

# COMP9444 Neural Networks and Deep Learning

## Term 3, 2020

### Exercises 2: Backpropagation

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#### 1. Identical Inputs

Consider a degenerate case where the training set consists of just a single input, repeated 100 times. In 80 of the 100 cases, the target output value is 1; in the other 20, it is 0. What will a back-propagation neural 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 to zero.)

#### 2. Linear Transfer Functions

Suppose you had a neural network with linear transfer functions. That is, for each unit the activation is some constant  $c$  times the weighted sum of the inputs.

- a. Assume that the network has one hidden layer. We can write the weights from the input to the hidden layer as a matrix  $\mathbf{W}^{HI}$ , the weights from the hidden to output layer as  $\mathbf{W}^{OH}$ , and the bias at the hidden and output layer as vectors  $\mathbf{b}^H$  and  $\mathbf{b}^O$ . Using matrix notation, write down equations for the value  $\mathbf{O}$  of the units in the output layer as a function of these weights and biases, and the input  $\mathbf{I}$ . Show that, for any given assignment of values to these weights and biases, there is a simpler network with no hidden layer that computes the same function.
  - b. Repeat the calculation in part (a), this time for a network with any number of hidden layers. What can you say about the usefulness of linear transfer functions?
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