

# Artificial Intelligence: Assignment 4 - Neural Networks

**Submit by: 06/05/2019**

April 6th, 2019

## Neural Networks

Maximum score: 2 points

This assignment was first proposed by Michael Mandel as part of the requirements to complete a neural network course in the computer science department of Ohio State University, USA. The original assignment can be found here: <http://mr-pc.org/t/cse5526/pdf/proj1.pdf>. The course on neural networks can be found here: <http://mr-pc.org/t/cse5526>.

Implement a two-layer Multi Layer Perceptron (MLP) with backpropagation training. Train it to solve the parity problem: The network will be given an input vector of 1s and 0s and should output a single value: 1 if the input pattern contains an odd number of 1s and 0 if it contains an even number of 1s. Follow the implementation and training algorithm introduced in the textbook. More material can be found in the excellent online book by Mackworth and Poole at <https://artint.info/2e/html/ArtInt2e.Ch7.S5.html>.

Use the following implementation details:

- Use 4 binary input elements, 4 hidden units, and one output unit
- Use a logistic sigmoid activation function,  $f(v) = \frac{1}{1+e^{-v}}$ , for all units.
- Initialize all weights and biases to uniform random numbers between -1 and 1.
- Stop the learning procedure when an absolute error (difference) of 0.05 is achieved for every training pattern.

Once you have implemented the model and training algorithm, perform the following experiments:

- Vary the value of the learning rate  $\lambda$  from 0.05 to 0.5 in increments of 0.05, and report the number of training epochs required to meet the stopping criterion for each choice of  $\lambda$ .
- Fix the learning rate and vary the number of input and hidden units. Report the number of training epochs required to meet the stopping criterion for each setting. Discuss patterns that emerge or “regimes” of behavior.

Once you studied the behaviour of your neural network on this simple task, use the datasets found here: <https://pjreddie.com/projects/mnist-in-csv/> to train a model to recognize digits.

You need to turn in:

- A 1-5 page summary report, including 1-2 plots of relevant results
- Your source code

Submission will be done via Moodle.