Introduction, Computer Operations, Data, and Program Development

Meteorology 227
Fall 2023
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
  - Java, C++, Python. Object oriented programming.
  - 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.
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.
- Current standard

Fortran 2023 is the informal title of the next Fortran standard.

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
Program Development

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
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.