CIS1400 – Programming Logic and Technique

Topic 5 → Repetition Control Structures

Chapter Topics

- 5.1 Introduction to Repetition Structures
- 5.2 Condition-Controlled Loops: While, Do-While, and Do-Until
- 5.3 Count-Controlled Loops and the For Statement
- 5.4 Calculating a Running Total
- 5.5 Sentinels
- 5.6 Nested Loops

Visual Basic Program Examples

5.1 Introduction to Repetition Structures

A repetition structure causes a statement or set of statements to execute repeatedly

Allows programmer to avoid <u>problems associated with</u> <u>duplicate code</u>

- Makes a program unnecessarily large
 - ▶ Can affect problem comprehension
 - ▶ Takes extra space on computer
- Is time consuming to write
 - Masks purpose of code sections that could reveal similarities
- Requires corrections or changes to be done many times
 - Increases maintenance efforts

5.2 Condition-Controlled Loops

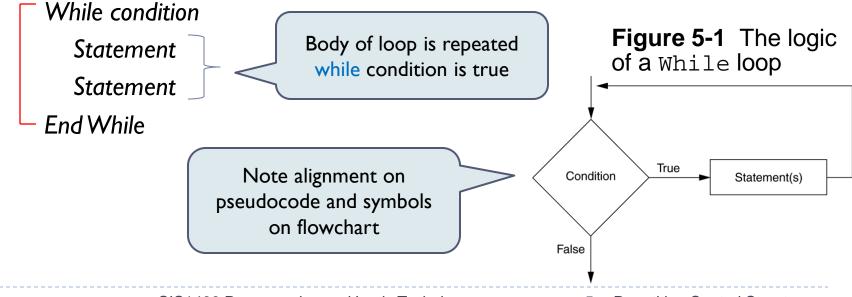
- ▶ A condition-controlled loop iterates based upon the value of an evaluated condition
- Sometimes referred to as indeterminate loops.
- Types:
 - While Loop
 - While a condition is true, do some task
 - Do-While Loop
 - Do some task, while condition is true
 - Do-Until Loop
 - Do some task, while a condition is false (or until it's true)
- With all loops, be careful not to create infinite loops always provide a way to break out of the loop!



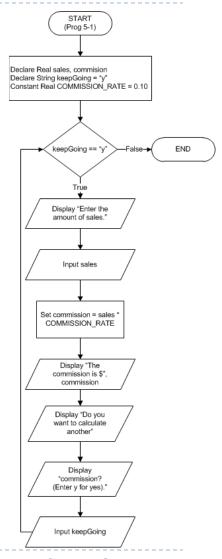
5.2 Condition-Controlled Loops

The While Loop – pretest loop

- Loop iterates while a condition is true
- condition tested before iteration
- possible to have no iteration
- condition should be initialized/set before condition testing



```
// Variable declarations
Declare Real sales, commission
Declare String keepGoing = "y"
// Constant for the commission rate
Constant Real COMMISSION RATE = 0.10
While keepGoing == "y"
 // Get the amount of sales
 Display "Enter the amount of sales."
 Input sales
 // Calculate the commission
 Set commission = sales * COMMISSION RATE
 // Display the commission
 Display "The commission is $", commission
 Display "Do you want to calculate another"
 Display "commission? (Enter y for yes)."
 Input keepGoing
End While
```

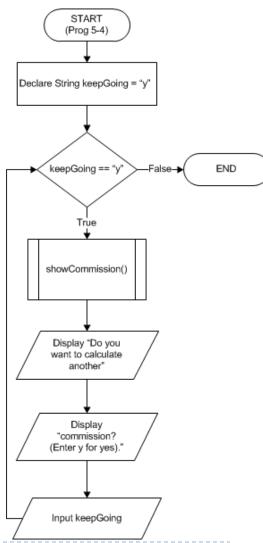


Infinite Loops

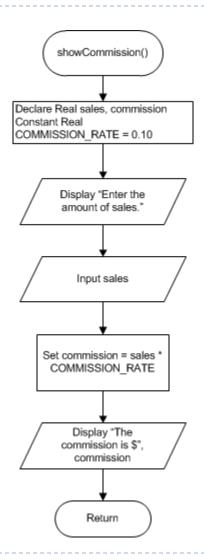
- Loop that has no way of stopping
 - Continues until program is interrupted
 - Occurs when code to modify condition is missing
- Loops must contain way to terminate
 - Rare exceptions

```
// Variable declarations
Declare Real sales, commission
Declare String keepGoing = "y"
// Constant for the commission rate
Constant Real COMMISSION_RATE = 0.10
// Warning! Infinite loop!
While keepGoing == "y"
    // Get the amount of sales
    Display "Enter the amount of sales."
    Input sales
    // Calculate the commission
    Set commission = sales * COMMISSION_RATE
    // Display the commission
    Display "The commission is $", commission
End While
```

```
Could also prompt
                             user for initial value.
Module main()
  // Local variable
 Declare String keepGoing = "y"
  // Calculate as many commissions
  // as needed.
 While keepGoing == "y"
   // Display a salesperson's commission
   Call showCommission()
   // Do it again?
   Display "Do you want to calculate another"
   Display "commission? (Enter y for yes)."
   Input keepGoing
 End While
End Module
```



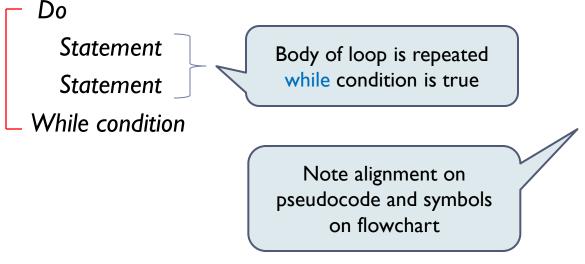
```
// The showCommission module gets the
// amount of sales and displays the
// commission.
Module showCommission()
 // Local variables
 Declare Real sales, commission
 // Constant for the commission rate
 Constant Real COMMISSION RATE = 0.10
 // Get the amount of sales
 Display "Enter the amount of sales."
 Input sales
 // Calculate the commission.
 Set commission = sales * COMMISSION RATE
 // Display the commission
 Display "The commission is $", commission
End Module
```



5.2 Condition-Controlled Loops

The Do-While Loop – posttest loop

- Loop iterates while a condition is true
- condition tested after iteration
- must have at least one iteration
- condition should be reset within loop body



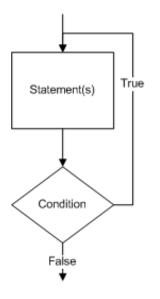
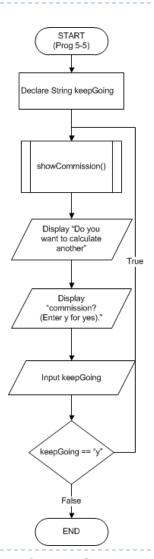
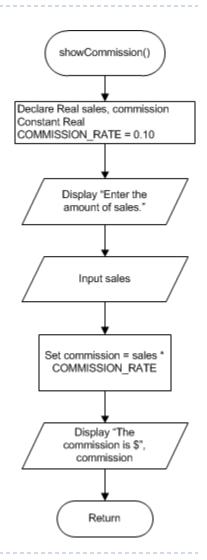


Figure 5-7 The Logic of a Do-While loop

```
Module main()
 // Local variable
 Declare String keepGoing
 // Calculate commissions as many
 // times as needed.
 Do
   // Display a salesperson's commission.
   Call showCommission()
   // Do it again?
   Display "Do you want to calculate another"
   Display "commission? (Enter y for yes)."
   Input keepGoing
 While keepGoing == "y"
End Module
```



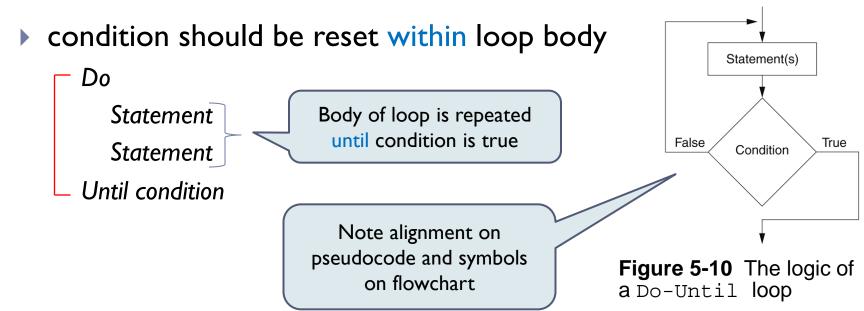
```
// The showCommission module gets the
// amount of sales and displays the
// commission.
Module showCommission()
 // Local variables
 Declare Real sales, commission
 // Constant for the commission rate
 Constant Real COMMISSION RATE = 0.10
 // Get the amount of sales
 Display "Enter the amount of sales."
 Input sales
 // Calculate the commission
 Set commission = sales * COMMISSION RATE
 // Display the commission
 Display "The commission is $", commission
End Module
```



5.2 Condition-Controlled Loops

The Do-Until Loop

- ▶ Loop iterates until a condition is true
 - not all languages support this type of loop
- condition tested after iteration
- must have at least one iteration

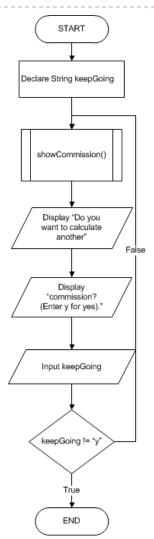


Do-Until Loop Example – Program 5-7

```
// Declare a variable to hold the password
Declare String password
// Repeatedly ask the user to enter a password
// until the correct one is entered
Do
 // Prompt the user to enter the
 // password
 Display "Enter the password."
 Input password
 // Display an error message if the
 // wrong password was entered.
 If password != "prospero" Then
   Display "Sorry, try again."
 End If
Until password == "prospero"
// Indicate that the password is
// confirmed
Display "Password confirmed."
```

Do-Until Loop Example – Sales Commissions

```
Module main()
 // Local variable
 Declare String keepGoing
 // Calculate commissions as many
 // times as needed.
 Do
   // Display a salesperson's commission.
   Call showCommission()
   // Do it again?
   Display "Do you want to calculate another"
   Display "commission? (Enter y for yes)."
   Input keepGoing
 Until keepGoing != "y"
End Module
```



5.2 Condition-Controlled Loops

Which loop to use?

- While Loop
 - Repeat task as long as condition is true
 - Ideal when loop may not execute at all
 - □ Condition is false at start
- Do-While Loop
 - Repeat task as long as condition is true
 - Ideal when loop should execute at least once
 - □ Condition is true or false at start
- Do-Until Loop
 - Repeat task as long as condition is false
 - Ideal when loop should execute at least once
 - Best for task performed until condition is true



5.3 Count-Controlled Loops

▶ A count-controlled loop iterates a specific number of times

Sometimes referred to as determinate loops

▶ A for loop is best used for this situation

For counterVariable = startingValue to maxValue

statement

statement

End For

There is an Initialization, Test, and Increment expression that controls the loop

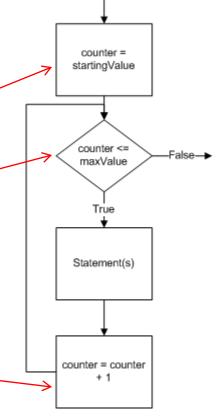
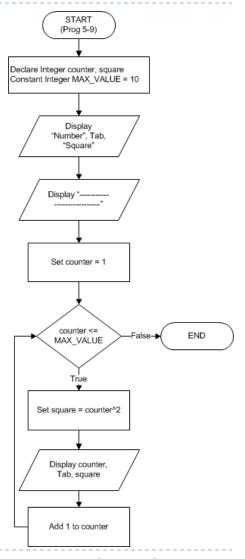


Figure 5-12 Logic of a count-controlled loop

```
// Variables
Declare Integer counter, square
// Constant for the maximum value
Constant Integer MAX VALUE = 10
// Display table headings.
Display "Number", Tab, "Square"
Display "----
// Display the numbers 1 through 10 and
// their squares.
For counter = 1 to MAX VALUE
 // Calculate number squared.
 Set square = counter^2
 // Display number and number squared.
 Display counter, Tab, square
End For
```



5.3 Count-Controlled Loops

For loops can also increment by more than one, count backwards by decrementing

For counterVariable = startingValue to endValue Step stepValue statement statement

Declare Integer counter
For counter = 1 To 5 Step 1
Display "Hello World"
End For

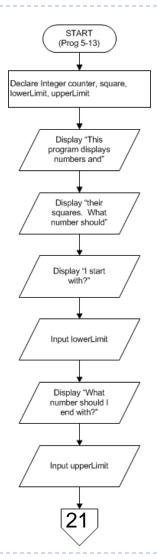
End For

Declare Integer counter
For counter = 2 To 10 Step 2
Display "Hello World"
End For

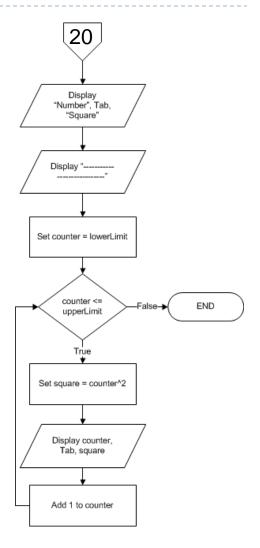
Declare Integer counter
For counter = 5 To 1 Step -1
 Display "Hello World"
End For

Declare Integer counter
For counter = 10 To 2 Step -2
Display "Hello World"
End For

```
// Variables
Declare Integer counter, square,
  lowerLimit, upperLimit
// Get the lower limit
Display "This program displays numbers and"
Display "their squares. What number should"
Display "I start with?"
Input lowerLimit
// Get the upper limit.
Display "What number should I end with?"
Input upperLimit
```

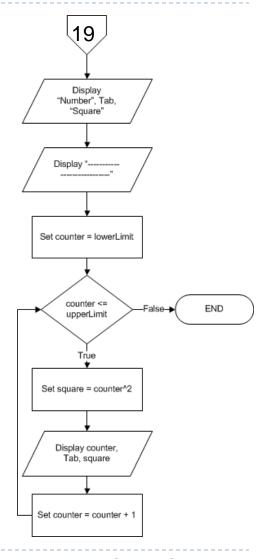


```
// Display table headings.
Display "Number", Tab, "Square"
Display "-----"
// Display the numbers and their squares.
For counter = lowerLimit to upperLimit
    // Calculate number squared.
    Set square = counter^2
    // Display number and number squared.
    Display counter, Tab, square
End For
```



Creating a count-controlled While Loop of previous

```
// Display table headings.
Display "Number", Tab, "Square"
Display "-----"
Set counter = lowerLimit
// Display the numbers and their squares.
While counter <= upperLimit
    // Calculate number squared.
    Set square = counter^2
    // Display number and number squared.
    Display counter, Tab, square
    Set counter = counter + 1
End While</pre>
```



5.3 Count-Controlled Loops

General loop concerns

- Do not forget to initialize the loop control variable
- Do not forget to modify the loop control variable
- Make sure loop is easily understood
- Many loops are interchangeable, but generally should keep in mind the following when selecting a loop type:
 - Number of iterations known?
 - Yes → use determinate loop (counter controlled)
 - No → use indeterminate loop (condition controlled)
 - Must have at least one iteration?
 - Yes → use posttest loop (do-while, do-until)
 - \triangleright No \rightarrow use pretest loop (while, for)

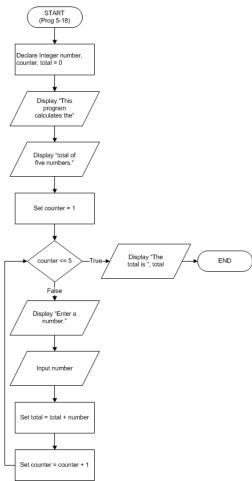
5.4 Calculating a Running Total

A running total (accumulator) is a sum of number that accumulates with each iteration of a loop

- Loop reads in each number
- Variable to accumulate numbers during each read

Program 5-18 Calculate a running total

```
Declare Integer number, counter, total = 0
Display "This program calculates the "
Display "total of five numbers"
For counter = 1 to 5
Display "Enter a number."
Input number
Set total = total + number
End For
Display "The total is ", total
```



5.5 Sentinels

Alternative designs for processing list of values:

- Ask user at end of each loop iteration if there is another value to process
 - Cumbersome for long lists
- Ask user at the beginning of the loop how many times the loop should process
 - Cumbersome for long lists and if user does not know number of items in list
- Ask user to input a number that would not be a valid value

A sentinel is a special value that marks the end of a list of values

- used as stop values for conditional loops
- Example: Program 5-19

5.6 Nested Loops

All loops can be nested:

- Loop inside of a loop
- No limitations on the types of loops that can be nested

Figure 5-21 Flowchart for a clock simulator

```
Declare Integer hours, minutes, seconds
Display "Clock Simulator Program"
For hours = 0 to 23
  For minutes = 0 to 59
    For seconds = 0 to 59
       Display hours, ":", minutes, ":", seconds
       End For
  End For
End For
```

