Project 11: Decision confidence

1) Construct a population of orientation-tuned neurons (putatively in primary visual cortex) with Poisson firing rates. Assume that contrast affects the tuning function multiplicatively. Consider the case where there are two possible orientations (A and B), and the task is to identify the correct orientation. On each trial, a single orientation is presented, resulting in random spike counts X. Compute the log-odds, log P(A|X)/P(B|X). Simulate decisions by comparing the log-odds to a decision threshold. How does accuracy change with contrast and the difference in orientation?

2) For each level of contrast and orientation difference, compute the variance of the log-odds across multiple presentations of the same stimulus. This is an inverse proxy for decision reliability, as in Boundy-Singer et al. (2023). How does decision reliability change with contrast and orientation difference?

3) Train a linear readout of decision reliability from population activity, using the estimates from part 2. How well does this readout do at predicting decision reliability? Plot the relationship between decision reliability and log-odds, and explain intuitively why it has a particular shape. Discuss this model in relation to the results from Boundy-Singer et al. (2025).

References:

Boundy-Singer, Z. M., Ziemba, C. M., & Goris, R. L. (2023). Confidence reflects a noisy decision reliability estimate. *Nature Human Behaviour, 7*, 142-154.

Boundy-Singer, Z. M., Ziemba, C. M., & Goris, R. L. (2025). Sensory population activity reveals downstream confidence computations in the primate visual system. *Proceedings of the National Academy of Sciences, 122*, e2426441122.