Computation & Cognition 2024-2025

Assignment 3: Decision making

Overview

In this assignment, we will explore formal models of *decision making*. The models we explore are evidence accumulation models (also known as sequential sampling models). Specifically, we focus on the diffusion decision model (DDM; sometimes called *drift diffusion model*). This paper gives useful background information about how the models are used in cognitive (neuro)science:

- Forstmann, B. U., Ratcliff, R., & Wagenmakers, E.-J. (2016). Sequential Sampling Models in Cognitive Neuroscience: Advantages, Applications, and Extensions. Annual Review of Psychology, 67(1), 641–666. https://doi.org/10.1146/annurev-psych-122414-033645

The model we will simulate is described by Bogacz et al. (2006), p. 704, section 'DDM':

- Bogacz, R., Brown, E., Moehlis, J., Holmes, P., & Cohen, J. D. (2006). The physics of optimal decision making: A formal analysis of models of performance in two-alternative forced-choice tasks. Psychological Review, 113(4), 700–765. https://doi.org/10.1037/0033-295X.113.4.700

Lab report contents

The goal of the lab report is to describe how you answered the questions in the assignment, and what you learnt about how formal models of decision making can help us understand cognitive processes. Structure your lab report as follows.

1. Getting started

Before starting the assignment, read the two papers (the Bogacz paper up to page 705, section 'DDM' – the remainder is not part of this assignment). How well is the DDM described in the papers? Did you understand how it is used to understand human decision making (and response time data)?

2. Simulating a random walk

We start by simulating a random walk. Was it clear from the assignment what a random walk is? Was the difference between variables *x* and *xs* clear? Did you succeed in reproducing the example plot?
To reproduce the plot, it is crucial that the *scale* argument of numpy's random.normal() function is set to the *square root of (c*dt)*, and that you call np.random.seed(5) at the top of the code cell.

3. Adding a threshold

What does the threshold 'do' in this random walk? Was it clear how the 'decision time' is determined by the number of steps it requires to reach the threshold, and the step size? Was it clear how *which choice* is made corresponds to *which threshold* (upper or lower) is reached? What does the histogram of decision times look like?

4. Adding a drift

What is the difference between a random walk without drift and a random walk with drift? Compared to the random walk model, how does adding a drift rate of v=1 change decision times and error rates? Did your *simulated* mean decision times and error rates correspond to the *analytically expected* mean decision times and error rates (given by Equations 8 in Bogacz et al. (2006))?

5. The effects of threshold and drift rates

What was the effect of increasing drift rate from v=1 to v=2 (assuming a constant threshold a=1) on the histogram of decision times, and on the error rate?
What was the effect of increasing threshold from a=1 to a=1.5 (assuming a constant drift rate v=1) on the histogram of decision times, and on the error rate?
How does a change in drift rate *differ* from a change in threshold?

6. Evaluation

Why is it useful to inspect the histograms produced by the DDM? How can these be used to determine whether the DDM can be used as a model of human decision making?

Overall, which aspects of the assignment did you find difficult? Was there information missing?

Submission

The deadline for submission of this lab report is Friday, March 21th 2025, 23:59.