COMPUTER SCIENCE TRIPOS Part IA – 2016 – Paper 1

1 Foundations of Computer Science (LCP)

(*a*) Write brief notes on functions as values and results in ML, illustrated with the help of the functionals `map` and `exists`. What functions can we obtain from these via currying? [6 marks]

(*b*) Consider the function `zarg` defined below:

```
fun zarg f ([],    e) = e
  | zarg f (x::xs, e) = f(x, zarg f (xs,e));
```

Show that with the help of this function, it is possible to write an expression for the sum of a given list of integers. Then describe what `zarg` does in general. [4 marks]

(*c*) A polymorphic type of branching trees can be declared as follows. Note that the children of a branch node are given as a *list* of trees, and that only the leaf nodes carry labels.

```
datatype 'a vtree = Lf of 'a
                  | Br of ('a vtree) list;
```

(*i*) Write a function `flat t` that converts a given tree `t` of this type to a list of the labels (without eliminating duplicates). Your function should run in linear time in the size of the tree. [4 marks]

(*ii*) Write a function `count x t` that counts the number of times that `x` occurs as a label in `t`, but without first converting `t` to a list.
Note: Minimal credit will be given for solutions that use `flat`. [5 marks]

(*iii*) What is the type of `count`? [1 mark]

All ML code must be explained clearly and should be free of needless complexity.