

Homework 6

CSC 7101, Spring 2009

Due: 29 April 2009

1. An `int` in Java is represented as a 32-bit number, `float` and `double` are represented as 32-bit and 64-bit IEEE 754 floating point numbers, respectively. Suppose we define the subtype relationship on integers and floating point numbers as a subset relationship on the sets of numbers that can be represented in a given type. Is `int` a subtype of `float`? Is it a subtype of `double`?

You can easily find the precise layout of IEEE floating points by searching for 'IEEE 754' on Google or other search engines.

2. Given the following Java code:

```
class C {
    public int foo (C x) { return 0; }
}

class D extends C {
    public int foo (C x) { return 1; }
    public int foo (D x) { return 2; }
}

C p = new D();
C q = new D();
int i = p.foo(q);
```

Which method is executed for the call `p.foo(q)`? Explain why.

3. Explain in English what the ML type

$$('a \rightarrow 'b \rightarrow 'c) \rightarrow ('d \rightarrow 'e) \rightarrow ('a * 'd) \text{ list} \rightarrow (('b \rightarrow 'c) * 'e) \text{ list}$$

stands for.

4. Suppose we allow subtyping for function types. E.g., a variable binding of the form (in ML syntax)

```
val f : s -> t = g;
```

would be legal if the type of function `g` is a subtype of `s->t`. I.e., `g` must be able to handle any argument of type `s` and produce a result that can be assigned to a variable of type `t`.

Assume `t` is a subtype of `s`. Which of the following function types is a subtype of which other function type?

- (a) `s -> s`
- (b) `s -> t`
- (c) `t -> s`
- (d) `t -> t`

5. Translate the following ML code into a C++ or Java class hierarchy.

```
/* A tree is either a Leaf containing an integer value or
   an interior Node with two subtrees. */
datatype Tree = Leaf of int
              | Node of Tree * Tree

/* Return the sum of all the integers stored in Leaf nodes. */
fun sum (Leaf i)      = i
  | sum (Node (l, r)) = sum l + sum r
```

Define the class hierarchy with classes `Tree`, `Leaf`, and `Node`, such that the following code works (in C++ syntax):

```
Tree * left  = new Leaf(1);
Tree * right = new Node(new Leaf(2), new Leaf(3));
Tree * root  = new Node(left, right);
int    h     = root->sum();
```

where `sum()` is a virtual function. Do not use an if-then-else.