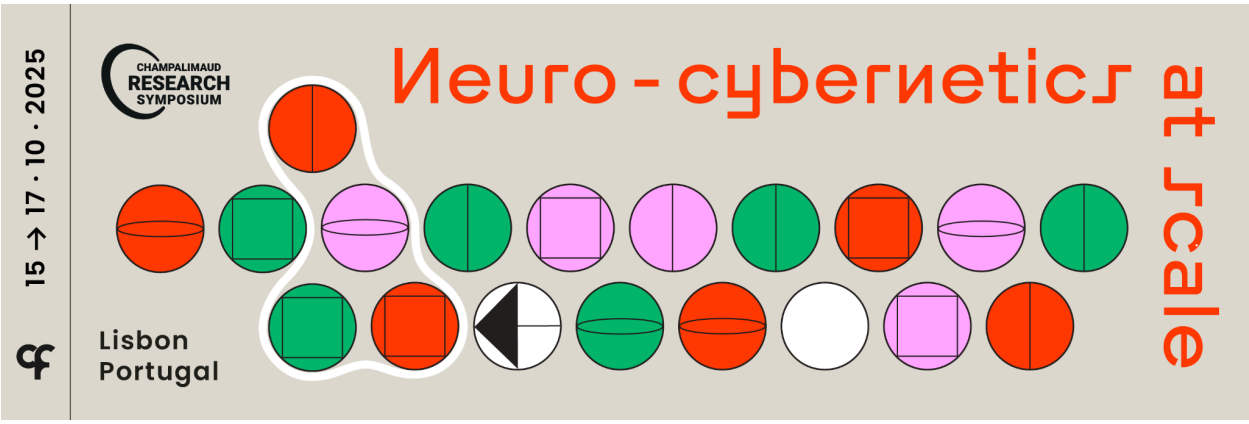

Towards a Disease Model of Cerebellar Ataxia Using Supervised Learning

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The cerebellum is believed to use a forward supervised learning approach to guide motor control and learning [1]. While the circuitry of the cerebellum has been well researched, there remains questions of how the cerebellum performs a wide range of computations, and how changes in these computations map to cognitive and motor dysfunction. We model the cells of the cerebellum using a recurrent neural network (RNN) [2], to then drive a cortical RNN [3] in control of a simple 2-joint arm model. We start with a fully functioning model that is able to achieve task specific movement while receiving time dependent input regarding the state of the arm. We aim to build a disease model of ataxia, a motor disorder marked by a lack of control over voluntary behavior, such as unwanted trembling of the limbs or uncoordinated movement. It is associated with unusual cerebellar activity, specifically of the purkinje cells (PCs), the sole output cells of the cerebellar cortex. Proposed sources of ataxia are changes in the intrinsic firing rate of PCs [4], and damage at the PC and climbing fiber (CF) synapse [5]. CF inputs signal error and induce complex spiking of the PCs, altering cerebellar output and influencing the resulting motor behavior. Towards modeling ataxia, we implement changes in intrinsic firing of the PCs in the cerebellar RNN by altering the bias term of the PC units while the model is attempting to perform previously learned tasks. We represent damage at the CF-PC synapse by modifying the strength of connections between PC and CF units, interrupting the flow of hypothesized error signals to the PCs, as the cerebellar network works to learn a task.This implementation is a step towards developing a model of cerebellar activity capable of producing ataxic patterns of movement in models of the limbs, guiding therapeutic efforts for cerebellar ataxia.

ataxia, cerebellum, motor disorder, supervised learning