**Advancing Human Purkinje Cell Model**

Cerebellar Purkinje cells (PCs) are the sole output of the cerebellar cortex and play a critical role in encoding sensory and motor information with remarkable precision. Their dendritic calcium spikes, triggered by clustered parallel fiber activation, are essential for synaptic plasticity and information processing. Despite their significance, computational models of PCs have focused exclusively on rodent data. Human PCs, however, exhibit unique morphological and functional features, including higher dendritic complexity, increased input thresholds for action potential generation, and a greater prevalence of multiple dendritic trunks, particularly in regions associated with cognitive processing. These species-specific differences remain unexplored, limiting our understanding of human cerebellar function.

I will build upon the work of Prof. Erik De Schutter’s lab in developing a human Purkinje cell model. Using the NEURON simulation environment, I will integrate calcium dynamics to eliminate current problems of the model, analyze the firing rate-current relationship, and investigate the influence of human-specific dendritic trunk morphologies on firing patterns and multiplexed coding. My work will focus on localized dendritic calcium spikes, their branch-specific generation, and their role in synaptic plasticity and cerebellar information processing.

This refined model will advance our understanding of human Purkinje cell function, providing insights into the functional consequences of morphological diversity and calcium dynamics. It will also establish a platform for studying neuropathologies associated with calcium channel dysfunction, such as ataxia, epilepsy, and migraines, bridging the gap between rodent models and human cerebellar physiology.

References:

1. Cirtala, G., & De Schutter, E. (2024). Branch-specific clustered parallel fiber input controls dendritic computation in Purkinje cells. <https://doi.org/10.1016/j.isci.2024.110756>
2. Zang, Y., & De Schutter, E. (2021). The Cellular Electrophysiological Properties Underlying Multiplexed Coding in Purkinje Cells.  https://doi.org/10.1523/JNEUROSCI.1719-20.2020