ReScience

[Re] Connectivity reflects coding: a model of voltage-based STDP with homeostasis

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Competing Interests:
The authors have declared that no competing interests exist.

Article repository

Code repository

A reference implementation of

→ Connectivity reflects coding: a model of voltage-based STDP with homeostasis, C. Clopath, L. Büsing, E. Vasilaki and W. Gerstner, In: Nature Neuroscience 13.3 (2010), pp. 344–352, doi= 10.1038/nn.2479

Introduction

Since the first describing of spike timing-dependent plasticity (STDP) [1], different description of STDP are published to reproduce different experimental findings. The early implementations, so called pair-based STDP learning rules, failed on reproducing some experimental observations, like from triplet or quadruplets experiments [3].

Here, we introduce a reimplementation of the Clopath et al. [2] STDP model, what is enable to reproduce experimental findings of triplet studies. The proposed model try to be more biological plausible than previous models with a theoretical approach, to be a voltage based STDP model. This means, that the occur of long term depression (LTD) or long term potentiation (LTP) depends on the postsynaptic membrane voltage. Clopath and colleagues could show that their learning rule can develop stable weights, as it is necessary for learning receptive fields of V1 simple cells. To achieve stable weights, they implemented a homeostatic mechanism to adjust the amount of generated LTD, over the relation between the average postsynaptic membrane potential and a reference value. Furthermore, their model lead to two different connection structures, depending on the spiking behavior of the neurons [2]. If neurons fire high at the same time, they build strong bidirectional connections (rate code). If neurons fire in a specific temporary order, they connection structure follow that order (temporal code). They used a adaptive exponential integrate-and-fire (AdEx) neuron model.

Their model is reimplemented in Python (v2.7) and with help of the neuronal simulator ANNarchy [4] (v4.6). For the analysis and the figures we used numpy (v1.11.0) and matplotlib (v1.5.1). Not only the voltage based STDP learing rule is reimplemented, even the AdEx neuron model. In the supplementary material of the original publication is the matlab source code for a simple example published. Besides them, it exists a matlab implementation to demonstrate the stable learning of weights on modeldb (http://modeldb.yale.edu/144566). The matlab implementation was used as a reference for the here presented one, and used for evaluation of the correctness.

Figure 1: Figure caption for Free!

Methods

The methods section should explain how you replicated the original results:

- did you use paper description
- did you contact authors ?
- did you use original sources ?
- did you modify some parts ?
- etc.

If relevant in your domain, you should also provide a new standardized description of the work.

Results

Results should be compared with original results and you have to explain why you think they are the same or why they may differ (qualitative result vs quantitative result). Note that it is not necessary to redo all the original analysis of the results.

Conclusion

Conclusion, at the very minimum, should indicate very clearly if you were able to replicate original results. If it was not possible but you found the reason why (error in the original results), you should explain it.

Table 1: Table caption

Heading 1			Heading 2		
cell1 row1	cell2 row 1	cell3 row 1	cell4 row 1	cell5 row 1	cell6 row 1
cell1 row2	cell2 row 2	cell3 row 2	cell4 row 2	cell5 row 2	cell6 row 2
cell1 row3	cell2 row 3	cell3 row 3	cell4 row 3	cell5 row 3	cell6 row 3

A reference to table 1. A reference to figure 1. A reference to equation 1.

$$A = \sqrt{\frac{B}{C}} \tag{1}$$

References

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