Subroutines and Functions

Chapter 6

Introduction

- So far, most of the code has been inside a single method for an event
  - Fine for small programs, but inconvenient for large ones
  - Much better to divide program into manageable pieces (modularization)
- Benefits of modularization
  - Avoids repeat code (reuse a function many times in one program)
  - Promotes software reuse (reuse a function in another program)
  - Promotes good design practices (Specify function interfaces)
  - Promotes debugging (can test an individual module to make sure it works properly)
- General procedures: procedures not associated with specific events
  - Sub
  - Function
  - Property

Sub Procedures

- The purpose of a Sub procedure is to operate and manipulate data within some specific context
- A general procedure is invoked by using its defined name
  - For example: Message()
  - You've been using Sub Procedures all the time:
    - E.g. g.DrawLine(Pens.Blue, 10, 10, 40, 40)

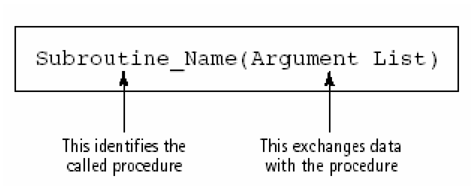
      CInt(txtInput.Text)

Creating a General Sub Procedure

- Ensure that the Code window is activated by:
  - Double clicking on a Form, or
  - Pressing the F7 function key, or
  - Selecting the Code item from the View menu
- Type a procedure declaration into the Code window
  - Public Sub procedure-name()
- Visual Basic will create the procedure stub
- Type the required code

Exchanging Data with a General Procedure

- Syntax for calling a Sub procedure into action: procedure-name(argument list)

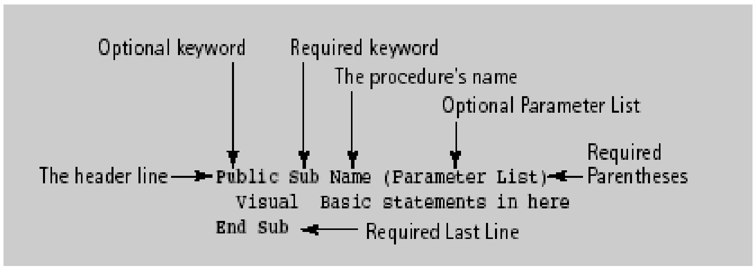

Subroutine_Name(Argument List)
This identifies the called procedure
This exchanges data with the procedure

Calling a Sub Procedure

Exchanging Data with a General Procedure (continued)

- A general Sub procedure declaration must include:
  - Keyword Sub
  - Name of the general procedure
    - The rules for naming Sub procedures are the same as the rules for naming variables
  - Names of any parameters
- Parameter: the procedure's declaration of what data it will accept
- Argument: the data sent by the calling function
- **Individual data types of each argument and its corresponding parameter must be the same**

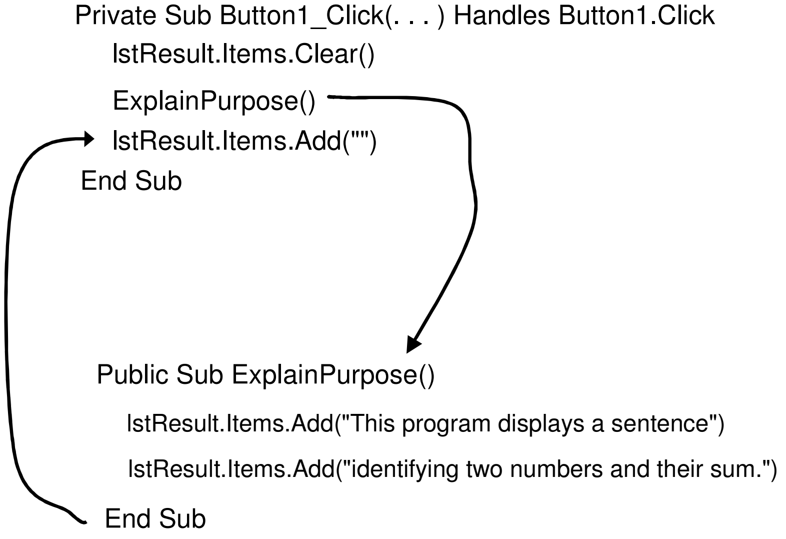
Exchanging Data with a General Procedure (continued)



```
Public Sub Name (Parameter List)
  Visual  Basic statements in here
End Sub
```

The Structure of a General Sub Procedure

Example



```
Private Sub Button1_Click(. . . ) Handles Button1.Click
   lstResult.Items.Clear()
   ExplainPurpose()
   lstResult.Items.Add("")
End Sub


Public Sub ExplainPurpose()
   lstResult.Items.Add("This program displays a sentence")
   lstResult.Items.Add("identifying two numbers and their sum.")
End Sub
```

Code Re-Use

- If in another place in the code you wanted to explain the purpose, you can just invoke the subroutine:

```
Public Sub OtherCode(…)
        ExplainPurpose()
        ‘ Presumably other code here
End Sub
```

- Avoids duplicate the same code in many places
- If you ever want to change the code, only one place needs to be changed

Passing Parameters

- You can send items to a Sub procedure

```
              Sum(2, 3)

Public Sub Sum(num1 As Double, num2 As Double)
     Console.WriteLine(num1+num2)
End Sub
```

- In the Sum Sub procedure, 2 will be stored in num1 and 3 will be stored in num2 and the sum will be output to the console

The order of the parameters determines which value is sent in as what variable! The data types must match!

Passing Variables

- We can pass variables too:

```
x = 2
y = 3
Sum(x,y)          ‘ Same as Sum(2, 3)
```

- The variables are evaluated prior to calling the subroutine, and their values are accessible via the corresponding variable names in the sub

Population Density Sub

- Subroutine to calculate population density:

```
Public Sub CalculateDensity(ByVal state As String, _
                ByVal pop As Double, _
                ByVal area As Double)
   Dim rawDensity, density As Double
   rawDensity = pop / area
   density = Math.Round(rawDensity, 1)     ' Round to 1 decimal place
   Console.Write("The density of " & state & " is " & density)
   Console.WriteLine(" people per square mile.")
End Sub
```

VB.NET adds “ByVal” if you leave it off.
We’ll discuss what this means shortly…

Parameters and Arguments

```
CalculateDensity("Alaska", 627000, 591000)
```

Arguments – what you send to a Sub procedure

```
Public Sub CalculateDensity(ByVal state As String, _
                            ByVal pop As Double, _
                            ByVal area As Double)
```

Parameters – place holders for what the sub procedure receives

If ByVal left off, VB.NET will add it

Code Reuse

- By making CalculateDensity a procedure subroutine, we can reuse it, e.g.:

  CalculateDensity(“Hawaii”, 1212000, 6471)

Sub Procedures Calling Other Sub Procedures

```
Private Sub btnDisplay_Click(...)
    Handles btnDisplay.Click
  FirstPart()
  Console.WriteLine("a")
End Sub

Sub FirstPart()
  SecondPart()
  Console.WriteLine("b")
End Sub

Sub SecondPart()
  Console.WriteLine("c")
End Sub
```

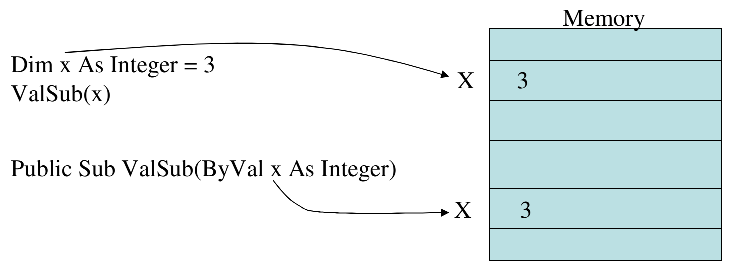
```
Output:
  c
  b
  a
```

In Class Exercises

- Write a Sub procedure that takes as arguments an animal and sound for the "Old McDonald Had A Farm" song and outputs the verse, e.g.:
  - Old McDonald had a farm, E-I-E-I-O.
  - And on his farm he had a cow, E-I-E-I-O.
  - With a moo moo here, and a moo moo there,
  - Here a moo, there a moo, everywhere a moo moo.
  - Old McDonald had a farm, E-I-E-I-O
- Complete the program in the Form Load event to output the verses for a cow, chicken, and lamb.
- Modify the Monty Hall Game Show program to use subroutines instead of repeating almost the same code in the "Else" portion of each button click (send in the number of the door that was clicked)

Passing by Value

- ByVal stands for "By Value"
  - Default mode, VB.NET adds this for you if you leave it off
- ByVal parameters retain their original value after Sub procedure terminates
  - Can think of this as a copy of the variable is sent in



ByVal Example

```
Public Sub CallingSub()
    Dim y As Integer
    y = 5
    Console.WriteLine("y is " & y)
    ValSub(y)
    Console.WriteLine("y is " & y)
 End Sub

 Public Sub ValSub(ByVal x As Integer)
    x = 10
    Console.WriteLine(" x is " & x)
 End Sub
```

Output?

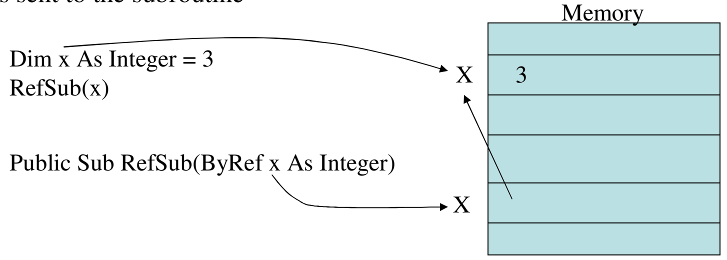
ByVal Example – Y to X

```
Public Sub CallingSub()
    Dim x As Integer
    x = 5
    Console.WriteLine(“x is " & x)
    ValSub(x)
    Console.WriteLine(“x is " & x)
End Sub

Public Sub ValSub(ByVal x As Integer)
    x = 10
    Console.WriteLine("x is " & x)
End Sub
```

Output?

Passing by Reference

- ByRef stands for "By Reference“
  - You can think of this as a reference, or pointer, to the original variable is sent to the subroutine



- ByRef parameters can be changed by the Sub procedure and retain the new value after the Sub procedure terminates

ByRef Example

```
Public Sub CallingSub()
    Dim y As Integer
    y = 5
    Console.WriteLine("y is " & y)
    RefSub(y)
    Console.WriteLine("y is " & y)
 End Sub

 Public Sub RefSub(ByRef x As Integer)
    x = 10
    Console.WriteLine(" x is " & x)
 End Sub
```

Output?

ByVal Example – Y to X

```
Sub CallingSub()
    Dim x As Integer
    x = 5
    Console.WriteLine(“x is " & x)
    RefSub(x)
    Console.WriteLine(“x is " & x)
 End Sub

 Sub RefSub(ByRef x As Integer)
    x = 10
    Console.WriteLine("x is " & x)
 End Sub
```

Any Difference in Output?

Local Variables

- Variables declared inside a Sub procedure with a Dim statement
- Parameters are also considered local variables; their values are gone when the subroutine exits (unless parameters were passed ByRef)

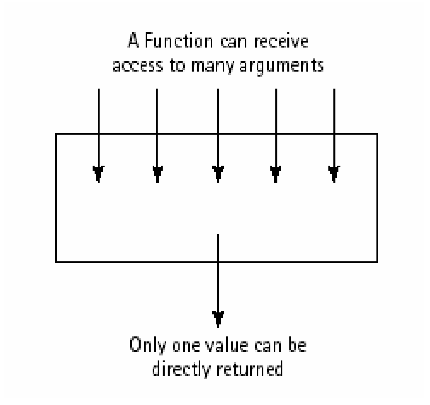
In-Class Exercise

- Write a subroutine that swaps two integer variables; e.g. Swap(x,y) results in exchanging the values in X and Y

Function Procedures

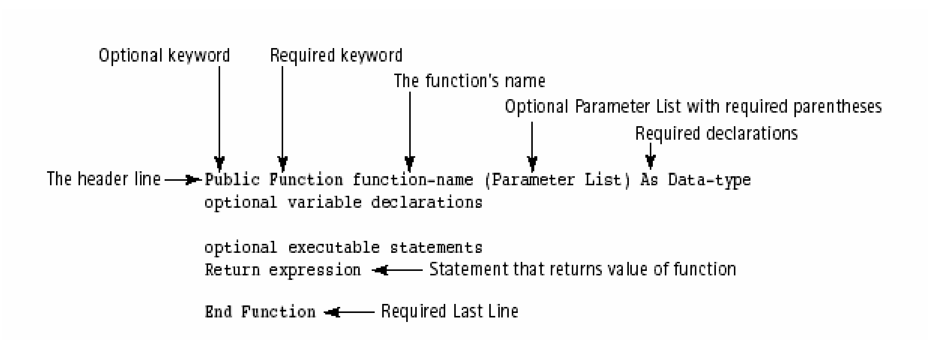
- A function directly returns a single value to its calling procedure
- Types of functions:
  - Intrinsic
  - User-defined

Function Procedures (continued)


A Function can receive access to many arguments
Only one value can be directly returned

A Function Directly Returns a Single Value

Function Procedures (continued)



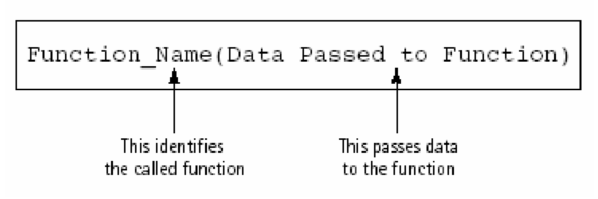
```
Public Function function-name (Parameter List) As Data-type
optional variable declarations

optional executable statements
Return expression

End Function
```

The Structure of a Function Procedure

Calling a Function Procedure

- To call a function procedure:
  - Give the function's name
  - Pass any data to it in the parentheses following the function name
- Arguments of the called function are the items enclosed within the parentheses in a calling statement

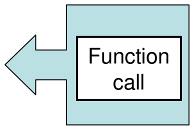
Calling a Function Procedure (continued)

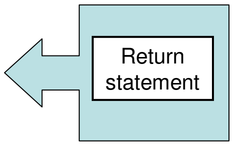

Function_Name(Data Passed to Function)
This identifies the called function
This passes data to the function

Calling and Passing Data to a Function

Sample

```
Private Sub btnDetermine_Click(...)
    Handles btnDetermine.Click
  Dim name As String
  name = txtFullName.Text
  txtFirstname.Text = FirstName(name)
End Sub

Public Function FirstName(ByVal name As String) As String
  Dim firstSpace As Integer
  firstSpace = name.IndexOf(" ")
  Return name.Substring(0, firstSpace)
End Function
```





Having Several Parameters

```
Private Sub btnCalculate_Click(...)
    Handles btnCalculate.Click
  Dim a, b As Double
  a = CDbl(txtSideOne.Text)
  b = CDbl(txtSideTwo.Text)
  txtHyp.Text = CStr( Hypotenuse(a, b) )
End Sub

Public Function Hypotenuse( ByVal a As Double, _
                    ByVal b As Double ) As Double
  Return Math.Sqrt(a ^ 2 + b ^ 2)
End Function
```

User-Defined Functions Having No Parameters

```
Private Sub btnDisplay_Click(...) _
    Handles btnDisplay.Click
  txtBox.Text = Saying()
End Sub

Public Function Saying() As String
  Return InputBox("What is your" _
           & " favorite saying?")
End Function
```

Comparing Function Procedures with Sub Procedures

- Subs are accessed using a call statement
- Functions are called where you would expect to find a literal or expression
- For example:
  - Result = *functionCall*
  - Console.WriteLine (*functionCall*)

Functions vs. Procedures

- Both can perform similar tasks
  - Use a function or subroutine when you find yourself repeating the same (or almost the same) code over and over again
- Both can call other subs and functions
- Use a function when you want to return one and only one value
  - A function or sub can also be declared with ByRef arguments to return multiple values back through the argument list

Collapsing a Procedure with a Region Directive

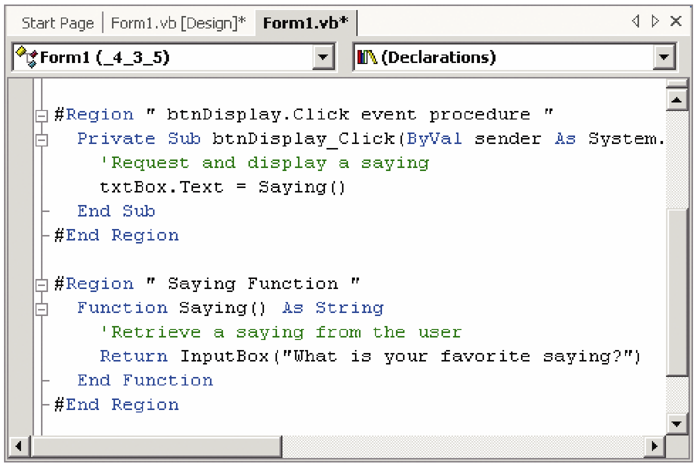
- A procedure can be collapsed behind a captioned rectangle
- This task is carried out with a **Region directive**.
- To specify a region, precede the code to be collapsed with a line of the form

`#Region "`*`Text to be displayed in the box.`*`"`

- and follow the code with the line

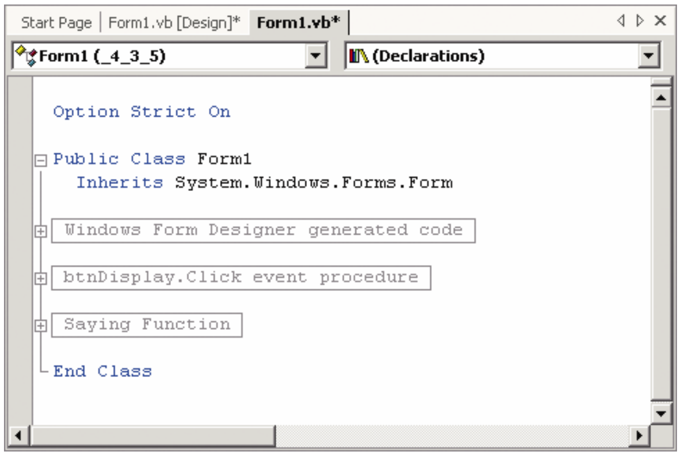
`#End Region`

Region Directives



```
#Region " btnDisplay.Click event procedure "
  Private Sub btnDisplay_Click(ByVal sender As System.
    'Request and display a saying
    txtBox.Text = Saying()
  End Sub
#End Region

#Region " Saying Function "
  Function Saying() As String
    'Retrieve a saying from the user
    Return InputBox("What is your favorite saying?")
  End Function
#End Region
```

Collapsed Regions



```
Option Strict On

Public Class Form1
  Inherits System.Windows.Forms.Form

 Windows Form Designer generated code

 btnDisplay.Click event procedure

 Saying Function

End Class
```

In-Class Exercises

- Write a function that takes as input a year (of data type String) and returns True if the string is a valid year from 1900-2006 and False otherwise
- Modify the Craps game from homework 2 to use functions to:
  - Roll the dice (no inputs, returns sum of two six sided dice)
  - Roll for the point (takes as input the value of the point)