# AI5031: Machine learning, exercise sheet 3

## 1 Preparations

Download the file linclass_skeleton .py from the E-Learning site and execute it with python3. If you are on a non-graphical terminal, download the Python file via
wget http://www.gepperth.net/alexander/downloads/linclass_skeleton.py
The program should load the data into traind and trainl. Please inspect the code!

## 2 ReLU

Implement the ReLU function as a Python function r(X) where X is a numpy array of arbitrary shape. Call the function from __main__ and print out results for $X = \begin{pmatrix} -1 & -1 & 5 \\ 1 & 1 & 2 \end{pmatrix}$. Hint: use mask indexing to set the negative parts of X to zero!

## 3 Softmax

Implement the softmax function in the method LinearClassifier .S. It should accept a 2D np array X and return a np array of the same dimensions. The usual assumptions that rows of X contain data samples holds here as well. Caution: you may need to work with reshape and broadcasting here to implement the softmax formula! Call the function from __main__ and print out results for $X = \begin{pmatrix} -1 & -1 & 5 \\ 1 & 1 & 2 \end{pmatrix}$. Perform the computation on paper to verify your results!

## 4 Implementing the cross-entropy loss

Implement the cross-entropy loss in the method LinearClassifier .loss. It should receive two 2D np.array's Y and T, where Y is computed ny LinearClassifier .f. Test it, from __main__, with the first digit and first label of the train data! Test with 2D matrices as well, each having a single row. The first row of Y should be (0,0,0,0.5,0,0.3,0,0.2, 0, 0), the first row of T should be (0,0,0,0,1,0,0,0,0,0).

## 5 Implementing the model function

Implement a linear classifier in the method LinearClassifier .f. It should receive a 2D np.array with $N$ rows and 784 columns, and produce a 2D np.array of N rows and 10 columns (why?). Test it, from __main__, with the first digit from the training data!