

Statements and expressions in Fortran

Victor Eijkhout, Susan Lindsey

Fall 2021

last formatted: October 26, 2021

Basics

1. Program structure

Structure of your program file:

```
Program foo  
  < declarations >  
  < statements >  
End Program foo
```

2. Things to note

- No includes before the program
- Program has a name (emacs tip: type `end<TAB>`)
- There is an `End`, rather than curly braces.
- Declarations first, not interspersed.

3. Comments

- Ignore to end of line

```
x = 1 ! set x to one
```

- comment after continuation

```
x = f(a) & ! term1  
+ g(b)    ! term2
```

- No multi-line comments.

Compilation

Filename has extension `.F90` or `.f90`.

(this is modern 'free format'; the old 'fixed format' uses extensions `.F` or `.f`)

Compiler: `ifort` (Intel)

or `gfortran` (Gnu compiler collection)

4. Variable declarations

- Variable declarations at the top of the program unit, before any executable statements.
- declaration

`type, attributes :: name1, name2,`

where

- *type* is most commonly integer, real(4), real(8), logical
 - *attributes* can be dimension, allocatable, intent, parameter et cetera.
- Keywords and variables are *case-insensitive*

5. Data types

- Numeric: Integer, Real, Complex (section ??).
- Logical: Logical.
- Character: Character. Strings are realized as arrays of characters.

6. Numeric types

Indicate number of bytes:

```
integer(2) :: i2
```

```
integer(4) :: i4
```

```
integer(8) :: i8
```

```
real(4) :: r4
```

```
real(8) :: r8
```

```
real(16) :: r16
```

```
complex(8) :: c8
```

```
complex(16) :: c16
```

```
complex*32 :: c32
```

7. Complex

Complex constants are written as a pair of reals in parentheses. There are some basic operations.

Code:

```
Complex :: &
    fortyfivedegrees = (1.,1.), &
    number,rotated
Real :: x,y
print *, "45 degrees:",
    fortyfivedegrees
x = 3. ; y = 1.; number = cmplx(x,y)
rotated = number * fortyfivedegrees
print '("Rotated number has Re=",f5
    .2," Im=",f5.2)',&
    real(rotated),aimag(rotated)
```

Output

[basicf] complex:

45 degrees:

(1.00000000,1.00000000)

Rotated number has Re
= 2.00 Im= 4.00

8. Strings

```
character*20 :: prompt  
prompt = "up to 20 characters"
```

9. Implicit typing

Fortran strictly does not need variable declarations (like python): variables have a type that is determined by name.

This is legal:

```
Program danger
  i = 3
  x = 2.5
  j = i * x
  print *,y
end Program danger
```

But:

This is **very dangerous**. Use `implicit none` in every program unit.

```
Program myprogram
  implicit none
  integer :: i
  real :: x
  ! more stuff
End Program myprogram
```

10. Boolean expressions

- Long form:

`.and. .not. .or.`

`.lt. .le. .eq. .ne. .ge. .gt.`

`.true. .false.`

- Short form:

`< <= == /= > >=`

11. Parameter

Variable=name+value.

What if the value should never change? Use the parameter attribute

```
real,parameter :: pi = 3.141592
```

This can not be changed like an ordinary variable.

Statements

12. Fortran statements

It's all much like C++:

- Assignments:

$x = y$

$x = 2*y / (a+b)$

- I/O: next
- conditionals and loops: later
- function calls: later

13. Statements

- One line, one statement

```
x = 1  
y = 2
```

(historical reasons)

- semicolon to separate multiple statements per line

```
x = 1; y = 2
```

- Continuation of a line

```
x = very &  
  long &  
  expression
```

14. Simple I/O

- Input:

`READ *,n`

- Output:

`PRINT *,n`

There is also Write.

The 'star' indicates that default formatting is used.
Other syntax for read/write with files and formats.

15. Arithmetic expressions

- Pretty much as in C++
- Exception: `r**a` for power r^a .
- Modulus is a function: `MOD(7,3)`.

Exercise 1

Write a program that :

- displays the message Type a number,
- accepts an integer number from you (use Read),
- makes another variable that is three times that integer plus one,
- and then prints out the second variable.

Optional exercise 2

Write two programs, one that reads a temperature in Centigrade and converts to Fahrenheit, and one that does the opposite conversion.

$$C = (F - 32) \cdot 5/9, \quad F = 9/5 C + 32$$

Check your program for the freezing and boiling point of water. (Do you know the temperature where Celsius and Fahrenheit are the same?)

Can you use Unix pipes to make one accept the output of the other?