EPSRC DTP PhD Research Project

Project Title: Improving Artificial Intelligence through Neuroscience

Primary Supervisor details: Joel Tabak j.tabak@exeter.ac.uk

https://medicine.exeter.ac.uk/people/profile/index.php?web_id=Joel_Tabak-Sznajder

Additional Supervisory team details:

Marc Goodfellow m.goodfellow@exeter.ac.uk

Department: Clinical and Biomedical Sciences (JT), Mathematics & Statistics (MG)
Location: Hatherly (JT), LSI (MG)

PhD Programme: PhD in Neuroscience

Project Description:

Neuroscience has been a major source of inspiration for modern Artificial Intelligence frameworks, such as Deep Networks, Reinforcement Learning, and Large Language Models. This project investigates how two recent Neuroscience developments could help improve Deep Networks.

The first development is the realisation in the last 20 years that a population of brain cells, astrocytes, have complex and coordinated responses to neural activity, and feedback onto neural activity. What is the effect of these neuron-astrocyte interactions on brain computations? We will explore the hypothesis that astrocytes provide a source of regularisation to neural networks. That is, they provide constraints to the networks, making them simpler and thus better able to generalise learned concepts to data they have not yet seen. We will also explore how simplifying Deep Networks can make them more explainable, and more resistant to injury.

The second development is the description of spontaneous, coordinated activity in developing networks. For instance, before eye opening there are spontaneous waves of activity on the retina, which drive synaptic plasticity in downstream brain structures, thalamus and visual cortex. So, before neural networks involved in visual processing “see” their first images, they have already been sculpted by spontaneous retinal waves. This means that the connections between neurons have an initial spatial structure. This could help develop new strategies for the initialisation of Deep Networks prior to training, which is

important because the initial connection weights of Deep Networks are critical for whether these networks can learn and how fast they can learn.

Implementing these Neuroscience-inspired strategies will lead to the development of better, more explainable, and less costly AI. This will also feedback to Neuroscience, providing testable hypotheses about the role of astrocyte cells and the role of early spontaneous activity in shaping neural networks.

For project specific enquiries please contact. Dr Joel Tabak - j.tabak@exeter.ac.uk