PRACTICAL SESSION 2: MODELLING THE EMERGENCE OF SEIZURES IN NETWORKS

This session aims to introduce a phenomenological model of seizure transitions, the theta model [1]. The theta model is a phase oscillator model, i.e. it describes the dynamics of an oscillator. A single oscillator may be used to represent the brain activity at one brain region. A network of oscillators may then represent the dynamics of a brain network. In this model, large oscillations represent seizure activity, whereas low amplitude fluctuations correspond to a 'normal' brain activity.

This worksheet is split into three parts:

1. Simulate a deterministic phase oscillator
2. Simulate a stochastic phase oscillator
3. Simulate a network of interacting phase oscillators

Part 1: Simulate a deterministic phase oscillator

In this section you are going to implement the theta model in its simplest form, i.e. a single ordinary differential equation (ODE) that describes the dynamics of a phase oscillator θ:

Part 2: Simulate a stochastic phase oscillator

Now let us consider a modification to Eq. (1) so that the phase oscillator becomes stochastic. One way of doing this is to simply add a noise term ϵ:

$=(1-\cos\theta)+(1+\cos\theta)I+\sigma\epsilon,$

where ϵ is normally distributed, with zero mean and standard deviation

Part 3: Simulate a network of interacting phase oscillators