Principles of Programming Languages - Homework 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** $\wedge$ **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: fact(U, 1) :- U = 0.
2: fact(U, V) :- not (U = 0), fact(U − 1, Y), V 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. Provide a brief discussion on how the internet affected the development of programming languages.

   Solution: We enumerate below some of the salient ways in which the internet affected the development of programming languages:

   (a) Supporting the need for network programming - Applications are not confined to those that run on isolated machines. Consequently, programming languages need to support features that enable network activities.

   (b) Support for Real-Time requirements - Prior to the advent of the internet, the correctness of a computation was mostly independent of the time taken to produce it. However, now the time taken to produce a computation is of paramount importance. Consider for example, the task of viewing a movie on the internet. It would be of limited use indeed, if the frames were not downloaded in real-time.

   □

5. 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. (See Page 66 of [Lou02].)

   □

References

[Lou02] Kennenth C. Louden. *Programming Languages: Principles and Practice.* Brooks/Cole, 2002.