

Deep learning Assignment 1 (2019)

MPhil in Computational Biology

March 15, 2019

If there are errors found, I will update the assignment on the web. **Due date: TBC**

Please submit your report to moodle, anonymised as before. Your report must be a maximum of twenty pages, excluding the appendix. Your appendix should contain only a copy of your code.

This assignment is worth 100% of your overall mark for this module. (This is a half-module).

1 Perceptron [10 marks]

(TN = Dayan and Abbott's Theoretical Neuroscience text.)

Construct a perceptron (equation 8.46 of TN) that classifies 10 binary inputs (each input ± 1) according to whether their sum $\sum u_a$ is positive or negative. Use a random set of binary inputs during training and compare the performance (both the learning rate and the final accuracy) of the Hebbian (equation 8.47 of TN), delta, and perceptron learning rules.

Repeat this training protocol, but this time attempt to make the output of the perceptron classify according to the parity of the inputs, which is the sign of their product $\prod u_a$. Why is this example so much harder than the first case?

2 Multi-layer perceptron [25 marks]

(a) [10 marks] Build a multi-layer perceptron (MLP) with one hidden layer to solve MNIST. Your code should be clearly documented and use only core R packages. Demonstrate your code on the parity problem from question 1.

(b) [15 marks] Use your implementation(*) to investigate the MNIST digits classification by a neural network with one hidden layer. Write up your results in the form of a report, including the effect of the following:

1. Role of bias units
2. Number of hidden units
3. Learning rate parameters
4. Rate of Dropout

Investigate how the hidden units contribute to solving the problem. Are there any digits that are particularly difficult to classify?

(*) If you cannot build a MLP from scratch, then use either the keras package or another suitable package, but make it clear what you have used. Partial credit for part (a) will be given if you write parts of the MLP, but then choose to use an external package for part b.

3 Critique of deep learning [15 marks]

Write a 3 page (maximum) essay summarising the arguments in (Marcus, 2018) and responses (e.g. <https://medium.com/syncedreview/gary-marcuss-deep-learning-critique-triggers-backlash-62c137a47836>.) What do you believe? Find and cite appropriate literature to support your arguments.

Marcus G (2018) Deep Learning: A Critical Appraisal. arXiv [csAI] Available at: <http://arxiv.org/abs/1801.00631>.