Assignment

Practical Assignment #4

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1 Input Data

1.1 Problem 1: Simple network

In the first problem a small neural network with 4 Layers was provided. In addition

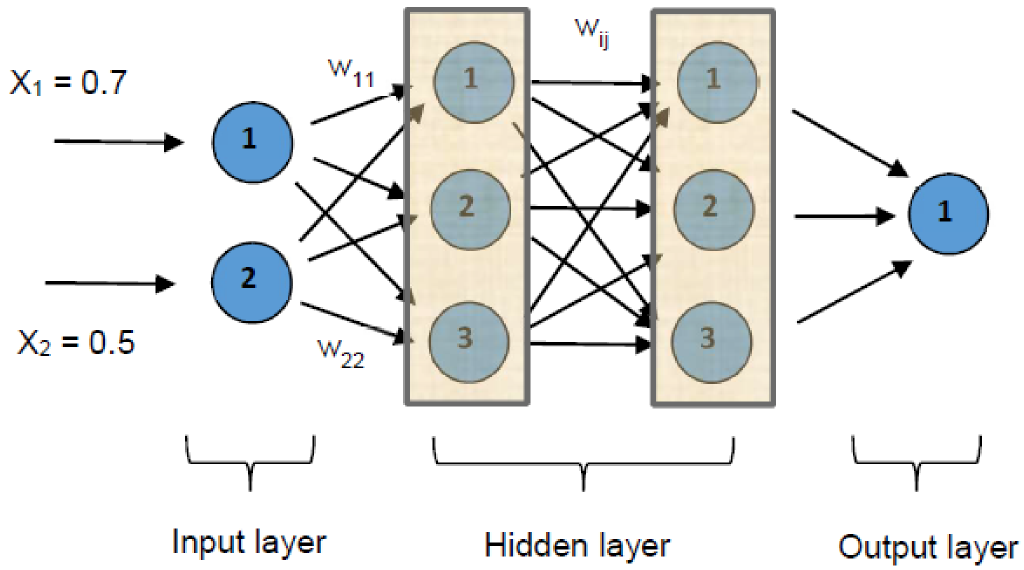


Figure 1.1: Simple neural network for problem 1

the input values and the weights for the connections of the fully connected layers were provided.

1.2 Problem 2: Backpropagation

Similarly to the first problem a small neural network was provided, in this case the network consists only of a single neuron with two inputs and an activation function Z.

Input layer:

$X_1 = 0.7$, $X_2 = 0.7$

Weights between Input layer – 1st hidden layer:

$W_{11} = 0.9$, $W_{12} = 0.3$, $W_{13} = 0.9$
$W_{21} = 0.1$, $W_{22} = 0.2$, $W_{23} = 0.4$

Weights between 1st hidden layer – 2nd hidden layer:

$W_{11} = 0.1$, $W_{12} = 0.8$, $W_{13} = 0.4$
$W_{21} = 0.5$, $W_{22} = 0.1$, $W_{23} = 0.6$
$W_{31} = 0.6$, $W_{32} = 0.7$, $W_{33} = 0.3$

Weights between 2nd hidden layer and output layer:

$W_{11} = 0.5$, $W_{21} = 0.7$, $W_{31} = 0.3$

Figure 1.2: Data provided for problem 1

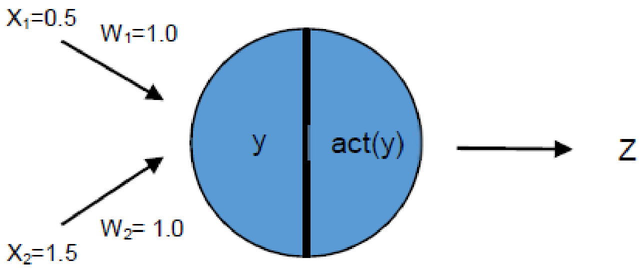
1.3 Problem 3: Artificial neural network

For the third problem a small neural network with 3 Layers was provided in form of a python script using the Pytorch library, in addition to the network a dataset called **One-hundred plant species leaves data set Data Set**. This dataset contains the leaves of 100 different plant species each represented with 16 examples of real leaves, which are themselves represented by a feature vector with 64 different elements representing different features.

1.4 Problem 4: Gradient Descent

The input data set consists of 1000 generated points with a X value between -5 and 5. The Y value is calculated with the formula $y = mx + c$ where m and c are assumed by us. Applying a random noise leads to the dataset which is shown in Figure 1.4

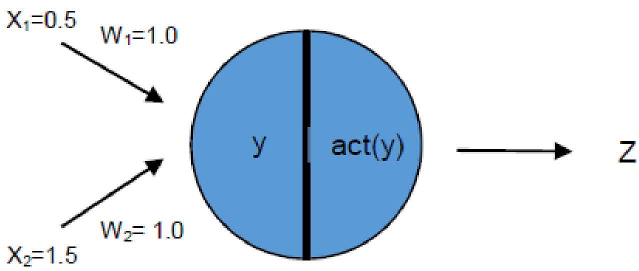
Further a jupyter notebook is provided which generate these data and provides a script which only need to be completed with the calculation of the gradient and updating and weight update for m and c.



$$y = w_1 \cdot X_1 + w_2 \cdot X_2 + b$$

Z = sigmoid(y)
b = 2.0
Z′ = 1.0

Figure 1.3: Single neuron for problem 2



$$y = w_1 \cdot X_1 + w_2 \cdot X_2 + b$$

Z = sigmoid(y)
b = 2.0
Z′ = 1.0

Figure 1.4: Generated input data of problem 4

2 Methods

2.1 Problem 1: Simple network

The task of problem 1 is to calculate the output of the given network using matrix operations. In order to execute the operations firstly the operation should be defined. It can be formulated as $x_j = f(x_i * w_{ij})$ with x_j being the output of layer j, x_i being the output of layer i, w_{ij} being the weight matrix for the connections between the layers i and j and $f()$ being the activation function of layer j which in our case is always the sigmoid function.

The matrices for the steps are the following:

- The input vector $x_0 = \begin{bmatrix} 0.7 & 0.5 \end{bmatrix}$
- The weight matrix $w_01 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$
- The weight matrix $w_12 = \begin{bmatrix} 0.9 & 0.3 & 0.9 \\ 0.1 & 0.2 & 0.4 \end{bmatrix}$
- The weight matrix $w_23 = \begin{bmatrix} 0.1 & 0.8 & 0.4 \\ 0.5 & 0.1 & 0.6 \\ 0.6 & 0.7 & 0.3 \end{bmatrix}$
- The weight matrix $w_34 = \begin{bmatrix} 0.5 & 0.7 & 0.3 \end{bmatrix}$

The final equation can be summarized as:
$f(\,f\,(\,f(\,f(x_0 * w_01) * w_12) * w_23) * w_34$

2.2 Problem 2: Backpropagation

2.3 Problem 3: Artificial neural network

2.4 Problem 4: Gradient Descent

3 Results

3.1 Problem 1: Simple network

3.2 Problem 2: Backpropagation

3.3 Problem 3: Artificial neural network

3.4 Problem 4: Gradient Descent

4 Discussion

4.1 Problem 1: Simple network

4.2 Problem 2: Backpropagation

4.3 Problem 3: Artificial neural network

4.4 Problem 4: Gradient Descent

5 Sourcecode

6 Bib

42 - the answer [1]

Bibliography

[1] Douglas Adams. *The hitchhiker's guide to the galaxy.* Pan Books, London, 2009.