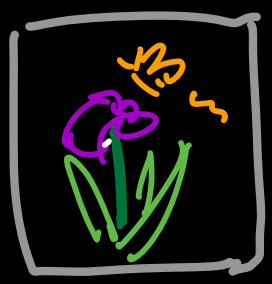
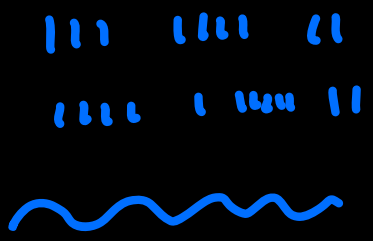
some common problems in neuroscience =





perception

behavior

decision making

stimuli

neural response

... ...

P1. (45 min)

An example experiment,

some typical data,

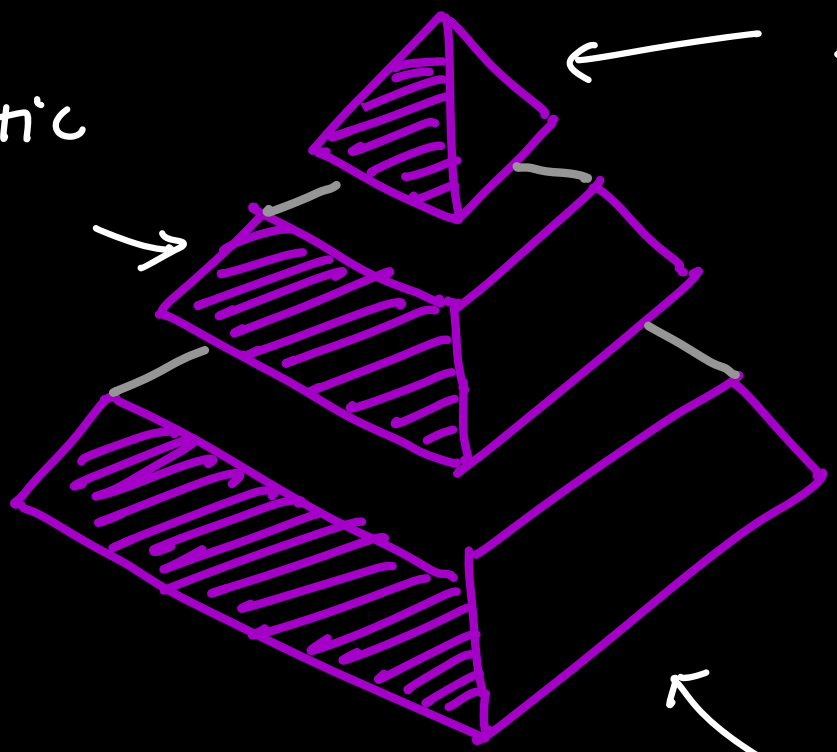
and some explorations.

P2. (45 min)

A classic model

for neural encoding

The model Universe =



interpretive, explanatory
- : "WHY?"

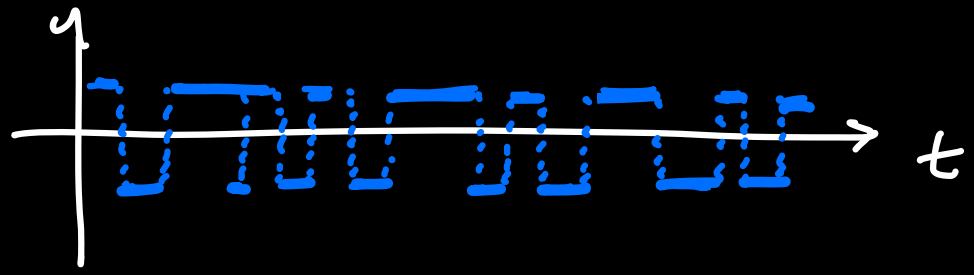
mechanistic
- : "HOW?"

descriptive =
- : "WHAT?"

today

Question Today:

x stimulus intensity



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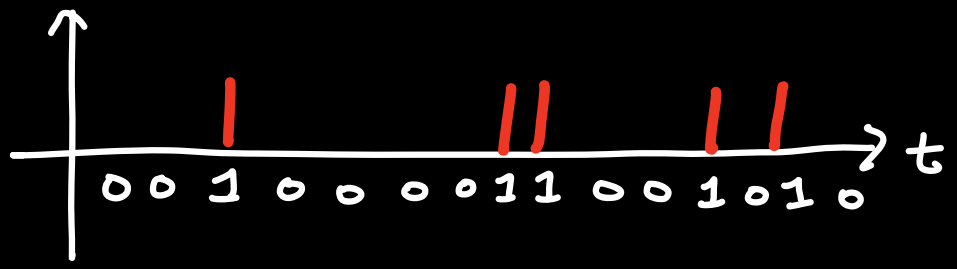
y retinal ganglion cell spikes

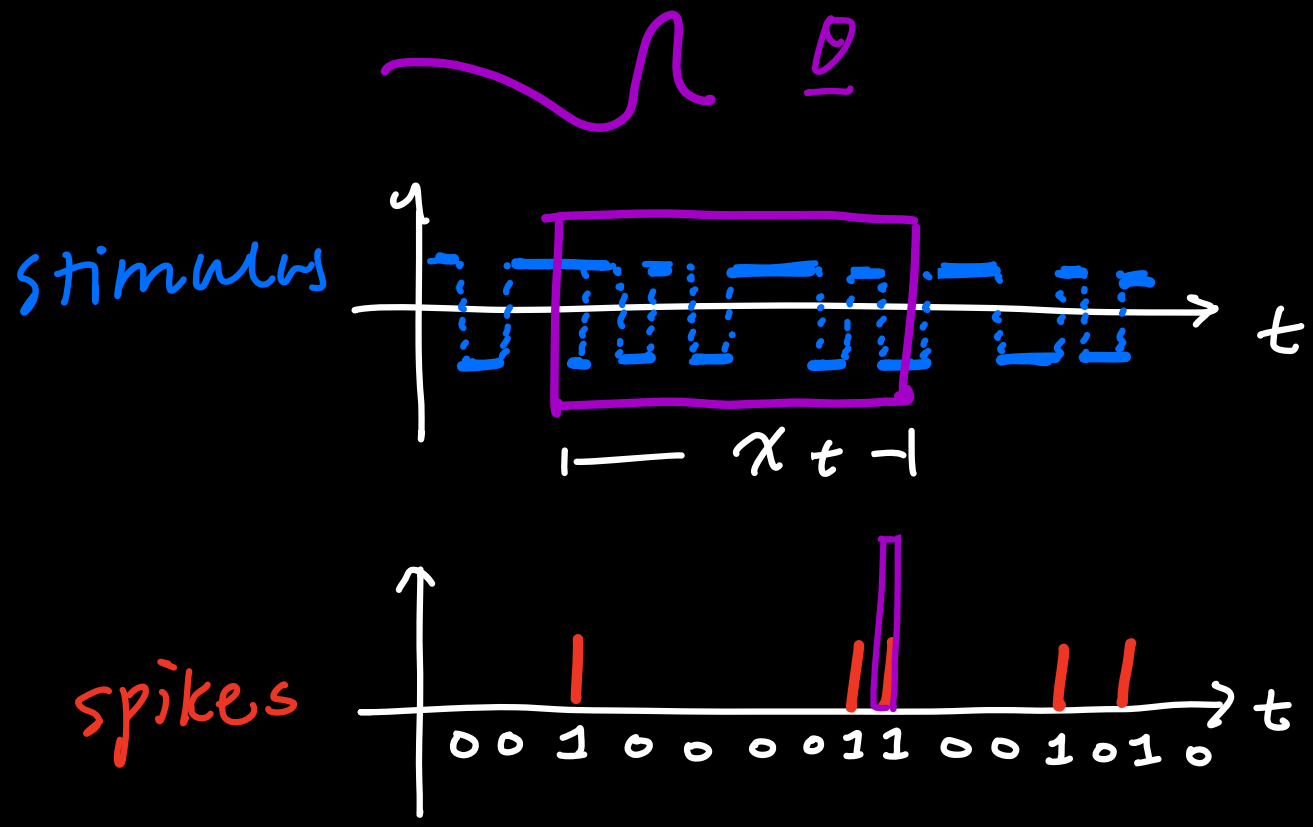


What's the cell activity given the stimulus intensity preceding it?

Proposed "WHAT" model:

A temporal filter!

- λ: firing rate
- y: spike
- η: Gaussian noise.



$$\lambda_t = \underline{\theta}^{\top} \underline{x}_t$$

$$y_t = \lambda_t + \eta_t$$

In equations, $\underline{y} = X\underline{\theta} + \underline{\eta}$ (linear model)

$$\begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \\ \vdots \end{bmatrix} = \begin{bmatrix} \sqcap\sqcap\sqcap\sqcap \\ \sqcap\sqcap\sqcap\sqcap \\ \vdots \end{bmatrix} \begin{bmatrix} \theta_1 \\ \theta_2 \\ \vdots \end{bmatrix} + \begin{bmatrix} \eta_1 \\ \eta_2 \\ \vdots \end{bmatrix}$$

$\leftarrow$ window $\rightarrow$ size

$\eta \sim \mathcal{N}(0, \sigma^2)$

$$\theta^* = \arg\max_{\theta} \log \mathcal{L}(\theta \mid X, y)$$

$$\rightarrow \theta^*_{MLE} = (X^T X)^{-1} X^T y$$

But spike noise isn't Gaussian!

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non-negative, discrete

↓

we need GLMs (Generalized Linear Model)