

Data Types and Intrinsic Functions

22.901 Introduction to Computer Programming for Nuclear Engineers

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Outline

- Variable declarations and data types
- Intrinsic functions
- Characters and strings

Ensuring Explicit Variable Declaration

- Lecture 1 highlighted that Fortran has implicit type designation depending on the first letter
- In reality, we do not want to be restricted to this so we will *declare* all variables
- When declaring variables we give the type, attributes, comments and other options
- If we forget to declare a variable, Fortran will use the implicit naming scheme!
 - What is the danger in this?
- To ensure that no variable is declared implicitly we use `implicit none`
- This statement should be listed at the top of every routine

DataTypes

- **integer** for exact whole numbers
- **real** for approximate, fractional numbers
- **complex** for complex, fraction numbers
- **logical** for boolean values `.true.` and `.false.`
- **character** for strings of characters
- **Note:** strings are constructed from an *array* of characters

When to use Integer vs. Real

Integers::

- Always think to yourself is this variable always a whole number?
- Loop counts or loop limits
- An index into an array
- For error codes

Reals::

- Are held as floating-point values
- Can be defined with decimals and exponents

How to declare a variable

```
integer :: i ! loop iteration counter for x
real :: flux ! scalar for total neutron flux
logical :: finished = .false. ! code completed?
character(len=8) :: astr ! a string
```

- All of the different type of declarations are above
- You can set values right in the declarations
- The '::' symbol separates the type info from the variable
- **Single vs. Double Precision**
 - Default is 4 bytes (single precision) $\text{real} \equiv \text{real}(4)$
 - To get double precision use $\text{real}(8)$, 8 bytes

Type Conversions

In any expression it is important to have the same variable type!

- `real(arg)` – converts `arg` to a real(4)
- `int(arg)` – converts `arg` to a integer(4)
- `dble(arg)` – converts `arg` to a real(8).
- `ceiling(x)` – smallest integer greater or equal to `x`
- `floor(x)` – largest integer less or equal to `x`
- `nint(x)` – nearest integer to `x`

Homework 1 w/ Declarations I

```
program assign1

implicit none

integer :: n ! integer to read in
integer :: i ! the output variable

! ask user for whole number 1–9
print *, 'Enter number 1–9::'
read *, n

! multiply by 9
i = 9*n

! add digits together
i = i/10 + mod(i,10)

! subtract by 5
```


Homework 1 w/ Declarations II

```
i = i - 5

! print out result
print *, 'The result is:', i

! terminate the program
stop

end program assign1
```

Fortran Intrinsic Functions

Fortran intrinsic functions are built-in routines that you can call

- `y = sqrt(x)`
- `pi = 4.0*atan(1.0)`
- `z = exp(3.0*y)`
- `u = log(x)` natural log use `log10` for base 10
- `sin(x), cos(x), tan(x)` ... angles are in rads
- `max(x,y), min(x,y)`

There are so many, please search internet if you are looking for something specific!

Character Type

- Used when strings of characters are required
- Fortran's basic type is a fixed-length string
- Character constants are quoted strings
 - `print *, 'This is a title'`
 - `print *, ''And so is this''`
- The characters between quotes are the value

Character Variables

```
character :: answer, marital_status  
character(len=10) :: name,dept,faculty  
character(len=32) :: address
```

`answer` and `marital_status` are each of length **1**.
They hold precisely one character each such are 'Y' or 'n'.

`name`, `dept` and `faculty` are of length **10**.
`address` is of length **32**.

If you do not use the full 'len' the rest is whitespace!

Character Concatenation

Strings may be joined using the `//` operator

```
character(len=6) :: identity,a,b,z
identity = 'TH' // 'OMAS'
a = 'TH'
b = 'OMAS'
z = a // b
print *,identity
print *,z
```

What is the result?

`//` does not remove trailing spaces!

Character Intrinsics

`len(c)` -- the storage length of `c`
`trim(c)` -- remove trailing blanks
`adjustl(c)` -- remove leading blanks
`index(str,sub)` -- position of a substring in string
`repeat(str,num)` -- copy a str num times and join

Again there are many intrinsics to search internet!

```
z = trim(a)//trim(b)
print *,z
```

This will give us THOMAS!

Parameters or Constants

- `parameter` is an optional attribute for a variable
- parameters cannot be changed during the execution of the code
- the actual values of the parameters are specific and substituted in a compile time
- this can reduce errors for variables that should not change

```
real(8), parameter :: pi = 3.14159_8 (or 3.14159D0)  
integer, parameter :: maxlen = 100
```

Calculating the Hypotenuse I

```
program pythag

implicit none

real          :: hyp      ! the measure of the hyp.
real          :: leg1     ! the measure of first leg
real          :: leg2     ! the measure of second leg
character(len=10) :: unitstr ! the unit

! read in both legs from user
print *, 'Enter both legs of right triangle::'
read *, leg1, leg2

! have the user enter units
print *, 'Enter units of legs'
read *, unitstr

! perform pythagorean theorem
```


Calculating the Hypotenuse II

```
hyp = sqrt(leg1**2 + leg2**2)

! print result
print *, 'The hypotenuse is:', hyp, ' '//trim(unitstr)

end program pythag
```

End of Class/External Assignment

Law of Cosines

- Declare all variables
- Get user input for 2 sides and an angle between (read in degrees)
- Also from user get name of the third side
- Perform law of cosines (be careful!)
- Print results to user, 'The length <sidename> is'