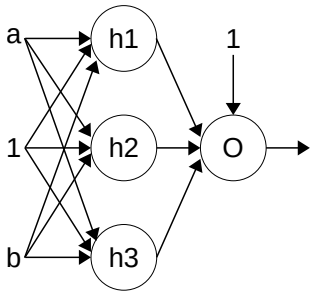
Programming Assignment 3

Write a program that implements a simple sigmoid neural network using the delta rule presented in the lecture. Use the following activation function:

$$\hat{y} = \frac{1}{1 + e^{-net}} \text{ and } net = \sum_i w_i \cdot x_i$$

where $\vec{w}$ is the vector of weights including the bias (w_0). Treat all attributes and weights as double-precision values.
Given are the two data sets named *Gauss3* and *Gauss4* as csv files. Your program should be able to read both data sets and treat the *last* value of each line as the class (1 being positive and 0 being negative). Your task is to correctly implement the backpropagation algorithm (as taught in lecture) with single sample correction (means you update the weights every data point). For that purpose, you are required to use a fixed architecture (for the sake of ease) as given in the Figure below.



The solution for *Gauss3* with a learning rate of $\eta = 0.2$ and 2 full iterations (meaning two times going through all data points) is given. The format is given by the header of the file. Here, `delta_h1` represent the error of `h1` and `h1` the output of `h1` itself. The same is true for other nodes. The first line after the header indicates the initialization for the weights. Please use this initialization as a hardcoded start also for the Gauss4 data set. Every other lines represents the weights after updating and the output and error for that iteration along with the original data point. For each data set, you can acquire one point, if the solution of your program returns correct results. If the program fails or the data format is incorrect, you will get zero points. Machine learning libraries are not allowed.
Your program must *at least* accept the following parameters:

1. **data** - The location of the data file (e.g. /media/data/car.csv).
2. **eta** - The learning rate for the backpropagation.
3. **iterations** - The number of iterations to calculate.

One iteration hereby always means, that all data points are touched exactly once. Your program will be called like this by the VPL evaluation (remember to call your file student.py!):

```
python3 student.py --data Gauss3.csv --eta 0.2 --iterations 2
```

The final program code must be uploaded to Moodle until Monday, the 11th of December 2023, 8:00am. *2 points*