Han Nguyen

CSC 527 – Homework 2

1. **Problem 1**
   a. If the bias/threshold value (b_k) is 0, x_1 is the excitatory signal, and x_2 is the inhibitory signal then the outcome of y_k neuron (table 01)

Table 01 – Outcome of y_k with b_k = 0

x_1	x_2	b_k	y_k
0	0	0	1
1	0	0	1
0	-1	0	0
1	-1	0	1

As shown in table 01, y_k will be fire (activate) whenever $x_1 = 1$ or $x_2 = 0$

   b. If the bias/threshold value (b_k) is 1, x_1 is the excitatory signal, and x_2 is the inhibitory signal then the outcome of y_k neuron (table 02)

Table 02 – Outcome of y_k with b_k = 1

x_1	x_2	b_k	y_k
0	0	1	1
1	0	1	1
0	-1	1	1
1	-1	1	1

As shown in table 02, y_k will always be fire (activate) because $b_k = 1 > 0$

   c. With only 2-input signals in Eq.1, there are 3 possible combinations:

- Excitatory and Excitatory

x_1	x_2
0	0
0	1
1	0
1	1

- Inhibitory and Inhibitory

x_1	x_2
0	-1
-1	0
-1	-1

- Excitatory and Inhibitory

x_1	x_2
-1	1
1	-1

d. With respect to b_k, the possible thresholds could be any value with real number (but it does not guarantee the outcome y_k will always be activate).

e. As shown on the table 01 & table 02, since the 2-input signals does not change, then we could observe that the outcome of y_k are depending on the threshold value (b_k).
Thus, if we plan to implement the MP neuron model in Eq.1 to has difference outcome, then we could change b_k value with respects x_1 is the excitatory signal, and x_2 is the inhibitory signal then:

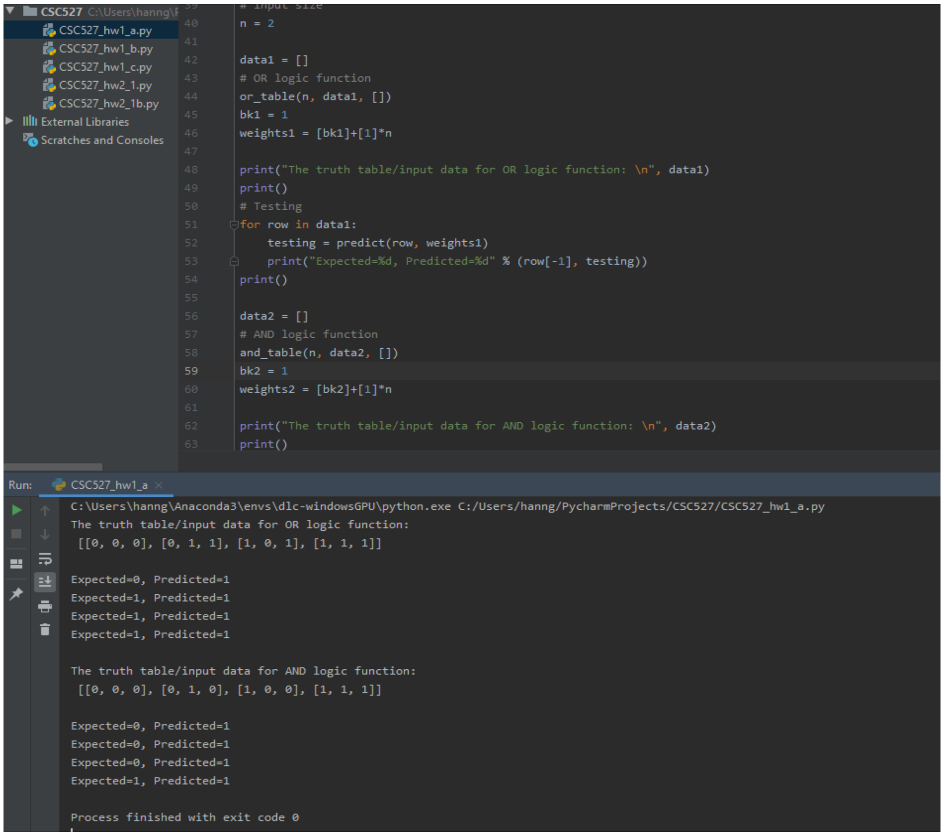
- If $b_k = 0$ and ($x_1 = 1$ or $x_2 = 0$), then the outcome $y_k = 1$
- If $b_k = -1$ and ($x_1 = -1$ or $x_2 = -1$), then the outcome $y_k = 0$
- If $b_k <= -2$, x_1 and x_2 could be any number, then the outcome $y_k = 0$
- If $b_k >= 1$, x_1 and x_2 could be any number, then the outcome $y_k = 1$

2. Problem 2

a. Assume that all the input signals are excitatory, then all combinations of 2-input MP neuron to activate $y_k = 1$:

x_1	x_2	b_k	y_k
0	0	1	0
0	1	1	1
1	0	1	1
1	1	1	0

b. No, it is impossible to implement this neuron using the Python program in Hw1.
Because in the Hw1, its condition is that any value of $b_k > -1$ the MP neuron will always be in the firing state ($y_k = 1$) including the scenario when $x_1 = x_2 = 1$, and it this problem, the condition for MP neuron will activate is either (x_1 or x_2) = 1 but not both.
The results from hw1 with $b_k = 1$ is shown below (figure 03).



```
# input size
n = 2

data1 = []
# OR logic function
or_table(n, data1, [])
bk1 = 1
weights1 = [bk1]+[1]*n

print("The truth table/input data for OR logic function: \n", data1)
print()
# Testing
for row in data1:
    testing = predict(row, weights1)
    print("Expected=%d, Predicted=%d" % (row[-1], testing))
print()

data2 = []
# AND logic function
and_table(n, data2, [])
bk2 = 1
weights2 = [bk2]+[1]*n

print("The truth table/input data for AND logic function: \n", data2)
print()
```

```
C:\Users\hanng\Anaconda3\envs\dlc-windowsGPU\python.exe C:/Users/hanng/PycharmProjects/CSC527/CSC527_hw1_a.py
The truth table/input data for OR logic function:
 [[0, 0, 0], [0, 1, 1], [1, 0, 1], [1, 1, 1]]

Expected=0, Predicted=1
Expected=1, Predicted=1
Expected=1, Predicted=1
Expected=1, Predicted=1

The truth table/input data for AND logic function:
 [[0, 0, 0], [0, 1, 0], [1, 0, 0], [1, 1, 1]]

Expected=0, Predicted=1
Expected=0, Predicted=1
Expected=0, Predicted=1
Expected=1, Predicted=1

Process finished with exit code 0
```

Figure 03 – Question 2b

c. Assume one input signal is excitatory and the other input signal is inhibitory

All possible combinations:

x_1	x_2	b_k	y_k
0	0	0	0
1	0	0	1
0	-1	0	0
1	-1	0	1

No, it is impossible to implement this neuron using the Python program in Hw1.
Because in this problem, the condition for MP neuron will activate is either (x_1 or x_2) = 1 but not both. However, if we import these input signals then the hw1 will give the outcome as:

x_1	x_2	b_k	y_k
0	0	0	1
1	0	0	1
0	-1	0	0
1	-1	0	1

d. Yes. It is possible to create a network of 2-input MP neurons that will activate if one but not both input signals has a value of 1.
Let us assume that all input is excitatory signal (0,1), then we will create a condition that if (x1 = 1 || x2 = 1), yk = 1, else yk = 0.