

ICS/CSE141: Programming Languages

Quiz 3

3 September 2004

Fill in your name and ID above! This quiz has 4 pages.

1 Matching in ML

Fill in the box with the result of the function call! (Remember that \wedge stands for string concatenation.)

```
fun f(x,y,z) = x ^ y ^ z;
```

```
f("1","2","3");
```

How many arguments does `f` take? What's its (or their) type? Which variables are bound by matching (`f`, `x`, `y` and/or `z`)? (10 Points)

2 Unification

Calculate the MGU for the following pairs of terms by using Martelli-Montanari's algorithm! Apply one of their six rules per step, i.e., don't just write down the result. (10 Points)

(a) $f(h(g(a,b)))$ and $f(h(g(y)))$

(b) $f(x,y,z)$ and $f(f(h(g)),h(x),h(z))$

(c) $f(x, y, z)$ and $f(f(h(g)), h(x), c)$

3 Backtracking

(a) Draw the backtracking tree for the following query. (15 Points)

```
(define *db* '((<- (a) (and (b) (c) (d)))
              (<- (b) (f))
              (e)
              (<- (f) (and))
              (<- (a) (f))
              ))

(query-infer '(and (a) (e)))
```

(b) How many successes are there? (5 Points)

4 map in ML

Again you have the chance to implement the `map` function on one of your quizzes. ;-) This time do it in ML! (10 Points)

What's the type of `map`?

5 Parameter Passing

Transform the following pseudo code into ML, once with pass-by-value and once with pass-by-ref. For both cases state what value goes into the box!

```
function f(x) = {  
    x = x + 1;  
    return x  
}  
int y = 1;  
f(y) + y;  $\implies$  
```

(20 Points)

Pass by value:

Pass by reference:

6 Reference Cells

Let's interpret ML's ":@" operator as a function, which takes two arguments, the left-hand-side and the right-hand-side. What is then :='s type? (5 Points)

Fill in the boxes with the value of the corresponding expressions. (Hint: Make sure that your values are consistent with the type above.) (5 Points)

```
val x = ref 0;
```

```
x := 3*(!x) + 5; ==> 
```

```
!x; ==> 
```

7 Trees in ML

Given the following inductive type definition, write an ML function `sumNodes` that takes an `int trie` and returns the sum of all the integers at the nodes. (20 Points)

```
datatype 'a trie = Leaf
                | Node of 'a * 'a trie * 'a trie;
```