BioNB330 Quiz 4 NAME

1. You want to design a neural network which can recreate or recall a pattern when complete with an incomplete version of that pattern. For example, a network with inputs (0,1,0,0) would end up with the activity vector (0,1,1,0). The same network, if activated with the vector (0,0,1,0) would end up with the activity vector (0,1,1,0) after one or more iterations.

1a. Choose a pattern with at least 3 items (numbers, dimensions) that you which to store. You can use 0 and 1 or -1 and 1 as the two possible states for each neuron.

1b. Write down all the necessary equations to design a network that can accomplish this task

1c. Make a schematic drawing of your network.

1d. Calculate the synaptic weights necessary to store the pattern you chose

1e. Present the network with an incomplete pattern and show that is performs the task.

PS: It does not matter what type of network you use, the only important thing is that it works!

**Choose either a linear associator, auto-associator or Hopfield type network, all should work. Write out ALL equations, draw network, calculate weights for the pattern of your choice, perturb pattern and calculate new pattern.**

1. You have recorded the following synaptic plasticity rule as a function of the time difference between the a pre- and a postsynaptic action potential:



2a. For the spike train shown in B, assume that at t=0 wpre,post = 1.0. Show how wpre,post changes during this spike train when the plasticity rule depicted in A is applied. Show your work (i.e. write down the approximate numbers for the weight changes and how you get them).

1. T1: Pre-post = -20ms; Dw =+10% = 0.1 w(t=1) =1.1
2. T2: pre-post = -20ms; Dw = +10% = 0.11; w(t=2)=1.21
3. T3: pre-post = -20ms; DW =+10% = 0.121; w(t=3)=1.331

2b. For the spike train shown in C, and assuming that increases and decreases in synaptic weight sum up linearly, show how the synaptic weight wpre,post changes during this spike train if the plasticity rule shown in A is applied. Assume that for each postsynaptic spike, only the immediately adjacent pre-synaptic spikes (before and after) are taken into account. The initial synaptic weight wpre,post = 1.0. Show your work (i.e. write down the approximate numbers for the weight changes and how you get them).

1. T1: pre-post=-20ms; Dw=+10%=0.1; w(t=1)=1.1
2. T2: pre-post=10ms; Dw=-10%=0.11;w(t=2)=0.99
3. T3: pre-post=-20ms; Dw=+10%=0.099; w(t=1)=1.089
4. T4: pre-post=10ms; Dw=-10%=0.1089;w(t=2)=0.9801

Using a simple example with 3 neurons, explain how the fact that ACh suppresses excitatory synaptic transmission during learning can decrease interfererence between memories.



1. Briefly explain with a drawing why an STDP learning rule is good at strengthening synaptic weights from presynaptic neurons that tend to fire synchronously.

Synchronous pre-synaptic spikes would drive the postsynaptic neuron in a manner that pre is before post in a brief interval and reliably time after time. The synapses from the synchronous spikes will the strengthened and those happening after will be weakened. After a while, mostly synchronous neurons will end up with strong synapses.