Information Processing and the Brain

For this course work you are asked to implement and explore the behaviour of a classical supervised learning algorithm and discuss how it relate to learning in the brain. You only need to select one of the topics below. You can choose your language of preference, but we would recommend using Python or Matlab. There are two parts to the coursework, the first requires you to implement backpropagation and the second, more speculative part, asks you to test a simplification of this algorithm which would make it more biologicaly plausible. The first part is worth 60%, the second 40%.

The backpropagation algorithm is often used in machine learning to solve the credit assignment problem. Please implement a simple feedforward network with one hidden layer and sigmoidal units to analysis the widely used handwritten digit recognition dataset (MNIST); you may use autograd to achieve this. You are welcome to use code from stardard examples in your implementation; you should write a paragraph describing your approach and a graph or table quantifying the performance of the algorithm.

Straightforard attempts to argue that deep learning resembles neuronal computation flounder because back-propagation requires that information about the behavious of later layers is required to determine learning in earlier layers. In this unit we have examined some ways this problem can be avoided. However, a counter proposal could hypothesis that learning does not need to occur in earlier layers. According to this hypothesis the role of the earlier layers is to provide a 'dictionary' of recodings of the input which the final layer can select from. The second part of this course work is to test this idea: it seems unlikely to be true but if it was it would be easy to suggest biological mechanisms to support this sort of learning.

One approach would be to train the network in the normal way and to then shuffle the weights connecting the input layer to the middle layer before retraining the network, this time only updating the weights that go from the middle layer to the output layer. How does this compare to the original? Who does this compare to a network without a hidden layer?

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