Advanced Neural Networks - Homework 4

Carolyn Atterbury

October 16, 2019

1 Leaky Integrate and Fire Model with Two Synapses

1.1 Single excitatory neuron, $n = 2$, $w = 1.1$, $risis = 5.0$ htz

The average spike times of excitatory neuron with two synapses can be seen in Figure 1. When the fractional shift is low (between 0.0 and 0.25) and high (between 0.75 and 1), then the risi of the output neuron is high. This is an indication that the spiking of the input neurons are complementing each other. When the input neurons are out of phase, there is no firing in the output neuron.

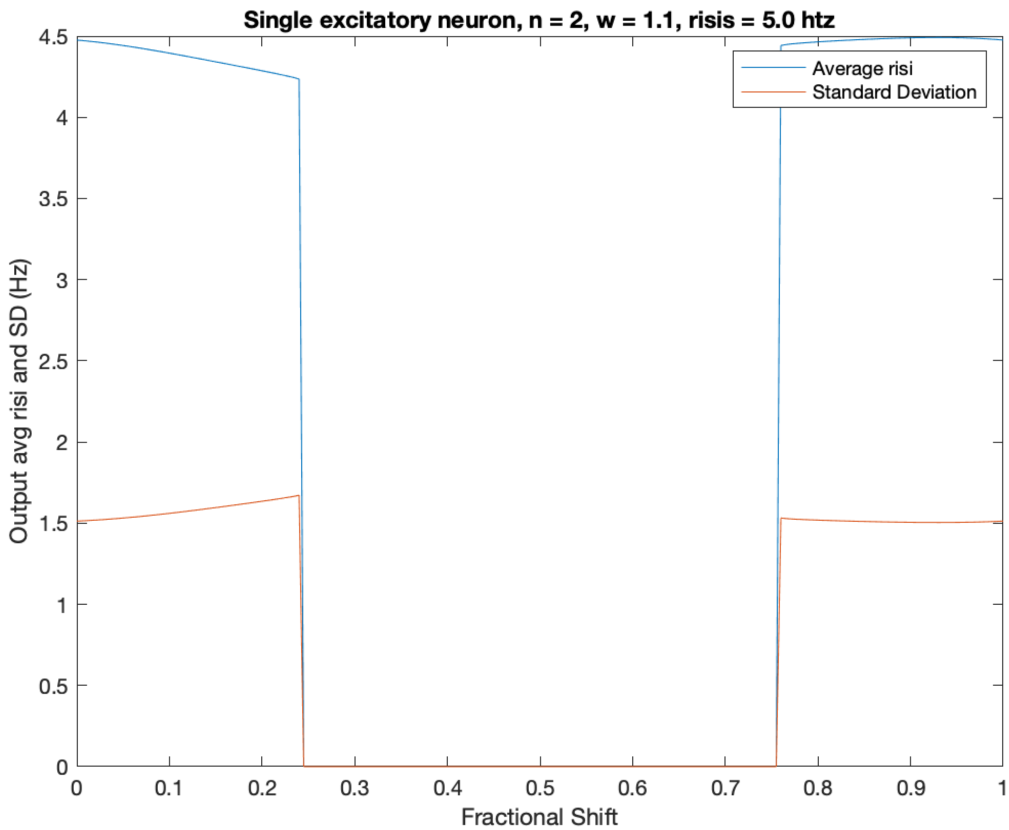

Figure 1: Average risi and standard deviation of excitatory with two synapses.

1.2 Single excitatory neuron, $n = 2$, $w = 1.0$, $risis = 10.0$ htz

In figure 2, we have input neurons firign at 10htz. The higher frequency of firing with the input neurons make the output neuron fire at a higher rate, and for more of the time. There is a smaller window at which the output neuron does not fire, and that is from 0.4 to 0.6 fractional shift.

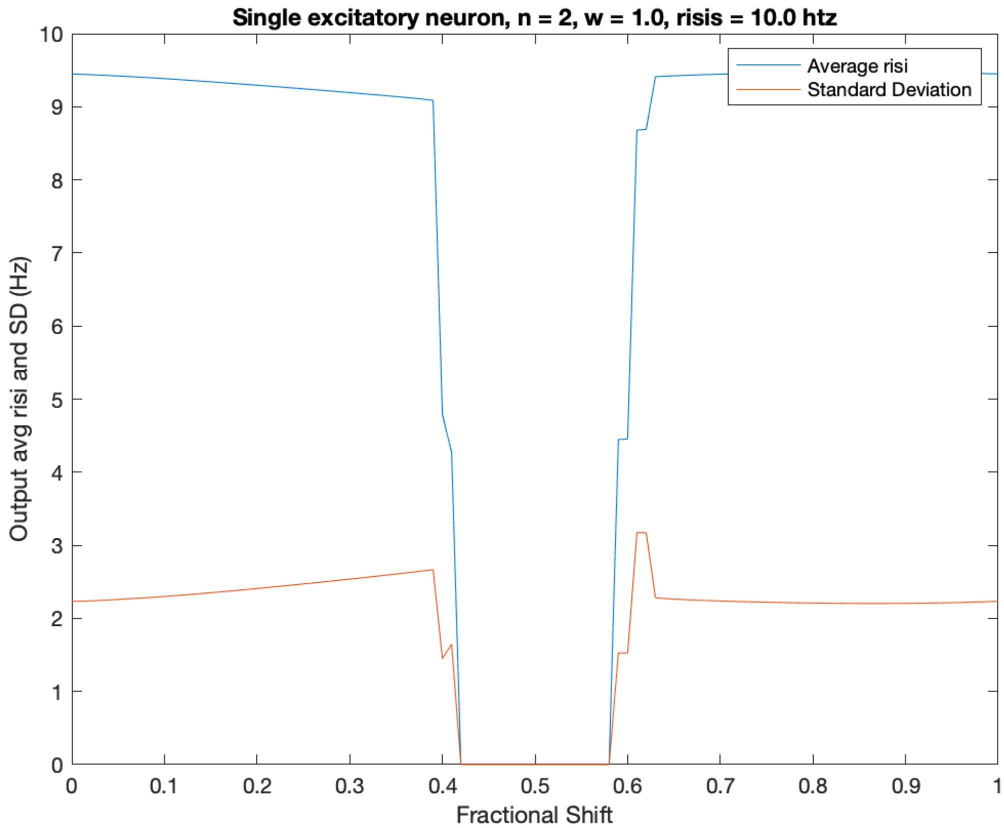

Figure 2: Average risi and standard deviation of excitatory neuron with two synapses, where $n = 2$, $w = 1.0$, $risis = 10.0$ htz

1.3 Single excitatory neuron, $n = 2$, $w = 0.6$, $risis = 20.0$ htz

The average firing rate with an inhibitory neuron can be seen in Figure 3. For this figure we have a higher firing rate of 20hz, but a lower weight of 0.6. The lower weight and higher frequency tend to balance each other out, as the output neuron does not fire for a larger gap of 0.3 to 0.7 fractional shift. Overall, the firing rate of the output neuron is higher, when it is firing.

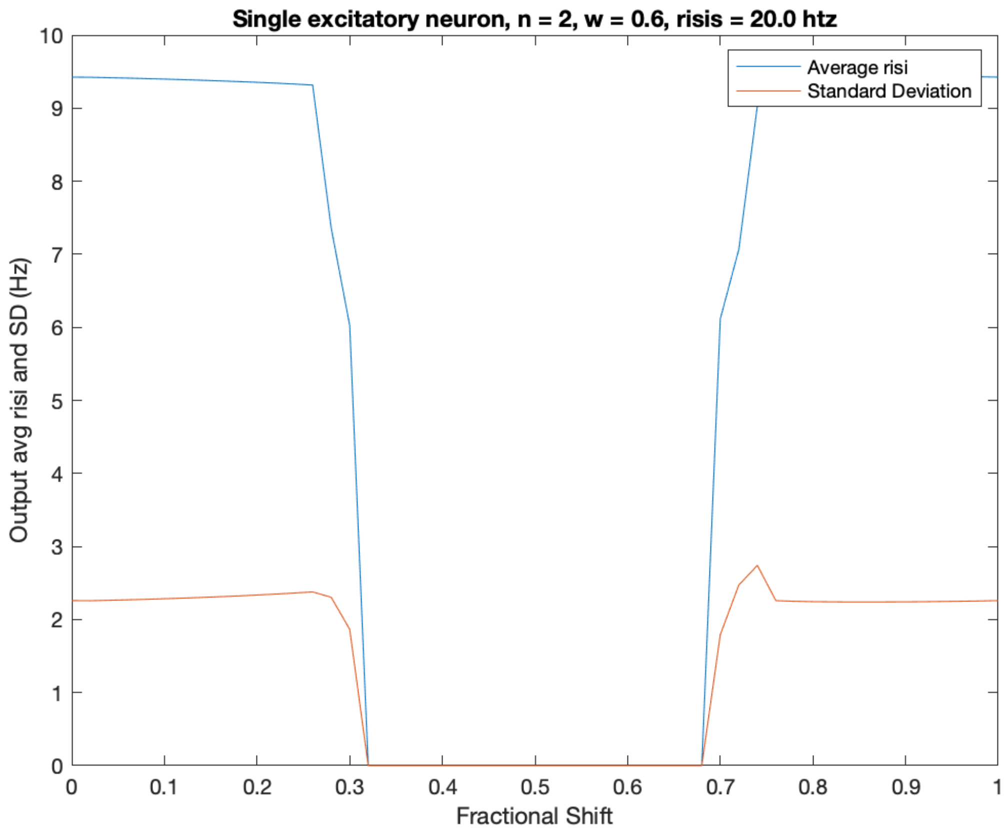

Figure 3: Single excitatory neuron, $n = 2$, $w = 0.6$, $risis = 20.0$ htz

1.4 Single inhibitory neuron, $n = 2$, $w = 1.1$, $risis = 5.0$ htz, $Ie = 2.5e = -10$

The average firing rate with an inhibitory neuron with two synapses can be seen in Figure 4. Overall a high electrode current where $Ie = 2.5e - 10$ is needed to make the neuron fire. The firing rate in this plot looks more continuous than the previous plots. Whenever the firing rate decreases, it begins to immediately increase again, due to the current.

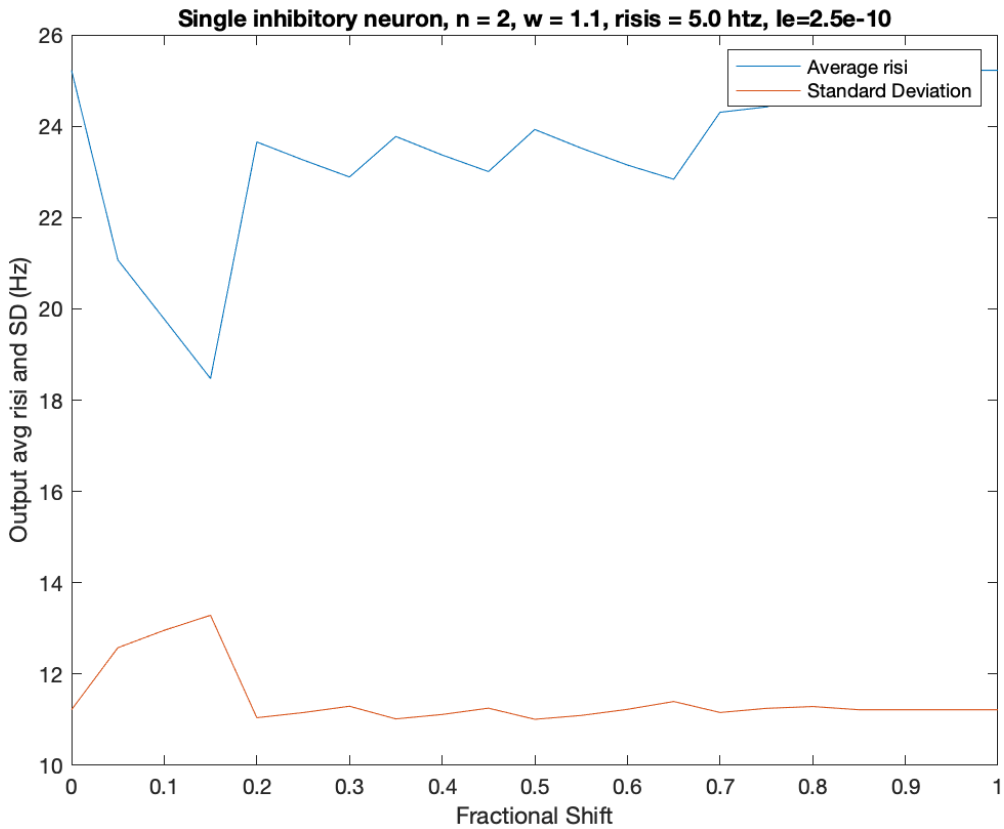

Figure 4: Single inhibitory neuron, $n = 2$, $w = 1.1$, $risis = 5.0$ htz, $Ie = 2.5e = -10$

1.5 Single inhibitory neuron, $n = 2$, $w = 1.0$, $risis = 10.0$ htz, $Ie = 2e = -10$

In Figure 5, we can see the firing rate of a neuron with two inhibitory synapses, and an input firing rate of 10hz. The firing rae goes down to zero with a fractional shift of 0.05, but it goes up again soon after. There is not a period of time with no firing, unlike the excitatory models.

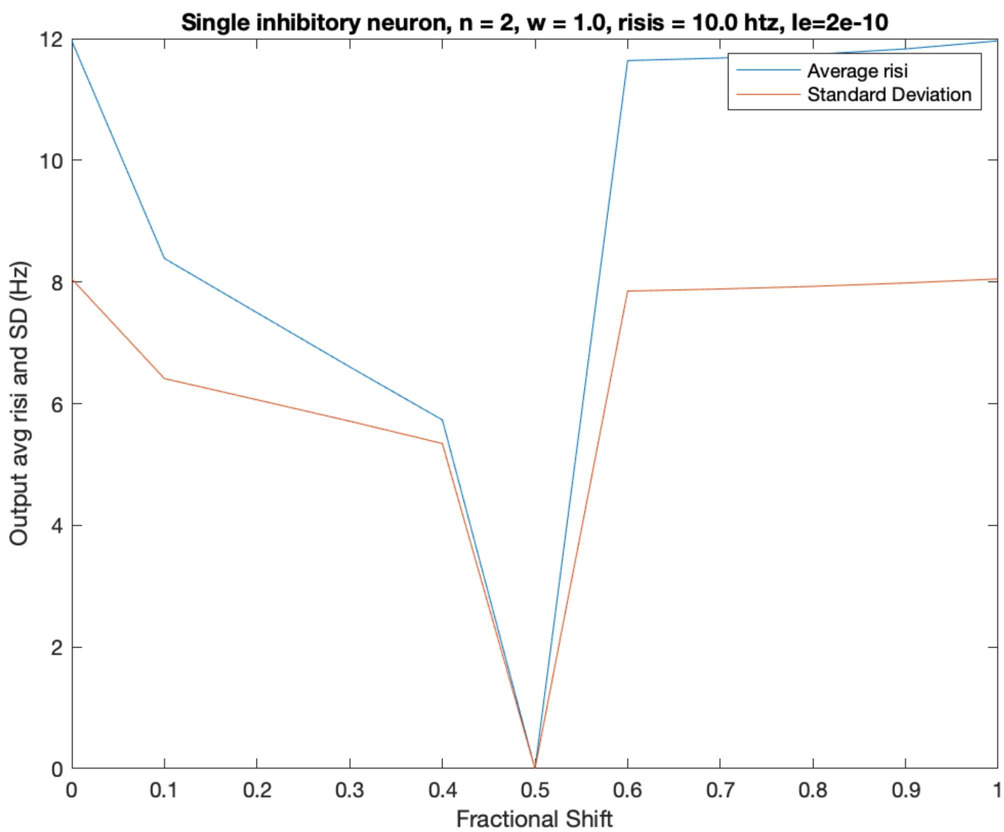

Figure 5: Single inhibitory neuron, $n = 2$, $w = 1.0$, $risis = 10.0$ htz, $Ie = 2e = -10$

1.6 Single inhibitory neuron, $n = 2$, $w = 0.6$, $risis = 20.0$ htz, $Ie = 2.1e = -10$

In Figure 6, we can see that the high firing rate of the inhibitory input neurons cause the output neuron to decrease its firing at a rapid rate, and then say inactive. Unlike the excitatory synapses, the inhibitory synapses with the added electrode current tend to make the output neuron's firing rate transition more gradually between firing and not firing. All the inhibitory synapse graphs tend to look more continuous.

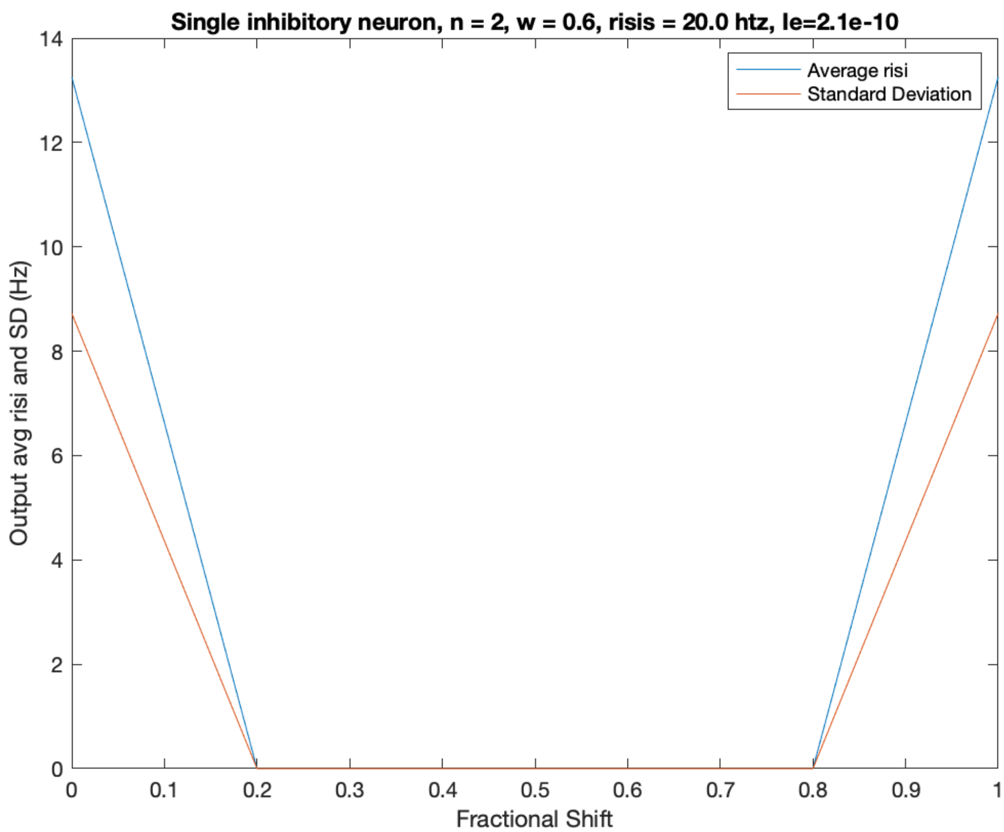

Figure 6: Single inhibitory neuron, $n = 2$, $w = 0.6$, $risis = 20.0$ htz, $Ie = 2.1e = -10$