Neural Likelihood

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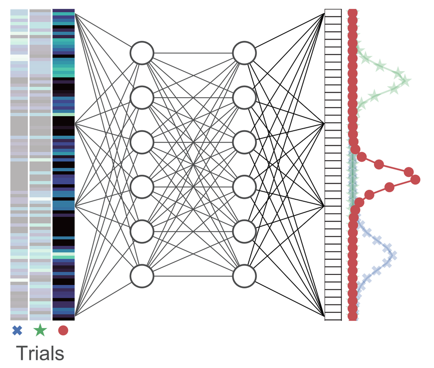
Introduction

- Perceptual decision making in humans and animals accounts for the uncertainty in the relevant stimulus variable
- The likelihood over the stimulus captures the uncertainty for a fixed neuronal response
- Full likelihood estimation can be challenging due to high dimensionality
- Previously used parametric models make **strong assumptions** about the form of the noise correlations
- We present a simple (yet general) neural network based method that makes **fewer assumptions** about the form of the likelihood function

Method

Our method relies on two key steps:

1. Recover an unnormalized likelihood from a model of the posterior using the known prior
2. Estimate the posterior using a neural network

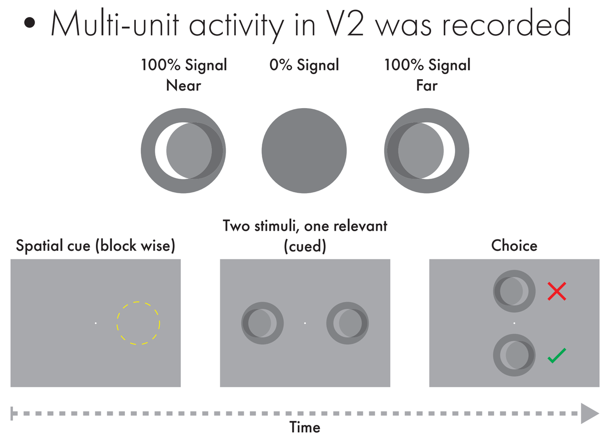


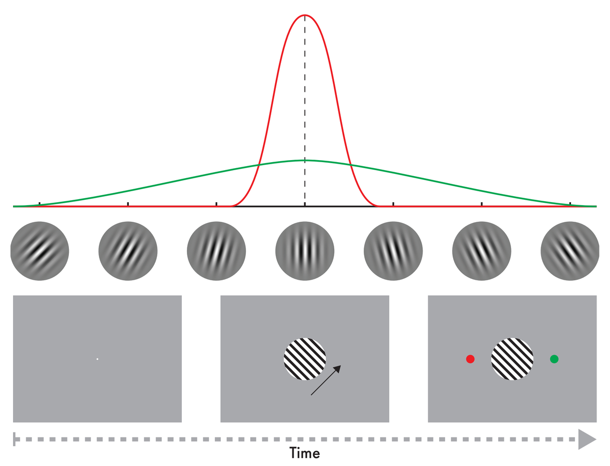
Discrete Stimulus

Continuous Stimulus

Experiments

- Monkeys classified trials into near or far, based on the predominantly occurring disparity in a random sequence of disparities.
- Multi-unit activity in V2 was recorded





- Monkey classified orientations as drawn from category 1 or 2 of known distributions.
- Contrast of stimulus was varied from trial to trial
- Multi-unit activity in V1 was recorded

Models

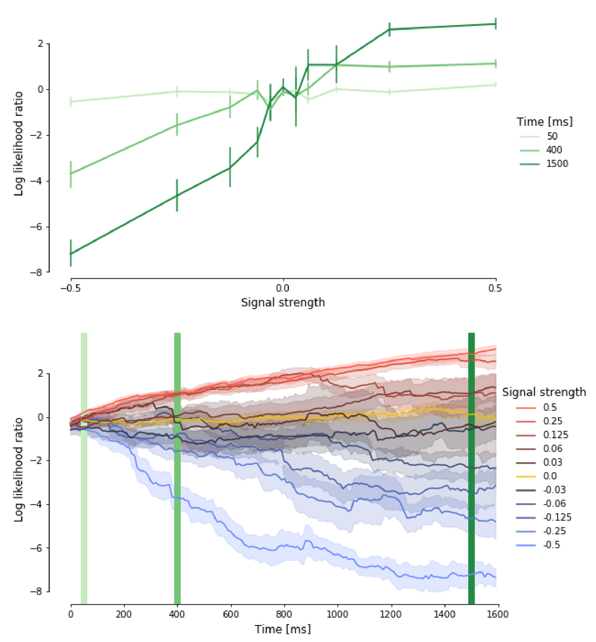
- Single-layer gated recurrent unit
- Same linear readout at each time step
- Initial hidden state is learned

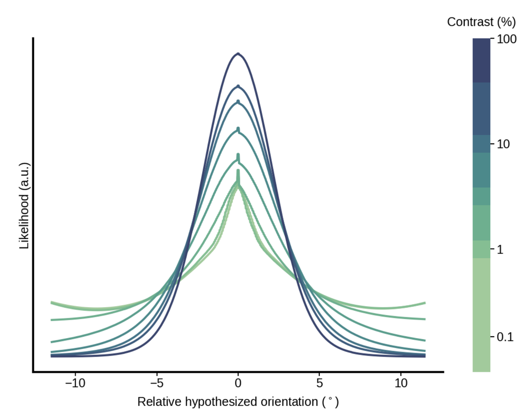
- Flow model

Results

Evidence for particular class increases...

- ...over time
- ...with higher signal strength



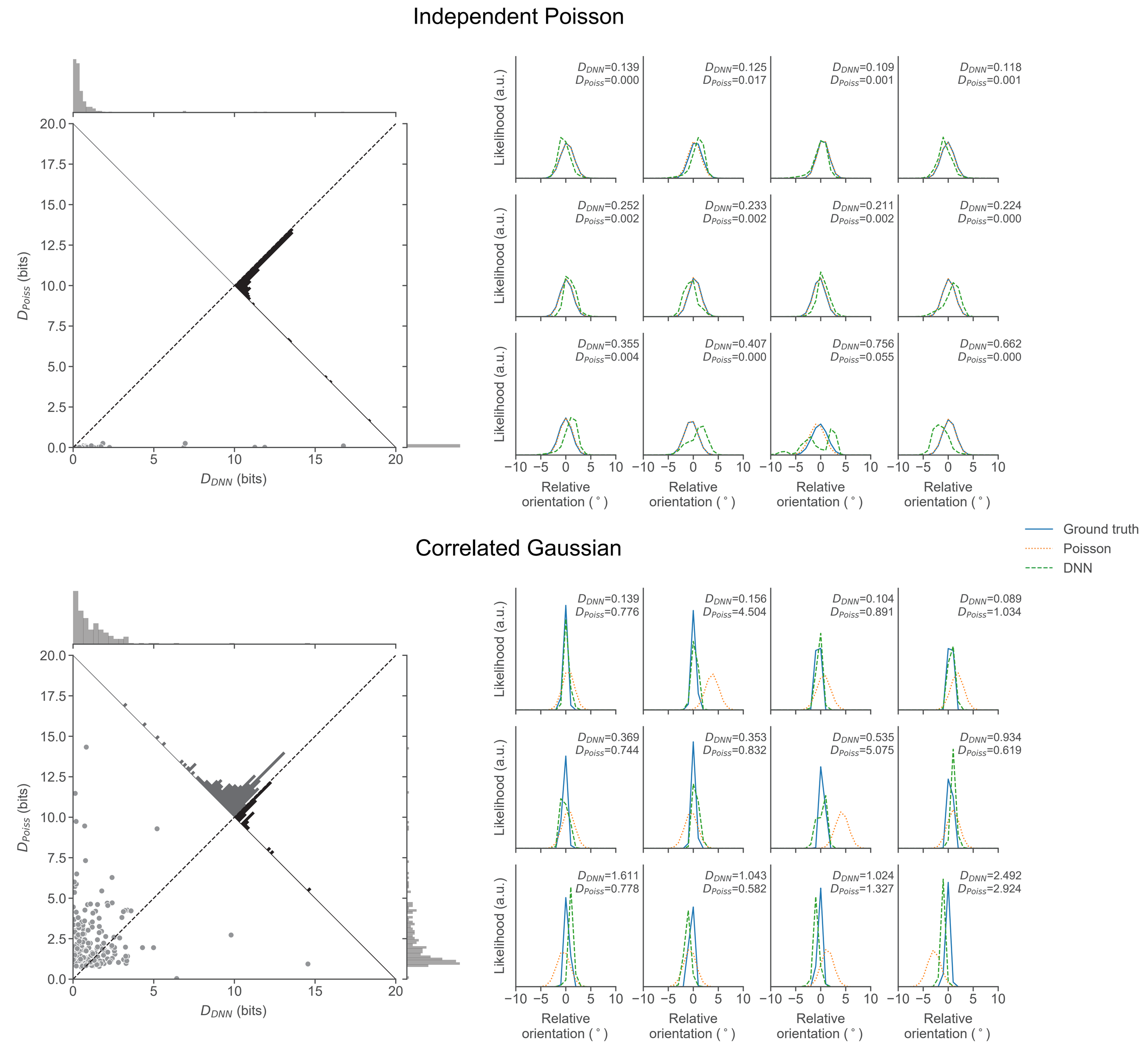


- For low contrast the uncertainty about the stimulus is higher so the likelihood curves become wider

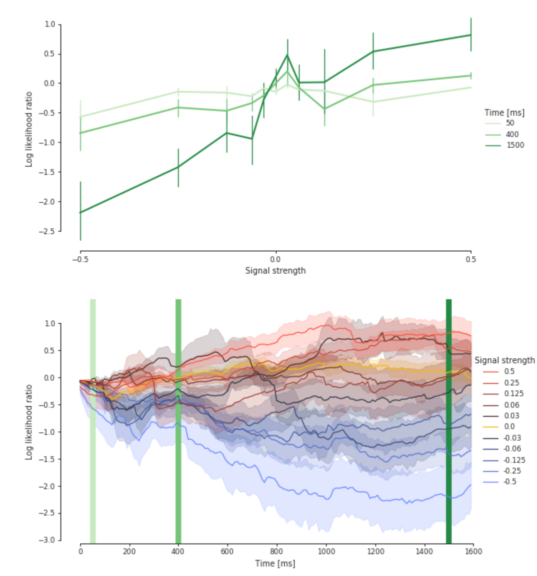
Deep-learning based likelihood decoders for perceptual decision making make **fewer assumptions** about the form of the likelihood function.

Take a picture to download the **full paper**

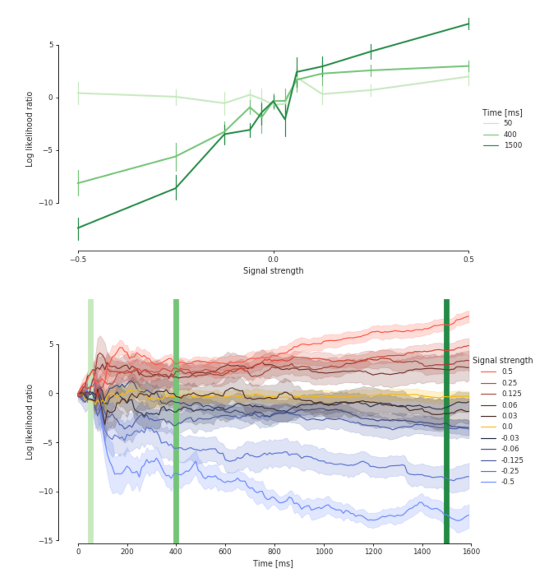
Toy Data



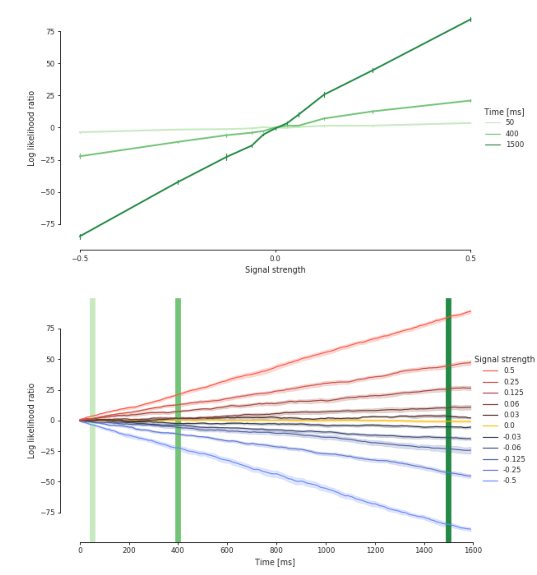
Different Readouts



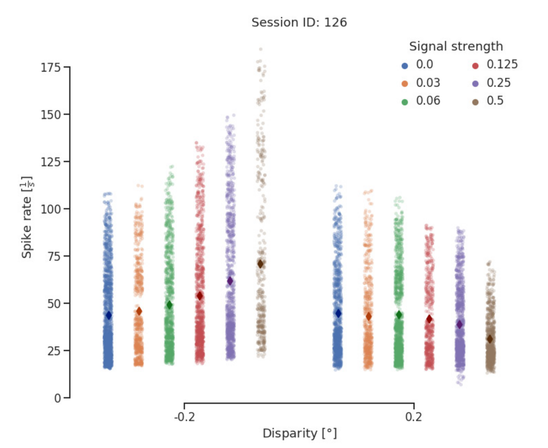
Logistic Regression



Ideal Observer



Spike Rate Analysis



Acknowledgements

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