Data-driven deep neural network models of visual processing in Drosophila

DNN models to predict visual projection neurons

- Visual projection neurons in fruit flies form a bottleneck, transferring most visual information to the central brain.
- This study aims to evaluate how well deep neural networks (DNNs), trained on actual neural responses, can predict these responses.
- DNNs can make predictions, but more diverse stimuli are needed to effectively differentiate between models.





We consider three model classes



Jonathan Skaza¹, Erin Wong², Arie Matsliah³, Benjamin Cowley¹ ¹Cold Spring Harbor Laboratory, Cold Spring Harbor, NY, USA, ²Great Neck South High School, Lake Success, NY, USA, ³Princeton Neuroscience Institute, Princeton University, Princeton, NJ, USA

true calcium

time →

predicted

time \rightarrow

LC15 LC4 0.5 overall held-out R² 0. one model • 100k params 500k params 0.3 • 1m params 0.2 0.1 blackbox connectome-inspired strf

spatiotemporal filters



at time t

Nern, A., et al. Connectome-driven neural inventory of a complete visual system. *bioRxiv* (2024). Stadele, C., et al. Non-canonical Receptive Field Proper- ties and Neuromodulation of Feature-Detecting Neurons in Flies. Current Biology, 30(13), 2508-2519.e6 (2020). Turner, M. H., et al. Visual and motor signatures of locomotion dynamically shape a population code for feature detection in Drosophila. eLife, 11, e82587 (2022).