CS2034B / DH2144B

Data Analytics: Principles and Tools

Western UNIVERSITY · CANADA

Week 5

Programming Part 1

Getting Started With Visual Basic for Applications (VBA)

Western Science

Example: Daily Interest

Sometimes formulas can get large enough to be error prone.

We may also want to make it easier to reuse a formula that we frequently need.

Example: Daily Interest

- Suppose we have interest compounded daily at a given annual rate r_a.

- How much interest accumulates after a certain number of days d?

Example: Daily Interest

After d days a principal amount P at annual rate r_a will earn interest equal to

$$Interest = ((1 + r_a)^{d/365} - 1)P$$

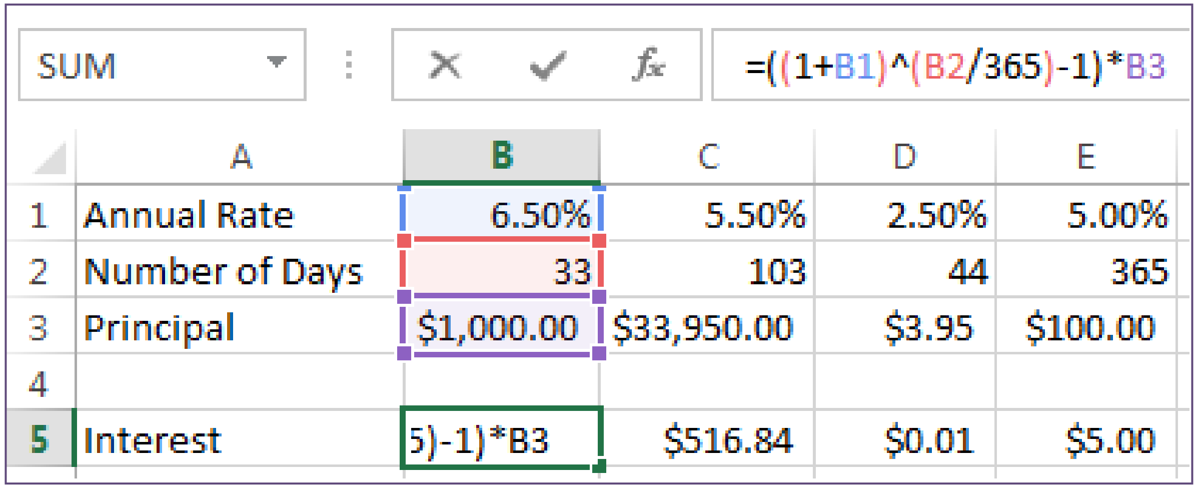
Example: Daily Interest

After d days a principal amount P at annual rate r_a will earn interest equal to

$$Interest = ((1 + r_a)^{d/365} - 1)P$$

We can write this as an Excel formula, e.g.

=((1+B1)^(B2/365)-1)*B3



SUM   =((1+B1)^(B2/365)-1)*B3

	A	B	C	D	E
1	Annual Rate	6.50%	5.50%	2.50%	5.00%
2	Number of Days	33	103	44	365
3	Principal	$1,000.00	$33,950.00	$3.95	$100.00
4					
5	Interest	5)-1)*B3	$516.84	$0.01	$5.00

Example: Daily Interest

- If a formula such as this appears in many cells, then it is susceptible to hard-to-spot editing errors.

- We would like to give formulas such as these short names and re-use them by that name, e.g.

```
=DailyInterest(B1, B2, B3)
```

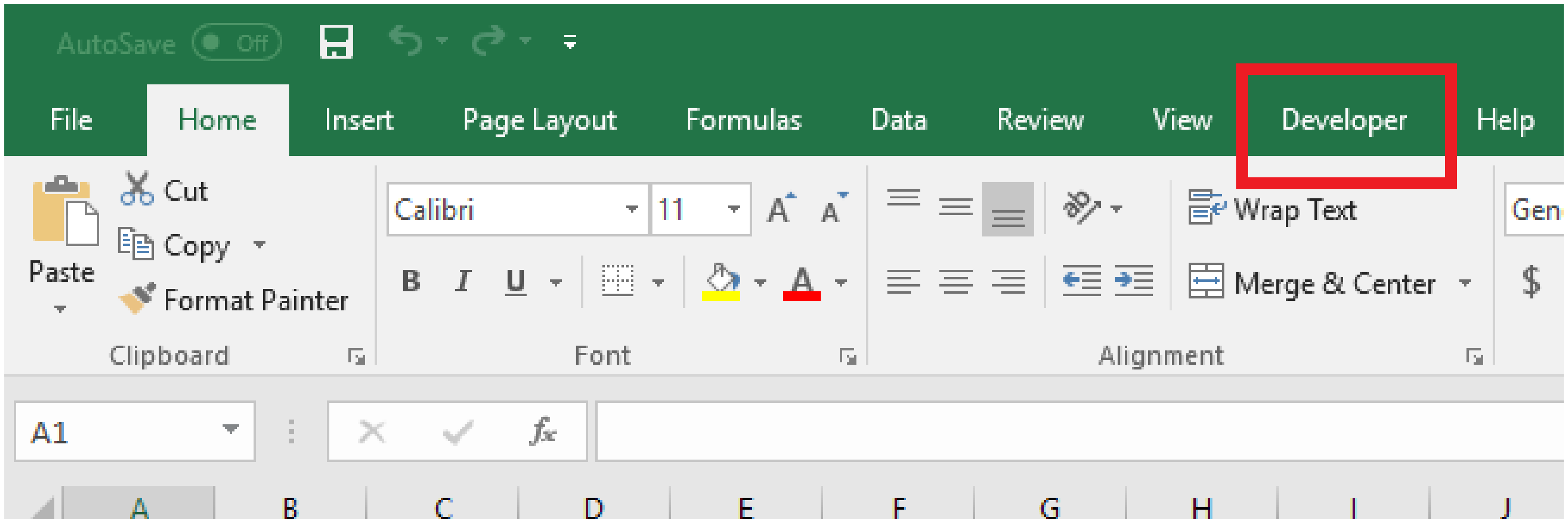
- We do this by programming new Excel functions in VBA.

VBA

VBA is the programming language used within Excel to develop functions, subroutines, and macros. It stands for **Visual Basic for Applications**

Exposing the Developer Tab

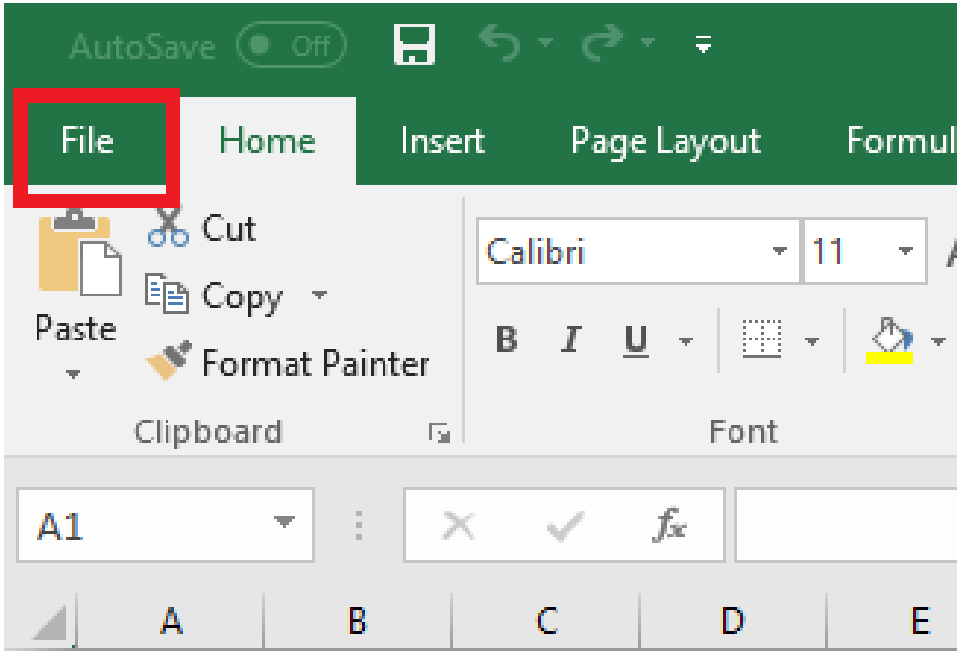
To program with VBA in Excel, we first need access to the developer tab:



Exposing the Developer Tab

In most cases, this tab is not displayed by default and we have to expose it as follows:

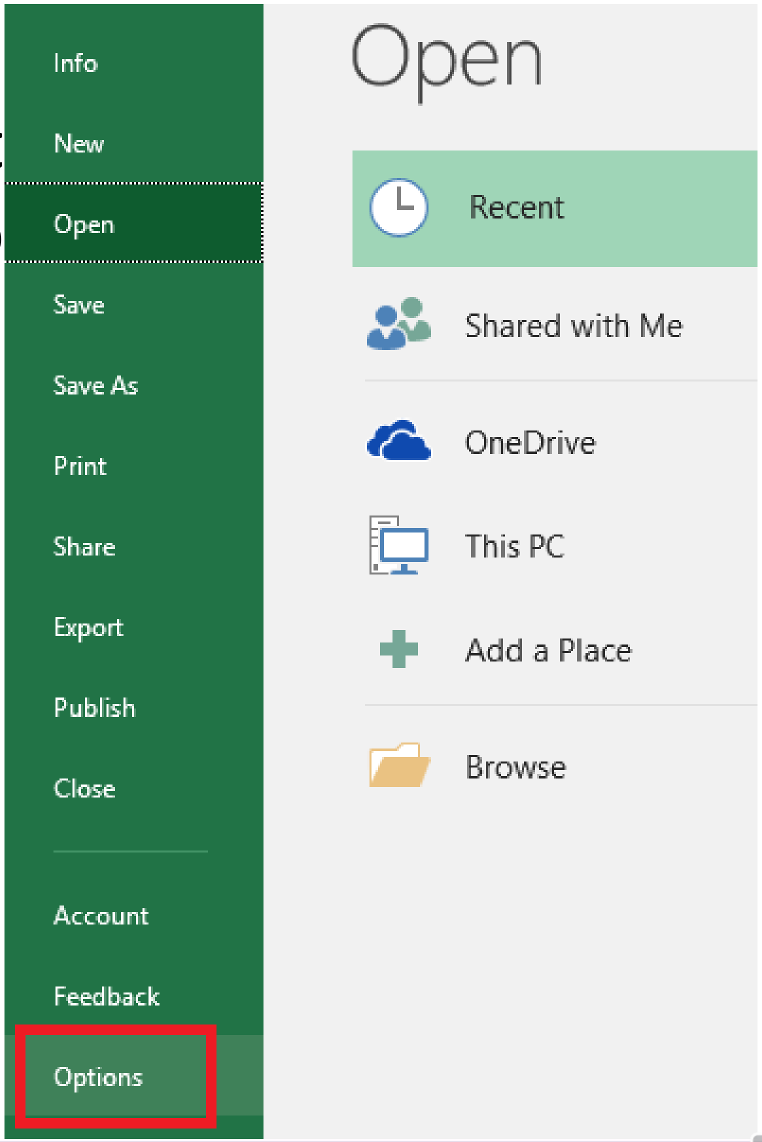
1. Click the file tab



Exposing the Developer Tab

In most cases, this tab is not
we have to expose it as follo

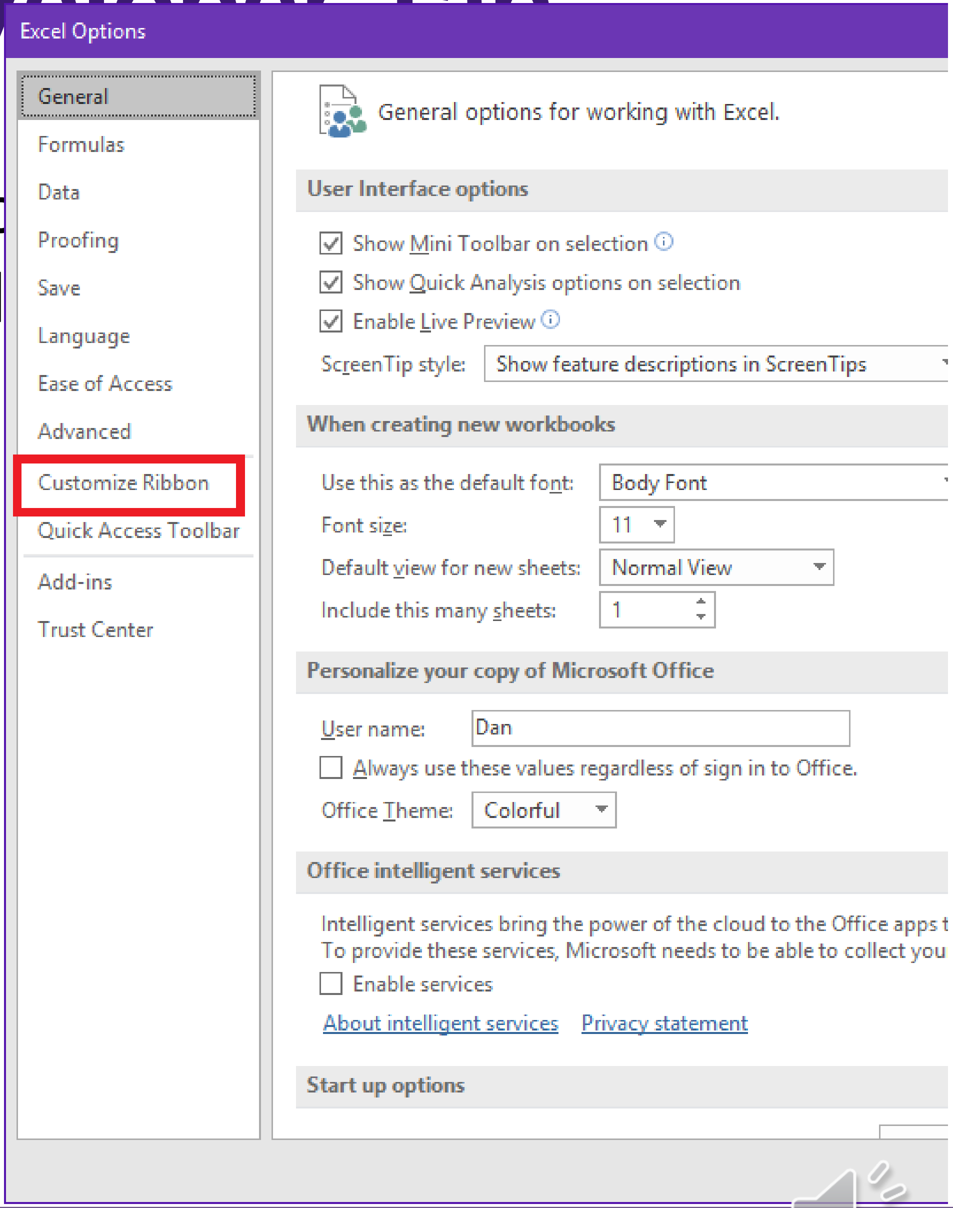
1. Click the file tab
2. Click options



Exposing the Developer Tab

In most cases, this tab is no
we have to expose it as foll

1. Click the file tab
2. Click options
3. Select "Customize Ribbon"


Excel Options

General
Formulas
Data
Proofing
Save
Language
Ease of Access
Advanced
Customize Ribbon
Quick Access Toolbar
Add-ins
Trust Center

General options for working with Excel.

User Interface options

- [✓] Show Mini Toolbar on selection
- [✓] Show Quick Analysis options on selection
- [✓] Enable Live Preview

ScreenTip style: Show feature descriptions in ScreenTips

When creating new workbooks

Use this as the default font: Body Font
Font size: 11
Default view for new sheets: Normal View
Include this many sheets: 1

Personalize your copy of Microsoft Office

User name: Dan
- [ ] Always use these values regardless of sign in to Office.

Office Theme: Colorful

Office intelligent services

Intelligent services bring the power of the cloud to the Office apps t
To provide these services, Microsoft needs to be able to collect you
- [ ] Enable services

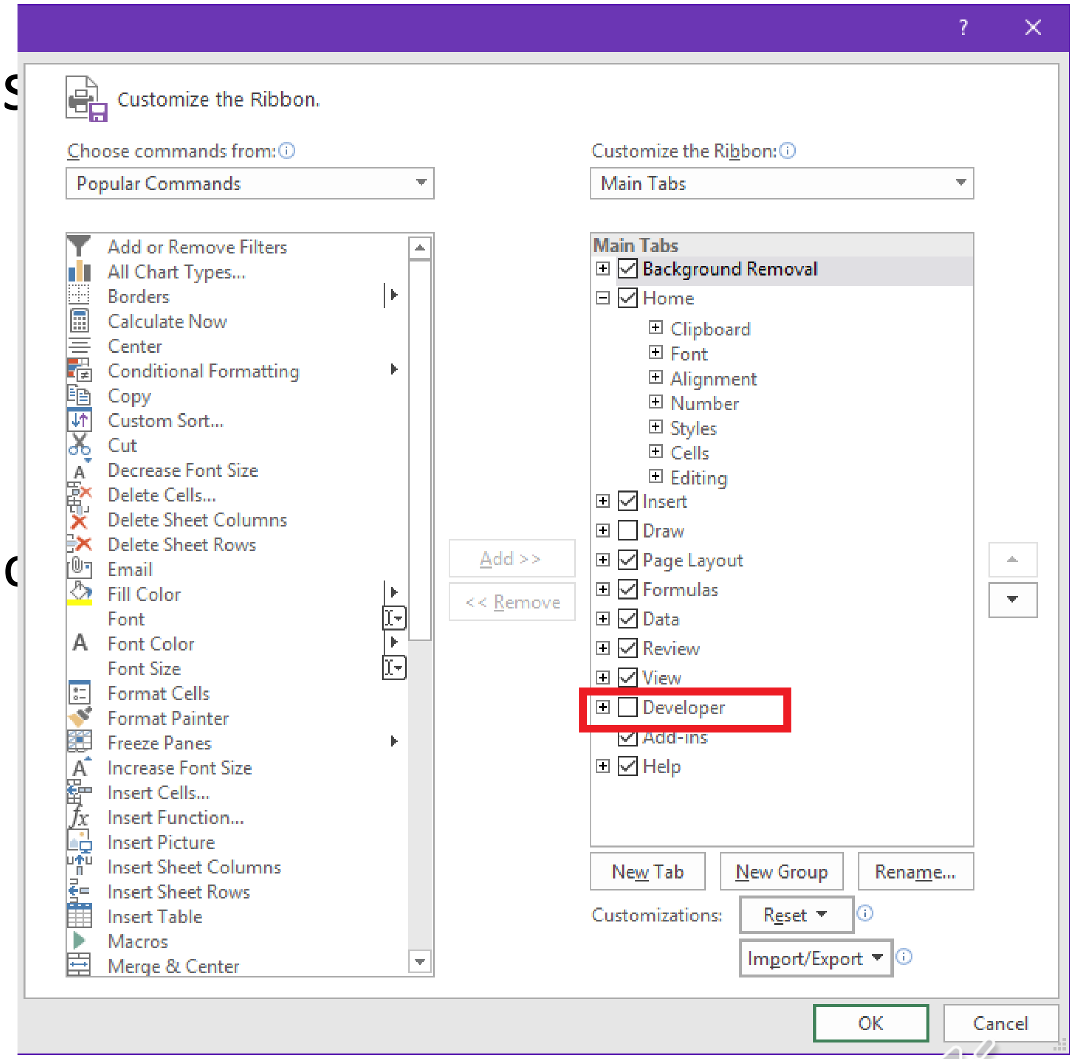
About intelligent services Privacy statement

Start up options

Exposing the Developer Tab

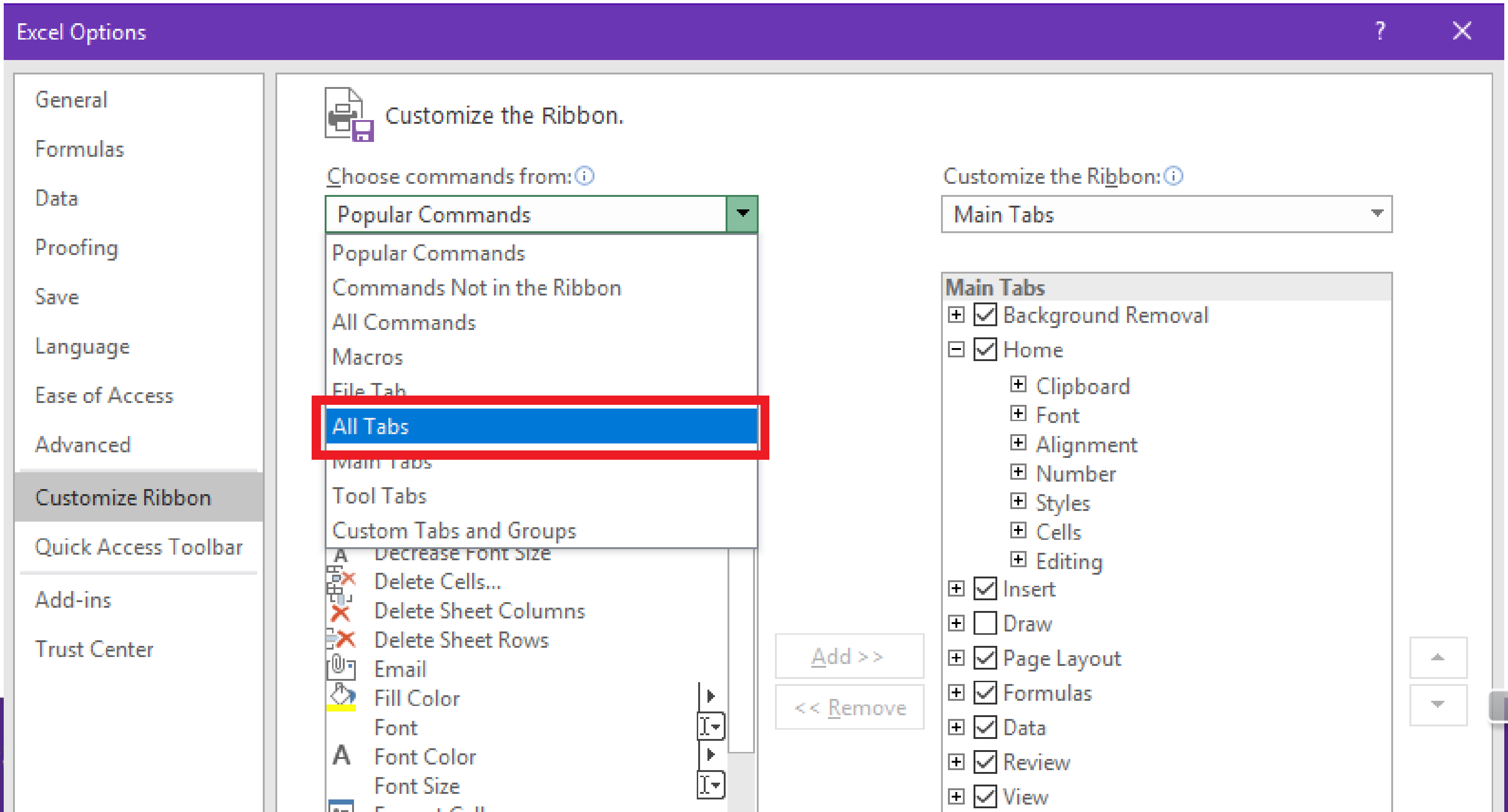
In most cases, this tab is
we have to expose it as

1. Click the file tab
2. Click options
3. Select “Customize Ribbo
4. Check the box next to
   Developer on the right
   & click OK



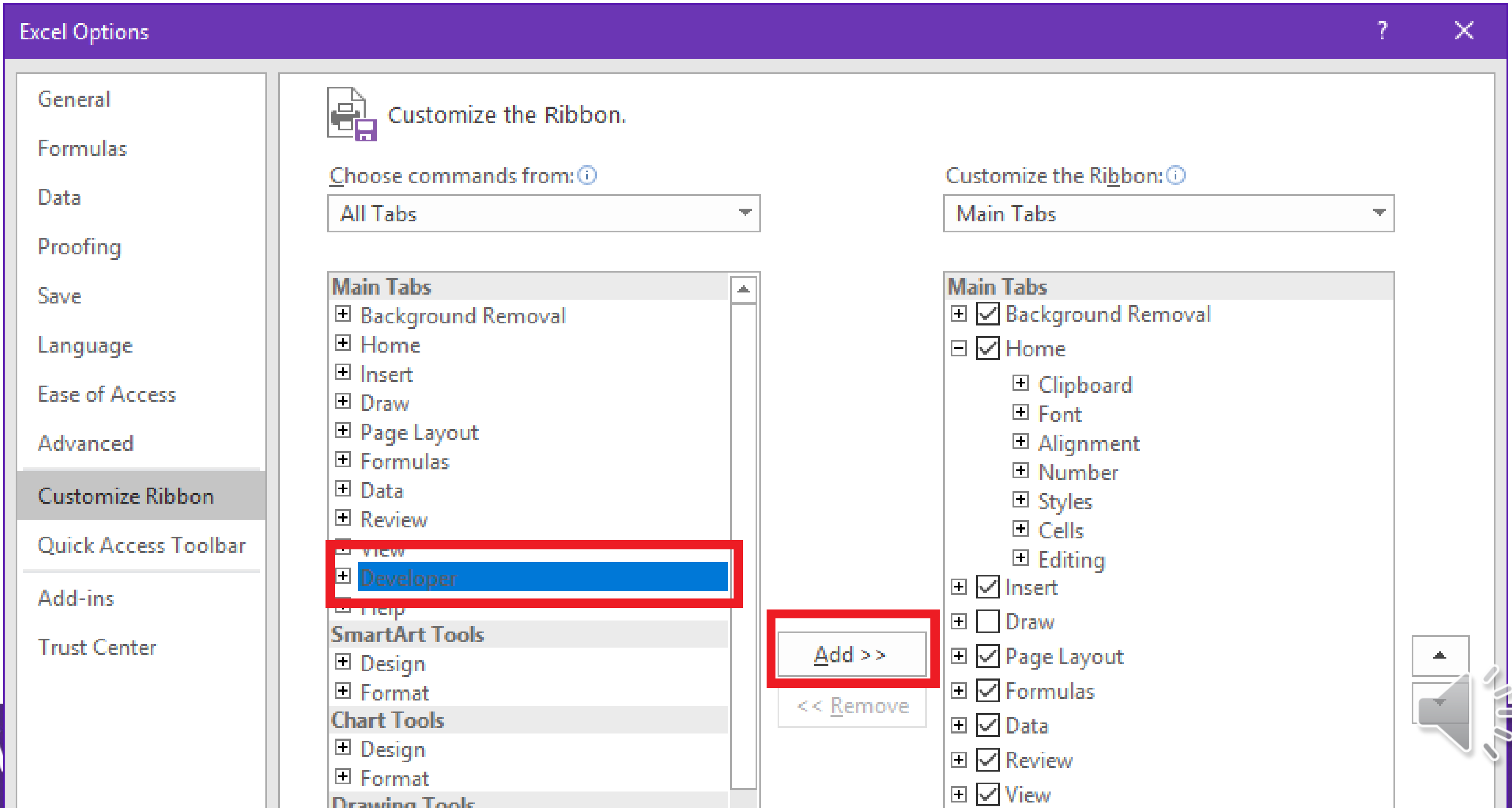
Exposing the Developer Tab

In some cases, the Developer tab option is not shown as an option to check. If this is the case, select “All Tabs” in the “Choose commands from:” drop down menu.



Exposing the Developer Tab

Select "Developer" and click the "Add >>" button. You should now be able to check the Developer check box on the right.



Excel Options

General
Formulas
Data
Proofing
Save
Language
Ease of Access
Advanced
Customize Ribbon
Quick Access Toolbar
Add-ins
Trust Center

Customize the Ribbon.

Choose commands from: All Tabs

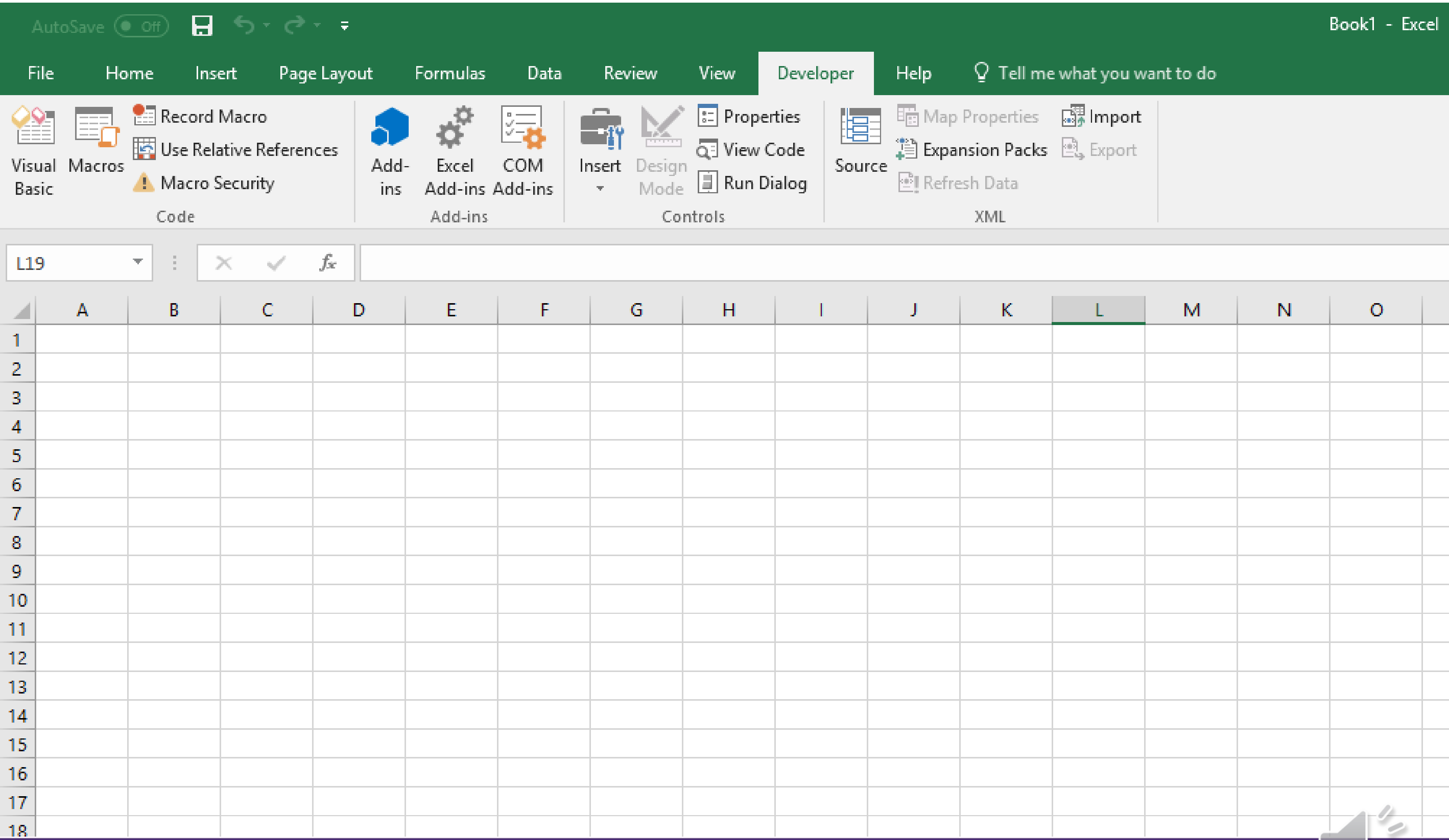
Main Tabs
⊞ Background Removal
⊞ Home
⊞ Insert
⊞ Draw
⊞ Page Layout
⊞ Formulas
⊞ Data
⊞ Review
⊞ View
⊞ Developer
⊞ Help
SmartArt Tools
⊞ Design
⊞ Format
Chart Tools
⊞ Design
⊞ Format
Drawing Tools

Add >>
<< Remove

Customize the Ribbon: Main Tabs

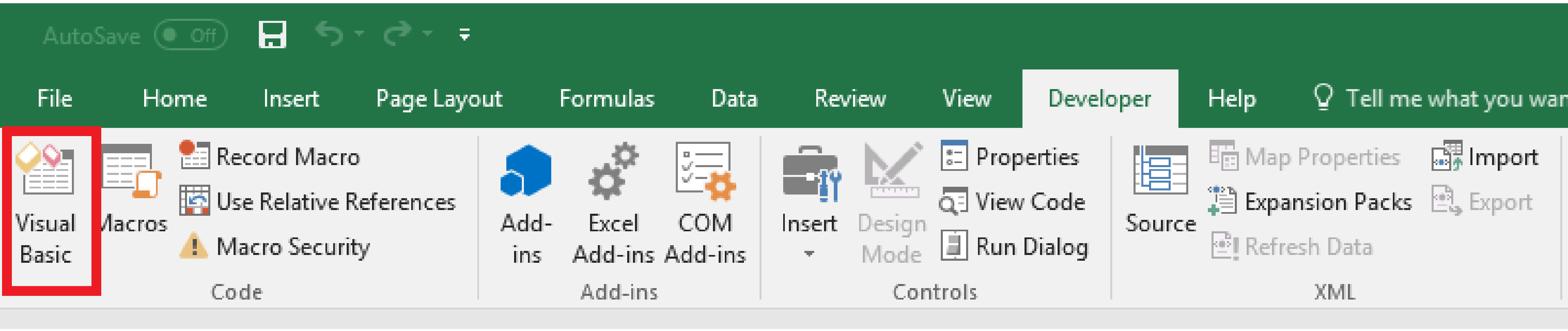
Main Tabs
⊞ ✓ Background Removal
⊟ ✓ Home
⊞ Clipboard
⊞ Font
⊞ Alignment
⊞ Number
⊞ Styles
⊞ Cells
⊞ Editing
⊞ ✓ Insert
⊞ ☐ Draw
⊞ ✓ Page Layout
⊞ ✓ Formulas
⊞ ✓ Data
⊞ ✓ Review
⊞ ✓ View

Exposing the Developer Tab

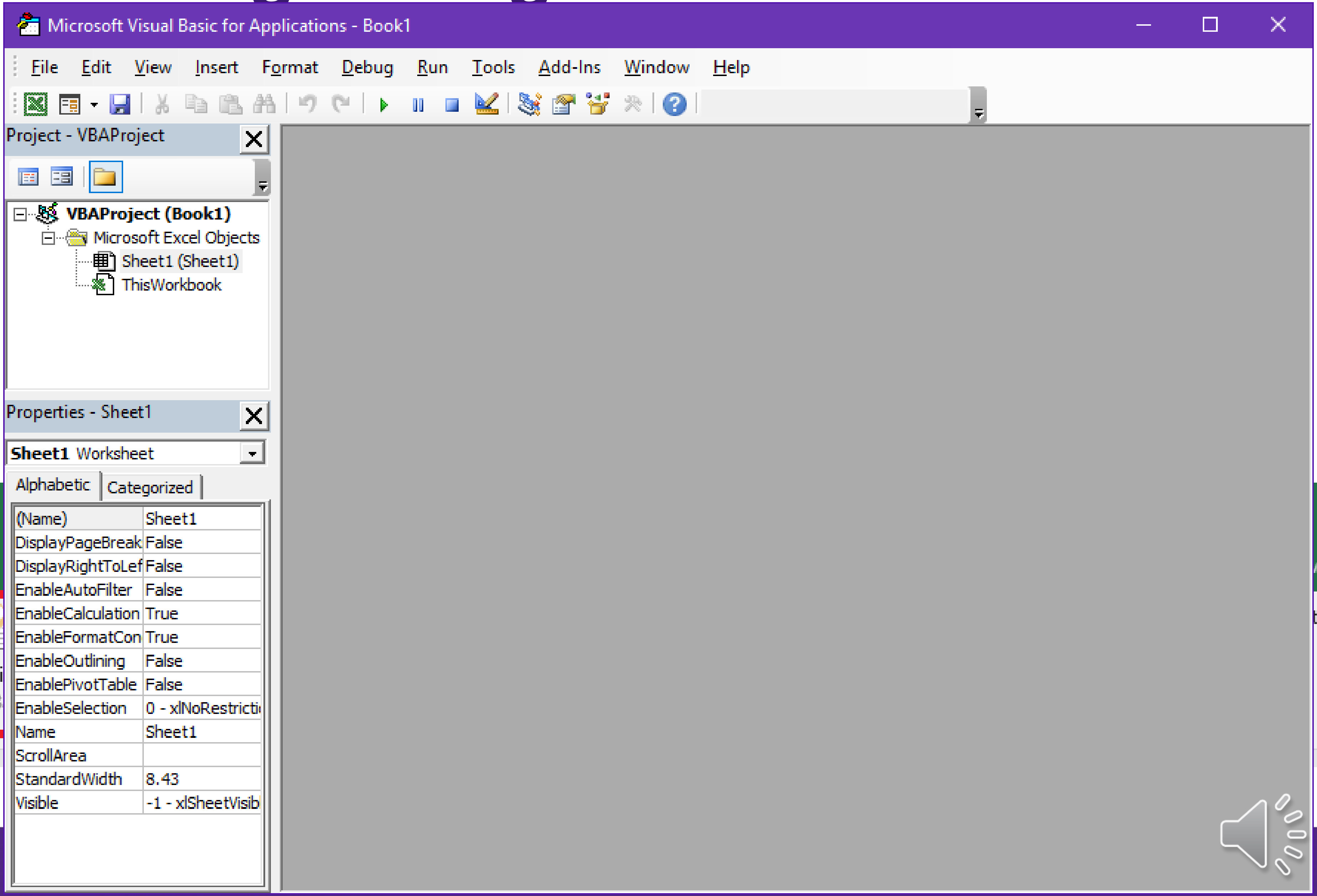


Adding a Program

- On the DEVELOPER tab, click Visual Basic.
- The Visual Basic for Applications (VBA) Integrated Development Environment (IDE) should appear.
- You can also get to the VBA IDE by typing Alt-F11.



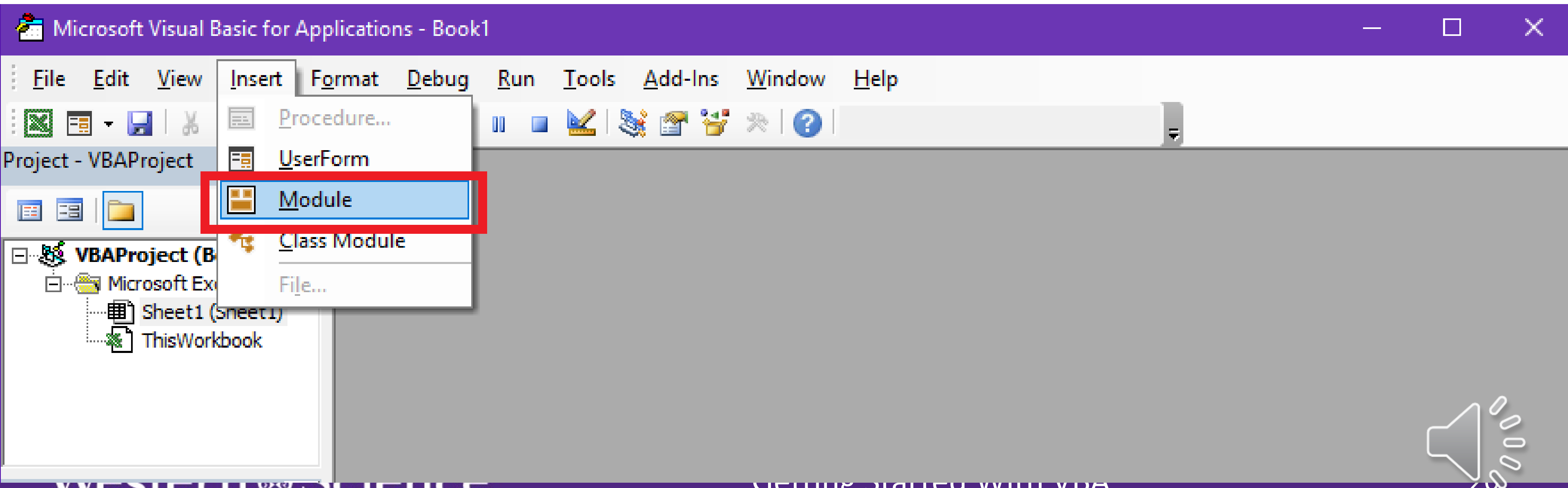
Adding a Program



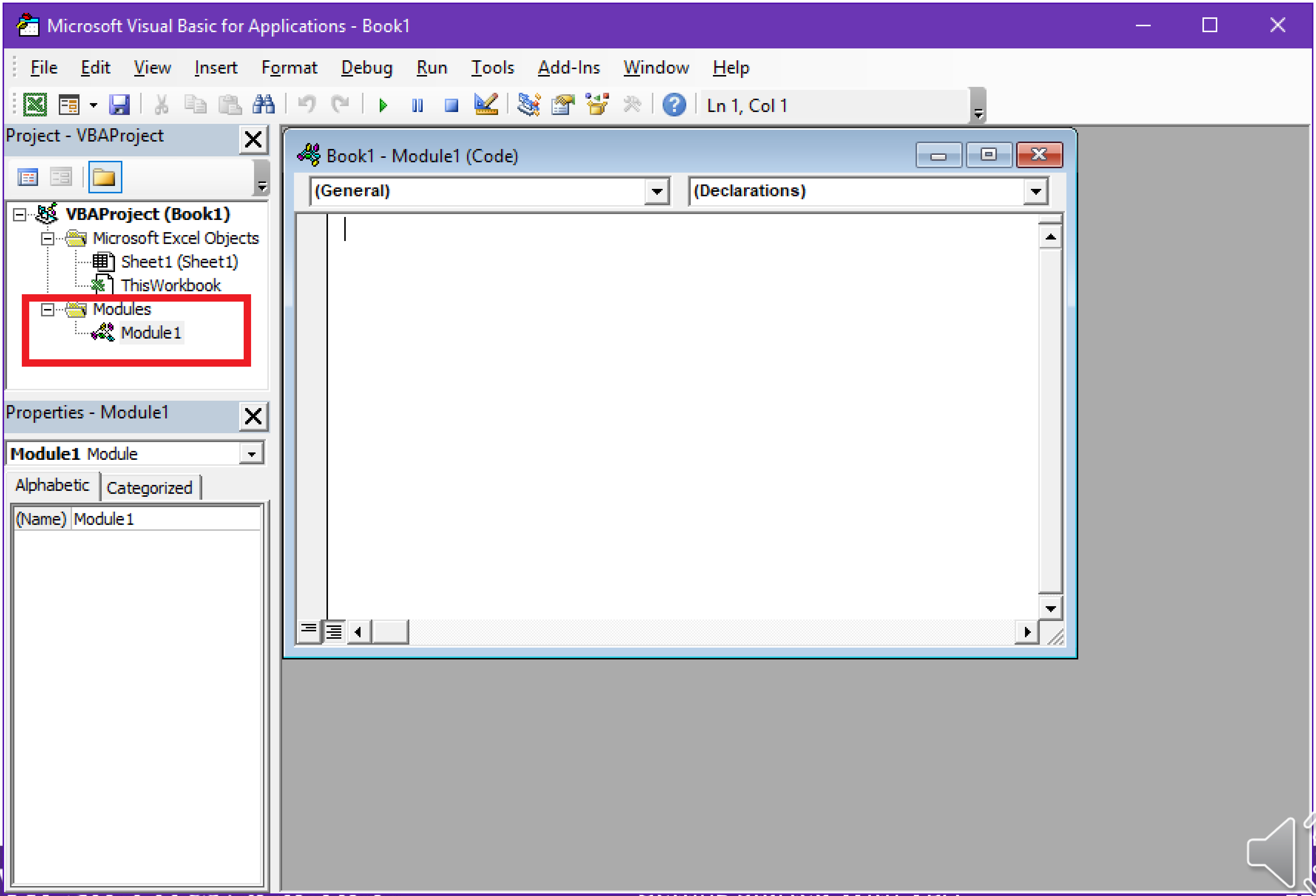
(Name)	Sheet1
DisplayPageBreak	False
DisplayRightToLef	False
EnableAutoFilter	False
EnableCalculation	True
EnableFormatCon	True
EnableOutlining	False
EnablePivotTable	False
EnableSelection	0 - xlNoRestricti
Name	Sheet1
ScrollArea	
StandardWidth	8.43
Visible	-1 - xlSheetVisib

Adding a Program

- All of our programs must exist in a "module", about which we will learn more later.
- Create a module by going to the **Insert** menu and selecting **Module**.
- This will create a module called Module1.

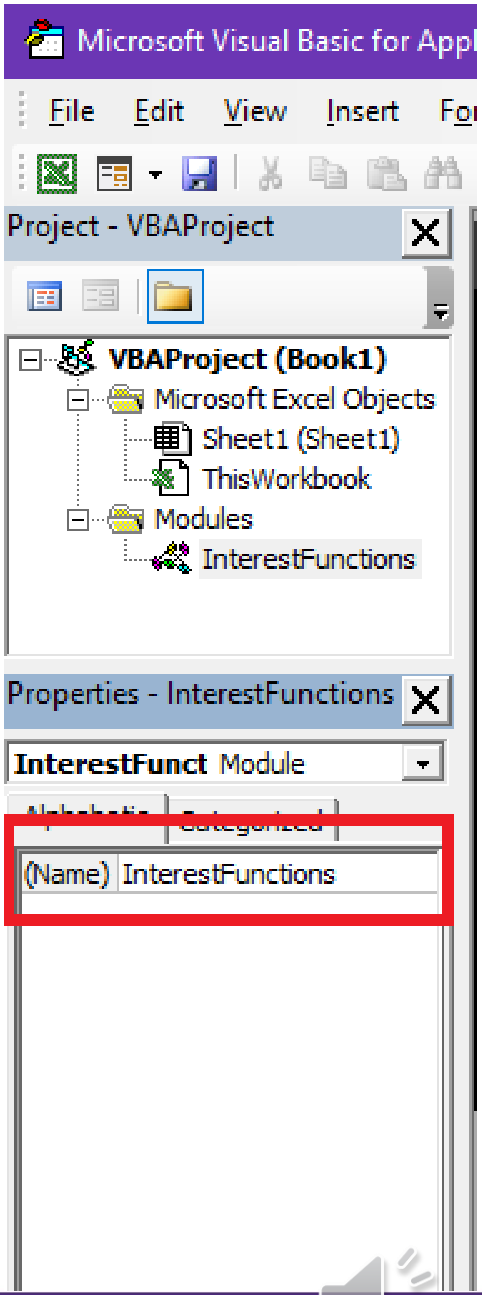


Adding a Program



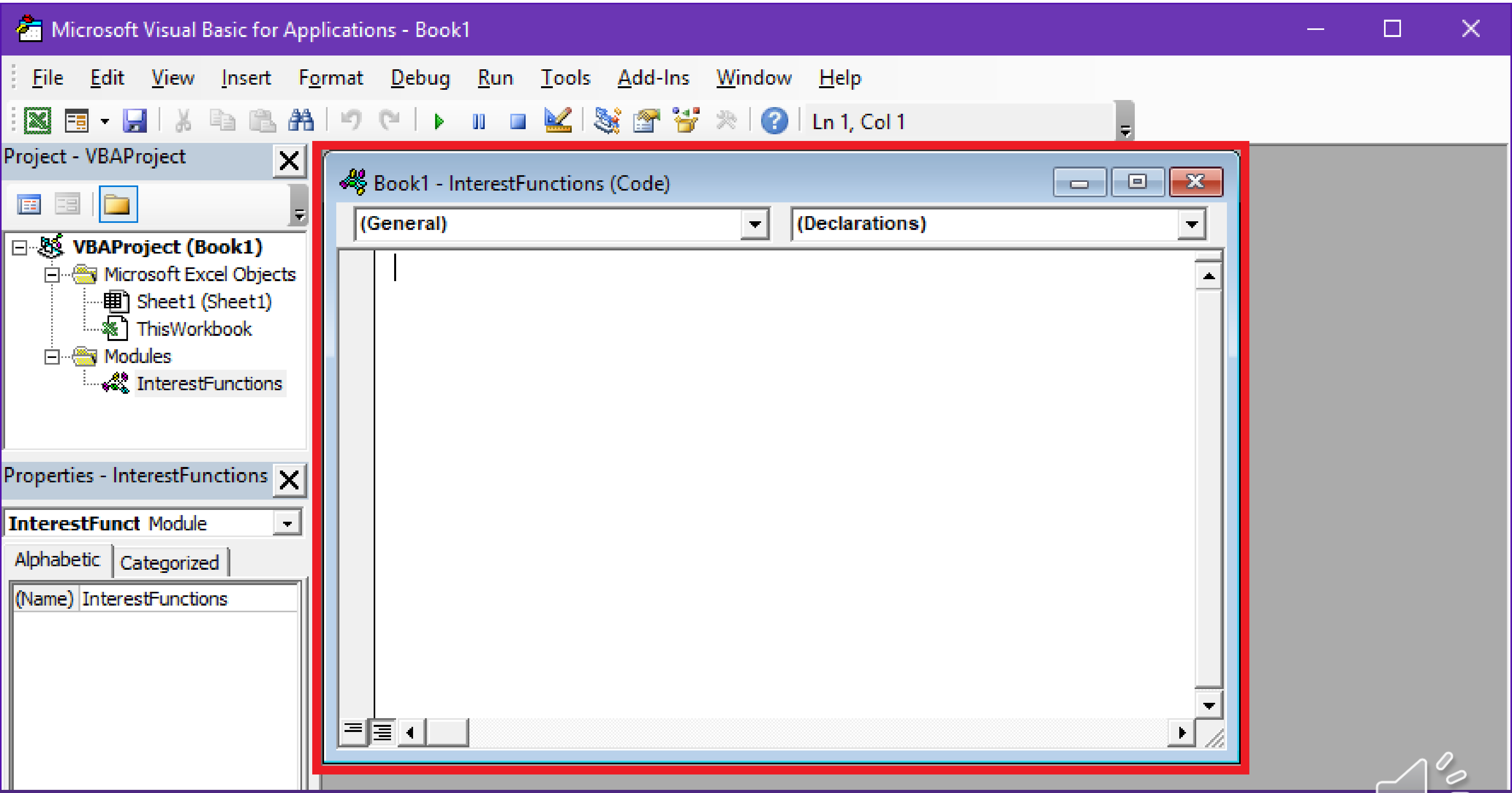
Adding a Program

- You can rename Module1 to something more meaningful by giving a new name in the Properties box.
- Then you can enter the code for the function.
- Here we add code to compute the DailyInterest.

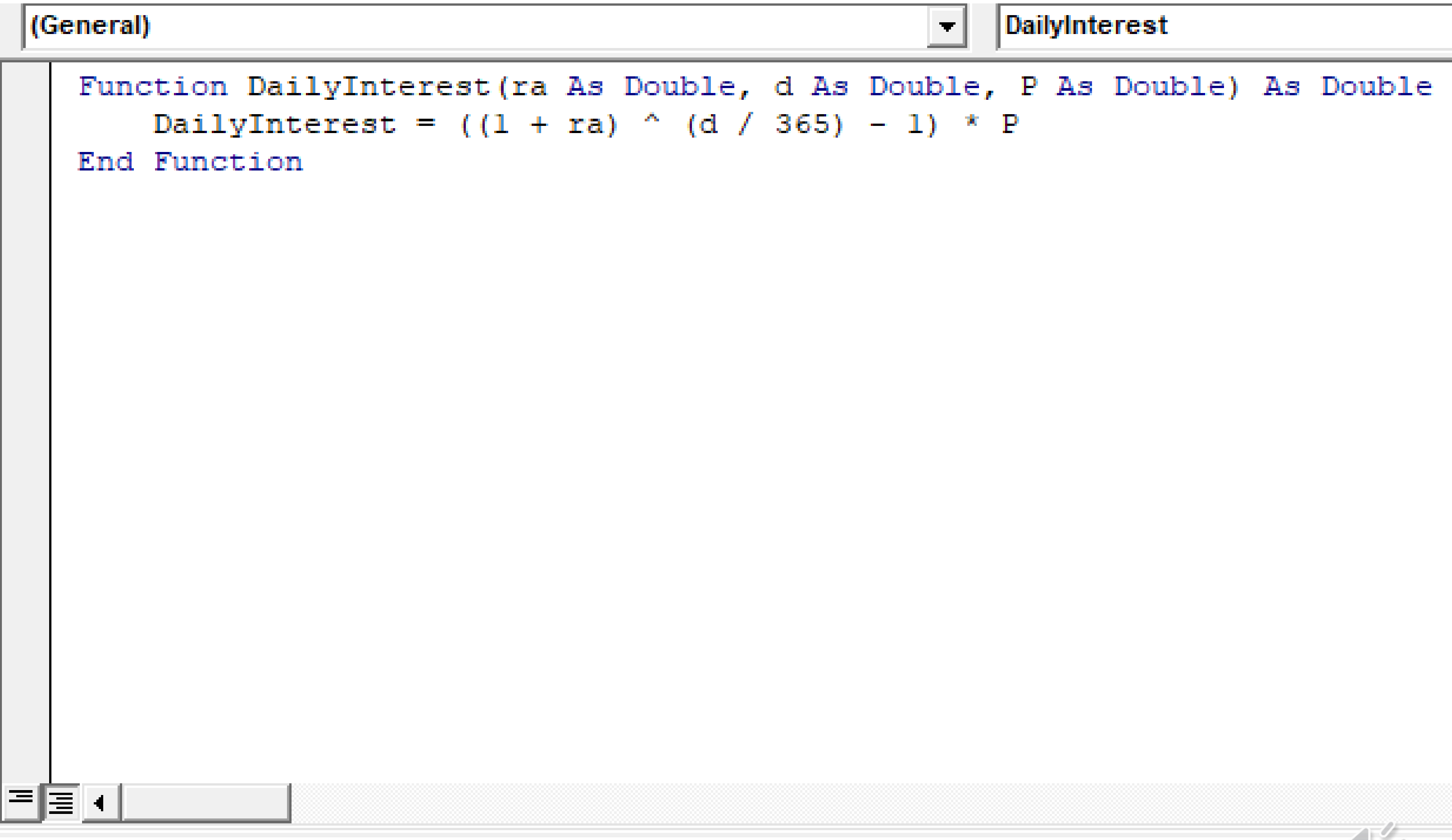


Adding a Program

Enter the code for your functions here



Adding a Program



```
Function DailyInterest(ra As Double, d As Double, P As Double) As Double
    DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
End Function
```

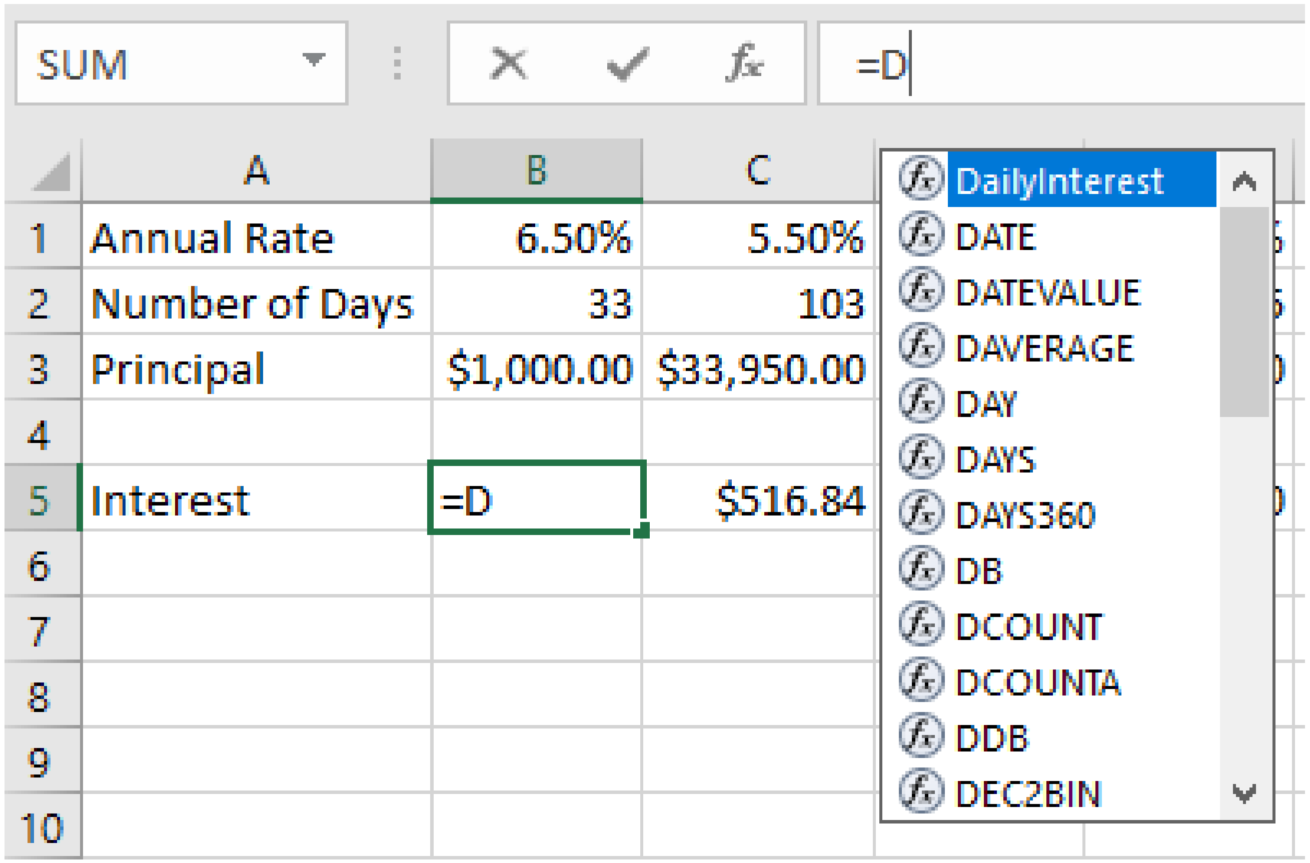
Adding a Program

- The worksheet should be saved as an “xlsm” file. This allows macros to be enabled when the worksheet is re-opened.

- In this worksheet, it is now possible to use the function DailyInterest as though it were built in.

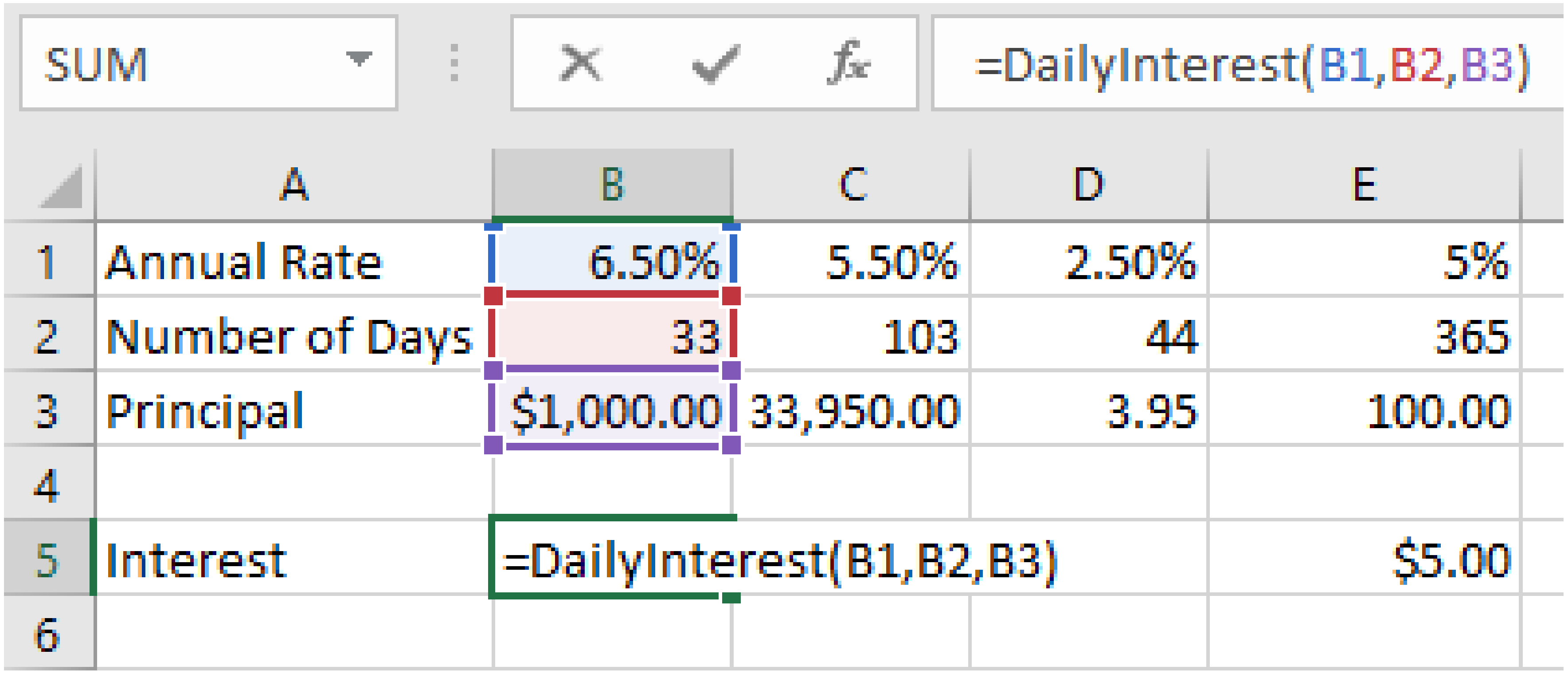
```
=DailyInterest(B1, B2, B3)
```

Adding a Program



	A	B	C
1	Annual Rate	6.50%	5.50%
2	Number of Days	33	103
3	Principal	$1,000.00	$33,950.00
4			
5	Interest	=D	$516.84
6			
7			
8			
9			
10			

Adding a Program



SUM | =DailyInterest(B1,B2,B3)

	A	B	C	D	E
1	Annual Rate	6.50%	5.50%	2.50%	5%
2	Number of Days	33	103	44	365
3	Principal	$1,000.00	33,950.00	3.95	100.00
4					
5	Interest	=DailyInterest(B1,B2,B3)			$5.00
6					

The Structure of a Function

```
Function DailyInterest(ra As Double, d As Double, P As Double) As Double
    DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
End Function
```

The Structure of a Function

Function Header

Describes the function and its parameters

↓

```
Function DailyInterest(ra As Double, d As Double, P As Double) As Double
    DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
End Function
```

The Structure of a Function

Function keyword
Tells VBA we are making a new function

```
Function DailyInterest(ra As Double, d As Double, P As Double) As Double
    DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
End Function
```

The Structure of a Function

Function name
Name that will allow us
to refer to this function

```
Function DailyInterest(ra As Double, d As Double, P As Double) As Double
    DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
End Function
```

The Structure of a Function

Parameters
Parameters the function will take

```
Function DailyInterest(ra As Double, d As Double, P As Double) As Double
    DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
End Function
```

The Structure of a Function

Parameters
Parameters the function will take

Parameter Name **Parameter Type**

```
Function DailyInterest(ra As Double, d As Double, P As Double) As Double
    DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
End Function
```

The Structure of a Function

Function Return Type
Type of data the function returns

```
Function DailyInterest(ra As Double, d As Double, P As Double) As Double
    DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
End Function
```

The Structure of a Function

```
Function DailyInterest(ra As Double, d As Double, P As Double) As Double
    DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
End Function
```

Function Body

Describes the steps, operations and calculations the function will take

The Structure of a Function

```
Function DailyInterest(ra As Double, d As Double, P As Double) As Double
    DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
End Function
```

Assignment of Result to Return
The value on the right of the equals will be the result of this function

Result to Return
Expression that computes the result

The Structure of a Function

```
Function DailyInterest(ra As Double, d As Double, P As Double) As Double
    DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
End Function
```

$\uparrow$

End of Function

Tells VBA that this is the end of our function.

User-Defined Functions

- User-defined functions may be used to perform complex calculations and return results for use in the worksheet.
- User-provided code may also be used to perform almost any action that you would do by hand on the worksheet. Code that **does not return a specific result** is called a “**subroutine**”, and is written with the keyword “sub” in VBA.
- To understand what can be done, we need to learn some programming.

Programming
Part 1

Western Science

Basic Data Types

Data Type	Memory	Range	Description	Examples
Double	8 Bytes	For negative values: -1.79769313486231E308 to -4.94065645841247E-324 For positive values: 4.94065645841247E-324 to 1.79769313486232E308	Positive and negative numbers that may have decimal points.	3.1456 -123.4567 5 9.0
Integer	2 Bytes	-32,768 to 32767	Positive and negative whole numbers without decimal points.	10 -1234 42
Long	4 Bytes	-2,147,483,648 to 2,147,483,647	Like an integer but longer (larger range).	10 -2140478234
Boolean	2 Bytes	True or False	Boolean values (true or false).	True False
String	1 Byte per char	Varies	Text and strings of characters.	"Hello World!" "123ABC!@#%"
Date	8 Bytes	1/1/100 to 12/31/9999	A calendar date.	12/4/2017 30/1/2018

Basic Operators

Arithmetic

+, -, *, /, (,), ^, Mod, \

Logic

And, Or, Not

Comparison

>, <, =, >=, <=, <>

Assignment

=

String

&

Basic Operators

Arithmetic

+, -, *, /, (,), ^, Mod, \

Comparison

>, <, =, >=, <=, <>

String

&

Logic

And, Or, Not

Assignment

=

Same as we saw in Excel

Basic Operators

Arithmetic

+, -, *, /, (,), ^, Mod, \

Logic

And, Or, Not

Comparison

>, <, =, >=, <=, <>

Assignment

=

String

&

Finds the remainder after dividing two numbers

10 Mod 2	0	15 Mod 9	6
5 Mod 2	1	0 Mod 4	0
42 Mod 4	2	4 Mod 0	#VALUE

Basic Operators

Arithmetic

+, -, *, /, (,), ^, Mod, \

Logic

And, Or, Not

Comparison

>, <, =, >=, <=, <>

Assignment

=

String

&

Integer division

10 \ 2	5	15 \ 9	1
5 \ 2	2	0 \ 4	0
42 \ 4	10	4 \ 0	#VALUE

Basic Operators

Arithmetic

+, -, *, /, (,), ^, Mod, \

Logic

And, Or, Not

Comparison

>, <, =, >=, <=, <>

Assignment

=

String

&

Boolean logic operators

True And False	False	False Or False	False
True And True	True	Not True	False
True Or False	True	Not False	True

Basic Operators

Arithmetic

+, -, *, /, (,), ^, Mod, \

Logic

And, Or, Not

Comparison

>, <, =, >=, <=, <>

Assignment

=

String

&

Boolean logic operators

5 > 4 And 5 < 2	False
5=6 Or 5<>6	True
NOT (6>=6)	False

Basic Operators

Arithmetic

+, -, *, /, (,), ^, Mod, \

Logic

And, Or, Not

Comparison

>, <, =, >=, <=, <>

Assignment

=

Assignment operator is used to assign a value to be the result of a function or the value of a variable.

String

&

Basic Operators

Arithmetic

+, -, *, /, (,), ^, Mod, \

Logic

And, Or, Not

Comparison

>, <, =, >=, <=, <>

Assignment

=

↑

Assignment operator is used to assign a value to be the result of a function or the value of a variable.

String

&

```
DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
```

Value on right is assigned to function or variable on left.

Example Function

Create a function that calculates the area of a circle given a radius.

$$A = \pi r^2$$

$$\pi \cong 3.14159$$

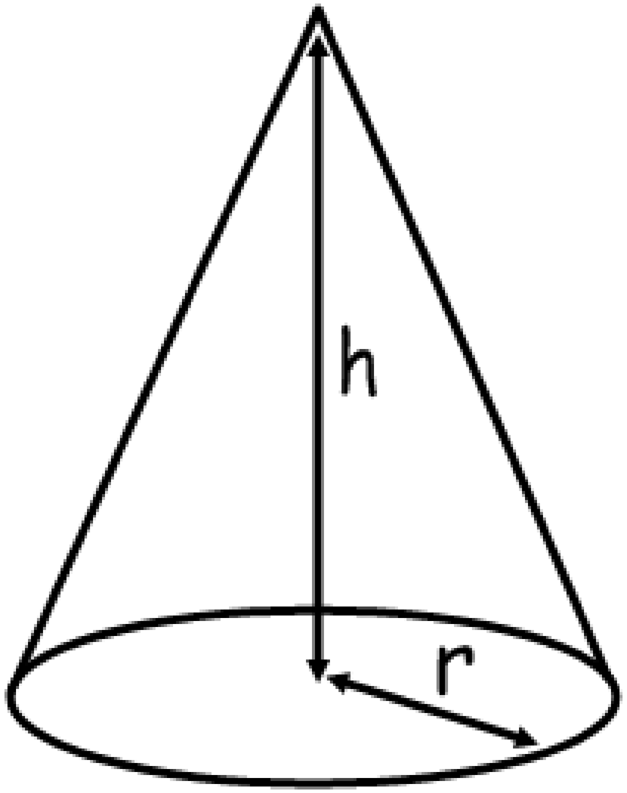
Example Function

Create a function that calculates the area of a circle given a radius.

```
Function CircleArea(radius As Double) As Double
   CircleArea = 3.14159 * radius ^ 2
End Function
```

Another Example

Create a function that calculates the volume of a cone given the height and radius.



$$V = \pi r^3 h$$

Another Example

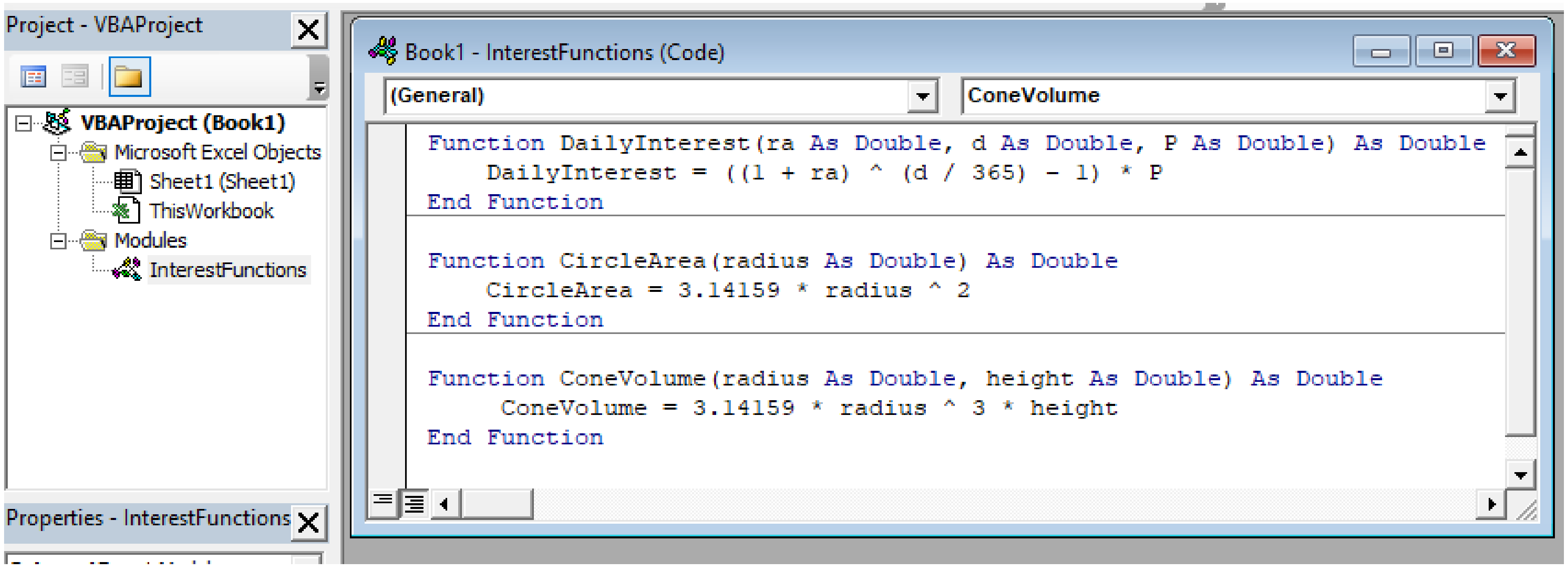
Create a function that calculates the volume of a cone given the height and radius.

```
Function ConeVolume(radius As Double, height As Double) As Double
    ConeVolume = 3.14159 * radius ^ 3 * height
End Function
```

Naming Functions and Modules

We can have multiple functions in a module, so long as the names do not conflict.

Each function and module needs a unique name.



```
Function DailyInterest(ra As Double, d As Double, P As Double) As Double
    DailyInterest = ((1 + ra) ^ (d / 365) - 1) * P
End Function

Function CircleArea(radius As Double) As Double
    CircleArea = 3.14159 * radius ^ 2
End Function

Function ConeVolume(radius As Double, height As Double) As Double
     ConeVolume = 3.14159 * radius ^ 3 * height
End Function
```

String Example

Create a function that adds the text “ing” to the end of strings.

```
Function AddIng(text As String) As String
    AddIng = text & "ing"
End Function
```

Boolean Example

Create a function that takes an Integer and returns True if the value is odd otherwise it returns False.

```
Function IsOdd(n As Integer) As Boolean
    IsOdd = (n Mod 2) <> 0
End Function
```

Variables

- A variable is a named storage location in a computer program
- Programs use variables to store values.
- These are like the cells names (e.g, A1, B2) but they are not part of a worksheet.
- Each variable holds a value, and the value can be changed by the execution of the program.

Variable Names

- Variable names cannot be reserved key words
  - Examples of reserved words are Sub, Integer, Function, Array, Else
- They are given names, like named cells in a worksheet.
- Name must start with a letter but following characters can have numbers or a _
- RegEx: [A-Za-z][A-Za-z0-9_]*

*Variable names are **not case sensitive** and by default the interpreter adjusts the names of all variables with the same letters so that their case matches the case in the variable declaration*

Variable Names

Which of the following are valid variable names?

age

Integer

1stName

First name

_name

Name_1

#name

Names2

myPercent%

Variable Type

- A variable is given a “type” to indicate what kind of values it will store.
- Same types we saw before, including:
  - Double
  - Integer
  - Long
  - Boolean
  - String
  - Date

Variable Declarations

To tell VBA that you wish to use a variable, you give the name and the type in a “Dim” declaration.
(“Dim” is short for “dimension”.)

For now, we will put these declarations inside a function or subroutine.

```
Dim n As Integer
Dim r As Integer, c As Integer
Dim x As Double, y As Double
Dim b as Boolean, s As String, i as Integer
Dim myLargeNum as Long
Dim myDate as Date
```

Variable Assignment

We use the assignment operator, =, to give variables a value.

```
Dim n As Integer
n = 42

Dim d As Double
d = 65 / 3

Dim s As String
s = "Hello World!"

Dim b as Boolean
b = 5 > 7 Or True
```

Variable Use

We can use the value of a variable in an expression by using its name.

```
Dim n As Integer
Dim d As Double
Dim b as Boolean

n = 42
d = n / 3
b = n > 20 Or n <= 14
```

Variable Use

We can use the value of a variable in an expression by using its name.

```
Dim n As Integer
Dim d As Double
Dim b as Boolean

n = 42
d = n / 3
b = n > 20 Or n <= 14
```

Variable	Value

Variable Use

We can use the value of a variable in an expression by using its name.

```
Dim n As Integer
Dim d As Double
Dim b as Boolean

n = 42
d = n / 3
b = n > 20 Or n <= 14
```

Variable	Value
n	

Variable Use

We can use the value of a variable in an expression by using its name.

```
Dim n As Integer
Dim d As Double
Dim b as Boolean

n = 42
d = n / 3
b = n > 20 Or n <= 14
```

Variable	Value
n	
d	

Variable Use

We can use the value of a variable in an expression by using its name.

```
Dim n As Integer
Dim d As Double
Dim b as Boolean

n = 42
d = n / 3
b = n > 20 Or n <= 14
```

Variable	Value
n	
d	
b	

Variable Use

We can use the value of a variable in an expression by using its name.

```
Dim n As Integer
Dim d As Double
Dim b as Boolean

n = 42
d = n / 3
b = n > 20 Or n <= 14
```

Variable	Value
n	42
d	
b	

Variable Use

We can use the value of a variable in an expression by using its name.

```
Dim n As Integer
Dim d As Double
Dim b as Boolean

n = 42
d = n / 3
b = n > 20 Or n <= 14
```

Equal to 42 / 3

Variable	Value
n	42
d	14.0
b	

Variable Use

We can use the value of a variable in an expression by using its name.

```
Dim n As Integer
Dim d As Double
Dim b as Boolean

n = 42
d = n / 3
b = n > 20 Or n <= 14
```

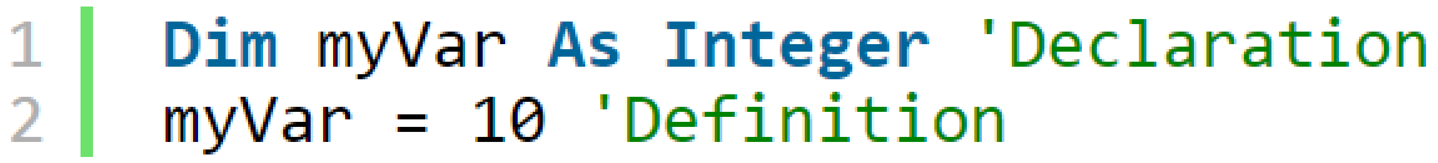
Variable	Value
n	42
d	14.0
b	True

Equal to 14 > 20 Or 14 <= 14

Variables

When using variables there are 2 steps you need to complete:

- **Declare** the variable – declare the symbolic variable name and the data type
- **Define** the variable – set a value to the variable



```
Dim myVar As Integer 'Declaration
myVar = 10 'Definition
```