Introduction to Computer Systems

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Week 8b: Pseudo Code and Algorithms
Algorithms

- **Definition**: an algorithm is an ordered set of unambiguous, executable steps that defines a terminating process.

- The steps are often called instructions.

- Termination is by a special instruction: halt.
Terminology

- **Programming language**: system for representing algorithms in a human readable form suitable for conversion to machine code.
- **Program**: representation of an algorithm in a programming language.
- **Pseudo code**: system for the informal representation of algorithms.
- **Hardware**: device to carry out the steps or instructions in a program.
Representation of an Algorithm

The same algorithm can be represented in many different ways:

- \[ F = (9/5)C + 32 \]
- \[ F \leftarrow (9*C)/5 + 32 \]
- To obtain F multiply C by \(9/5\) and then add 32.
- Lookup table for Fahrenheit and Centigrade
Program 1 for XOR

Input: binary digits a,b
Output: a XOR b

- If a==0 and b==0 Return 0
- If a==0 and b==1 Return 1
- If a==1 and b==0 Return 1
- If a==1 and b==1 Return 0

- Halt
Program 2 for XOR

Input: binary digits a,b
Output: a XOR b
1. If a==b Return 0
2. Else Return 1
3. Halt
Program 3 for XOR

Input: binary digits a, b
Output: a XOR b

1. Convert a to the integer ia
2. Convert b to the integer ib
3. ic = remainder on dividing ia+ib by 2
4. Return ic
5. Halt
Pseudo Code for Algorithm Representation

- Very useful informal representation of algorithms.
- Preferable to using program code when designing an algorithm.
- Basic structures (assignment, loops, arrays ...) are similar across many programming languages.
Pseudo Code: assignment

- General form
  \[ \text{name} \leftarrow \text{expression} \]

- Examples
  \[ \text{funds} \leftarrow \text{current} + \text{savings} \]
  \[ x \leftarrow 10 \]
Pseudo Code: conditional selection

- General form
  ```
  if (condition) then (activity)
  else (activity)
  ```

- Example
  ```
  if (year is leap year)
    then d <- total divided by 366
    else d <- total divided by 365
  ```

- Key or reserved words in bold
Pseudo Code: repeated execution

- General form
  \[ \textbf{while} \ (\textit{condition}) \ \textbf{do} \ (\textit{activity}) \]

- Example
  \[ \textbf{while} \ (\textit{tickets remain}) \ \textbf{do} \ (\textit{sell a ticket}) \]
Pseudo Code: indentation

- if (not raining)
  then (if (temperature = hot)
      then (go swimming)
      else (play golf)
  )
  else (watch television)

- if (not raining) then (if (temperature=hot) then (go swimming) else (play golf)) else (watch television)
Procedure

- Definition: set of instructions which can be used as a single unit in different contexts.

- A procedure call contains the name of the procedure and any data supplied to the procedure.

- A result calculated by the procedure can be obtained using a return statement.
Example of a Procedure

Definition of a procedure

```plaintext
procedure temp(c)
    f=(9/5)*c+32;
    return f;
endProcedure
```

Procedure call

```plaintext
f1=temp(34)
```
Pseudo Code: procedures

- General type
  ```
  procedure name
  ```

- Examples
  ```
  procedure helloWorld //no parameters
  procedure sort (List) // parameter List
  ```
Pseudo Code: alternatives to brackets

- **procedure** *name*
  
  *(activity)*

  **endProcedure**

- **while** *(condition)*
  
  **do** *(activity)* **endDo**

  **endWhile**
Exercise 1

- Write an algorithm in pseudo code to carry out the following task:

  input: a 1-dimensional array A of integers

Exercise 2

Design an algorithm for finding all the factors of a positive integer. For example, in the case of the integer 12, your algorithm should report the values 1, 2, 3, 4, 6 and 12.
Exercise 3

The following is an addition problem in decimal notation. Each letter represents a different digit. Which letter does each digit represent?

XYZ
+ YWY
====
ZYZW