Prof. Dr. Gregor Schöner November 14, 2019

Exercise 2, hand in by Nov 21, 2019

This exercise sheet still refers to Chapter 1 “Neural Dynamics” by Gregor Schöner, Hendrik Reimann, and Jonas Lins from the book “Dynamic thinking” (G Schöner, J Spencer and the DFT Research Group, Oxford University Press, 2016) (a proof of that chapter is downloadable on the course webpage).

Consider the neural dynamics illustrated in Figure 1.19 and described by equations 1.9 and 1.10. Consider the sigmoid to be a step function, $g(u) = 0$ for $u <= 0$ and $g(u) = 1$ for $u > 0$. The goal is to build and understand a neural dynamics that generates a ”XOR” function at the output of one of the two neurons, say, $g(u_1)$. Input comes from two binary variables, $b_i \in \{0, 1\}$, with $i = 1, 2$.

1. Make a table of the XOR function for these binary variables. The binary variables need to be mapped onto inputs, s_i for the two neurons. The simplest solution is to have $s_1 = s_2 = b_1 + b_2$. Make a drawing of this network that maps b_i onto the neurons.

2. How must the resting levels, h_i, and coupling strengths, c_{ij}, be chosen so that u_1 produces the right output? Analyze and argue why this is right. [This is the only hard part of this exercise and worth 50% of the points.]

3. There is a famous result in the literature that says that you need a hidden neuron (so at least a two layer neural network) to realize the XOR function. Is your neural dynamics consistent with that claim?