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A mathematical metaplasticity model to stabilize spike timing-dependent plasticity. ZEYUAN WANG, LUIS CRUZ, Drexel University — In the brain, neurons are connected through neural networks that propagate signals in the form of voltage spikes. An important open question in biophysics is how the brain learns. Spike timing-dependent plasticity is a learning rule that is widely found in the brain. This rule is crucial for understanding how the brain learns and building efficient and functional artificial spiking neural networks. However, recent computational studies have shown that it has intrinsic run-away dynamics, causing the strengths of the connections to diverge. Here we aim to study how to stabilize it in a single neuron. We build a mathematical model based on a biological mechanism called metaplasticity, which modifies the speed and conditions of learning rules. This model includes negative feedback dynamics to balance the potentiation and depression of the strengths of connections. With this model, a single neuron fed with repeated input patterns in random order can achieve stable strengths of connections and produce stable output patterns. Our results indicate that spike timing-dependent plasticity can be stabilized with the mathematical metaplasticity model. Future research will address the behavior of this stabilized spiking timing-dependent plasticity in the context of a neural network.

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