Principles of Programming Languages - Scrimmage I (Solutions)

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1 Problems

1. Argue that if a programming language has a **while** statement, it does not need an **if** statement.

   Solution: The principal difference between an **if** construct and a **while** construct is that if a condition is satisfied, the former executes a statement once, whereas the latter could execute it multiple times. In order to enforce that the **while** construct executes a statement precisely once, when a condition is satisfied, we use the following strategy: Let **cond** denote the condition for entering the **if** construct. Use (**cond** ∧ **flag**) as the condition for entering the **while** construct, where **flag** is set to **true**, before entering the loop and set to **false**, immediately upon entry. This will guarantee that the statement inside the **while** construct is executed precisely once, thereby mimicking the **if** construct. □

2. Write a Prolog-style fragment to implement the factorial function.
   Solution:

   1: $\mathbf{fact}(U, 1) :- U = 0.$
   2: $\mathbf{fact}(U, V) :- \mathbf{not}\ (U = 0), \mathbf{fact}(U - 1, Y), V \text{ is } U * Y.$

   Algorithm 1.1: Implementing the factorial function in Prolog

   □

3. Write a functional-style (i.e., **C** with recursion) fragment for the problem of determining the number of digits of a positive integer.
   Solution:

   Function NumDigits(n)
   1: **if** (n / 10 == 0) **then**
   2:    return(1)
   3: **else**
   4:    return(1+NumDigits(n / 10))
   5: **end if**

   Algorithm 1.2: A functional algorithm for counting digits of a positive number

   □

4. Discuss how the following features have been promoted and violated in the **C** programming language: (a) Generality, and (b) Extensibility.

   Solution:

   (a) Generality in **C**, has been promoted by the existence of variable-length arrays and violated by the non-existence of direct comparison between structures.

   (b) Extensibility in **C**, has been promoted by the overloading of the "+" operator for addition in that the programmer does not have to specify whether he is adding floats or integers. Extensibility has been violated to the extent that the "+" operator cannot be overloaded for matrix addition.

   □