Prof. Dr. Gregor Schöner October 26, 2017

Exercise 5, Oct 26, 2017

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).

1. Write down the neural dynamics of the forward network shown in Figure 1.2. The downward arrows are excitatory couplings, so that the sigmoided activation of the activation variable from which the arrow starts shows up as a positive additive contribution to the dynamics of the activation variable at which the arrow ends. Weight factors (connective strengths) multiply each input. Assume that weights are chosen such that activation variable 4 goes above zero only if both its inputs are above threshold and the sigmoid is a steep step function. Assume the same for activation variable 5 and 6. Under those conditions, describe and illustrate the output of the network in response to a set of input patterns s_1, s_2, s_3 that count from 0 to 7 in binary representation ($s_i \in \{0, 1\}$).

2. Based on what you learn about inhibitory coupling among activation variables around Figure 1.19, make a thought experiment for this two-neuron network. That is, describe the stable activation patterns that are possible in response to the set of 4 input patterns in which inputs s_1 and s_2 take on all combinations of values of 0 or 1. Assume that an input of 1 is strong enough to push an activation variable above threshold if there is no inhibition from the other neuron, but not, if there is inhibition from the other neuron. In each case, you will need to step through 4 cases of initial conditions for the two neurons, in which either neuron can be below or above threshold before the stimulus is applied. You could use tables or other ways of illustrating this (e.g., you can use the four quadrants of a two-dimensional coordinate frame that spans activations u_1 and u_2).

3. In light of the dependence on the initial state of the activation variables uncovered in the previous tasks, go back to Figure 1.3 which has recurrent connections. Can the output of that network still be given by a look-up table of the kind used for the network in Figure1.2? Just think about the possible complexitities in a network like that and say one or two things about that.