

# COMPUTER SCIENCE TRIPOS Part IA – 2012 – Paper 1

## 1 Foundations of Computer Science (LCP)

Recall that a dictionary of  $(key, value)$  pairs can be represented by a binary search tree. Define the *union* of two binary search trees to be any binary search tree consisting of every node of the given trees.

- (a) Write an ML function `union` to return the union of two given binary search trees. [*Note:* You may assume that they have no keys in common.] [6 marks]

Define a *slice* of a binary search tree to be a binary search tree containing every  $(key, value)$  node from the original tree such that  $x \leq key \leq y$ , where  $x$  and  $y$  are the given endpoints.

- (b) Write an ML function `takeSlice` to return a slice – specified by a given pair of endpoints – from a binary search tree. [4 marks]

- (c) Write an ML function `dropSlice` to *remove* a slice from a binary search tree: given a tree and a pair of endpoints, it should return the binary search tree consisting of precisely the nodes such that  $x > key$  or  $key > y$ . [*Hint:* First consider the simpler task of deleting a node from a binary search tree.] [8 marks]

- (d) The tree  $t$  need not be identical to that returned by

```
union(takeSlice(t, x, y),
      dropSlice(t, x, y))
```

Briefly explain how such an outcome is possible. [2 marks]

[*Note:* All ML code must be explained clearly and should be free of needless complexity.]