

Introduction to Computer Programming

22.901 Introduction to Computer Programming for Nuclear Engineers

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Outline

- Intro to programming

Programming Languages - Nuclear Perspective

- Numerical Programming Languages
 - Fortran, C, C++, etc.
 - compiled languages
 - very fast, low-level programming
- Scripting Languages
 - Python, Perl, Visual Basic, etc.
 - interpreted languages
 - good for data/file manipulation
 - not as fast, high-level programming
- Developmental Languages
 - MATLAB, Python, etc.
 - great environment for algorithm development
 - excellent post-processing capability
 - recommend for HWs and projects

Coding Jargon

- Source Code - an ASCII text file development by the programmer with code in it
- Compiler - the program that converts the source code to machine code
 - C compilers - gcc, icc ...
 - C++ compilers - g++ ...
 - Fortran compilers - f77, g77, f90, f95, gfortran, ifort ...
- Program - the compiled source code

Fortran Programming Language

- In this course we will focus of Fortran
- Many nuclear engineering codes are *still* developed in Fortran!
- Classical Fortran
 - FORTRAN II-IV and Fortran 66 (1958-1966)
 - FORTRAN 77 - standard programming language (still seen today!)
- Modern Fortran
 - Fortran 90,95,2003,2008
 - free format source code, structures, dynamic memory allocation

How can I use Fortran?

- Windows - Download Cygwin and get the gfortran compilers
- Mac/Linux - Download gfortran compilers
- In 22.901 we will SSH to the department's linux cluster
 - Windows - download SecureFX/SecureCRT from MIT IST site
 - Mac/Linux - SSH right from the terminal
- To Login the following info is needed for SecureCRT
 - hostname: `cheezit.mit.edu`
 - username: `fortran12`
 - passowrd: `22.901IAP2012`
 - Mac/Linux: `ssh fortran12@cheezit.mit.edu`
- see Stellar document about navigating a Linux shell

How to Compile Fortran Code with gfortran

- Compile and Link

```
gfortran -o myCode myCode.f90
```

- Compile only

```
gfortran -o myCode.o -c myCode.f90
```

- Link only

```
gfortran -o myCode myCode.o
```

- To include external files use `-I<path>`

- To link external libraries use `-L<path>`

The Simplest Fortran Code

```
program simplest  
  
    ! terminate the code  
    stop  
  
end program simplest
```


Interacting with the User

- You may want to see what your code does!
- Use `print *, 'str1', var1, var2, var3`
 - This will print to the terminal screen (STDOUT) on one line
 - There are more advanced formatting methods (save for later)
- To read something in from the user, use `read *, var1, var2`
- So now as a right of passage, print “Hello World!” to the screen

Hello World! Code

```
program helloworld  
  
! print hello world to stdout  
print *, 'Hello World!'  
  
! terminate the program  
stop  
  
end program helloworld
```

Code Structure

A line can be up to 132 characters

A comment is from ! to the end of line

You can have blank lines

To continue a line place a & at the end and begin the next line with &

The code structure ::

- 1 start of a program, program name1
- 2 declaration of all variables
- 3 all of the execution statements
- 4 end of program, end program name1

Variables

- An ASCII alphanumeric word that represents a space in memory
- In Fortran the first character must be a letter (not case sensitive!!)
- By default variables beginning with I-L are integers, all else are reals (floats)
- This is the implicit naming structure of Fortran, later we will declare explicitly
- Some examples (Real or Integer ...)::
 - HYP - ??
 - K9 - ??
 - pi - ??
 - 9X_Y - ??

Simple Math

- Order of Operation Applies!
- Parentheses - $()$
- Exponent - $**$
 - if exponent is a whole number, list as integer (e.g. 2 not 2.0)
- Multiplication/Division - $*, /$
- Addition/Subtraction - $+, -$
- Mathematical expressions should be of the same type (integer, real, etc.)
 - $a = 2, b = 3, c = 5, d = 4$
 - $e = (d + c) ** a / b + d ???$
- Modulo - $a = \text{mod}(x, y)$

Integer vs. Real Division

- Although not commonly used, division can be performed with integers
- The two numbers are divided and the decimal is truncated
- For example $5/3 = 1$
- Division with Real variable types will give the correct answer
- For example $5/3 = 1.666666\dots$

End of Class/External Assignment

Write a code to do the following:

- 1 Ask user to enter any whole number 1-9
- 2 Read in the number (real or integer??)
- 3 Multiply the number by 9
- 4 Add both digits together (hint: use Modulo)
- 5 Subtract by 5
- 6 Print out result

Try different numbers, notice anything??