Prof. Dr. Gregor Schöner October 26, 2017

Exercise 4, Oct 26, 2017

This exercise uses the same interactive MATLAB simulator
`launcherTwoNeuronSimulator.m`
that we used last week. The program simulates two activation variables, informally called neurons, with external input, self-excitation, interaction, and noise, as defined by the equations

$$\begin{aligned}\tau_1\ \dot{u}_1(t) &= -u_1(t) + h_1 + s_1(t) + c_{11}\ g(u_1(t)) + c_{12}\ g(u_2(t)) + q_1\ \xi_1 \\ \tau_2\ \dot{u}_2(t) &= -u_2(t) + h_2 + s_2(t) + c_{21}\ g(u_1(t)) + c_{22}\ g(u_2(t)) + q_2\ \xi_2\end{aligned}$$

where the sigmoid function, g, is given by

$$g(u) = \frac{1}{1 + \exp(-\beta u)}.$$

Use the simulator to explore the dynamics of two neurons with mutual inhibition.

1. Bistability: Set the interaction parameters of the system to mutual inhibition ($c_{12} = c_{21} = -10$ with $c_{11} = c_{22} = 0$). Add a stimulus to u_1, then to u_2 . Remove the stimuli and reapply them in the opposite order. Note which attractor the system relaxes to in each case.

2. Selection: Add a small amount of noise to the system and give the same stimulus to both neurons. Reset the system several times to observe the selection decision the system makes. Change the relative strengths of the stimuli by a small amount and observe how the stronger stimulus is favored in the selection.

3. Biases: Reduce the inhibition of one neuron while keeping the other one invariant. How does this bias the selection decision and why?

4. Combine competition and self-excitation: Add self-excitation back into the system ($c_{11} > 0$ and $c_{22} > 0$) and establish that selection still works, still is bistable, and still can be biased.