Introduction to Neural and Cognitive Modelling (CS9.427)

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Assignment 2.1

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The Colab notebook containing the code can be found **here**.

1 Exercises

1.1 Neuron Activity

1.1.1 Background Rate

The background rate has a great impact on neuron activity. For background rates ≤ 20 Hz, the neurons go almost completely silent (it is nondeterministic as the connections are randomly sampled).

1.1.2 Connection Strength & Inhibition Gain

The neuronal activity is extremely sensitive to the connection strength J. We have seen that with background rate 20 Hz and $J = 0.1$ mV, there is almost no activity; setting $J = 0.2$ mV causes an explosion in activity (Figure 1).

In contrast, the inhibition gain g has next to no effect. Even reducing it from 0.7 to (the value under which the above observations were made) to 10^{-4} makes no visible difference.

1.2 Oscillatory Behaviour

The default values of J (0.1 mV) and g (0.7) cause the group of neurons to fire roughly simultaneously in an oscillatory manner; frequency depends directly on the background rate. This effect is clearest in the range $30 \leq f \leq 60$ Hz (see figures).

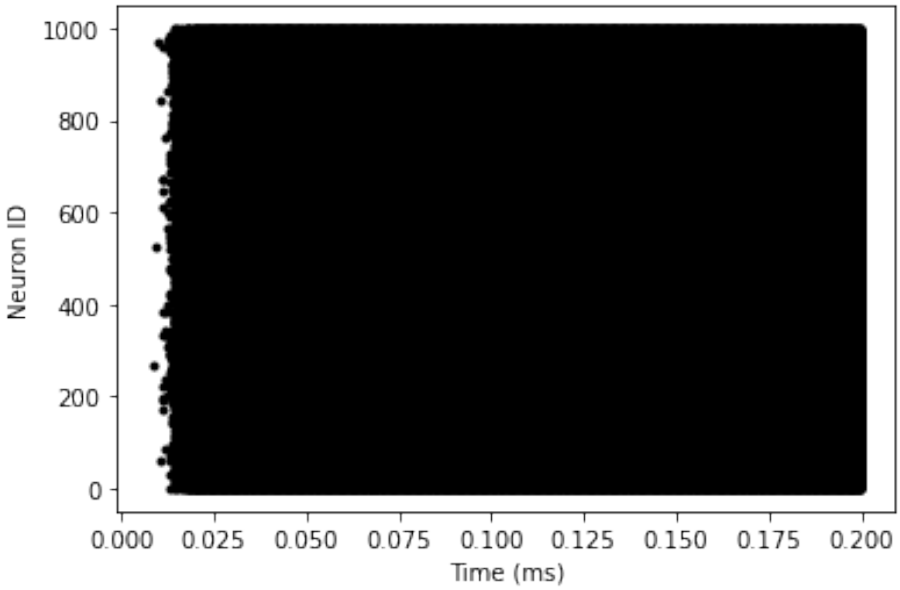

Figure 1: Explosion of Neuron Activity due to J

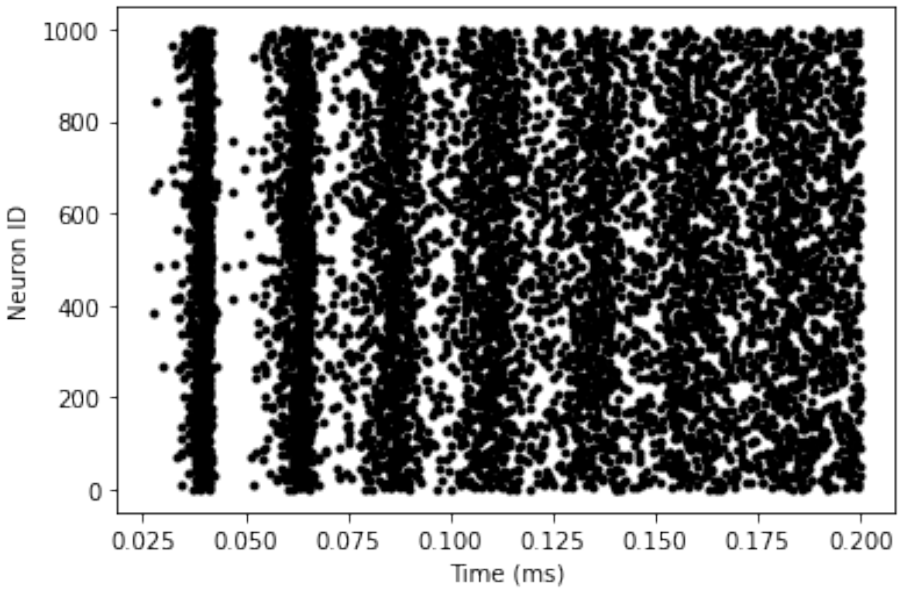

Figure 2: Oscillatory Behaviour under $f = 50$ Hz

1.3 Two Populations

We can create two populations in exactly the same manner as the single population created earlier; the synapses leading out of excitatory neurons (regardless of the postsynaptic neuron) use the event `v_post += J`, while those leading out of inhibitory neurons use the event `v_post -= g*J`.