

CSci 4651 Fall 2003
Problem Set 5: Types.
Due Wednesday, October 29th

Problem 1. Use the type inference algorithm to find out the type of a function `f` for the following cases. If there is no valid type for `f`, then justify it using the algorithm.

- `fun f(x, y) = x(y + 1);`
- `fun f(x, y) = x(2::y) + 2;`
- `fun f(0, y) = nil |
 f(x::xs) = x + f(x -1, ys);`
- `fun f(0, y) = nil |
 f(x, nil) = nil |
 f(x, y::ys) = x::f(x-1, ys);`

Problem 2. Exercise 6.10, p. 160. You don't need to give the details of the type inference for the functions `f` and `g`, just write down the types.

Problem 3. Part 1. Consider ML type declaration

```
type Celsius = real;  
type Fahrenheit = real;
```

Recall that conversion from Fahrenheit to Celsius is done according to the formula $((t - 32) * 0.5555556)$, where t is temperature in Fahrenheit.

Question 1. Fill in the code for the function `lower` which takes the first argument as temperature in Fahrenheit, the second argument as temperature in Celsius, and returns `true` if the first temperature is lower, and `false` otherwise:

```
fun lower(x:Fahrenheit,y:Celsius) = ...
```

Here is an example of using the function

```
val x = 55.5:Fahrenheit;  
val y = 23.0:Celsius;  
lower (x,y);
```

(the function should return true)

Question 2. Will the function give a type error if one of the parameters given to it is `real`? When the first parameter is of type `Celsius` and the second one is in `Fahrenheit`? Write ML code to test this behaviour. Submit your test examples and explain the results.

Question 3. Now consider the following definition:

```
datatype Temperature = Celsius of real | Fahrenheit of real;
```

To create an instance of Temperature that stores the value in a celsius, you need to write:

```
val x = Celsius(23.0);
```

A function that compares two temperatures will now have 4 cases and will work on all possible combinations of celsius/fahrenheit. Fill in the missing cases for this function:

```
fun lower (Celsius(x),Celsius(y)) = x < y |  
  lower (Celsius(x), Fahrenheit(y)) = x < ((y - 32.0) * 0.55555556) |  
  ....
```

Create several instances of Temperature and test the function on these instances.

Question 4. Will you be able to use this function on reals? Please explain your answer.

Question 5. Write a function add to add two instances of Temperature. Make sure it works correctly for all possible combinations of temperatures in celsius and fahrenheit.

Question 6. Suppose you are writing software for a hospital to automatically alert personnel if a patient's temperature goes above a specified level. Of the two ways of declaring type (the one in question 1 and in question 3), which one would you use for the software and why?