

Introduction to Scientific Programming

Data Types

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Intrinsic Data Types

- Numeric Data Types
 - `integer`
 - `real`
 - `complex`
- Non-numeric
 - `character`
 - `logical`

Intrinsic Data Types

- `type-spec [attribute-spec] :: entity-declaration list`
- *Short: Type [Optional attributes] :: Variables*

<code>integer[kind selector]</code>	<code>kind selector</code>
<code>real[kind selector]</code>	<code>kind=<kind-value></code>
<code>complex[length selector]</code>	
<code>logical[length selector]</code>	<code>length selector</code>
<code>character[length selector]</code>	<code>len=<length-value></code>

- *Attributes: parameter, allocatable, dimension, intent, optional, save, pointer, target*

implicit none - a digression

- If **implicit none** is not specified in a program and/or a subprogram block (subroutine, function)
 - variables with names that begin with the letters **i-n** are **integer** by default
 - variables with names that begin with **a-h** or **o-z** are of type **real**
- Using **implicit none** is advisable (at least for beginners)
 - misspelled variable names will be detected by the compiler
 - Use **implicit none** in all your code/homework: **programs!** (*and functions and subroutines*)
 - All integers in examples will start with letters **i-l**

Intrinsic Data Types - **integer**

```
integer                :: i      ! Default 4 bytes
integer(kind=4)        :: j      ! Explicitly 4 bytes
integer(8)             :: k      ! Explicitly 8 bytes

integer, parameter     :: lng=selected_int_kind(16)
integer(kind=lng)       :: l

i = 5; j = 6; k = 7_8; l = 2_lng

print *, huge(i), huge(j)      ! huge() is a build-in function and
                                ! returns the largest value of the
argument type
```

Output:

```
2147483647    9223372036854775807
```

- **selected_int_kind(n)** returns the kind value needed to specify precision to **n** decimal places
- Good for portability
- Constants can be defined to arbitrary precision, e.g., **2_lng**

Intrinsic Data Types - **real**

- 32-bit by default, with a range $[10^{-38}, 10^{38}]$; 64-bit $[10^{-308}, 10^{308}]$ (and negative!)

```
real                :: x      ! Default 4 bytes
real(4)             :: y      ! Explicitly 4 bytes
real(8)             :: z      ! Explicitly 8 bytes

integer, parameter  :: db=selected_real_kind(12,99)
real(kind=db)       :: r

x = 5.; y = 6.; z = 7._8; r = 2_db      ! Multiple statements in one line
print *, huge(y), tiny(y)              ! tiny() returns smallest number
print *, huge(z), tiny(z)
```

Output:

```
3.4028235E+38  1.1754944E-38
1.797693134862316E+308  2.225073858507201E-308
```

- **selected_real_kind(n,m)** returns the kind value needed to specify precision to **n** decimal places and exponent up to **m**
- Good for portability
- Constants can be defined to arbitrary precision, e.g., **2_db**

Intrinsic Data Types - **complex**

- 32-bit by default, same as default real

```
complex :: i, pt
...
i  = (4.0, 1.0) ! Real part, imaginary part
pt = 4.0        ! What does this do?

print *, 'i  = ', i
print *, 'pt = ', pt
```

Output:

```
i  = (4.000000,1.000000)
pt = (4.000000,0.0000000E+00)
```

Intrinsic Data Types - **character** (String)

- Length specifiers
- String can have a length of zero

```
character(len=10)  :: first, last ! String of max length 10
character(len=20)  :: full       ! String of max length 20

first = ' '        ! String with no content ' '
first = 'John'      ! 4 letters + 6 trailing blanks 'John '
last  = 'Doe'
full  = first       ! Assignment
full  = first // last ! Assignment with concatenation
print *, full
full  = trim(first) // ' ' // trim(last) ! trim() cuts off trailing print
*, full                ! blanks
                        ! // concatenates strings
```

Output:

John Doe

John Doe

Intrinsic Data Types - **logical** (Boolean)

- Can assume one of two values: **.true.** or **.false.**
- Can be assigned an expression. Its value is the same as the truth value of the expression

```
logical          :: b1, b2, b3
logical, parameter :: always_true = .true.

b1 = .true.
b2 = .false.
b3 = b1 .and. b2          ! Relational operator .and.
print *, 'b1, b2, b3 = ', b1, b2, b3
b3 = b2 .or. always_true  ! Relational operator .or.
print *, 'b1, b2, b3 = ', b1, b2, b3
```

Output:

```
b1, b2, b3 = T F F
b1, b2, b3 = T F T
```

In Class Lab

Write a program that accepts three numbers, (a, b, and c) from the keyboard and your name (name)

- The program will the say hello to you i.e. “Hello, Jim”
- It will then calculate the volume of a sphere with a being the radius.
 $V = (4/3) * \pi * a^3$ (NOTE: the 2 *'s are used for exponent, i.e. a^3 would be $a^{**3.0}$)
- Calculate the volume of a cube with ‘a’ being the length, ‘b’ being the height, and ‘c’ being the width.
- BONUS: multiply a, b, and c. Divide by 7. Take your answer and convert it to an integer.

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