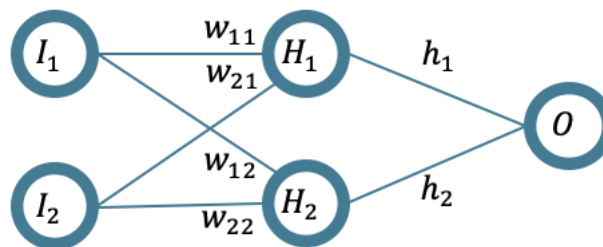


# [AAA] Advanced Analytics and Applications

Summer Semester 2021

## Problem Set 6 –Neural Networks & BackProp

1. Calculation Task: Assume we have the following fully connected neural network with 2 input nodes, 2 hidden nodes and one output node.



Furthermore, we have one training dataset  $[(I_1 = 2, I_2 = 3), O = 1]$ . The initial weights are set as following

$$w_{11} = 0.11 \quad h_1 = 0.14$$

$$w_{21} = 0.21 \quad h_2 = 0.15$$

$$w_{12} = 0.12$$

$$w_{22} = 0.08$$

Finally, we set the learning rate to  $\eta = 0.05$ , use a MSE loss function and trivial linear activation functions (i.e., identity function). Calculate the updated weights using the BackProp (just one step).

Proceed as follows:

- Predict the linear output based on the given training data point.
- Calculate the error using the loss function.
- Calculate the derivative of the loss function with respect to each weight.
- Update the current weights  $w_{ij}^k$  (similar for h) based on the following formula

$$w_{ij}^{k+1} = w_{ij}^k - \eta \partial L / \partial w_{ij}^k$$

- Using the updated weights, calculate the new prediction.

## 2. Programming Neural Networks:

- a. Our objective is to classify news articles with deep learning.
- b. Load the Reuters Dataset (similar to IMDB) as follows:

```
# Loading the reuters dataset
from keras.datasets import reuters
(train_data, train_labels), (test_data, test_labels) = reuters.load_data(num_words=10000)
```

- c. Read dataset description  
<https://keras.io/api/datasets/reuters/>
- d. Model a suitable deep neural network at least with two hidden layers and an output layer with 46 nodes (for each news category one node).
- e. Plot the training and validation loss from 1 epoch to 20 epochs.
- f. What happens when we reduce the nodes in the second hidden layers to 2 nodes?

## 3. Regression with Deep Learning

- a. Our objective is to train a deep learning network to predict housing prices (i.e., regression task).
- b. Load the Boston Housing Dataset as follows:

```
from keras.datasets import boston_housing
(train_data, train_targets), (test_data, test_targets) = boston_housing.load_data()
```

- c. Read the dataset description  
[https://keras.io/api/datasets/boston\\_housing/](https://keras.io/api/datasets/boston_housing/)
- d. Design and implement a deep learning architecture to predict housing prices.
- e. Since the dataset is quite small, the variance of the validation set might be too high. To cope, we use k-fold cross validation. Implement k-fold cross validation and retrain the deep learning network accordingly.
- f. How many epochs should we use to train our model?