Model-based analysis of neurobiological data to study the representation of natural features

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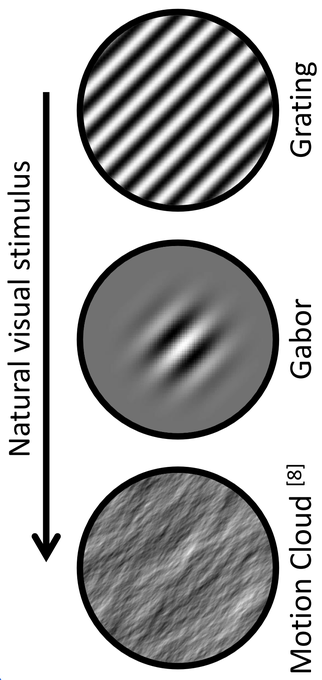
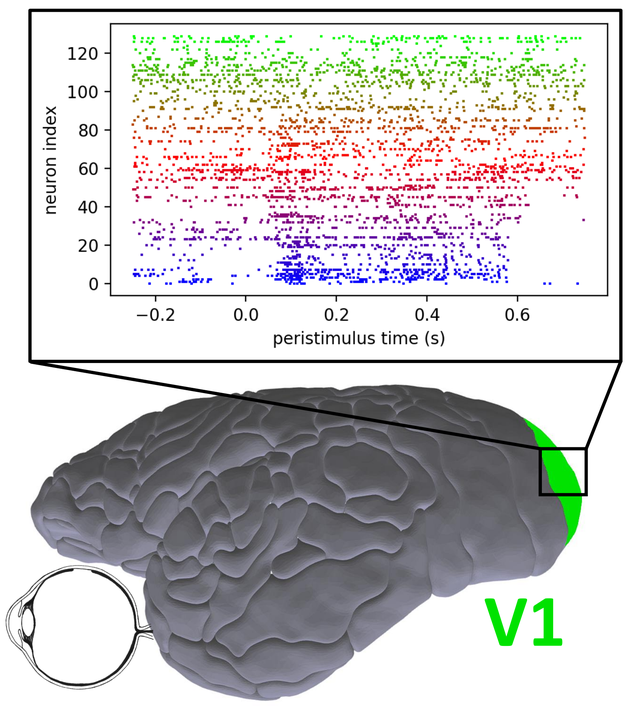
Introduction





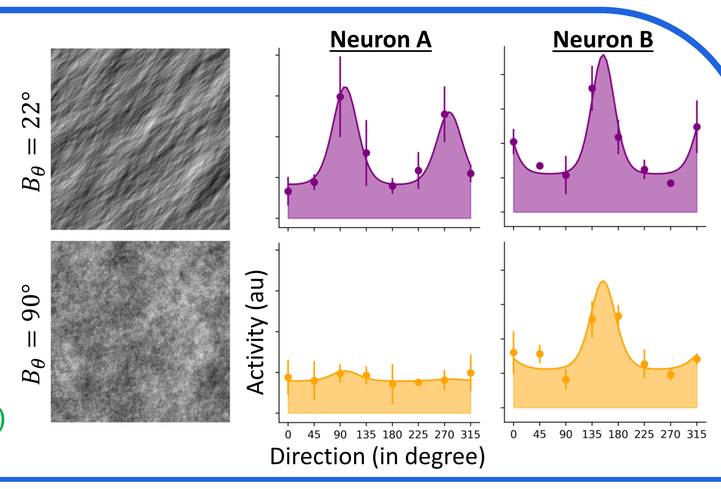
Encoding model

Predicting neuronal activity as a function of stimulus **parameters**

$$\text{fr} = \text{level activity} \times \text{direction selectivity}$$

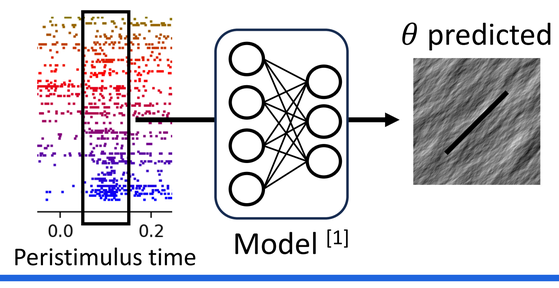
$$\text{level activity} = R_0 + (R_{\max} - R_0)$$

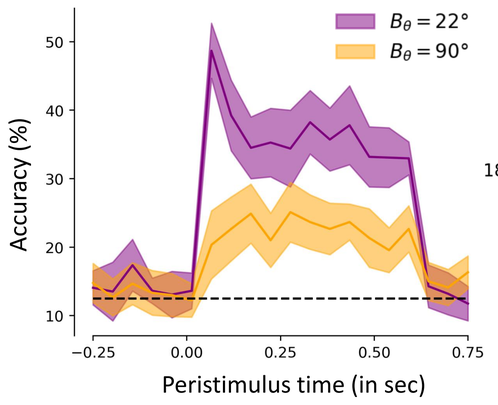
$$\text{direction selectivity} = \exp \kappa_\theta\left(\cos\left(2 \times (\boldsymbol{\theta} - \theta_0)\right) - 1\right) + \kappa_\phi \left(\cos(\boldsymbol{\theta} - \theta_0) - 1\right)$$

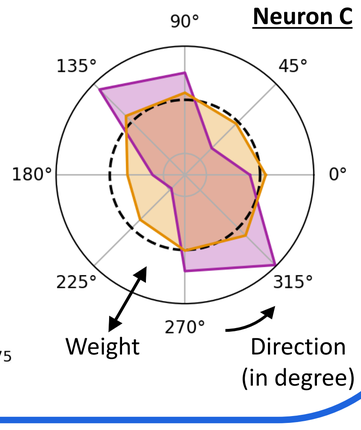


Decoding model

Predict stimulus parameters based on **neuronal activity**



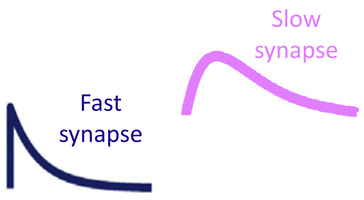




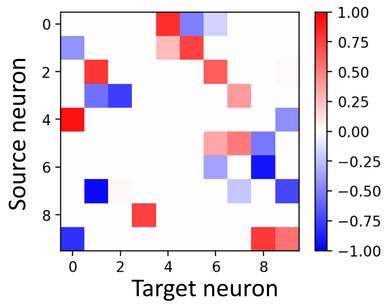
Project

Encoding model

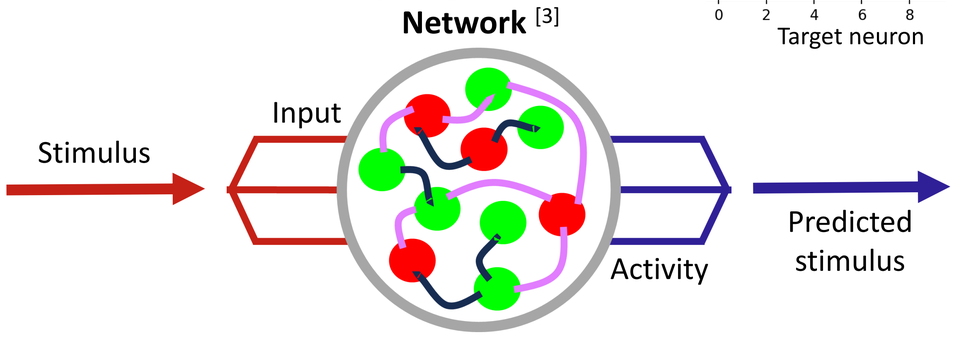
Synaptic diversity [3]



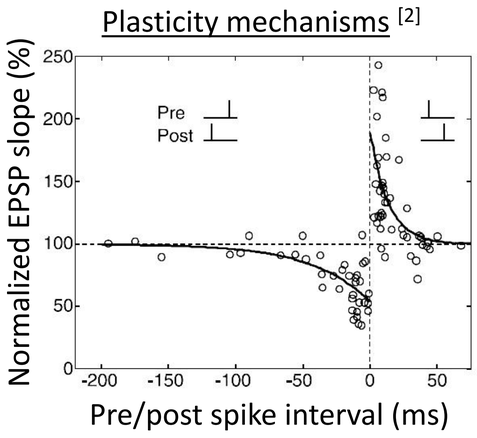
Sparse connectivity



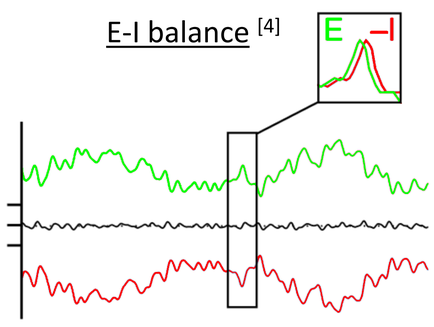
Spiking Neuronal Network [3]

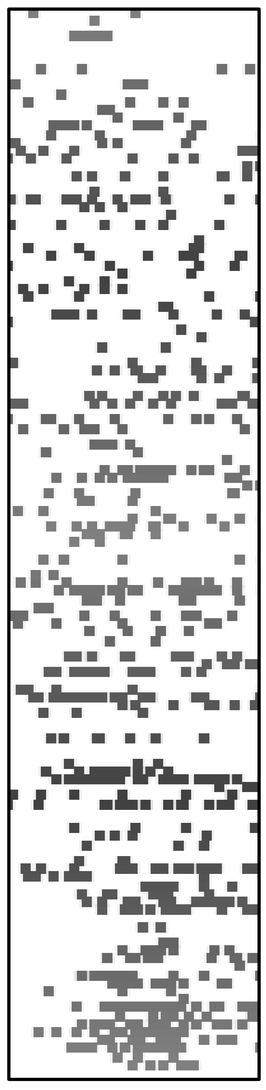


Plasticity mechanisms [2]

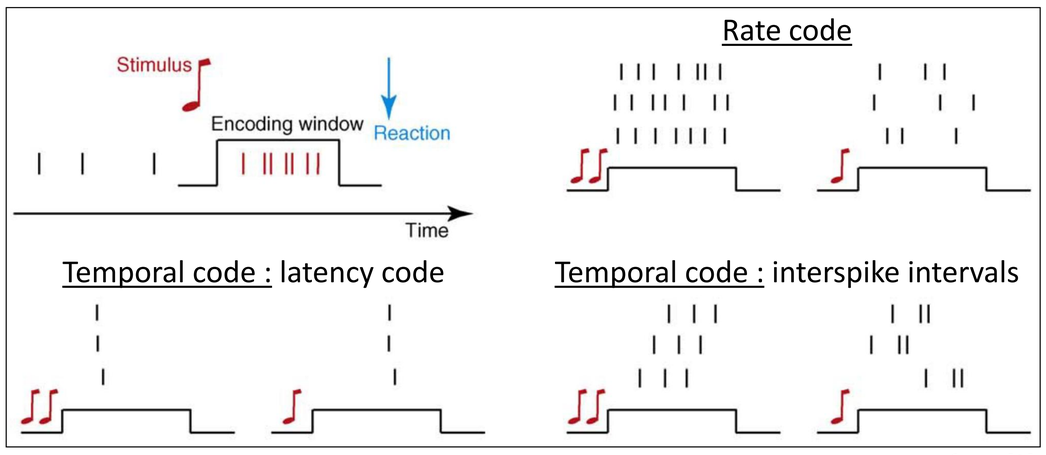


E-I balance [4]



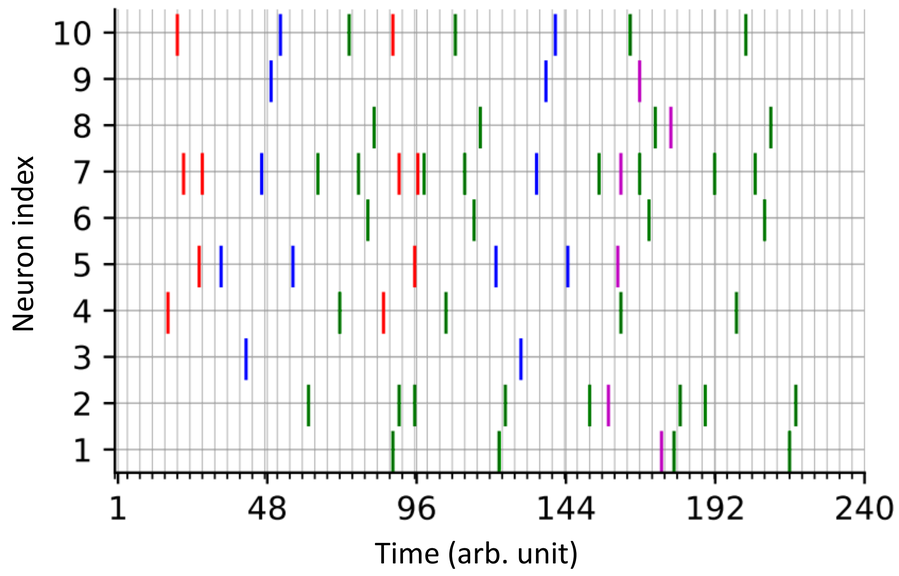


Decoding model



from [9]

Pattern detection [5]



Develop an encoding model that is **biologically plausible** and whose result is close to a **natural activity**.

Develop a population decoding model to test various **code hypotheses**, such as the existence of **spatio-temporal patterns**.

Goals

1. Explore representations of information and hypothesise about the underlying mechanisms. [6, 7]
2. Developing new methods for analysing large-scale brain recordings.
3. Maintain the explicability of the analysis and avoid all the black-box models.

References

[1]. Berens et al., 2012
[2]. Bi & Poo, 1998
[3]. Denève et al., 2017
[4]. Denève & Machens, 2016
[5]. Grimaldi et al., 2022
[6]. Hénaff et al., 2020
[7]. Ladret et al., 2023
[8]. Leon et al., 2012
[9]. Panzeri et al., 2010

Bibliography

GitHub