Supervision Assignments in AI
Easter Term 2019
Set 3: Artificial Neural Networks

Supervisor : Dionysis Manousakas
dm754@cam.ac.uk

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1. (*AIMA18.22*) Suppose you had a neural network with linear activation functions. That is, for each unit the output is some constant c times the weighted sum of the inputs.

   a. Assume that the network has one hidden layer. For a given assignment to the weights w, write down equations for the value of the units in the output layer as a function of w and the input layer x, without any explicit mention of the output of the hidden layer. Show that there is a network with no hidden units that computes the same function.

   b. Repeat the calculation in part (a), but this time do it for a network with any number of hidden layers.

   c. Suppose a network with one hidden layer and linear activation functions has n input and output nodes and h hidden nodes. What effect does the transformation in part (a) to a network with no hidden layers have on the total number of weights? Discuss in particular the case $h \cdot n$.

2. (*AIMA18.23*) Suppose that a training set contains only a single example, repeated 100 times. In 80 of the 100 cases, the single output value is 1; in the other 20, it is 0. What will a backpropagation network predict for this example, assuming that it has been trained and reaches a global optimum? (Hint: to find the global optimum, differentiate the error function and set it to zero.)