, especially contrasted in classification problems, providing veracity, replicability and support to these studies, conceiving these findings as a guide stone for further research under the premise of a performance improvement with the introduction of astrocytes to classical artificial neuronal networks.

These algorithms can be easily transferred to solve, for example, medical problems for disease diagnosis, analysis of medical signals or images, home automation, security, object identification, etc. In short, provide a new method of machine learning that can facilitate data analysis in any area.

KEYWORDS:

Sinapsis tripartita; astrocito artificial; Red NeuroAstrocítica Artificial; Machine Learning, Neurociencia; Inteligencia Artificial.

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