Introduction, Computer Operations, Data, and Program Development

Meteorology 227
Fall 2020
Programming?

• Programming Language: An artificial language that can be used to control the behavior of a machine (often a computer). (Wikipedia)
  – A standard communication technique for expressing instructions to a computer (Wikipedia).

• What languages have you heard of?

• Common (and not so common) languages: FORTRAN, C, C++, C#, Python, Perl, COBOL, BASIC, R, Pascal, Java, PHP, Lisp, Ruby, Ruby on Rails, AJAX, and so on, and so on.
Let’s take a moment to examine the current programming trends........
Why FORTRAN?

• FORTRAN = FORmula TRANslation

• Built for scientific programming.

• First “High-Level” programming language.
  – Platform independent
  – Statements don’t look like machine language.
  – Portability, ease of use.

• Legacy codes
Programming for Meteorology and ISU

• NWS/Broadcast
  – AWIPS2 is primarily written in Java and plugins to AWIPS2 in Python.

• Research/Graduate School
  – FORTRAN, Python
  – Legacy codes, rapid processing of data.

• How does this impact ISU meteorology?
  – Programming requirement will accept either Mteor 227 or Comp Sci 207 (Java)
  – Mteor 227 will be offered every year during the fall semester.
  – Fortran and Python
History

• 1954-57
  – John Backus (IBM)
  – IBM Mathematical FORmula TRANslation system
  – Fortran 0 and Fortran I

• 1958
  – FORTRAN II
    • Separate compilation of modules.
  – Fortran III
    • Inlined assembly code.

• 1961
  – FORTRAN IV
  – Improved portability.
  – Implementation of new statements (common and equivalence).
History cont.

• 1963
  – ~40 different compilers.
    • Compiler: translates the FORTRAN code to something that the machine
      will understand.
  – Standardization needed.

• 1966
  – FORTRAN 66
  – First ANSI version.
    • ANSI – American National Standard Institute

• 1978
  – FORTRAN 77
  – Second standard
  – Structured programming and other new features.

• 1991
  – FORTRAN 90
  – Third standard
  – New version promised in 10 years.
History cont.

- **1997**
  - FORTRAN 95
  - Largely a ‘Bug-Fix’ release of FORTRAN 90.
  - Some extensions, mainly HPF extensions (see below)
  - Fourth standard

- **Late 2004**
  - FORTRAN 2003
  - Object Oriented programming support.
  - Improved operability with C.

- **Late 2010**
  - FORTRAN 2008 (Find out more at http://j3-fortran.org/)
  - Co-Array FORTRAN (see below) extensions.
History cont.

• 2018
  – FORTRAN 2018 (previously known as FORTRAN 2015)
  – Planned minor revision
  – Further interoperability between FORTRAN and C.
  – More Parallel features
  – Corrections of inconsistencies in FORTRAN 2008 (“Wart removal”)
  – Released November 2018.

• Other types of Fortran
  – Co-Array FORTRAN (F--): Extension of 95/2003 for parallel processing.
Six Basic Computer Operations

1. Receive Information
   • Read TEMP
   • Get MAX_TEMP
   • Read TEMP, DEW_POINT

2. Provide Information
   • Print ‘Tornado Warning’
   • Write METAR to file
   • Print TEMP, DEW_POINT

3. Perform Arithmetic
   • Add DAILY_RAIN to MONTHLY_RAIN
   • COUNT=COUNT+1
Six Basic Computer Operations

4. Assign a value to a variable or memory location.
   • Initialize MAX_TEMP, MIN_TEMP to zero.
   • Set counter to zero.
   • RAIN = RAIN + INCREMENT

5. Compare two variables and select one of two options
   • Selective execution

6. Repeat a group of actions
   • Repetitive execution (loops)
Data Types

- Integer
  - 32, -40, 212

- Real
  - 3.14, 2.5E6, 9.81

- Character
  - ‘F’, ‘C’, ‘%’

- Boolean
  - Two possible values: true or false
Stages in Program Development

- Programming: Development of a solution to an identified problem, and the setting up of a related series of instructions which, when directed through computer hardware, will produce the desired result.

- How do you do this?
  - Jumping straight to the code can be time consuming (error checking) and inefficient.
  - Seven Steps
1. Define the problem

2. Outline the solution
   - Break into smaller tasks or steps
   - Establish an outline solution
     - Inputs
     - Outputs
     - Processing steps to produce the required output
   - Defining diagram (later)
3. Develop the outline into an algorithm
   – A set of precise steps that describe exactly the tasks to be performed and the order in which they are to be carried out.
   – Pseudocode, flow-charts, Nassi-Schneidermann diagrams.

4. Test the algorithm for correctness.
   – Use test data to check instructions
   – Keep track of all major variables
     • Desk check
Program Development cont.

5. Code the algorithm into a specific programming language.
   – Finally, you get to write code!

6. Run the program on the computer.

7. Document and maintain the program.
   – Document, document, document!
   – Comments, comments, comments!
Algorithm

• A set of detailed, unambiguous, and ordered instructions developed to describe the processes necessary to produce the desired output from a given input.
  – Lists the steps involved in accomplishing a task.

• Written in English and not a formal document.

• Pseudocode, flowcharts, Nassi-Schneiderman diagrams.
Pseudocode

- Essentially structured English
- Statements written in simple English
- Each instruction is written on a separate line.
- Keywords and indentation are used to signify particular control structures.
- Each set of instructions is written from top to bottom, with only one entry and one exit.
- Groups of statements may be formed into modules, and that group given a name.
Flowcharts

- Terminal symbol (starting and stopping points)
- Input/Output symbols
- Process symbols
- Predefined process symbol
- Decision symbol
- Flow lines
Example Problem

• Take a temperature input from the user in either degrees F or C and output the same temperature converted to the other unit.
  – Follow 7 steps of program design.
  – Defining diagram.
  – Solution algorithm (flowchart)
  – Desk Check.