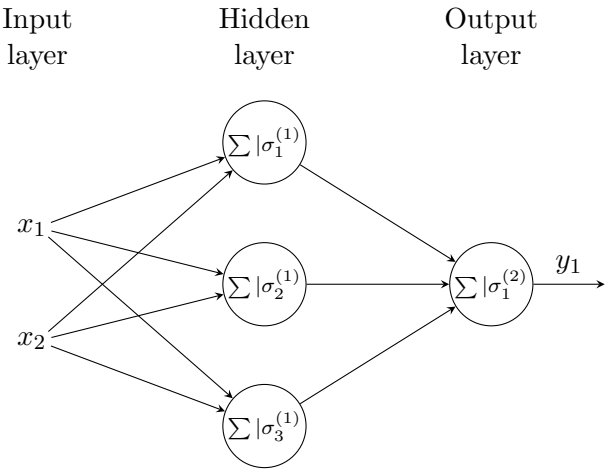
Exercise Sheet 9

1. Exercise: Basic Neural Network Model

The goal of this exercise is the implementation of forward, backward, and update steps for a basic neural network with the following architecture. The implemented methods are used to train the network for a binary classification task. All activation functions σ are sigmoid functions.



(a) Load the dataset `data_exercise_mlp.pkl` provided in the Moodle-Course.

(b) Split the dataset into random train and test subsets, with the train subset accounting for 80% of the total data.

(c) Implement the Neural Network class with the following functions.

```
class NeuralNetwork():
    def __init__(self, feat_dim, hidden_dim , out, lr):
        '''Initialize the network using the input feature
        dimension, the hidden dimension, output dimension
        and the learning rate lr.'''

    def forward(self, x):
        '''Implement the forward path of the neural
        network and return the class prediction.'''
        return y

    def backward(self, loss):
        '''Implement the backward path of the neural
        network and return the gradients for the
        learnable parameters.'''
        return gradients
```

```
def update_weights(self, gradients):
    '''Update the network's learnable parameters
    using SGD. '''
```

(d) The binary Cross-Entropy Loss function is used as error metric for the binary classification. Implement a loss function accordingly.

(e) Instantiate your `NeuralNetwork` class with a learning rate (lr) of 0.001 and the correct model dimensions. The weights are randomly initialized for values within the range $[-1, 1]$.

(f) Iterate over your training data for $E = 100$ epochs and update your model weights for each prediction step. Save your loss values in an appropriate data structure and plot your loss curve of the training.

(g) Test your trained model on the test dataset and generate a confusion matrix to evaluate your model.

(h) Is your network Overfitting or Underfitting? If yes, what has to be done to overcome this problem? Explain your answer.

(i) Generate a comparable plot as follows that shows both the actual labels from the test data and the predicted labels.