Computer Science Comprehensive Exam—Spring 2000
Programming Languages

Instructions: Do not put your name on the exam, please answer all the questions directly on the exam itself. You must answer the **last two questions** and five of the remaining questions.

Explain answers as fully as possible, give examples if appropriate, define terms. Answer first, the questions you know best. Circle the problem number of the $(2 + 5 = 7)$ problems you choose to have graded.

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

2. What is a functional programming language? Why are they important? Name at least two functional languages.

3. What are regular expressions? Where are the used?

4. What is a type insecurity? Why is it bad? Give an example from Pascal (or elsewhere).

5. All imperative languages have a `for` loop that executes a predetermined number of times. Some small differences in the `for` exist between different languages. Explain clearly what some of these differences are.

6. Consider two separate, independent executions of the following Ada-like program. Assuming that `X` is passed by value, 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 := 0;  I := 2;  X := 6;
    end P;
begin
    P (A[I]); -- call P
    -- value of "I", values of "A"?
end PP;
```

7. What is a procedure closure?

8. What are opaque and transparent data types?

9. In every language since PL/I, exception propagation is essentially the same. Describe exception propagation as in, for example, ML, Ada, C++, Modula-3, and Java.

10. What is type inference?

11. The two kinds of functional languages are eager and [ ]. Give the name of a language of each kind.

12. (You must answer this question.) What is a higher-order function? In any functional language, give an example.

13. (You must answer this question.) Consider the following PROLOG clauses (`x`, `h`, `t`, and `z` are variables):

```
A([],x,x).
A([h|t],x,[h|z]) :- A(t,x,z).
```

What are the answers to the following queries (`x`, and `y` are variables)? If there is more than one solution, give any two of them.

(a) `A([E],[],[E])?`

(b) `A([E],[],[E,F])?`

(c) `A([],[],x)?`

(d) `A([E],[],x)?`

(e) `A([E],[F],x)?`

(f) `A([E,F,G],[H,I],x)?`

(g) `A(y,[H,I],[G,H,I])?`

(h) `A(x,y,[E,G,I])?`

(i) `A([x|y],[H,I],[G,H,I])?`

(j) `A([x|F],[y|H,I],[E,F,G,H,I])?`