3.3 Correlations and STDP

(Video 3.3) We have looked at STDP and at correlations in spike times separately, now let us put the two together. Create two separate groups with each 10 excitatory spike trains that have instantaneous correlation, and use $r_{\text{source}} = r_{\text{target}} = 10$ Hz, and $c = 0.1$. Now input them onto the LIF neuron and put STDP in all the synapses. Set the STDP learning rate to be lower, $A_{\text{LTP}} = 0.02$ and $A_{\text{LTD}} = -0.01$, and start all excitatory weights at $w_{\text{e}} = 0.5$. Also include 10 inhibitory inputs with weight 1 and a firing rate of 10 Hz, without STDP.

What do you see in the weights of the excitatory input groups? Normally, the two groups should compete for the weight increase onto the neuron. Do both groups reach the maximum weight? Now change the correlation between the spikes: group 1, $c_1 = 0.1$ and group 2, $c_2 = 0.2$, but maintain the same firing rate for all inputs. Simulate for long enough so you can see well what happens to the weights of the two groups. If everything is correct you should see that correlations as well as firing rates can influence the competition between groups of weights.

If you add exponential cross-covariance, but do not change $c1$ and $c2$, does it influence the weight evolution of the two competing groups? You may have to adjust the weights and learning rates to produce reasonable output firing rates. Another effect you can look at is how the difference in initial weight in the two groups can influence weight competition by STDP. You can also test if an initial advantage in the weights for one group can overcome a weaker correlation or lower firing rate of that group in the competition for synaptic strength.

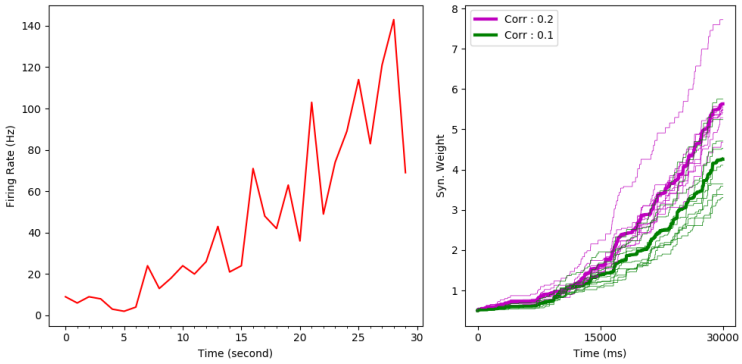

Figure 1: A LIF neuron with two separately correlated excitatory input groups, one with c = 0.2 and one with c = 0.1. Left: The firing rate of the neuron increases over time. Time bins of 1 second are used to record the spikes. Right: Synaptic weights from two groups of excitatory inputs are shown evolving over time through STDP. The thin lines show individual weights, the thick line the average from the corresponding group. Although the firing rates of the inputs groups are identical, the weights from the group with higher correlation increase faster on average.