

Engineering and Physical Sciences Research Council Doctoral Landscape Award

PROJECT TITLE: Improving Artificial Intelligence through Neuroscience

Lead Supervisor Details:

Joel Tabak

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Additional Supervisor(s): Professor Marc Goodfellow, m.goodfellow@exeter.ac.uk (University of Exeter, Department of Mathematics and Statistics / Living Systems Institute)

Project details: 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 more 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 feed back onto neural activity. What is the effect of these neuron-astrocyte interactions on brain computations?

You 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. Concretely, you will add astrocyte-inspired regularisation rule to Deep Network training, and then test whether the resulting networks generalise better, are more resistant to injury, and are easier to explain than standard ones. 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. So, before neural networks involved in visual processing "see" their first images, they have already been sculpted by spontaneous retinal waves. In other words, the connections between neurons are not set randomly. This could help with initialisation of Deep Networks. Initial connection weights determines whether the networks can learn effectively and how fast they learn. Learning also requires a large amount of data, because of the large number of connection weights that need to be optimised through training. Drawing on what is known about these waves and the plasticity they drive, you will apply the resulting synaptic plasticity rules to initialise Deep Networks, and then determine if this speeds up learning and if less data is required to train the networks. Answering these questions will lead to the development of better, more explainable, and more sustainable AI.

Project specific entry requirements: A degree in Mathematics, Physics, Natural Sciences, Computer Science, Engineering or Neuroscience. Some programming experience (in any language) is expected. Previous experience of machine learning or of Neuroscience is welcome but is not required, as training will be provided in both.

Potential PhD programme of study: PhD in Neuroscience



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Department: Clinical and Biomedical Sciences

Location: Brain Health Hub, Hatherly Building (Streatham Campus) and Living Systems Institute (Streatham Campus)

Please direct project specific enquiries to: Dr Joel Tabak, j.tabak@exeter.ac.uk

Please ensure you read the entry requirements for the potential programme you are applying for.

To Apply for this project please click on the following link - [APPLY HERE](#)



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