## Week 6 Exercises: Neural Networks I

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### Week 6 Exercises: Neural Networks I

(1.0 points possible)

For these exercises, you should review the notes on Neural Networks.

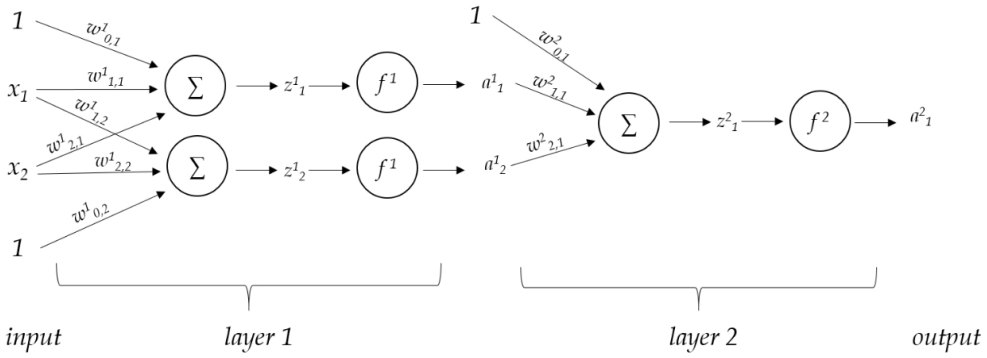
# 1) Prediction

Consider the following data set:

```
X = np.array([[0, 1, 2],
              [0, 1, 2]])
Y = np.array([[0, 1, 0]])
```

The columns of X and Y are the data points and corresponding labels.

We will be looking at the behavior of the following simple two-layer network:




Assume that within each layer, each unit has the step activation function $f(z)$ given by

$$f(z) = \begin{cases} 1 & \text{if } z > 0 \\ 0 & \text{otherwise} \end{cases}.$$

Let the weights in the first layer (layer 1) be:

- $w^1_{0,1} = -0.5, w^1_{1,1} = 1, w^1_{2,1} = 0$
- $w^1_{0,2} = 1.5, w^1_{1,2} = -1, w^1_{2,2} = 0$

**1A)** Enter a matrix $Z$ where each column represents the outputs of the hidden units ($f^1(z^1_1)$ and $f^1(z^1_2)$) for each of the input vectors in `X`.

Enter a Python list of lists [[a,b,c],[d,e,f]], each list is a row of the matrix.

[[0, 1, 1], [1, 1, 0]]

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**1B)** Pick weights for the second layer $w^2_{0,1}, w^2_{1,1}, w^2_{2,1}$ so that the desired outputs are predicted correctly.

Enter a Python list of 3 numbers $[w^2_{0,1}, w^2_{1,1}, w^2_{2,1}]$ [-2, 1.5, 1.5]

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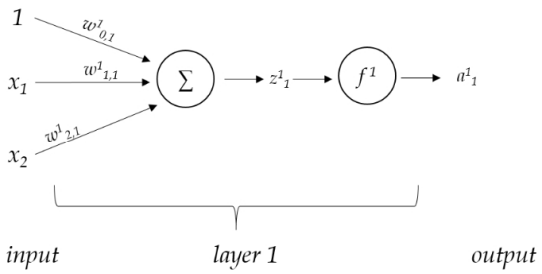
## 2) Training

Now, we will consider the classification of a different set of `X` and `Y` data, with a different single layer network having the following structure and activation function:

$$z = w^1_{1,1}x_1 + w^1_{2,1}x_2 + w^1_{0,1}$$

In this network we have $f^1(z) = z$, so our output $a^1_1 = z^1_1$.




Assume the initial weights are $w^1_{0,1} = 1, w^1_{1,1} = 1, w^1_{2,1} = 1$, and the step size is 0.5 (not usually a good idea, but okay for now).

The current training example is $x^{(i)} = [1, 2]^T, y^{(i)} = -1.$

**2A)** What is the output value $a^1_1$, given current input $x^{(i)}$ and the current weights?

Enter a number 4

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**2B)** What will the values of weights $w^1_{0,1}, w^1_{1,1}, w^1_{2,1}$ be after one step of stochastic gradient descent at the given training example $x^{(i)} = [1, 2]^T, y^{(i)} = -1$ using our definition of hinge loss $L_h(v) = max(0, 1 - v)$?

Enter a Python list of 3 numbers $[w^1_{0,1}, w^1_{1,1}, w^1_{2,1}]$ (to 3 decimal places)

[0.5, 0.5, 0]

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**2C)** What would the output value $a^1_1$ be, for this same input $x$, with these new weights?

Enter a number 1

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**2D)** What would happen to the $v_i$ if we did another SGD update, for that same point, with step size 0.5, as before?

Enter a Python list of 3 numbers $[w^1_{0,1}, w^1_{1,1}, w^1_{2,1}]$ [0, 0, -1]

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**2E)** Now what would the output be?

Enter a number -2

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**2F)** What if we do one more update, for that same point?

Enter a Python list of 3 numbers $[w^1_{0,1}, w^1_{1,1}, w^1_{2,1}]$ [0, 0, -1]

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