

## COMPUTER SCIENCE TRIPOS Part IB – 2021 – Paper 6

### 1 Artificial Intelligence (sbh11)

The standard *linear regression* model uses a hypothesis

$$h(\mathbf{x}, \mathbf{w}, b) = \mathbf{w}^T \mathbf{x} + b$$

to fit  $m$  examples  $((\mathbf{x}_1, y_1), \dots, (\mathbf{x}_m, y_m))$  by minimizing the error

$$E(\mathbf{w}, b) = \sum_{i=1}^m (y_i - h(\mathbf{x}_i, \mathbf{w}, b))^2.$$

- (a) Derive a *gradient descent* algorithm for training the linear regression model described. [5 marks]
- (b) In the application of interest, you believe that it is desirable to train such that the learned parameters have  $\|\mathbf{w}\| \simeq 1$ . Suggest a modification to  $E(\mathbf{w}, b)$  that facilitates this, and derive the corresponding gradient descent training algorithm. [5 marks]
- (c) Describe the components of a general *heuristic search* problem. [4 marks]
- (d) You are faced with a heuristic search problem, but the heuristics you have so far developed are less effective than desired. Suggest two ways in which supervised machine learning might be used to develop a better heuristic, mentioning if necessary any corresponding disadvantages of using the approach. You may assume that a collection of problems to be solved by the heuristic search is available. [6 marks]