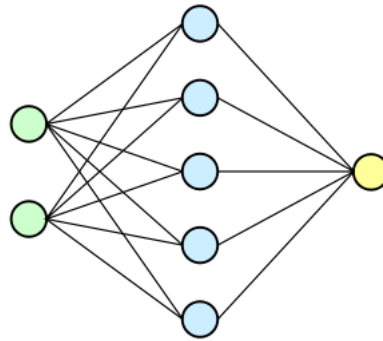# Neural Networks

Exercises

1. Which of the following are true about neural networks? *(Select all that apply)*

    a. Neural networks are universal approximators.

    b. Neural networks have no internal, automated process for selecting useful inputs.

    c. Neural networks are easy to interpret and thus are very useful in highly regulated industries.

    d. Neural networks cannot model nonlinear relationships.

2. For the neural network shown below, how many parameters must be estimated? While no bias terms are drawn in this network, you should assume they exist for both the input and the hidden layer.

3. Another neural network has two inputs, X_1 and X_2. One of the activation functions (i.e. the function linking the inputs to one of the hidden units) is:

$$H_1 = \tanh(3 - 2X_1 + 4X_2).$$

For this function find, if possible, the bias. If not possible, explain.

4. *(True/False)* When a neural network for a binary response has no hidden layer then the model it is fitting is mathematically equivalent to a logistic regression.

5. *(True/False)* The hyperbolic tangent function is a function with a range from 0 to 1.

6. The following parameter output comes from a neural network run on a subset of three variables from the concrete dataset. Those input variables are:

(a) fineagg

(b) slag

(c) superplastic

The network created here has one hidden layer with two hidden units and a bias term in the hidden layer.

```
The NEURAL Procedure

                    Optimization Results
                    Parameter Estimates

                                              Gradient
                                              Objective
 N Parameter                     Estimate     Function

 1 fineagg_H11                   2.049942     0.015858
 2 slag_H11                      0.605445     0.017060
 3 superplastic_H11             -2.294231     0.021655
 4 fineagg_H12                  -1.308505    -0.080962
 5 slag_H12                     -2.626001     0.027747
 6 superplastic_H12             -2.509042    -0.032177
 7 BIAS_H11                     -1.117641    -0.009181
 8 BIAS_H12                      3.832763    -0.031624
 9 H11_strength                 -7.739118     0.000114
10 H12_strength                 -7.258123     0.000113
11 BIAS_strength                38.415742     0.000076675

Value of Objective Function = 202.37832594
```

a. Draw the network and label each edge in the network with its associated parameter value.

List of Key Terms

Input Layer

Hidden Layer

Hidden Unit

Sigmoid Function

Bias

Output Layer

Backpropagation