Thanks to Profs Brent Doiron and Adrienne Fairhall For many of these slides and images!! Tuning curve: r = f(s)



Gaussian tuning curve of a cortical (V1) neuron

How repeatable is response across trials?



Coarse potential



Carandinni PLoS Bio. 2004

How repeatable is response across trials?



Coarse potential







define window of length T

Trial 1





mean across trials $(n) = mean_T$ variance across trials $(n) = var_T$ FANO FACTOR $F_T = \frac{var_T}{mean_T}$

In vivo responses are very unreliable



Fig. 1.14, Abbott and Dayan: Responses from MT visual neurons (O'Keefe et al '97)

Code-break: run generate_simple_spiketrain.m from website compute Fano for Poisson process numerically

Boardwork: compute fano factor for Poisson process

In vivo responses are very unreliable



FANO FACTOR FOR POISSON PROCESS = 1

So responses appear as noisy as for this "maximally random" model

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Evidence for "dynamic balance" regime of cortex [Board].

This famous theoretical prediction of balance has been checked in experiments



Okun and Llampl, 2008

• Neural responses are noisy! How do we deal with that?

• In previous, our model assumed that every spike is independently produced, and the probability of a spike depends only on the rate, r(t): Poisson noise



Stimulus parameter

- look at + run code … hist_demo.m:
- making histograms

Do I stay or do I go?









Bill Newsome

Making a decision



Britten et al. '92

Predicting from neural activity



Maximum Likelihood decoding

2 Coins.

The green coin is biased heavily to land heads up, and will do so about 90% of the time.

The purple coin is slightly weighted to land tails up, about 60% of flips. Both coins are otherwise identical.

I'll pull a coin out of the bag without looking, flip it in secret, and tell you what landed up, either heads or tails. To win this game, you have to guess which color of coin I picked out of the bag.

Boardwork: decision via max likelihood

Maximum Likelihood decoding

Two world class sprinters running the 150m dash: Donovan Bailey, and Michael Johnson.

Each runner has a normal (Gaussian) distribution for their finishing times: Donovan has a mean of 15 seconds with a standard deviation of 1second, Michael has a mean of 17 seconds with a standard deviation of 1.5 seconds. In this game, I'll tell you the finishing time of one of the runners, and you win if you guess who ran that time correctly.



MAXIMUM LIKELIHOOD DECODING OF RESPONSE r FOR STIMULUS "+" VS STIMULUS "-"



Shaded area: given that stim - is presented, probability of guessing + =PROBA (ERROR | -)

ERROR RATE = PROBA (ERROR | -) P(-) + PROBA (ERROR | +) P(+) where P(-) and P(+) are probabilities of presenting stim - and +

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FRACTION CORRECT = (1 - ERROR RATE)
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Among all decoding strategies, FRAC CORRECT is largest via maximum likelihood decoding when P(-) = P(+).

Neurons vs organisms



Close correspondence between neuron decoding and behavior..

So why so many neurons? Hypothesis: redundant codes (Zohary et al Nature '96): Still actively debated today!