PSY 265: Homework 6

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We will be working with the network shown in **figure 4** below. Further information regarding the network setup can be found in homework assignment instructions 5 and 6.

1 Inject current to RSN_1

With a $100pA$ current injection into RSN_1, simulating a response to stimulus 1, we see activation of the MSN neurons, with no clear favoring towards either of the MSN neurons because the weights of each input from RSN_1 to either MSN neurons are equal.

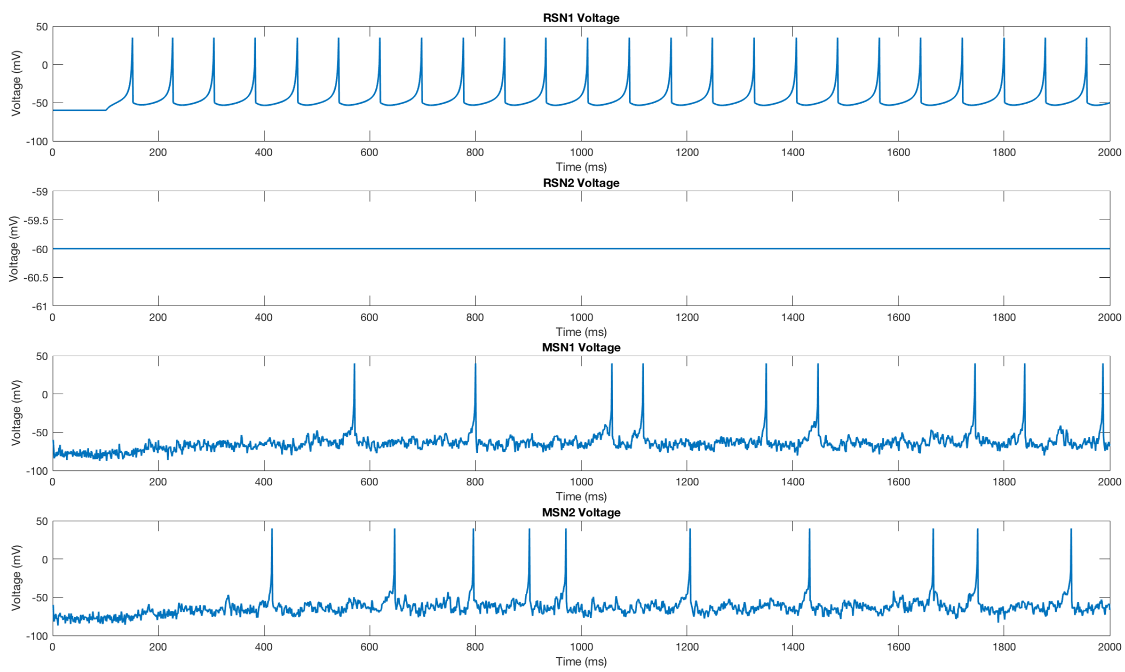

Figure 1: Voltage across time of neurons in the network after injecting a current into RSN_1 at $t = 100ms$.

2 Inject current to RSN_2

Similar to question 1, we simulate a response to stimulus 2 by RSN_2 and get non-biased activation of both MSN neurons.

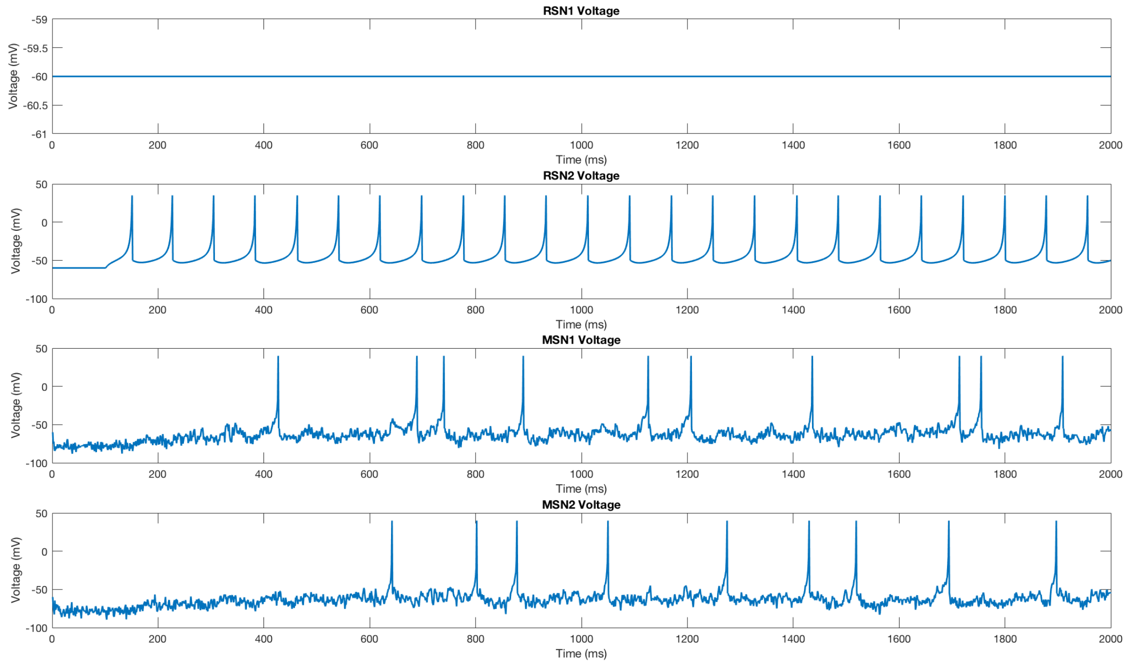

Figure 2: Voltage across time of neurons in the network after injecting a current into RSN_2 at $t = 100ms$.

3 Record the behavioral response of the network to stimulus 1 or 2

We simulate a response to stimulus 2 from RSN_2 over 10 trials and record the behavior of the network. The table below shows the response of the network (1 or 2) and the reaction time (RT) (ms) for each response. Note that $RT = 2000$ for all trials because we have an unbiased network so the response is randomly chosen at $t = 2000ms$. Over a larger number of trials we may find that the network will respond with some $RT < 2000$, but there will be a low variability in RT and responses from each MSN because neither MSN is being favored by RSN_2.

Trial	1	2	3	4	5	6	7	8	9	10
Response [1, 2]	2	1	1	1	1	2	1	2	1	1
Reaction Time (ms)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

4 Implement a reinforcement learning algorithm in the network to learn to respond correctly to stimulus 1 or 2

In **figure 3**, we can see that the network is learning across trials because RT decreases and accuracy tends toward 1 as we iterate through trials. We implemented a learning algorithm that updates the weights of each connection between RSN and MSN neurons. The expected weights of a trained network are an favored weight from RSN_1 to MSN_1 and a favored weight from RSN_2 to MSN_2, with an unfavored weight for connections from RSN_1 to MSN_2 and RSN_2 to MSN_1. This is what we find to be the case when comparing the resulting weights to the initial weight of 275 for all connections between RSN and MSN neurons.

W_{E11}	W_{E12}	W_{E21}	W_{E22}
606.2522	178.7574	157.3129	360.8321

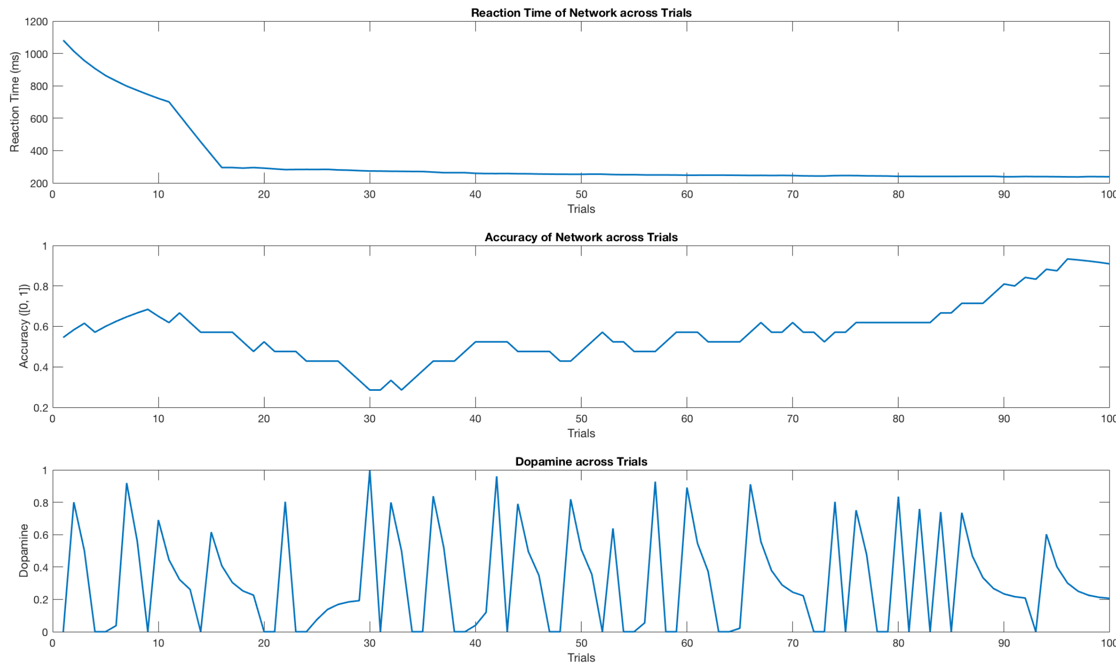

Figure 3: Behavioral network performance across 100 trials.

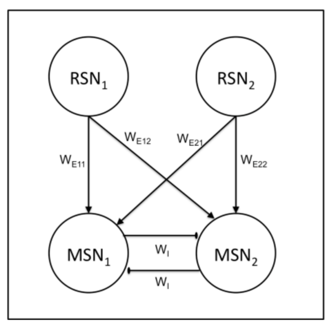

Figure 4: Simple network where regular spiking neurons (RSN) send excitatory input to the striatal medium spiny neurons (MSN) and the MSN neurons send inhibitory input to each other.