

Understanding direction selectivity of dendrites in pyramidal cells

Dendrites are the main input site of cortical pyramidal cells. It was shown in [1] that dendrites in cortical pyramidal cells can discriminate spatio-temporal patterns of synaptic inputs. In [2], this was further studied and it was proposed to utilize this capability in technical applications based on energy-efficient neuromorphic systems.

The goal of this project is to understand this mechanism, perform further simulations and tests, in order to lay the foundation for further investigations (not necessarily part of the project) on plasticity mechanisms that could enhance this feature of dendrites.

In [2], simulations in Mathematica are provided (code is available) that models this phenomenon. The simulations should be implemented in Python and extended.

[1] Branco, T., Clark, B. A., & Häusser, M. (2010). Dendritic discrimination of temporal input sequences in cortical neurons. *Science*, 329(5999), 1671-1675.

[2] Boahen, K. (2022). Dendrocentric learning for synthetic intelligence. *Nature*, 612(7938), 43-50.

Goals & Tasks

- Understand the publications [1] and [2].
- Implement the mechanism in Python.
- Explore the mechanism to obtain a deep understanding of it.
- Perform further simulations to test specific properties of the model.

Qualifications

- Interest in computational neuroscience.
- Experience with Python.
- Registered to one of the following:
 - ✓ **Bachelor Thesis**
 - ✓ **Seminar Project**

Contact

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