DFT workshop, G. Schöner, J. Spencer May 2008

Exercise: neural dynamics simulations

The neuronal dynamics simulated in the lectures is

$$\tau \dot{u}_1(t) = -u_1(t) + h_1 + S_1(t) + c_{11}\sigma(u_1(t)) + c_{12}\sigma(u_2(t))$$
$$\tau \dot{u}_2(t) = -u_2(t) + h_2 + S_2(t) + c_{22}\sigma(u_2(t)) + c_{21}\sigma(u_1(t))$$

The sigmoidal function is given by

$$\sigma(u) = \frac{1}{1 + \exp[-\beta\ u]}$$

Use the `simulator.m` to explore this equation. In each task, vary the intial condition `u(1,:)=[-2 -4]` to test, from where the system relaxes to which attractor.

1. First set all coupling parameters $c_{..}$ and inputs $S_{1,2}$ to zero. Examine relaxation to the resting level using the pre-relaxation interval (setting: `pre_relax_time=10; main_time=10; total_time=10;`).

2. Now use the time-varing input to examine, how the system follows shifts of the attractor (setting: `pre_relax_time=10; main_time=20; total_time=30;` and vary the values of `S1=0; S2=0;` in the different epochs).

3. Now activate the coupling terms (settings: `c12=-2.5; c21=-2.5;`) and use the initial conditions to explore the resulting bistability. This can be done in the pre-relaxation interval (`pre_relax_time=20; main_time=20; total_time=20;` and setting the stimulus in that interval to `S1=2; S2=2;`). Also vary these stimulus strenghts asymmetrically and establish that the basins of attraction begin to differ.

4. Finally, introduce self-stabilization (`c11=2.0; c22=2.0;`) and examine how a positive solution arises for increasing input strength.