Syllabus Content:

2.3.6 Structured programming

- use a procedure
- explain where in the construction of an algorithm it would be appropriate to use a procedure
  - a procedure may have none, one or more parameters
  - a parameter can be passed by reference or by value
- show understanding of passing parameters by reference
- show understanding of passing parameters by value
  - a call is made to the procedure using CALL <identifier> ()
- use a function
- explain where in the construction of an algorithm it is appropriate to use a function
- use the terminology associated with procedures and functions: procedure/function header, procedure/ function interface, parameter, argument, return value
  - given pseudocode will use the following structure for function definitions:
  - a function is used in an expression, for example
- write programs containing several components and showing good use of resources

2.3.6 Structured programming

Subroutines & Procedures

Initially, a program was written as one monolithic block of code. The program started at the first line of the program and continued to the end.

Program languages have now been developed to be structured. A problem can be divided into a number of smaller subroutines (also called **procedures**). From within one subroutine, another subroutine can be called and executed.

Subroutine

A subroutine is a self-contained section of program code that performs a specific task, as part of the main program.

Procedure

Procedure is giving a group of statements a name. When we want to program a procedure we need to define it before the main program. We call it in the main program when we want the statements in the procedure body to be executed.

Pseudocode

```
PROCEDURE <identifier>
<statement (s)>
ENDPROCEDURE

PROCEDURE <identifier> (BYREF <identifier>: <data type>)
<statement (s)>
ENDPROCEDURE

PROCEDURE <identifier> (BYVALUE <identifier>: <datatype>)
<statement (s)>
ENDPROCEDURE
```

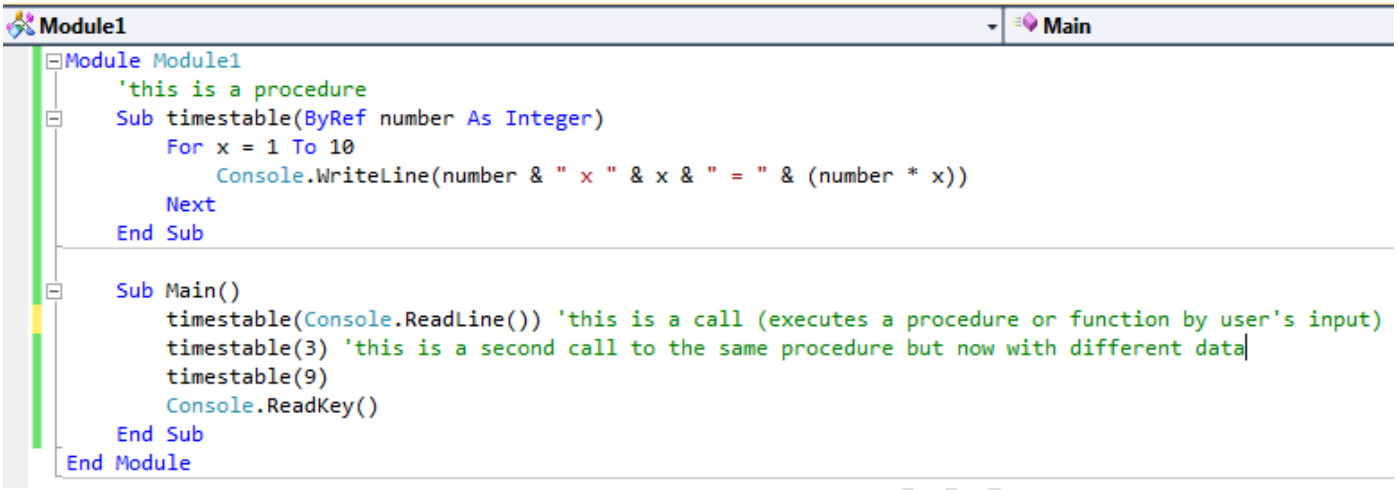
ByRef vs. ByVal

Parameters can be passed by reference (ByRef) or by value (ByVal).

If you want to pass the value of the variable, use the ByVal syntax. By passing the value of the variable instead of a reference to the variable, any changes to the variable made by code in the subroutine or function will not be passed back to the main code.

This is the default passing mechanism when you don't decorate the parameters by using ByVal or ByRef.

If you want to change the value of the variable in the subroutine or function and pass the revised value back to the main code, use the ByRef syntax. This passes the reference to the variable and allows its value to be changed and passed back to the main code.



Example Program – Procedures

Global Variables declared

```
Module Module1

    Dim num1 As Integer
    Dim num2 As Integer
    Dim answer As Integer

       Sub input_sub()
              Console.Clear()
              Console.WriteLine("Enter number 1")
              num1 = Console.ReadLine
              Console.WriteLine("Enter number 2")
              num2 = Console.ReadLine
       End Sub

       Sub Calculation()
              answer = num1 * num2
       End Sub

       Sub output_sub()
              Console.Write("the product of " & num1 & " and " & num2 & " is ")
              Console.WriteLine(answer)
              Console.ReadLine()
       End Sub

    Sub Main()
        input_sub()
        Calculation()
        output_sub()
    End Sub

End Module
```

Parameter

A parameter is a value that is 'received' in a subroutine (procedure or function).
The subroutine uses the value of the parameter within its execution.

The action of the subroutine will be different depending upon the parameters that it is passed.
Parameters are placed in parenthesis after the subroutine name.
For example: Square(5) 'passes the parameter 5 – returns 25

ByRef vs. ByVal

Parameters can be passed by reference (**ByRef**) or by value (**ByVal**).

If you want to pass the value of the variable, use the **ByVal** syntax. By passing the value of the variable instead of a reference to the variable, any changes to the variable made by code in the subroutine or function will not be passed back to the main code.

This is the default passing mechanism when you don't decorate the parameters by using **ByVal** or **ByRef**. If you want to change the value of the variable in the subroutine or function and pass the revised value back to the main code, use the **ByRef** syntax. This passes the reference to the variable and allows its value to be changed and passed back to the main code.

Variable Scope

A variable holds data while the program is running. The scope of a variable defines where it can be seen. They are classifies as either global or local

Global Variable

A global variable is declared in a module and is accessible from any procedure or function within that module.

Local Variables

A local variable is declared in a procedure or function and is only accessible within that procedure of function.

Parameters

As mentioned above, local variables only have a lifespan of the procedure. Sometimes it is useful to pass a value from one procedure to another. This is done by using parameters (or arguments)
A parameter can be passed from one procedure to another by value or by reference.

By Value

The word ByVal is short for "By Value". What it means is that you are passing a **copy** of a variable to your Subroutine. You can make changes to the copy and the original will not be altered.

```
Module Module1
    Dim num1 As Integer
    Dim num2 As Integer
    Dim answer As Integer

    Sub input_sub()
        Console.Clear()
        Console.WriteLine("Enter number 1")
        num1 = Console.ReadLine
        Console.WriteLine("Enter number 2")
        num2 = Console.ReadLine
    End Sub

    Sub Calculation()
        answer = num1 * num2
    End Sub

    Sub output_sub()
        Console.Write("the product of " & num1 & " and " & num2 & "
is ")
        Console.WriteLine(answer)
    End Sub

    Sub Main()
        Dim answer As Char

        Do
            input_sub()
            Calculation()
            output_sub()

            Console.WriteLine("another go? Y/N")
            answer = Console.ReadLine()
        Loop Until UCase(answer) = "N"

    End Sub
```

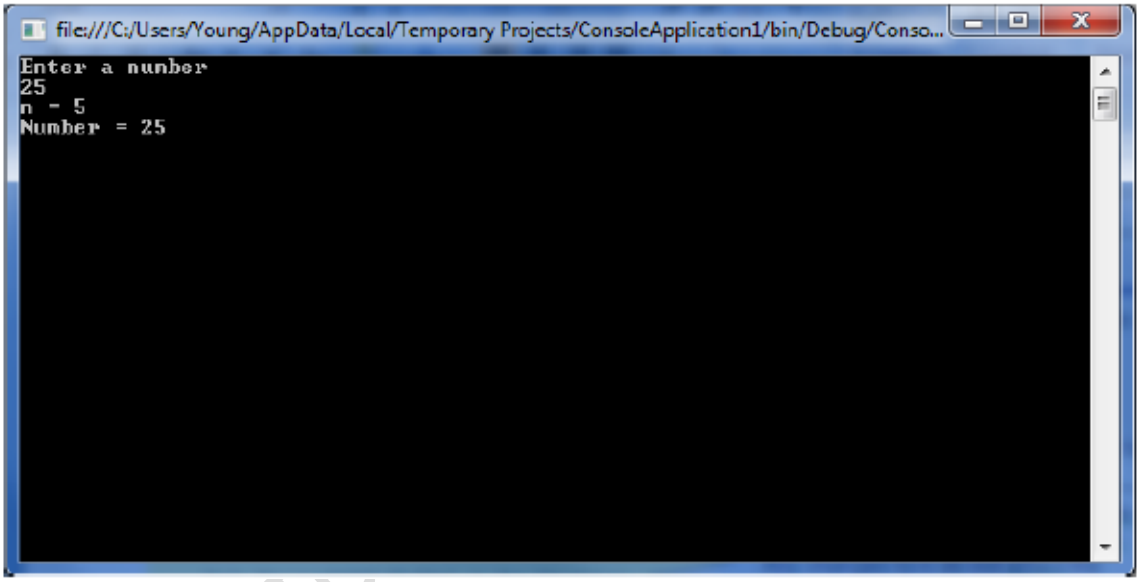
Global variables, declared before any subroutines and are available throughout the

Local variable declared within a subroutine and is only available within this subroutine.

```
Module Module1

    Sub WriteSQRT(ByVal n As Double)
        n = Math.Sqrt(n)
        Console.WriteLine("n = " & n)
    End Sub

    Sub Main()
        Dim number As Double
        Console.WriteLine("Enter a number")
        number = Console.ReadLine
        WriteSQRT(number)
        Console.WriteLine("Number = " & number)
        Console.ReadLine()
    End Sub

End Module
```

This procedure us expecting a double variable, which is known locally as **n**. Any changes to n do not effect the original variable

The variable **number** is passed to the subroutine *WriteSQRT*



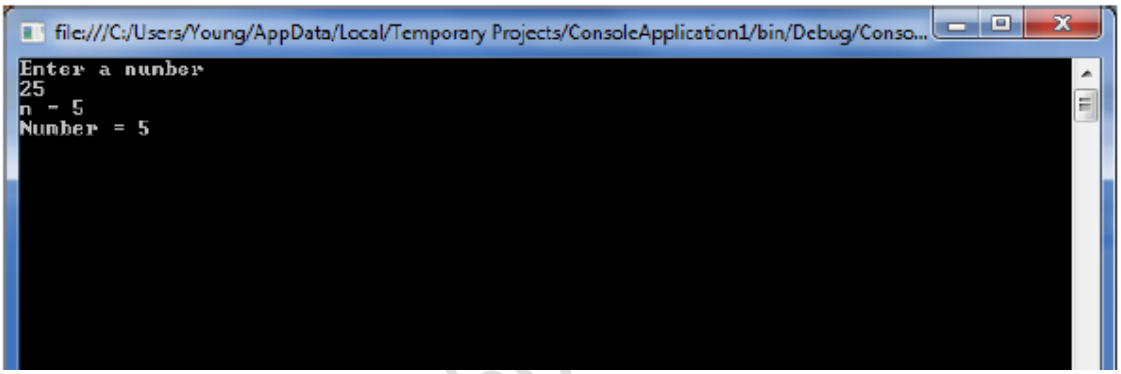
By Reference

ByRef is the alternative. This is short for By Reference. This means that you are not handing over a copy of the original variable but pointing to the original variable. Any change you make to the variable within your subroutine will effect the variable itself.

```
Module Module1

    Sub WriteSQRT(ByRef n As Double)
        n = Math.Sqrt(n)
        Console.WriteLine("n = " & n)
    End Sub

    Sub Main()
        Dim number As Double
        Console.WriteLine("Enter a number")
        number = Console.ReadLine
        WriteSQRT(number)
        Console.WriteLine("Number = " & number)
        Console.ReadLine()
    End Sub

End Module
```

This procedure us expecting a double variable, which is known locally as **n**. Any changes **WILL** effect the original variable

The variable **number** is passed to the subroutine *WriteSQRT*



A procedure is a group of statements that together perform a task when called. After the procedure is executed, the control returns to the statement calling the procedure. VB.Net has two types of procedures:

- Functions
- Sub procedures or Subs

Functions return a value, whereas Subs do not return a value.

Defining a Function

The Function statement is used to declare the name, parameter and the body of a function. The syntax for the Function statement is:

```
[Modifiers] Function FunctionName [(ParameterList)] As ReturnType
    [Statements]
End Function
```

Functions

Functions are similar to subroutines, except that they always return a value. They are normally used in either **assignments** (A:=TaxA(370);) or **expressions** (IF taxA(15000) THEN….)
The function names doubles as a procedure name and a variable.

```
Module Module1
    Function square(ByVal x As Integer) As Integer
        square = x * x
    End Function
End Module
```

Square is the function name, that is expecting an integer to be passed (byref) to it.

The result is assigned to the function name which is dimensioned as an integer. The function name can be used as a variable containing the result within other procedures.

ByRef vs. ByVal

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If you want to change the value of the variable in the subroutine or function and pass the revised value back to the main code, use the ByRef syntax. This passes the reference to the variable and allows its value to be changed and passed back to the main code.

Pseudocode

```
FUNCTION <identifier> RETURNS <datatype>
<statement (s)>
ENDFUNCTION

FUNCTION <identifier> (<identifier> : <datatype>)
RETURNS <data type> // function has one or more parameters
<statement(s)>
ENDFUNCTION
```

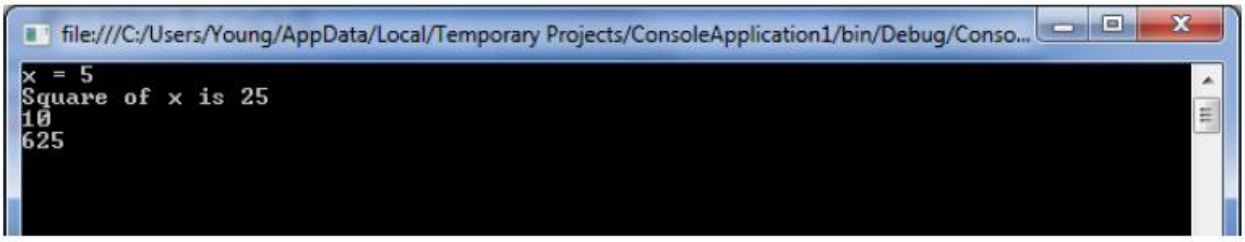
Example Program in VB - Functions

Module1 | Main

```
Module Module1
    'this is a function (functions return a value)
    Function adder(ByRef a As Integer, ByVal b As Integer)
        adder = a + b
        Return adder
    End Function

    Sub Main()

        Dim x As Integer
        x = adder(2, 3) 'call to function adder which returns a value
        Console.WriteLine("2 + 3 = " & x)
        'you can simply then code by putting the call directly into the print statement
        Console.WriteLine("4 + 6 = " & adder(4, 6))

        Console.ReadKey()
    End Sub
End Module
```

Example Program – Functions

```
Module Module1
    Function square(ByVal x As Integer) As Integer
        square = x * x
    End Function
    Function sum(ByRef a As Integer, ByRef b As Integer) As Integer
        sum = a + b
    End Function
    Sub Main()
        Dim number As Double = 5
        Console.WriteLine("x = " & number)
        Console.WriteLine("Square of x is " & square(number))
        Console.WriteLine(sum(3, 7))
        Console.WriteLine(square(sum(16, 9)))
        Console.ReadLine()
    End Sub
End Module
```



Programming languages, such as VB.net and spreadsheets, have many functions built-in. Examples include

SUM(range) Spreadsheet: to add a block of cell values.
LCASE(string) VB: converts a string to upper case
ROUND(integer) Round the integer up
RANDOM Generate a random number

Example

Following code snippet shows a function *FindMax* that takes two integer values and returns the larger of the two.

```
Function FindMax(ByVal num1 As Integer, ByVal num2 As Integer) As Integer ' local
variable declaration
    Dim result As Integer
    If (num1 > num2) Then
        result = num1
    Else
        result = num2
    End If
    FindMax = result
End Function
```

Function Returning a Value

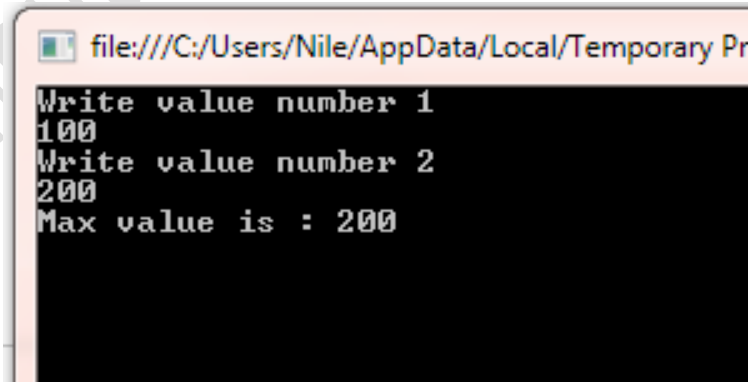
In VB.Net, a function can return a value to the calling code in two ways:

- By using the return statement
- By assigning the value to the function name

The following example demonstrates using the *FindMax* function:

```
Module module1
    Function FindMax(ByVal num1 As Integer, ByVal num2 As Integer) As Integer
        ' local variable declaration */
        Dim result As Integer
        If (num1 > num2) Then
            result = num1
        Else
            result = num2
        End If
        FindMax = result
    End Function
    Sub Main()
        Dim a As Integer
        Console.WriteLine("Write value number 1")
        a = Console.ReadLine()
        Dim b As Integer
        Console.WriteLine("Write value number 2")
        b = Console.ReadLine()
        Dim res As Integer
        res = FindMax(a, b)
        Console.WriteLine("Max value is : {0}", res)
        Console.ReadLine()
    End Sub
End Module
```

When the above code is compiled and executed, it takes value 1 & value 2 as input and produces the maximum value for example:

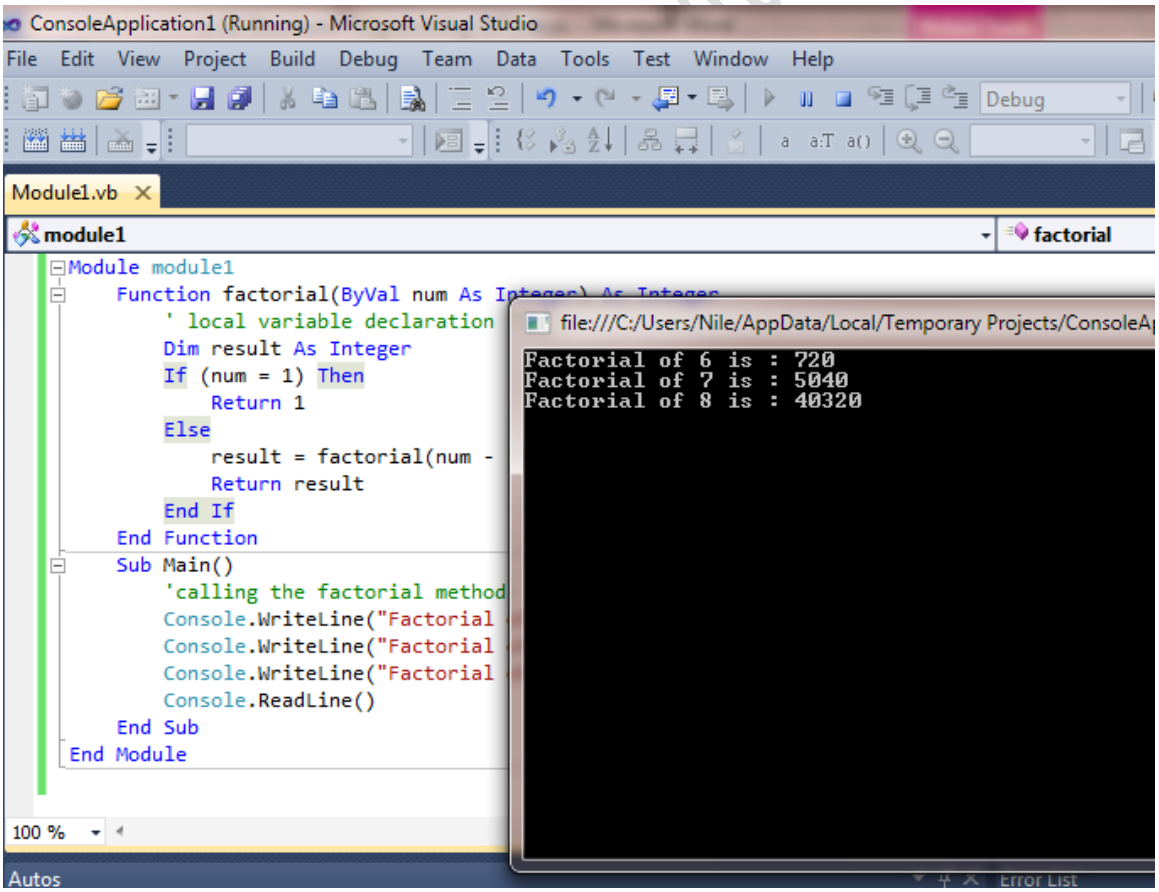


Recursive Function

A function can call itself. This is known as recursion. Following is an example that calculates factorial for a given number using a recursive function:

```
Module myfunctions
    Function factorial(ByVal num As Integer) As Intege ' local variable declaration */
        Dim result As Integer
        If (num = 1) Then
            Return 1
        Else
            result = factorial(num - 1) * num
            Return result
        End If
    End Function
    Sub Main()
        'calling the factorial method
        Console.WriteLine("Factorial of 6 is : {0}", factorial(6))
        Console.WriteLine("Factorial of 7 is : {0}", factorial(7))
        Console.WriteLine("Factorial of 8 is : {0}", factorial(8))
        Console.ReadLine()
    End Sub
End Module
```

When the above code is compiled and executed, it produces the following result:



Calling a Function

You call a `Function` procedure by using the procedure name, followed by the argument list in parentheses, in an expression. You can omit the parentheses only if you aren't supplying any arguments. However, your code is more readable if you always include the parentheses.

You call a `Function` procedure the same way that you call any library function such as `Sqrt`, `Cos`, or `ChrW`.

You can also call a function by using the `Call` keyword. In that case, the return value is ignored. Use of the `Call` keyword isn't recommended in most cases. For more information, see Call Statement.

Visual Basic sometimes rearranges arithmetic expressions to increase internal efficiency. For that reason, you shouldn't use a `Function` procedure in an arithmetic expression when the function changes the value of variables in the same expression.

Syntax

```
[ Call ] procedureName [ (argumentList) ]
```

Parts

`procedureName`
Required. Name of the procedure to call.

`argumentList`
Optional. List of variables or expressions representing arguments that are passed to the procedure when it is called. Multiple arguments are separated by commas. If you include `argumentList`, you must enclose it in parentheses.
Remarks

You can use the `Call` keyword when you call a procedure. For most procedure calls, you aren't required to use this keyword.

You typically use the `Call` keyword when the called expression doesn't start with an identifier. Use of the `Call` keyword for other uses isn't recommended.

If the procedure returns a value, the `Call` statement discards it.

Example

The following code shows two examples where the `Call` keyword is necessary to call a procedure. In both examples, the called expression doesn't start with an identifier.

```
Sub TestCall()
    Call (Sub() Console.Write("Hello"))()

    Call New TheClass().ShowText()
End Sub

Class TheClass
    Public Sub ShowText()
        Console.Write(" World")
    End Sub
End Class
```

References:

Visual Basics Console Cook Book by
VB.NET Console Book by ***Dough Semple***
https://www.tutorialspoint.com/vb.net/vb.net_functions.htm
https://docs.microsoft.com/en-us/dotnet/visual-basic/language-reference/statements/function-statement