Session 3: Bifurcations in a Model of Decision Making

This practical session aims to introduce you to stability analysis and bifurcations in a model of decision making in the brain. The practical is split into three parts, which take you through the steps to simulate and analyse the Wong-Wang model of decision making. The parts are outlined below:

1. Simulating decision-making in the brain
2. Stability analysis of the undecided steady state; how are decisions forced?
3. Bifurcation analysis of decision making and working memory in neurodegeneration

Part 1: Simulating decision-making in the brain

In this section you will simulate the Wong-Wang model of decision-making in the brain. Specifically, you will simulate the response of two selective populations of neurons to a random dot motion stimulus; Population 1 is selective to dots moving left, and Population 2 is selective to dots moving right. You will study how altering the amount of coherence in the direction of movement of the dots alters the response of the network.

Part 2: Stability analysis of the undecided state; how are decisions forced?

In part 1, the simulated participant always made a decision. In this section, we will consider the conditions required to force a decision by performing a stability analysis on the symmetric steady state; i.e. the steady state corresponding to both populations having approximately equal firing rates, corresponding to no decision having been made. For this section, motion coherence will always be set to zero.

Part 3: Bifurcation analysis of decision-making and working memory in neurodegeneration

In this section, we will study how working memory of a decision arises based on a bifurcation diagram. Then, we will reduce the strength of NMDA synapses and see how this changes the bifurcation diagram and alters decision-making and working memory.