Advanced Neural Networks - Homework 5

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November 6, 2019

1 Winner Takes All - 4 neurons

In this section, we simulate the Winner Takes All problem with a 4 neurons. In Figure 2 we can see with inputs of 1.0 and 0.95, the y3 neuron ends up "Winning" and the y4 neuron goes up to over 0.5 before getting suppressed.

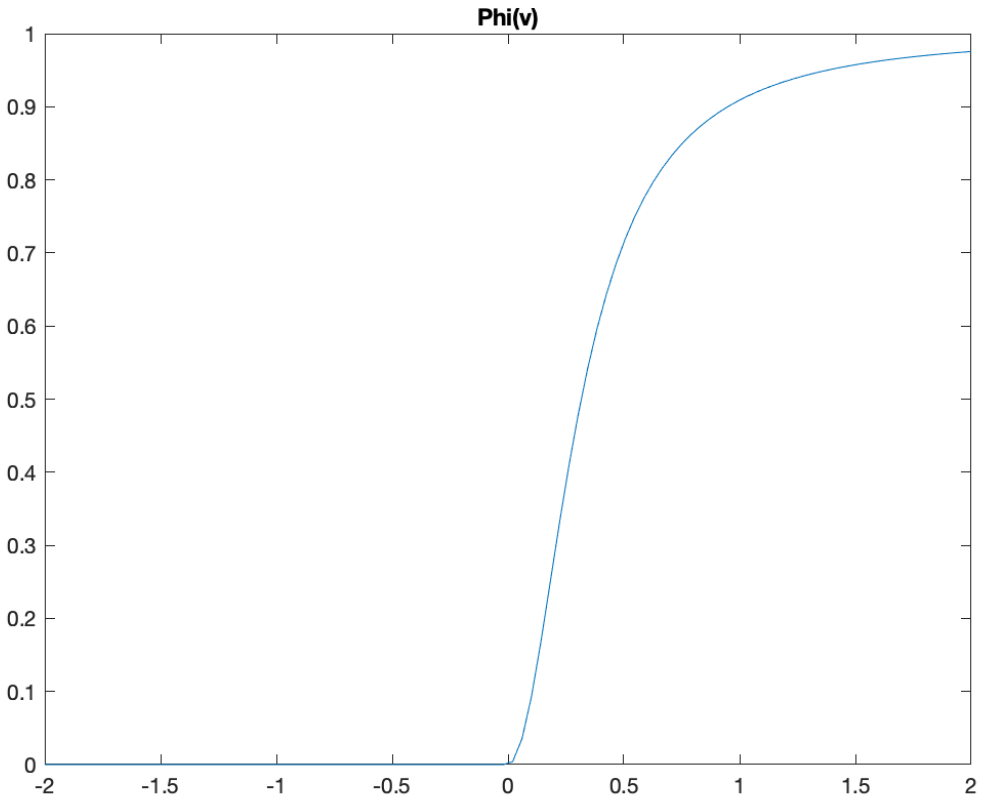

Figure 1:

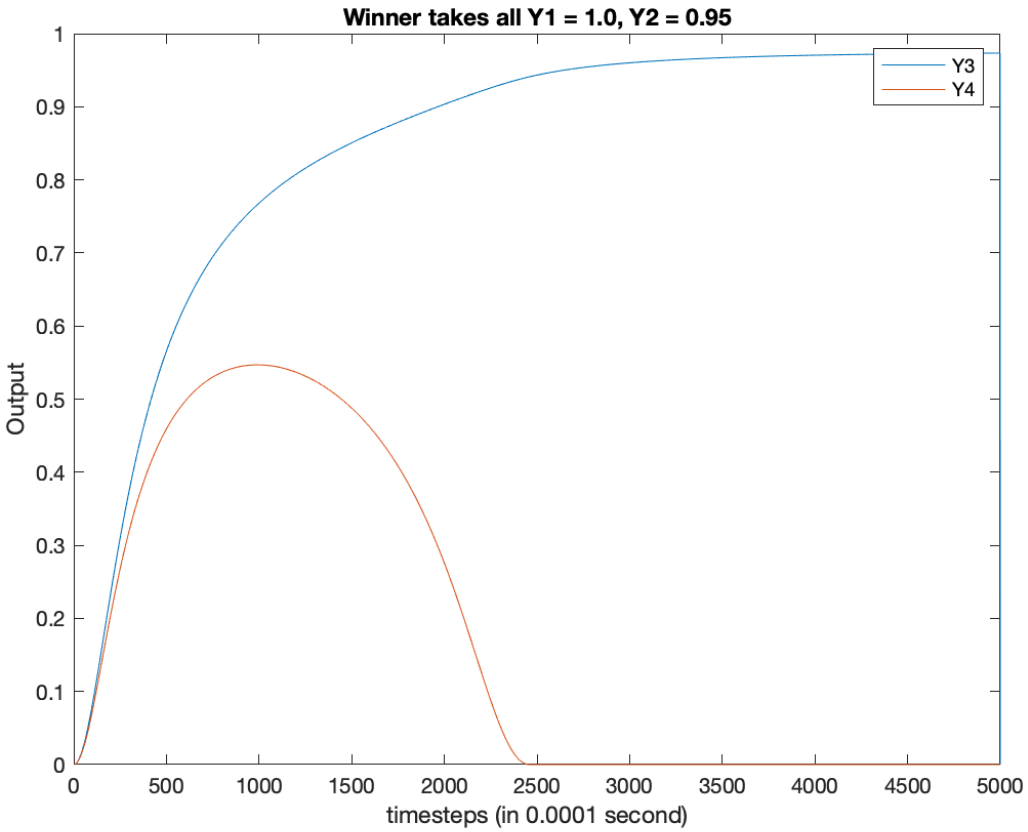
Winner takes all Y1 = 1.0, Y2 = 0.95
Y3
Y4
Output
timesteps (in 0.0001 second)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000

Figure 2:

In Figure 3, the input neurons are both set to 1.0, and they have equal lateral inhibitory weights. In this case, there is not a clear "winner", though y3 has a slightly higher output. This could be because y3 is calculated first in the loop iteration.

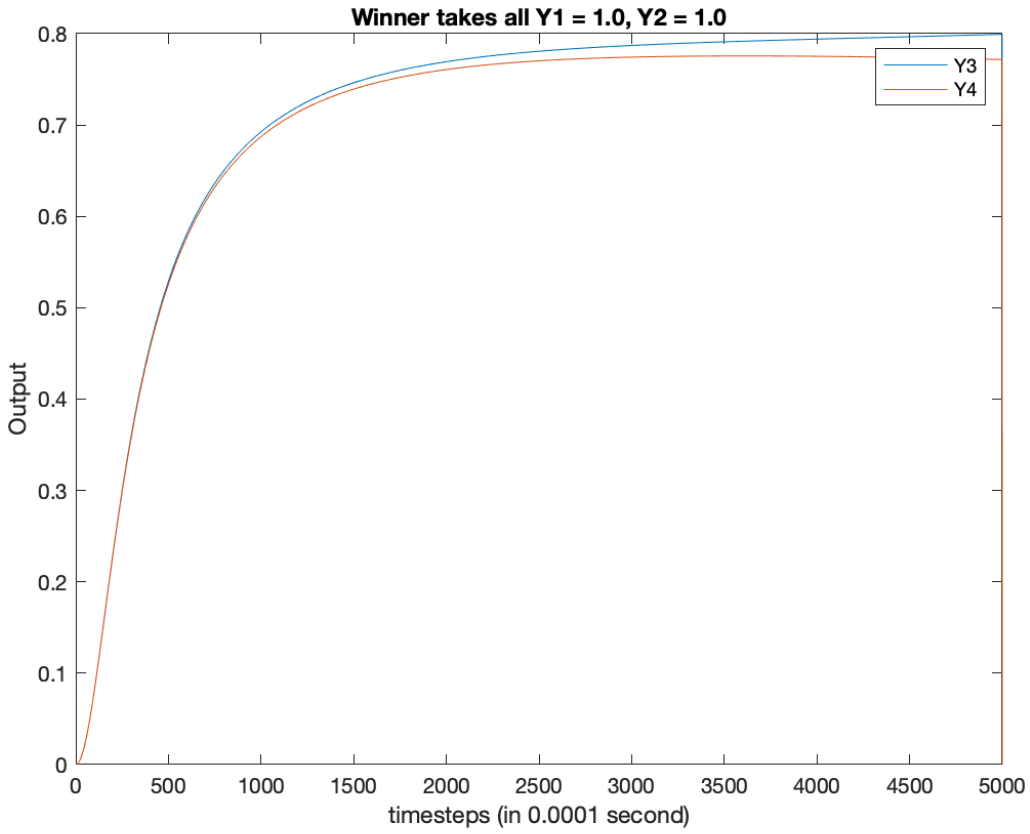

Figure 3:

In Figure 4, we have input neurons of 0.8 and 0.5. In this example, y4 is suppressed much more quickly and reached a stable state after 500 timesteps.

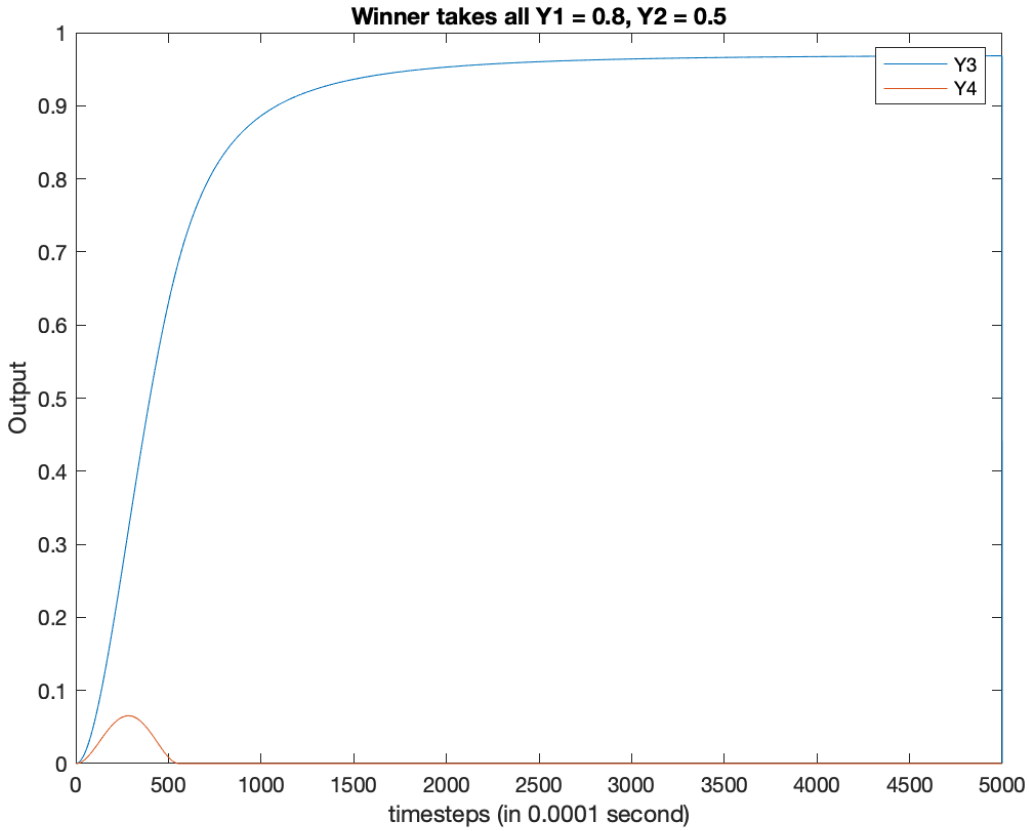

Figure 4:

In Figure 5 the lateral inhibitory weights were changed, so that $W_{34} = -1.0$ and $W_{43} = -1.0$. In this example, there was no "winner" selected, as y3 and y4 had similar outcomes. It looks like the lateral inhibitory weights have to have a greater absolute value in order to be effective in inhibiting the other neuron.

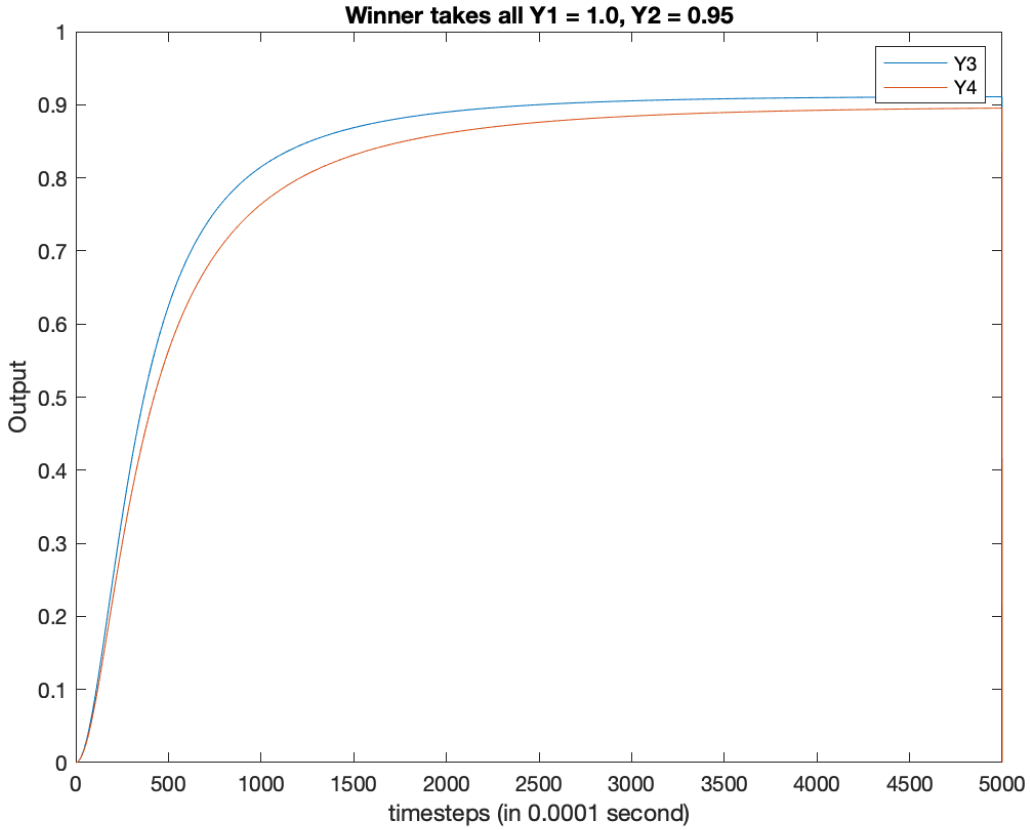

Figure 5: Winner take all where $W_{34} = -1.0$ and $W_{43} = -1.0$

2 Winner takes all - 5 neurons

In Figure 6, we have five neurons, where y1 inputs to y3 and y4, and y2 just inputs to y5. There are lateral inhibitory connections between y3 and y4, and also y4 and y5. In this example, y4 is suppressed immediately. This could be because y4 is being inhibited from both sides. The weight matrix for this example is below.

$$W = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & -\frac{3}{2} & 0 \\ 1 & 0 & -1 & 1 & -\frac{3}{2} \\ 0 & 1 & 0 & 1 & 1 \end{pmatrix}$$

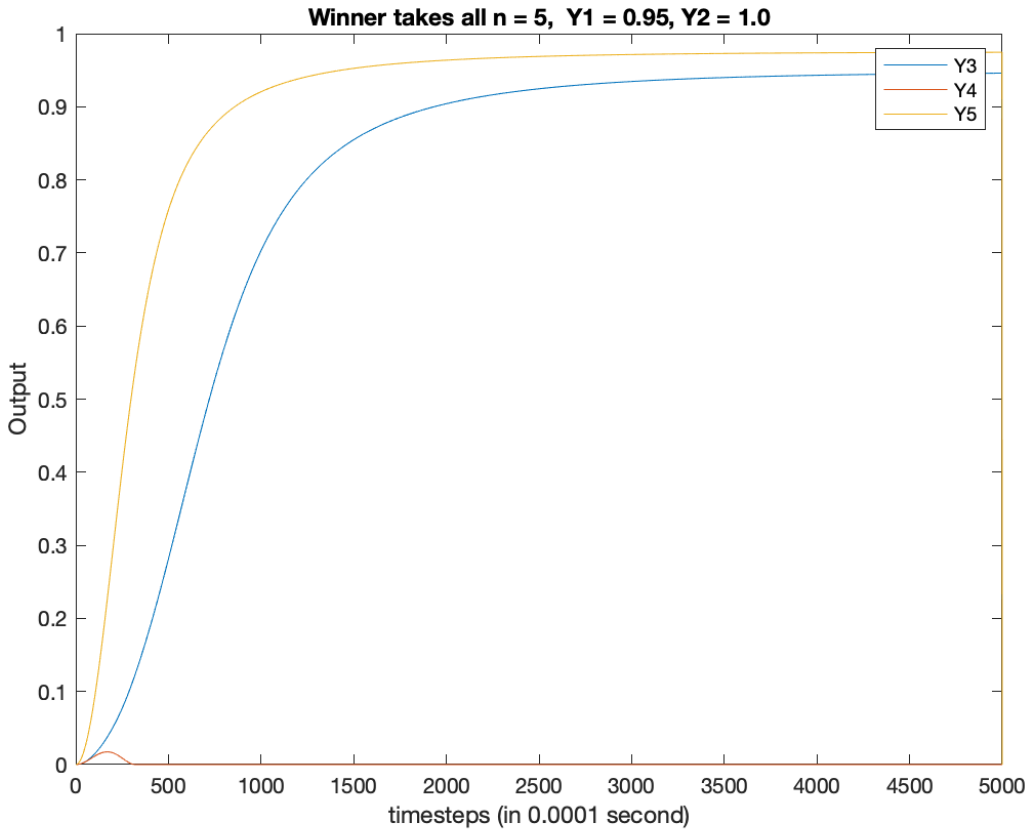

Figure 6:

In Figure 7, we have lateral inhibition between all three of the neurons in the second later. y3 inhibits y4, y4 inhibits y5, and y5 inhibits y3. The effects are much more interesting. y5 had the highest output, but all neurons had relatively high outputs.

$$W = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & -\frac{3}{2} & 1 \\ 1 & 0 & 1 & 1 & -\frac{3}{2} \\ 0 & 1 & -\frac{3}{2} & 1 & 1 \end{pmatrix}$$

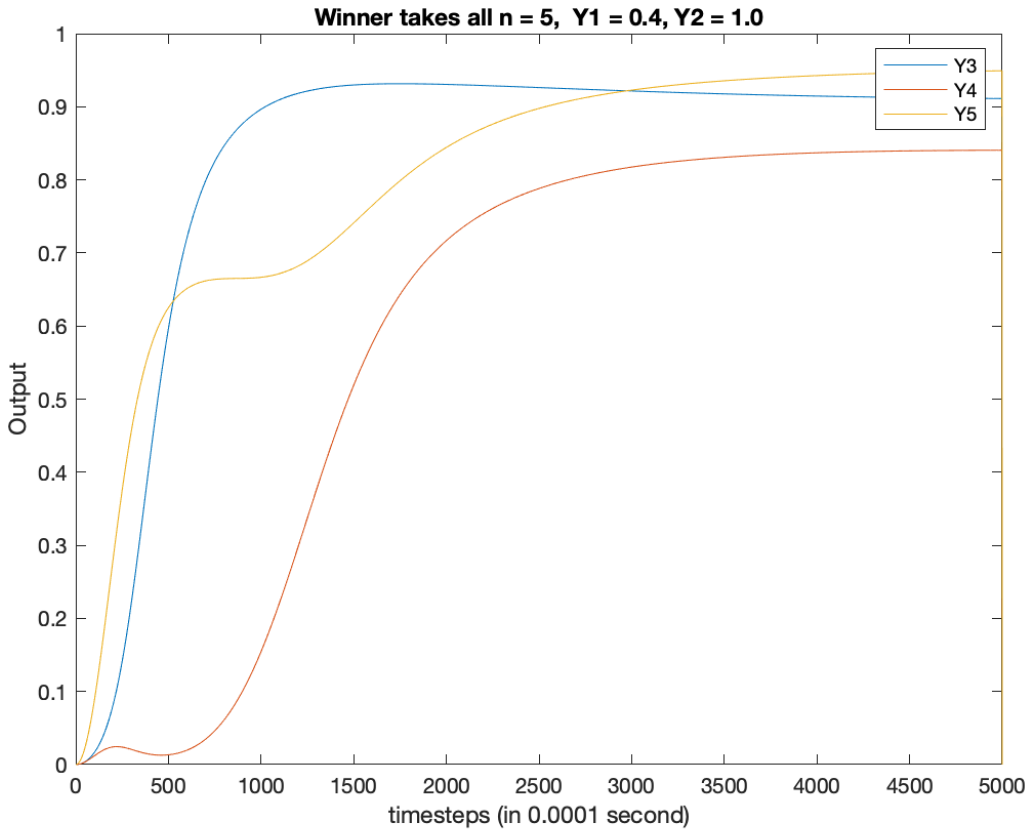

Figure 7:

In Figure 8, we have lateral inhibition between y3 and y4, and y4 and y5, but not between y3 and y5. y1 provides input to y3 and y4, and y2 provides input to y4 and y5. In this case, y4 has input from two neurons, but also lateral inhibition from two neurons. y5 has the highest output overall, followed by y4. y3 is inhibited early in the process.

$$W = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & -\frac{3}{2} & 0 \\ 1 & 1 & -1 & 1 & -\frac{3}{2} \\ 0 & 1 & 0 & 1 & 1 \end{pmatrix}$$

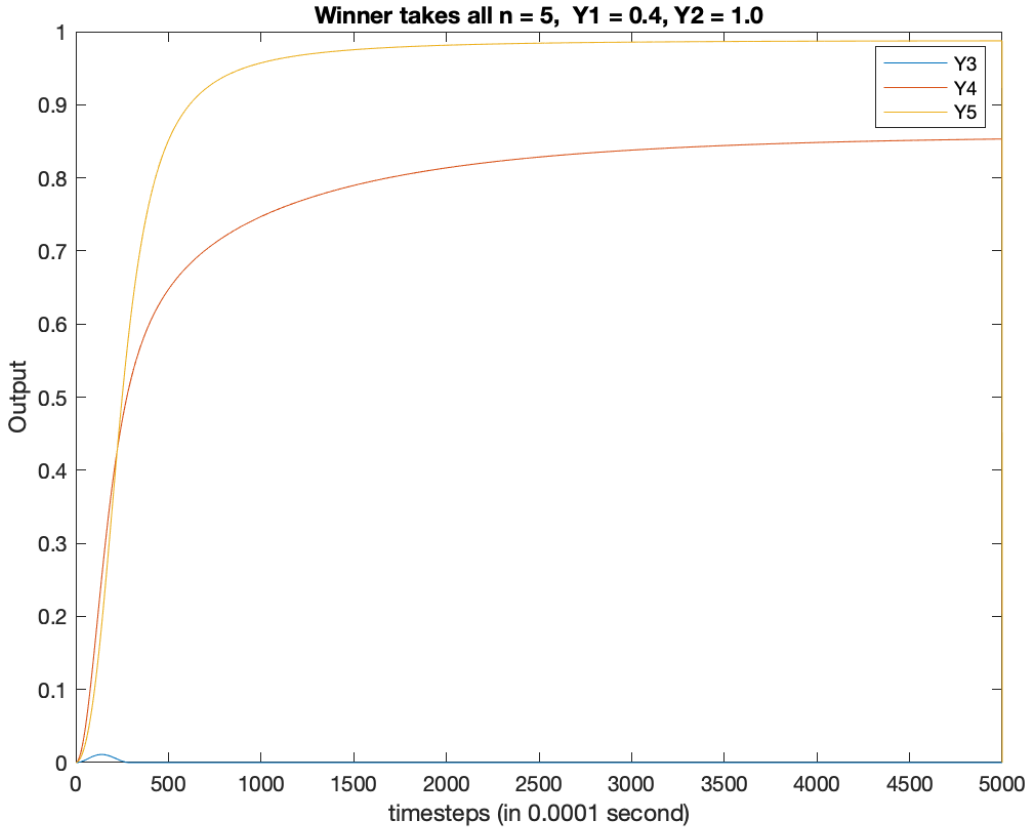

Figure 8: