**Computational Modelling of Homeostatic Plasticity Mechanisms for Functional Recovery of Neuronal Networks after Peripheral Lesions**

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Plasticity mechanisms in the brain are essential for learning, memory formation, repair, and functional recovery after disruption. More specifically, synaptic plasticity refers to the ability of existing synapses to adapt their strengths, whereas structural plasticity involves the formation or removal of synaptic connection or neurons. Structural plasticity can restore neural activity in response to disruptions such as peripheral lesions.

To study the relationship between synaptic and structural plasticity and network repair, Sinha et al. [1] have recently developed a computational model of peripheral lesioning and proposed neuronal growth rules for network rewiring after deafferentation. The proposed project involves the further development and extension of this work to investigate potential mechanisms that can improve network repair and recovery of function after the peripheral lesions.

Sinha and collaborators found that (i) both homeostatic structural and synaptic plasticity contribute to repair after a lesion, (ii) the repaired state did not return to the pre-lesion state because of increased coupling between neurons, and (iii) the ability of the network to recall previously stored associative memories deteriorated after rewiring due to changes in network connectivity.

The project will build on the Sinha model and investigate topics that could include:

1. Factors that can contribute to improved network repair and functional recovery, in particular, with respect to associative memory and pattern recognition.
2. Formal approaches to analysing the rewired networks and the repair process, potentially using simplified mathematical models and/or topological data analysis.
3. More detailed multi-compartmental / morphological neuronal models to investigate cellular mechanism that affect the neuronal growth rules and the repair process.

**Supervisory Team**

Dr Muhammad Yaqoob (University of Hertfordshire, UK), Dr Ankur Sinha (University College London, UK), Dr Christoph Metzner (Technical University Berlin, Germany), Prof Volker Steuber (University of Hertfordshire, UK)

**Candidate Specification**

The project will be conducted in a multidisciplinary environment. The candidate should have a strong technical background in computational neuroscience, computer science, physics, maths, engineering, neuroscience or a related discipline and good mathematical and programming skills.

**Reference**

[1] Sinha, A., Metzner, C., Davey, N., Adams, R., Schmuker, M., & Steuber, V. (2021). Growth Rules for the Repair of Asynchronous Irregular Neuronal Networks after Peripheral Lesions. *PLoS Computational Biology*, *17*(6), e1008996. https://doi.org/10.1371/journal.pcbi.1008996