

Computer Science Comprehensive Exam—Spring 2003  
Programming Languages

**Instructions:** Do *not* put your name on the exam, please answer all the questions directly on the exam itself. Answer **all** the questions. Explain answers as fully as possible, give examples if appropriate, define terms. Answer first, the questions you know best.

1. What is the difference between a compiled and an interpreted language? Which one is Java?

2. What is a precondition and a postcondition?

3. What is static type-checking? What is dynamic scoping? Is it possible to do static type checking with dynamic scoping? Why, or why not? Give an example.

4. Consider two separate, independent executions of the following Ada-like program. Assuming that X is passed by copy-in/copy-out, what are the values of I and A after the call? Assuming that X is passed by reference, what are the values of I and A after the call?

```
PP: declare
  -- declare an array of 5 elements
  A: array (1..5) of Integer := (1,2,3,4,5);
  I: Integer := 1;
  procedure P (X: Integer) is
  begin
    X := 18; I := 2; X := 10;
  end P;
begin
  P (A[I]); -- call P
  -- value of "I", values of "A"?
end PP;
```

5. What is information hiding?

6. What object-oriented features are different in Java than in C++?

7. What is the type of the following ML function? Describe in words what the function does.

```
fun pr [row] = row
  | pr [r1::r2::rows] =
      if abs(hd r1)>=abs(hd r2) then pr(r1::rows) else pr(r2::rows)
  ;
```

8. Find the (most general) unifying substitution for each of the following pairs of terms ( $x$ ,  $y$ , and  $z$  are variables), if it exists. To the right of each pair, write “no unifier” if none exists, otherwise give the unifying substitution.

(a)  $g(a, c)$   $g(a, d)$

(b)  $h(c, a, x)$   $h(c, a, y)$

(c)  $g(a, b)$   $g(a, b)$

(d)  $g(y, x)$   $g(a, h(b, c, y))$

(e)  $g(g(a, b), h(x, a, y))$   $g(g(z, b), h(b, a, b))$

(f)  $g(g(a, x), h(a, x, b))$   $g(g(a, b), h(a, a, b))$

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

(h)  $g(g(a, x), h(y, a, b))$   $g(z, x)$

(i)  $g(g(a, x), h(y, a, b))$   $g(y, x)$

9. Given the relations

Father(x,y)	x is the father of y
Mother(x,y)	x is the mother of y
Female(x)	x is female
Male(x)	x is male

define PROLOG relations for the following notions:

- (a) x is a sister of y (same parents)
- (b) x and y are siblings (brother or sister)
- (c) x is a grandson of y
- (d) x is a descendant of y