

## 2003 Paper 1 Question 6

### Foundations of Computer Science

- (a) Explain in detail how a binary search tree represents a dictionary. If reference types are not used, what is the average-case cost of an update operation? [8 marks]
- (b) A *mutable* binary tree is either a leaf or a branch node containing a label and references to two other mutable binary trees. Present the ML datatype declaration for mutable binary trees. [2 marks]
- (c) Describe how to use this datatype to implement (mutable) binary search trees. Give ML code for the lookup and update operations. The update operation must never copy existing tree nodes. [10 marks]