Coursework2

Yuli Zhi fh19804

PartA

Question1

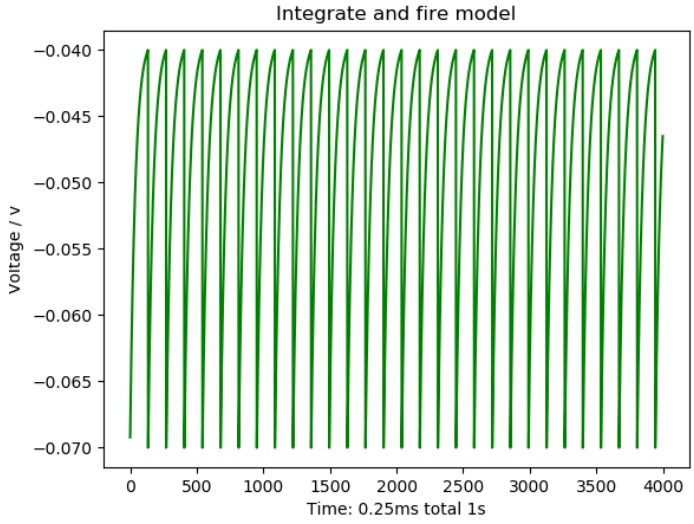

Figure 1: Integrate Spike

Question2

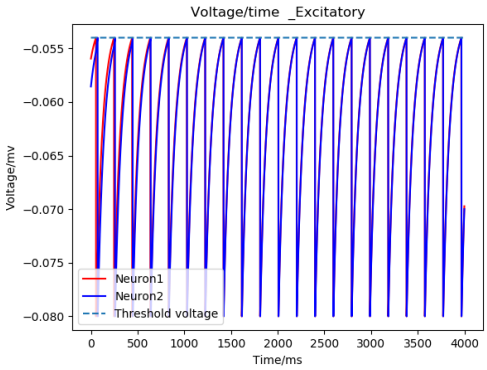

Figure 2: Two neurons Excitatory

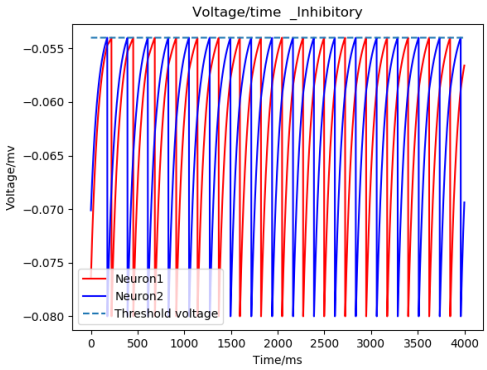

Figure 3: Two neurons Inhibitory

The left graph shows that two neurons have excitatory synaptic connections between each other, and the right is the inhibitory one. Excitatory synaptic connection graph shows that two neurons tend to synchronize. While in inhibitory connection, two neurons have different impulse times. In the same time, One is impulse, and another is calm.

COMSM2127

1) $I_e = (V_{th} - E_L)/R_m$

the minimal current to produce an action potential $I_e = 3nA$

2)

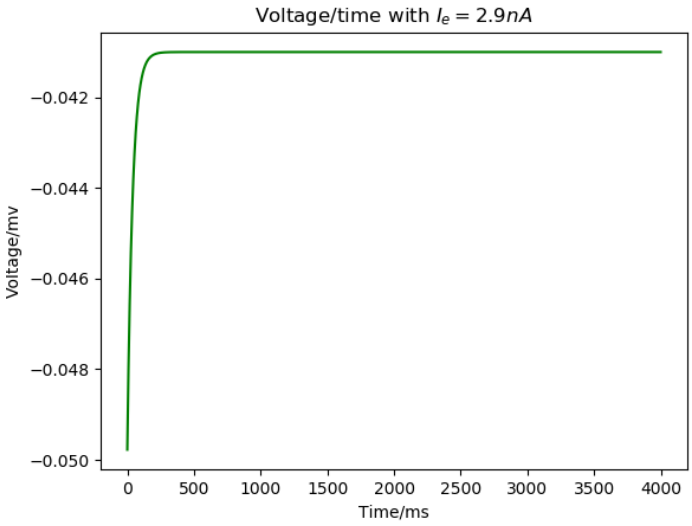

Figure 4: Integrate Spike

3)

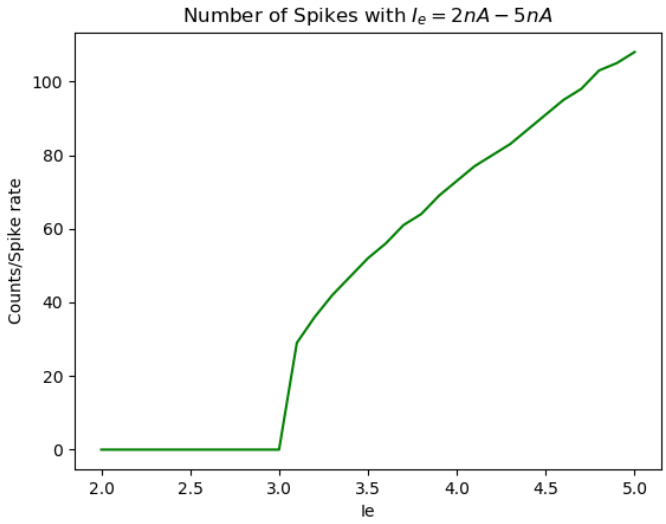

Figure 5: Integrate Spike

PartB

Question 1

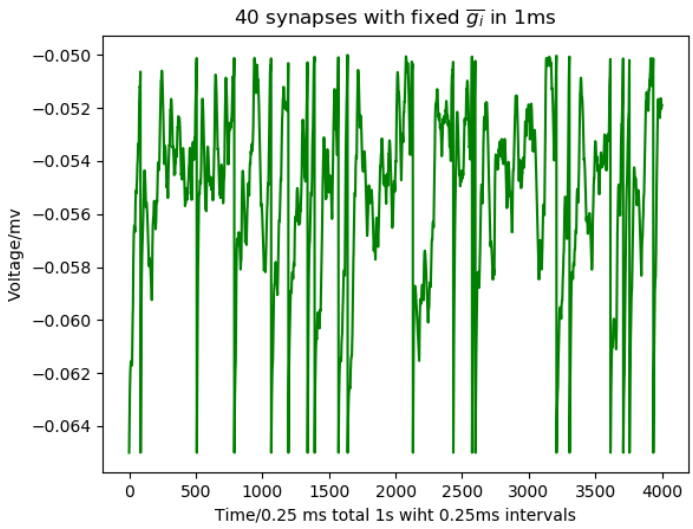

Figure 6: Integrate Spike

Neuron firing irregularly at a rate of roughly 20 Hz

Question 2

1) The Figuer 7 shows the synaptic strength distribution converge towards at normal distribution shape which center at nearly 2nS. And figure 8 illustrate the average firing rate of the postsynaptic neuron as a function of time (300s). The Spike rate is stable at around 1Hz after a Convergence stage.

2) The average value of synaptic weight is around 2.0435 nS. In the last 30 seconds, STDP-on mode 's fire rate is around at 1Hz, while in STDP-Off mode, the spike rate is around zero. Just one spike in last 30s for STDP-off mode generally.

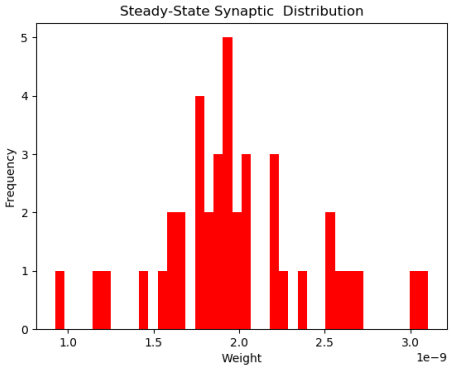

Figure 7: Steady-State synaptic weight with STDP on

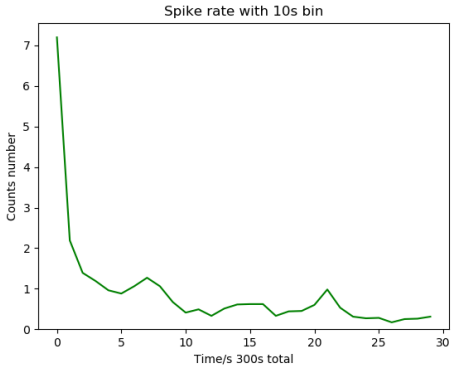

Figure 8: Steady-State spike fire rate with STDP on

Question 3

The figure 9 shows the STDP on mode between 10 and 20Hz,it generally declines with the increasing input frequency. And there are some sudden growth point. However, figure 10 illusrates that the STDP off mode has an upward trend with increasing input frequency. Because, the higher input frequency makes the S increase directly, and g is constant in STDP-off mode. So that, the post-neuron can spike more.

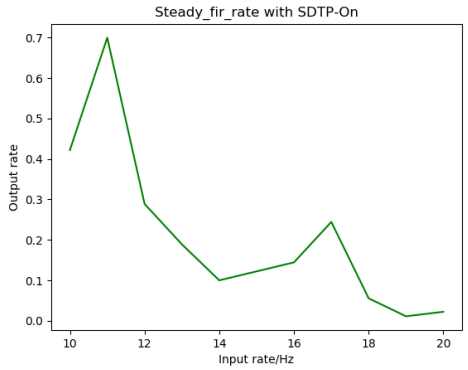

Figure 9: Fire rate with STDP On: input 10-20Hz

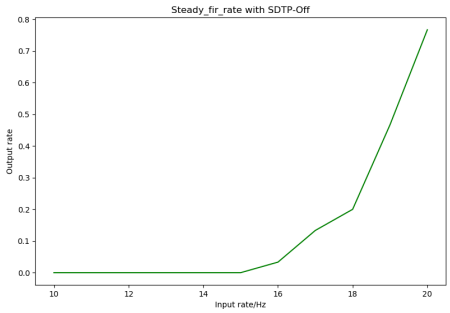

Figure 10: Fire rate with STDP Off: input 10-20Hz

The figure 11 and figure 12 shows the steady-state synaptic strength distribution for r = 10 Hz and r = 20 Hz for the 'STDP on' case. The higher input frequency 's synaptic weights distribution is more even than lower input frequency. The reason could be that higer input frequency makes more pre-synaptic spike. As the 40 pre-synaptic has the same possion process. Their distribution is more even.

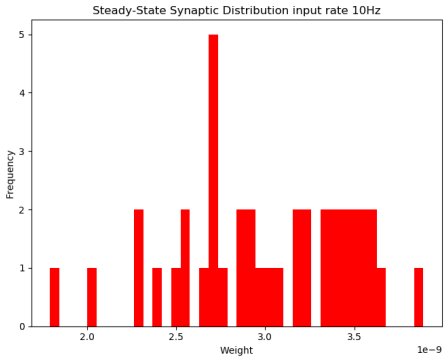

Figure 11: Fire rate with STDP On: input 10 Hz

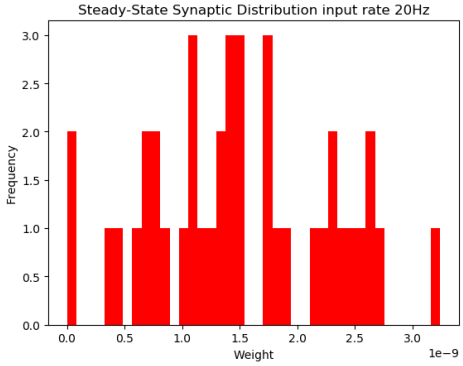

Figure 12: Fire rate with STDP On: input 10 Hz

Question 4

The high degree of correlation (B is high) means that steady-state synaptic weights will be also temporally correlated.

The figure the mean and standard deviation of the steady-state synaptic strengths as a function of B. The green line is mean, while red line is std. There has been a decline in the mean of weight. And the Std is relatively stable and slightly increased, this means that the weight of the synapse is less balanced.

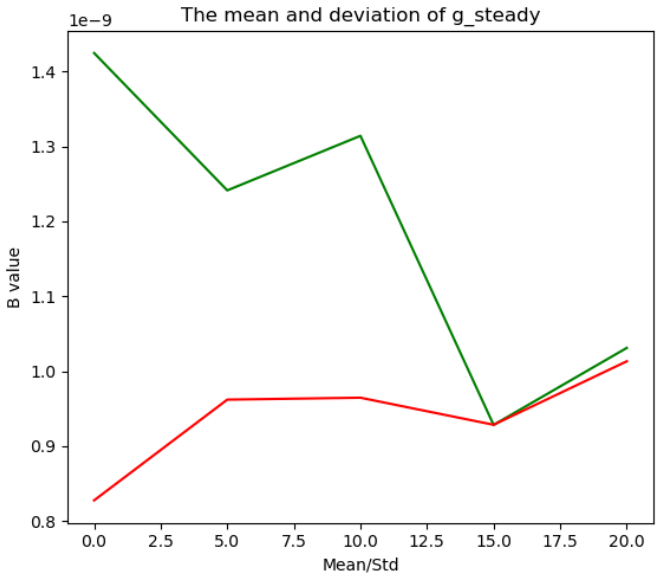

Figure 13: Integrate Spike

B=0 means input frequency is fixed, and small standard deviation it is becasue, in 300s, each synapse has the same possion (same active probability) But for B=20, the synapse face different possion process in different time. The probability is variant, When the post-protrusion is activated, the frequently activated pre-synapse has a larger weight value.

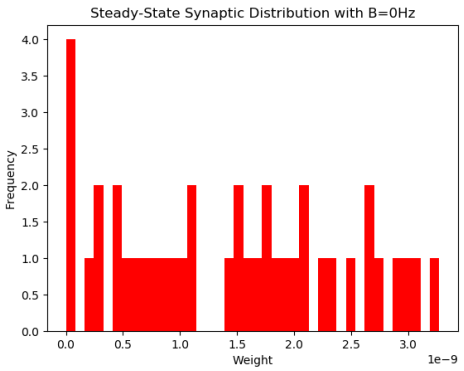

Figure 14: Steady-State synaptic weights with B = 0

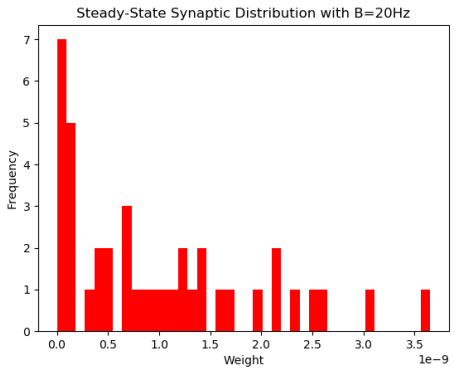

Figure 15: Steady-State synaptic weights with B = 20

The plot is like the bell shape with the tallest in the middle, decreasing on both sides.

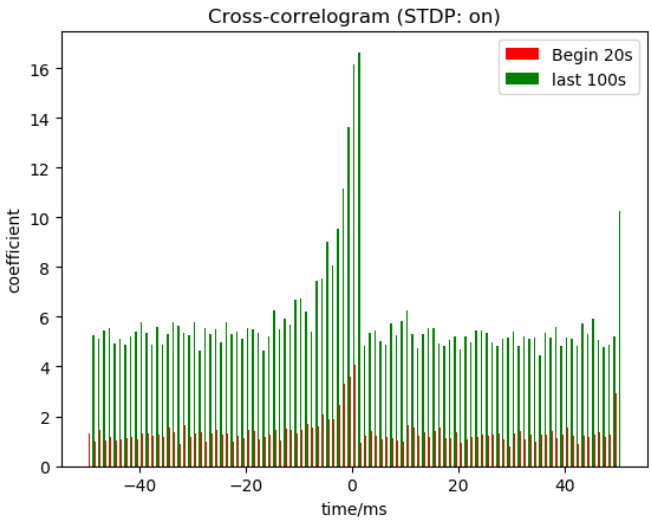

Figure 16: cross-correlogram for both cases (start and end of the simulation)