Meta-learning synaptic plasticity rules to approximate gradient descent

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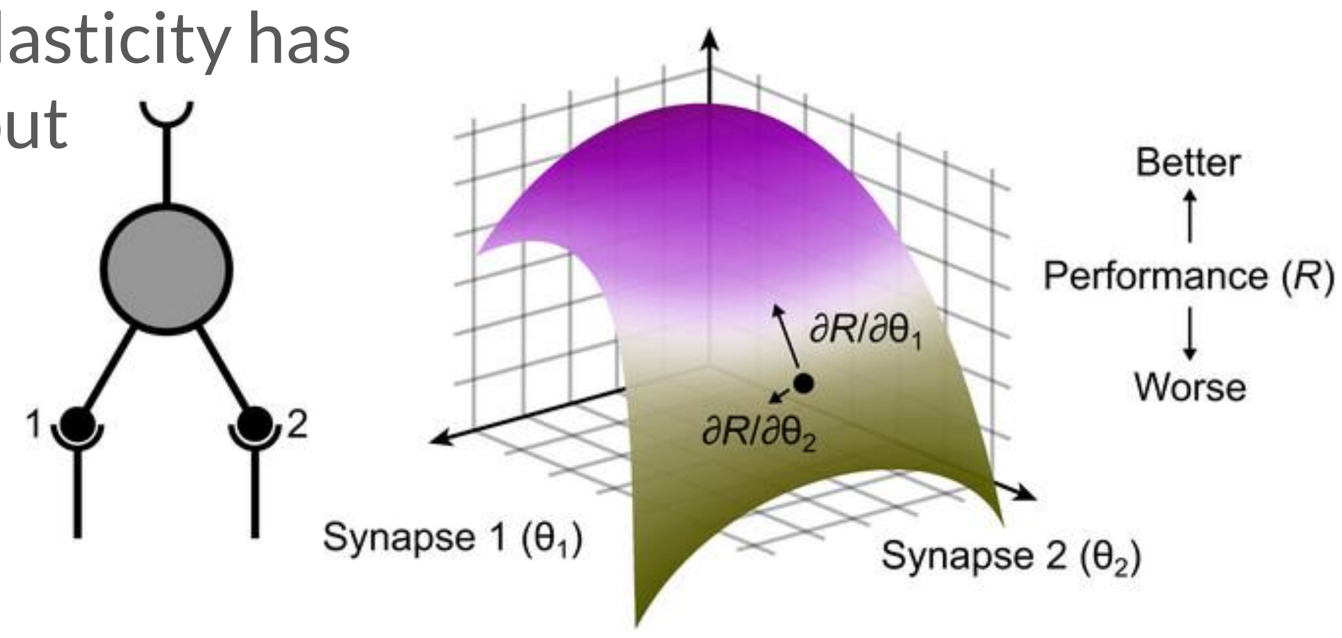
Abstract

- Evolution derives learning mechanisms that are easily interpretable by humans? Probably **not**
- We *meta-learn* synaptic plasticity rules with many degrees of freedom and explore how gradient descent (**GD**) can best be approximated
- Our method can solve non-trivial problems with GD-like performance

Introduction

- The study of plasticity has always been about **gradients**!

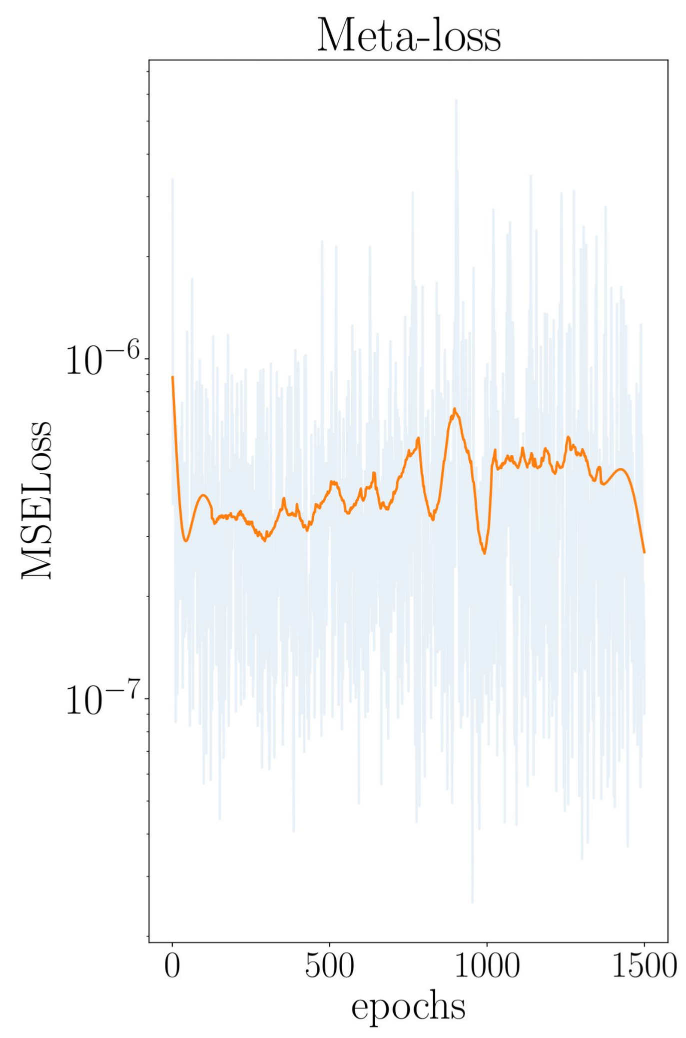
Richard & Kording, 2023

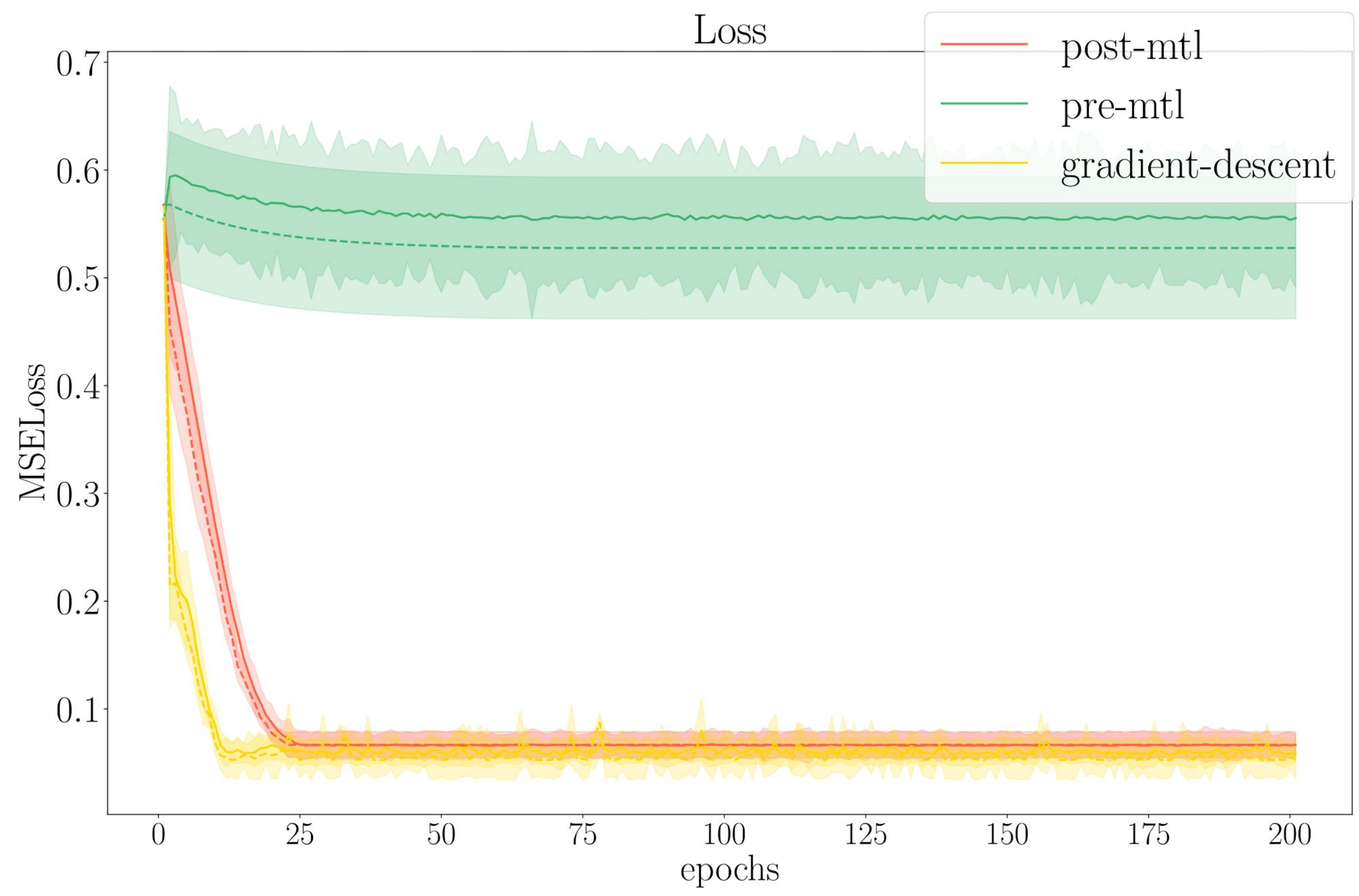


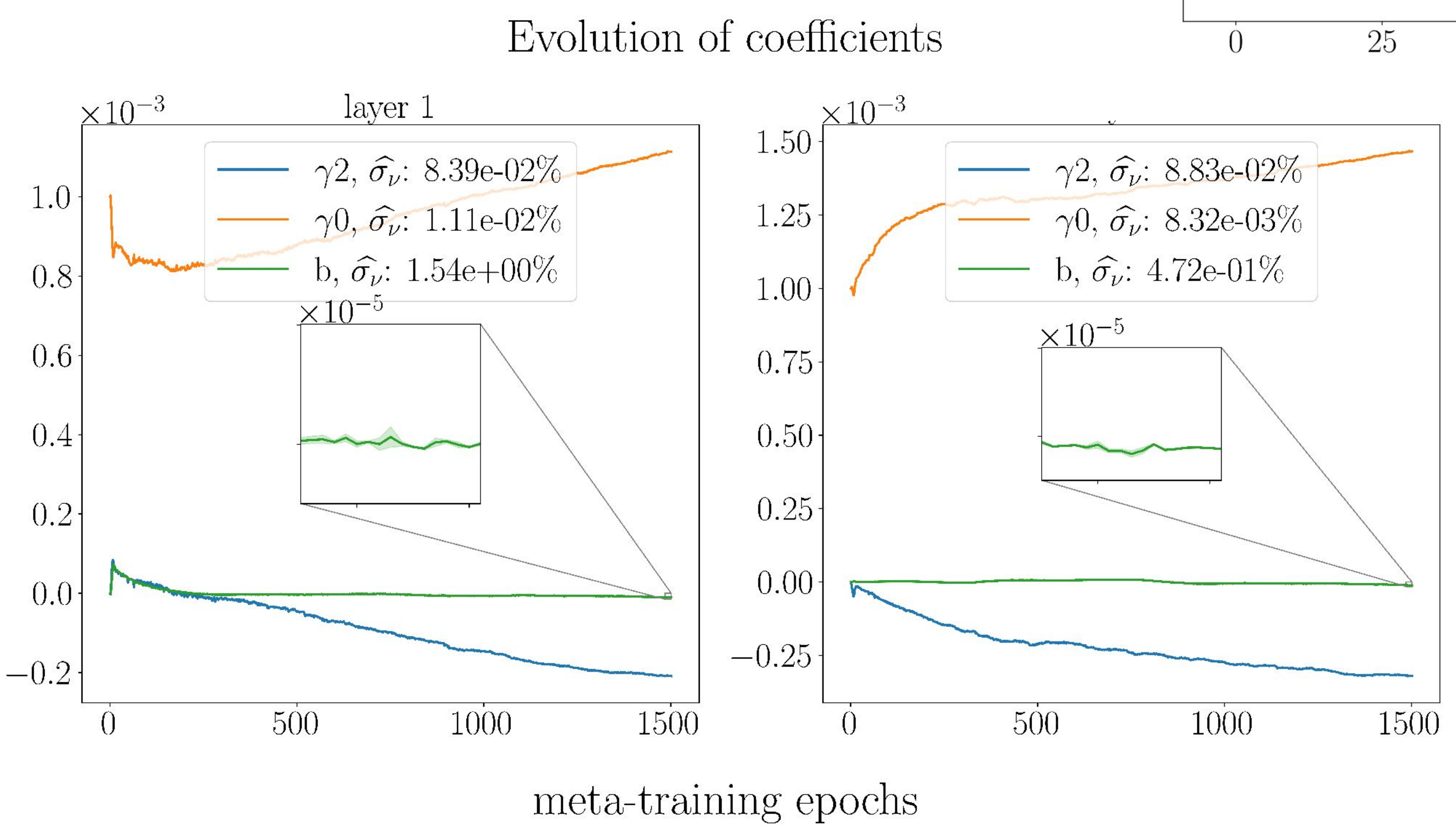
- Can we optimize **Hebbian** learning rules to approximate **GD**? 🤔

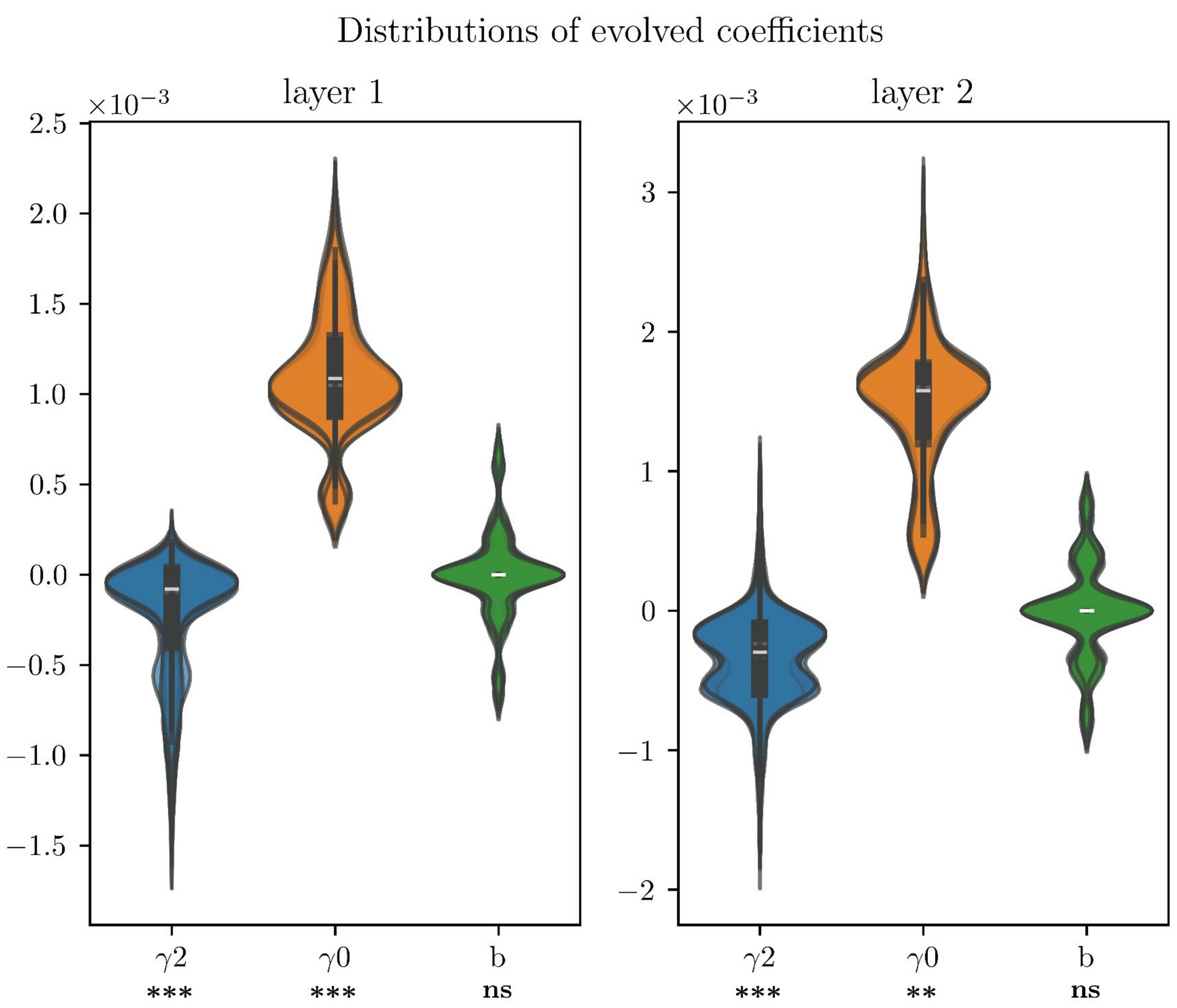
$$\frac{d}{dt}w_{ij} = \gamma_2(1 - w_{ij})v_i v_j - \gamma_0 w_{ij} + b$$

Results









Conclusions

- Optimized Hebbian plasticity **can** approximate GD without backward passes during the training phase
- Conditions:
  - unique set of coefficients per synapse
  - *slight* deviation from mean
- Biological *interpretation*: compensation for the lack of **useful** neuronal heterogeneity

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