

# Procedures and Conditionals

22.901 Introduction to Computer Programming for Nuclear Engineers

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# Outline

- Subroutines
- Functions
- Logical Operators

# Sub-Dividing the Problem

- Most programs are **thousands** of lines!
- You may notice you have to have similar code in multiple places
- Want to have good organization

use procedures

# So what can we do?

- There must be a single **main** program
- **Subroutines** and **functions** are called procedures
- For now we will list them in one file

## Subroutines::

- Code that exists somewhere else
- You can pretty much do anything

## Functions::

- Purpose is to return a result

# Calling a subroutine

- use the call statement, `call <sub name>(args...)`

The subroutine is defined somewhere else:

- `subroutine <name>(args)`
- `use ...`
- `implicit none`
- variable declarations
- executable statements
- `end subroutine <name>`

# Dummy Arguments

- Variable names in a procedure, only exist in that procedure
- Fortran is **pass-by-reference**
- The memory location are only passed between procedures (copies are not made!)
- Therefore in arguments list only order matters, not the name!
- Each argument must match in type and rank

# Functions

- Use when the result is a single value
- For example to return the maximum value of a vector
- **Important:** The function name defines the variable in the function
- The function name is returned at the end of a function

```
a = maxval(vec,n)
function maxval(v,n)
  integer :: n ! length of vector
  real :: maxval ! the maximum value of a vector
  real :: vec(n) ! the vector
  ...
end function maxval
```

# The Intent Attribute

- You can make arguments read-only, write-only or read-write(default)
- This should be used to avoid overwriting a variable
- It is an attribute so it is listed before the ::
- Example::
  - `integer, intent(in) :: avar ! read-only`
  - `integer, intent(out) :: avar ! write-only`
  - `integer, intent(inout) :: avar ! read-write`
  - `integer :: avar ! read-write`



# Internal Procedures

- use the `contains` command
- this will be use a lot more for modules and object-oriented programming
- included procedure are internal and are private to other routines
- they may not contain their own internal subprograms

```
program test
...
contains
subroutine atest
...
end subroutine atest
end program test
```

# Calculating zeta I

```
program zeta

  implicit none

  real :: zeta_fun ! zeta function
  real :: zeta_val ! zeta variable
  real :: val=2.0 ! random value

  ! call zeta subroutine
  call zeta_sub(val,zeta_val)

  ! print results
  print *, 'From subroutine:', zeta_val
  print *, 'From function:', zeta_fun(val)

end program zeta

subroutine zeta_sub(x,zeta)
```

# Calculating zeta II

```
real, intent(in) :: x      ! an input value
real, intent(out) :: zeta ! the answer

zeta = 3.14159/x

end subroutine zeta_sub

function zeta_fun(x)

real, intent(in) :: x      ! an input value
real              :: zeta_fun ! the answer

zeta_fun = 3.14159/x

end function zeta_fun
```

# Decision Making - Conditionals

- Almost every time we code, decisions need to be made from within the code
- Conditionals allow us to execute certain parts of code
- We will go over the following constructs:
  - if statement
  - if-then statement
  - if-else statement
  - if-elseif-else statement

# The 'if' statement

- Oldest and simplest control statement
- `if (logical expression) <execute statement>`
- If the LHS is `.true.`, the RHS is executed
- This is only useful if there is a simple decision and one execute statment
- For anything more complicated, we need to go to block statements

```
if (x < a) x = a
```

# The 'if-then' block statement

- A block if-then statement is more flexible than the if statment
- It has the following form:

```
if (logical expression) then
    execute statements
    more execute statements
end if
```

- If the logical expression is `.true.` then the block is executed

```
if (coremap(i,j,k) == 99999) then
    beta = eval_albedo(i,j,k)
    D = beta(2)/beta(1)
    Dhat = D/dx*(flux(i,j,k))
end if
```

# The 'if-else' block statement

- A block if-then statement is more flexible than the if statment
- It has the following form:

```
if (logical expression) then
    execute statements
else
    execute statements
end if
```
- If the logical expression is `.true.` then the first block is executed. Otherwise, the second block is omitted

```
if (coremap(i,j,k) == 99999) then
    beta = eval_albedo(i,j,k)
else
    beta = 1.0
end if
```

# Including the 'else if'

- You can use as many `else if` statements as you want
- There is only 1 `end if` per `if` (none for `else if`)
- All `else if` statements must be listed before the `else`
- They are checked in order until the first `.true.` is evaluated
- You don't have to have the `else` statement



# Logical Operators

Order of logical operation is used

- `()` - inside out, and function references
- `.not.` - left to right
- `.and.` - left to right
- `.or.` - left to right
- `==, /=, >, <, >=, <=` - left to right

# Square root I

```
program squareroot

  implicit none

  real :: valin  ! the val to be square rooted
  real :: valout ! the output value

  ! read in val from user
  print *, 'Enter a real number:'
  read *, valin

  ! determine if the square root is real or complex
  if (valin > 0.0) then

    ! take the sqrt
    valout = sqrt(valin)

    ! print the result
```

# Square root II

```
    print *, 'The square root is also real:', valout
else if (valin < 0.0) then

    ! make the valin positive and take sqrt
    valout = sqrt(-1.0*valin)

    ! print the result
    print *, 'The square root is complex: +/-', valout, 'i'

else

    print *, 'The square root is obviously 0.0!'

end if

end program squareroot
```

# End of class/External Assignment

- Write a program that solves the quadratic equation

$$y = ax^2 + bx + c$$

- Have the user enter coefficients  $a$ ,  $b$  and  $c$
- Depending on the sign of the discriminant you will have 3 rules:
  - Imaginary, Real, or Double real root
- Calculate appropriate number of solutions
- Print result to user