# Statements and expressions in Fortran

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# Basics

# Program structure

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

# Statements

- One line, one statement

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

- semicolon to separate multiple statements per line

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

- Continuation of a line

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

# 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.

# 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`, `parameters` et cetera.

# Data types

- Numeric: `Integer`, `Real`, `Complex`. Further specifications for numerical precision are discussed in section **??**.
- Logical: `Logical`.
- Character: `Character`. Strings are realized as arrays of characters; chapter **??**.

# Implicit typing

Fortran does not need variable declarations (like python):
variables have a type that is determined by name.
This is very dangerous. Use `implicit none` in every program unit.

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

# Single/double precision constants

**Code:**

```
real(8) :: x,y,z
x = 1.
y = .1
z = x+y
print *,z
x = 1.d0
y = .1d0
z = x+y
print *,z
```

**Output**
**[basicf] e0:**

```
1.1000000014901161
1.1000000000000001
```

# Double precision constants

```
real(8) :: x,y
x = 3.14d0
y = 6.022e-23
```

- Use a compiler flag such as `-r8` to force all reals to be 8-byte.
- Write `3.14d0`
- `x = real(3.14, kind=8)`

# Floating point 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
```

# Numerical precision

Number of bytes determines numerical precision:

- Computations in 4-byte have relative error $\approx 10^{-6}$
- Computations in 8-byte have relative error $\approx 10^{-15}$

Also different exponent range: max $10^{\pm 50}$ and $10^{\pm 300}$ respectively.

# Complex

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

**Code:**

```
Complex :: &
     fourtyfivedegrees = (1.,1.), &
     other
print *,fourtyfivedegrees
other = 2*fourtyfivedegrees
print *,other
```

**Output**
**[basicf] complex:**

```
(1.00000000,1.00000000)
(2.00000000,2.00000000)
```

# Arithmetic expressions

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

# Boolean expressions

- Long form:
  `.and.  .not.  .or.`
  `.lt.  .le.  .eq.  .ne.  .ge.  .gt.`
  `.true.  .false.`
- Short form:
  `< <= == /= > >=`

# Statements

# 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.

# 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.

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

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?