

UNIVERSITY OF BIRMINGHAM

School of Computer Science

MSc Introduction to Artificial Intelligence (Online paper)

Main Summer Examinations 2020

MSc Introduction to Artificial Intelligence (Online paper)

- (a) Assume that we have N products, each with a weight and a profit. We would like to decide which of these products to load in a lorry, with the objective of maximising the total profit of loaded products. The maximum weight W that the lorry can withstand must not be exceeded. To solve this problem using an optimisation algorithm, we decide to *modify* the objective of the problem to the following function, as a strategy to deal with the maximum weight constraint:

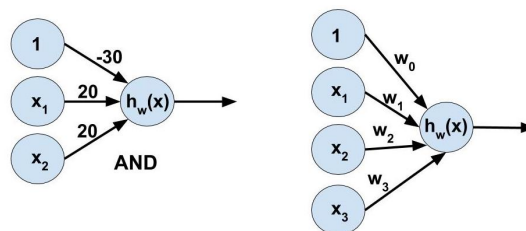
$$\text{maximise} \quad \sum_{i=1}^N v_i p_i - \sum_{i=1}^N v_i w_i \quad (1)$$

where v_i has value 1 (one) if product i is loaded and 0 (zero) if it is not loaded; p_i is the profit of product i ; and w_i is the weight of product i .

- (i) Is this strategy adequate to deal with the constraint? Why?
- (ii) Give an example of a feasible and an infeasible solution that illustrates your argument, along with their objective values computed using Eq. 1. If your answer to (a)(i) is yes/no, your example should support/refute the proposed strategy to deal with the constraint. Assume that $W = 8$, $N = 3$, $p_1 = 10$, $p_2 = 5$, $p_3 = 20$, $w_1 = 3$, $w_2 = 3$, and $w_3 = 4$.

[20 marks]

- (b) (i) List *one* advantage and *two* disadvantages of the KNN algorithm.
- (ii) The Neural Network on the left performs the logical operation AND on the inputs x_1 and x_2 using one neuron. The incomplete network on the right is required to perform a given logical operation on three input variables.



The activation function of the above Neural Networks is the Sigmoid function given by the equation $\frac{1}{1+e^{-x}}$. You may assume that $\text{sigmoid}(x) \approx 0$ for $x \leq -4$ and $\text{sigmoid}(x) \approx 1$ for $x \geq +4$.

For each of the logical operations below, provide values for w_0 , w_1 , w_2 , and w_3 so that the network performs this logical operation on three inputs. Draw a table to illustrate the input and output for each of your nodes that clearly shows why your network performs this operation.

(i) AND

(ii) OR

[20 marks]