

Artificial Intelligence: Assignment 4 - Neural Networks

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Neural Networks

Artificial neural networks, a simplified model that is inspired by the brain neural system, can be implemented in various flavours. In this assignment you will implement your own neural network from scratch. Using as a reference the material available in Chapter 22 of our textbook, *Artificial Intelligence: a Modern Approach*, by Peter Norvig and Stuart Russell (4th edition), implement an algorithm for a multi-layer perceptron (feed-forward network) and train with backpropagation learning. Start with two layers and try adding some more layers. 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. Use the following basic implementation details:

- Use 4 binary input elements, 4 hidden units, and one output unit
- Use a logistic sigmoid activation function, $f(v) = 1 / (1 + \exp(-v))$ 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 λ 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 λ .
- 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.

Try your MLP program with the classical MNIST dataset and report results for loss and accuracy. Train and test sets for MNIST in CSV (Comma Separated Values) format can be found [here](#).

What to deliver?

1. Written report

Organization:

Introduction

- What is a neural network?
- What is it good for?

Algorithms and architectures for neural networks

- search books and the internet for the most popular algorithms
- explain differences among them
- discuss about how the characteristics of the networks can affect results: number of layers, number of neurons in each layer, learning rate, dropout, number of epochs etc

Implementation

- language
- data structures used and justification for using them
- organization of your code

Results

- report the results (loss and accuracy for each dataset) for the test set

Final Comments and Conclusions

2. source code and how to compile, run etc, as well as the runtime environment used to run and test your program. The program must run from the command line.

As usual, submission will be done through Moodle UP.