Control Constructs

Control Constructs

These will change the sequential execution order
Will cover the main constructs in some detail
We will cover procedure call later

The main ones are:

- Conditionals (IF etc.)
- Loops (DO etc.)
- Switches (SELECT/CASE etc.)

Loops are by far the most complicated.

Single Statement IF (1)

The oldest and the simplest is the single statement IF

IF (logical expression) simple statement

If the logical expression is .True. then the simple statement is executed.

If the logical expression is .False. then the whole statement has no effect.

Single Statement IF (2)

Some examples:

```
IF (X < A) X = A

IF (INT(a*b-c) <= 47) mytest = .true.

IF (MOD(Cnt,10) == 0) WRITE(*,*) CNT
```

Unsuitable for anything complicated.

Only action statements (assignment, input/output) can be used. Nothing complicated like another IF statement or anything containing blocks.

Block IF Statement

A block IF statement is much more flexible

Here is the most traditional form of it

```
IF (logical expression) THEN
      then block of statements
ELSE
      else block of statements
ENDIF
```

If the expr is .TRUE. then the first block is executed
If not, the second block is executed.

ENDIF or END IF can be used.

Example

```
LOGICAL :: flip

IF (flip .AND. X /= 0.0) THEN
      PRINT *, 'Using the inverted form'
      X = 1.0/A
      Y = EXP(-A)
ELSE
      X = A
      Y = EXP(-A)
ENDIF
```

Omitting the ELSE

The ELSE and its block can also be omitted.

```
IF (X > Maximum) THEN
    X = Maximum
ENDIF

IF (name(1:4) == "Miss" .OR.   &
    name(1:4) == "Mrs.") THEN
        name(1:3) = "Ms."
        name(4:) = name(5:)
ENDIF
```

Including ELSE IF Blocks (1)

ELSE IF functions much like ELSE and IF

```
IF (X < 0.0) THEN                ! This is tried first
    X = A
ELSE IF (X < 2.0) THEN           ! This second
    X = A + (B-A)*(X-1.0)
ELSE IF (X < 3.0) THEN           ! This third
    X = B + (C-B)*(X-2.0)
ELSE                             ! This is used if none succeed
    X = C
ENDIF
```

Including ELSE IF Blocks (2)

- You can have as many ELSE IFs as you wish
- There is only one ENDIF for the whole block
- All ELSE IFs must come before any ELSE
- They are checked in order and the first success is taken
- You can omit the ELSE in these constructs
- ELSE IF can also be spelled ELSEIF

Named IF Statements (1)

The IF can be preceded by <name>:
And the END IF followed by <name> (note!)
And any ELSE IF / THEN and ELSE may be

```
myifblock: IF (X < 0.0) THEN
      X = A
ELSE IF (X < 2.0) THEN myifblock
      X = A + (B-A)*(X-1.0)
ELSE  myifblock
      X = C
ENDIF myifblock
```

Named IF Statements (2)

The IF construct name must match and be distinct
Can be a great help for checking and clarity
You should name at least all long IFs

If you don't nest IFs that much this style is fine:

```
myifblock: IF (X < 0.0) THEN
      X = A
ELSE IF (X < 2.0) THEN
      X = A + (B-A)*(X-1.0)
ELSE
      X = C
ENDIF myifblock
```

Block Contents

- Almost any executable statements are okay
  - Both kinds of IF, complete loops, etc.
  - You may never notice the few restrictions
- This applies to all of the block statements
  - IF, DO, SELECT, etc.
- Avoid deep levels and very long blocks
  - Purely because they will confuse human readers

Example

```
phasetest: IF (state == 1) THEN
      IF (phase < pi_by_2) THEN
            ...
      ELSE
            ...
      ENDIF
ELSE IF (state == 2) THEN phasetest
      IF (phase > pi) PRINT *, 'A bit odd here'
ELSE phasetest
      IF (phase < pi) THEN
            ...
      ENDIF
ENDIF phasetest
```

SELECT CASE (1)

An alternative to the IF block for selective execution is the SELECT CASE statement. Can be used if the selection criteria are based on simple values in INTEGER, LOGICAL and CHARACTER.

It provides a streamlined syntax for an important special case of a multiway selection.

SELECT CASE (2)

The basic format is:

```
SELECT CASE ( <selector> )
        CASE (label-list-1)
            statements-1
        CASE (label-list-2)
            statements-2
        CASE (label-list-n)
            statements-n
        CASE DEFAULT
            statements-default
END SELECT
```

SELECT CASE (3)

The label-list can take one of many forms:

- val → a specific value
- val1, val2, val3 → a specific set of values
- val1:val2 → values between val1 and val2 inclusive
- val1: → values larger than or equal to val1
- :val2 → values less than or equal to val2

val, val1 and val2 must be constants or parameters!
Examples: select_example1.f90 & select_example2.f90

SELECT CASE (4)

Some important notes:

- The values in the label-lists should be unique. Otherwise you will get a compilation error.
- CASE DEFAULT should be used if possible as it guarantees that a match will be found even if it is an error condition.
- Technically the CASE DEFAULT can be placed anywhere within the SELECT CASE statement but the preferred position is at the bottom.

DO Construct

The loop construct in Fortran is known as the do loop.
The basic syntax is:

```
[ loop name ] DO [ loop control ]
      block of statements
END DO [ loop name ]
```

- loop name and loop control are optional
- With no loop control it loops indefinitely
- END DO or ENDDO can be used.

Indexed DO Loop (1)

This is the most common form.

```
DO <control-var> = <initial>, <final> [,<step>]
      block of statements
END DO
```

- <control var> is an integer variable.
- <initial>, <final> and <step> are integer expressions
- If <step> is omitted its default value is 1.
- <step> cannot be zero.

Indexed DO Loop (2)

If <step> is positive:

- <control-var> receives the value of <initial>.
- If the value of <control-var> is less than or equal to <final>, the block of statements contained within the loop are executed.
- Then the value of <control-var> is iterated by <step> and compared to <final>.
- When the value of <control-var> exceeds the value of <final> execution moves below the END DO.

Indexed DO Loop (3)

If <step> is negative:

- <control-var> receives the value of <initial>.
- If the value of <control-var> is greater than or equal to <final>, the block of statements contained within the loop are executed.
- Then the value of <control-var> is iterated by <step> and compared to <final>.
- When the value of <control-var> is less than the value of <final> execution moves below the END DO.

Indexed DO Loop (4)

Important notes:

- <step> cannot be zero.
- Before the loop starts the values of <initial>, <final> and <step> are evaluated exactly once. i.e., these values are never re-evaluated as the loop executes.
- Never attempt to change the values of <control-var>, <initial>, <final> or <step>.
- Don't use real variables for the loop expressions.
- Examples: simpleloop.f90

Non-Indexed DO Loop

We can omit the loop control but then we need a way to exit the loop.

- The EXIT statement brings the flow of control to the statement following the END DO.
- The CYCLE statement starts the next iteration.
- Examples: exitloop.f90

WHILE Loop

The WHILE loop control has the following form:

```
DO WHILE ( <logical expression> )
.
END DO
```

- The logical expression is reevaluated for each cycle
- The loop exits as soon as it becomes .FALSE.
- It's actually a redundant feature as the same thing can be accomplished with an EXIT statement.
- Examples: whileloop.f90

CONTINUE Statement

CONTINUE is a statement that does nothing

Used to be fairly common particularly before END DO came along but now it is rare.

It's mainly a placeholder for labels
This is purely to make the code clearer

It can be used anywhere a statement can.

RETURN and STOP

RETURN causes a procedure to halt execution with control given back to the calling program

STOP halts execution cleanly.

Typically used with an IF statement to stop the program if some error condition is encountered.