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C#



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LECTURE: INTRODUCTION VISUAL STUDIO IDE

- THE INTEGRATED DEVELOPMENT ENVIRONMENT
- DIFFERENT PROJECT TYPES
- REVIEW OF ALGORITHMS
- FORMS APPLICATION
- TOOLBOX AND OBJECTS IN IT
- INTRODUCING PROPERTIES AND METHODS
- ONE SIMPLE EXAMPLE, HELLO VB!



WHAT IS AN IDE

- IDE stands for “Integrated Development Environment”
- Integrated because the IDE’s generally have everything, we need to do our work. This includes:
 - Source Code Editors: This is the text editor where we can write our code
 - Local build Automation: these are tools that automate repetitive tasks. This can include compiling our code with the press of a button, rather than going into PowerShell to compile the code.
 - Debugger: Having access to a built-in debugger has great advantages. You can go through your code step by step and when you find the bug, you can edit the source code directly rather than going from a separate system.



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INSTALLING VISUAL STUDIO

- Visual Studio is a Microsoft IDE, that is different from Visual Studio Code. VS Code is a text editor, While Visual Studio is an IDE.
- <https://visualstudio.microsoft.com/>



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INSTALLING VISUAL STUDIO

The screenshot shows the Microsoft Visual Studio download page. At the top, there's a navigation bar with links for Microsoft, Visual Studio, Developer Tools, Downloads, Buy, Subscriptions, and Free Visual Studio. On the right side of the nav bar are links for All Microsoft, Search, and Sign in.

The main content area features a large purple button with the text "Download Visual Studio" and a dropdown menu showing "Community 2022", "Professional 2022", and "Enterprise 2022". Below this, there are three cards:

- Visual Studio**: Described as "The most comprehensive IDE for .NET and C++ developers on Windows. Fully packed with a sweet array of tools and features to elevate and enhance every stage of software development." It includes a "Learn more" link and a "Download Visual Studio" button.
- Visual Studio for Mac**: Described as "A comprehensive IDE for .NET developers that's native to macOS. Includes top-notch support for web, cloud, mobile, and game development." It includes a "Learn more" link and a "Download Visual Studio for Mac" button.
- Visual Studio Code**: Described as "A standalone source code editor that runs on Windows, macOS, and Linux. The top pick for JavaScript and web developers, with extensions to support just about any programming language." It includes a "Learn more" link and a "Download Visual Studio Code" button.

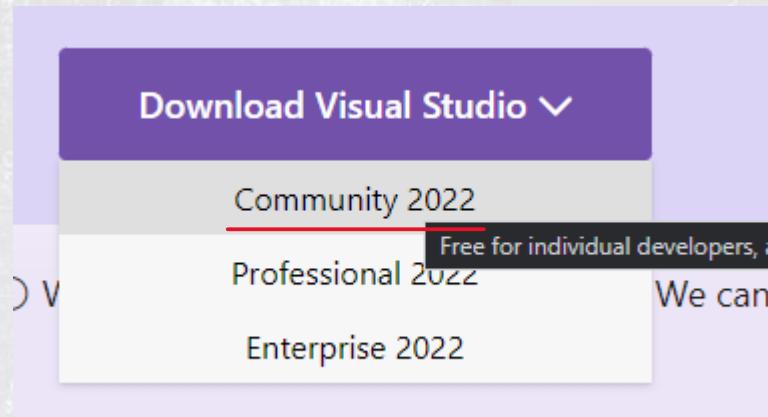
At the bottom left, there's a note: "Wondering which tool is best for you? We can help." On the far right, there's a "Feedback" link.



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INSTALLING VISUAL STUDIO

The screenshot shows the Microsoft Visual Studio download page. At the top, there's a banner with a man and a woman looking at a laptop screen. Below the banner, the text "Thank you for downloading Visual Studio" is displayed, along with a link to "click here to retry" if the download doesn't start. On the left, a sidebar lists options like "Install Visual Studio", "Getting started", "Personalize", "Start a tutorial", ".NET", "C++", and "Python". A red diagonal line points from this sidebar to a warning message at the bottom. The main content area includes sections for "New to Visual Studio?", "Install Visual Studio", and "Getting started with Visual Studio IDE". A footer bar at the bottom contains a warning about the executable file and buttons for "Keep" or "Discard".

Microsoft | Visual Studio | Developer Tools | Downloads | Buy | Subscriptions | Free Visual Studio

All Microsoft | Search | Sign in

Thank you for
downloading
Visual Studio

Your download will start shortly. If your download does not begin, click here to retry

New to Visual Studio?

Install Visual Studio

Getting started with Visual Studio IDE

This type of file can harm your computer. Do you want to keep VisualStudioSetup.exe anyway? [Keep](#) [Discard](#)

To develop any type of app or learn a language, you'll be working in the Visual Studio Integrated Development Environment (IDE). Beyond code editing, Visual Studio IDE brings together graphical designers, complex code

Show all X Feedback



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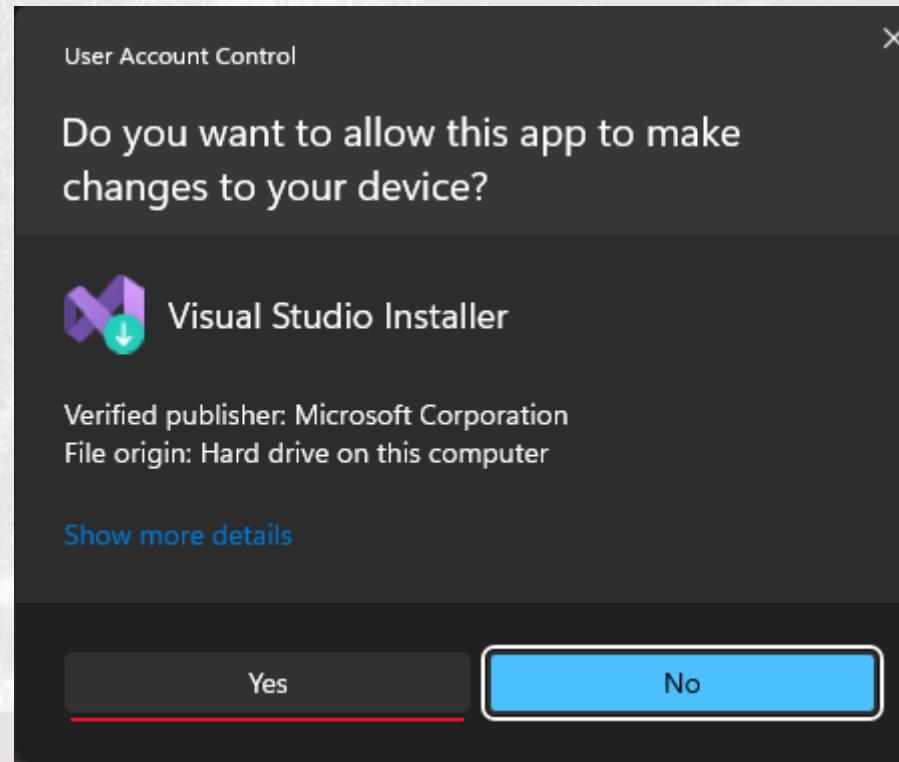




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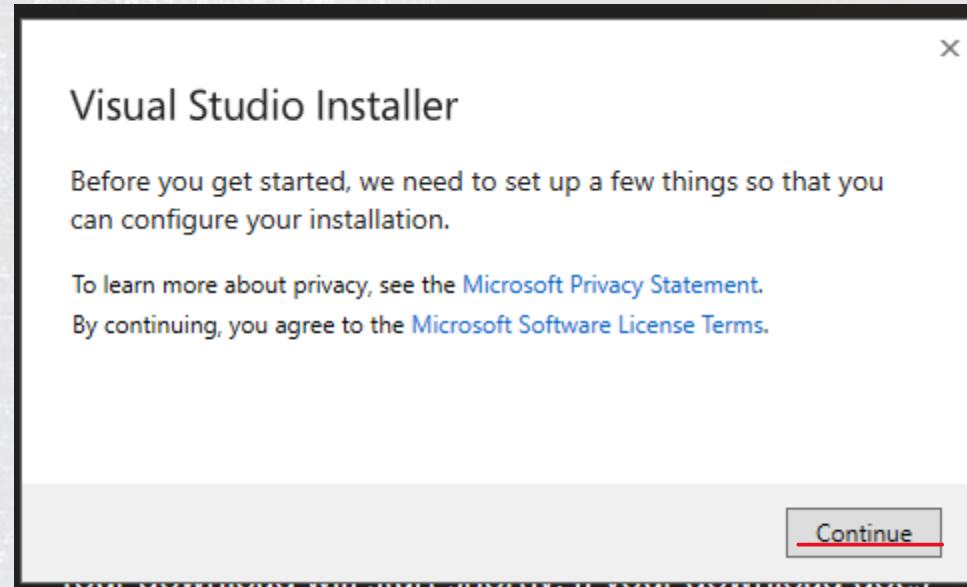




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INSTALLING VISUAL STUDIO

ASP.NET and web development
Build web applications using ASP.NET Core, ASP.NET, HTML/JavaScript, and Containers including Docker supp...

.NET desktop development
Build WPF, Windows Forms, and console applications using C#, Visual Basic, and F# with .NET and .NET Frame...

Universal Windows Platform development
Create applications for the Universal Windows Platform with C#, VB, or optionally C++.

Desktop development with C++
Build modern C++ apps for Windows using tools of your choice, including MSVC, Clang, CMake, or MSBuild.

Data storage and processing
Connect, develop, and test data solutions with SQL Server, Azure Data Lake, or Hadoop.

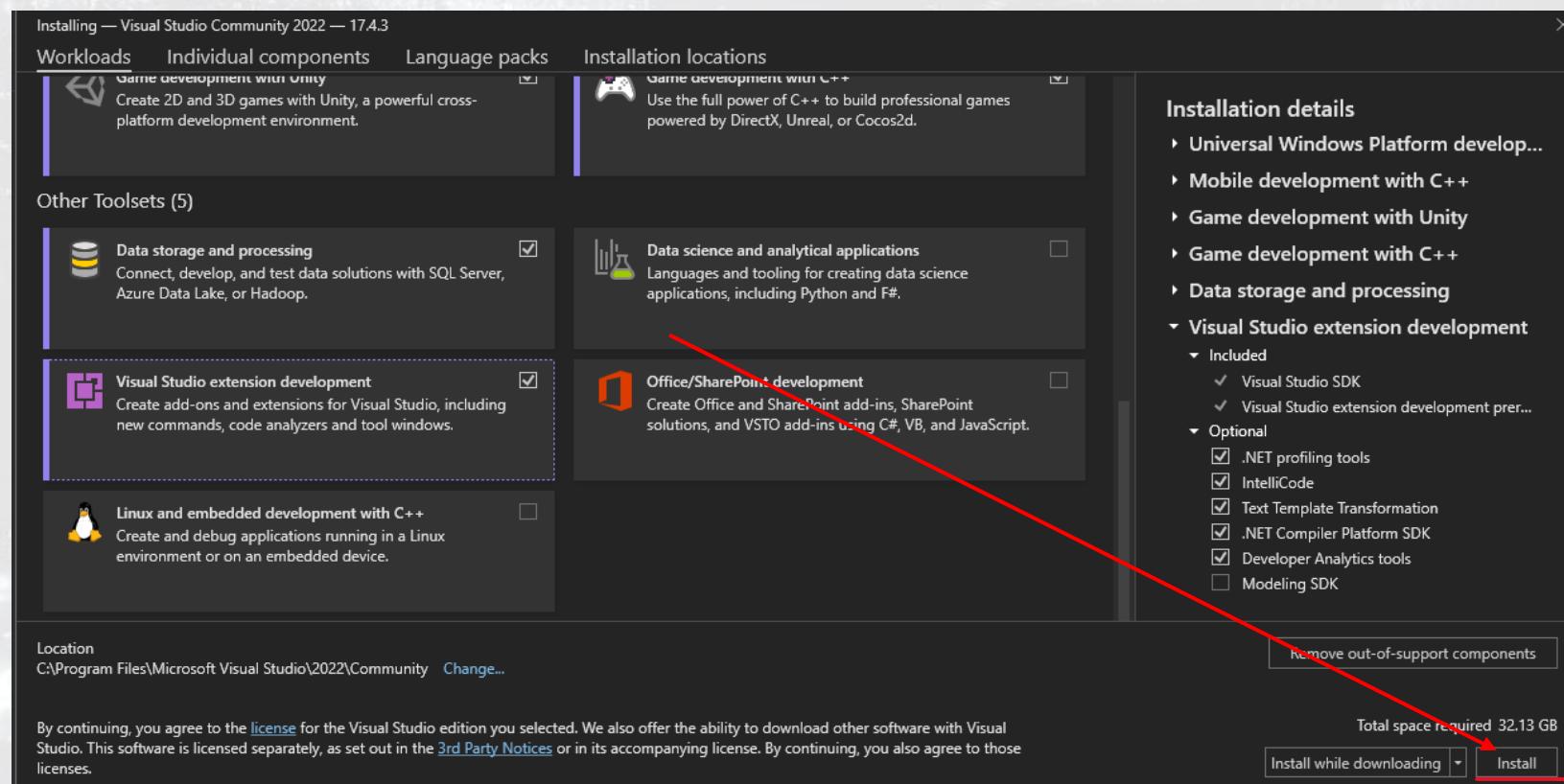
Visual Studio extension development
Create add-ons and extensions for Visual Studio, including new commands, code analyzers and tool windows.



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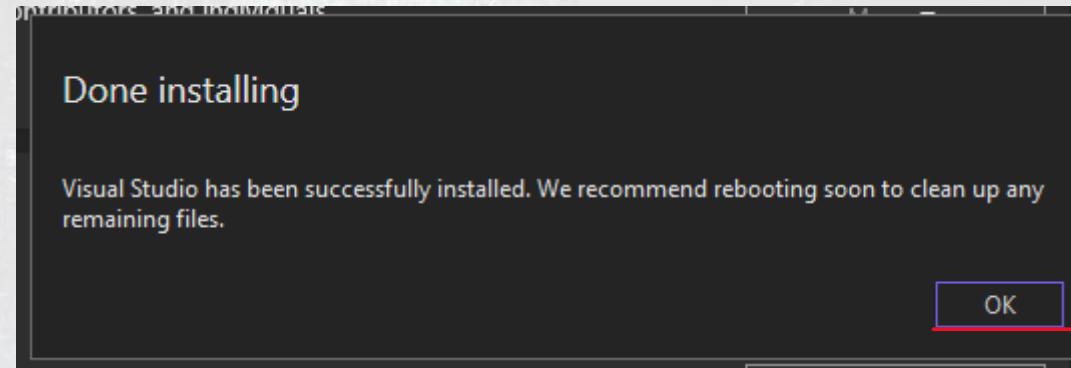




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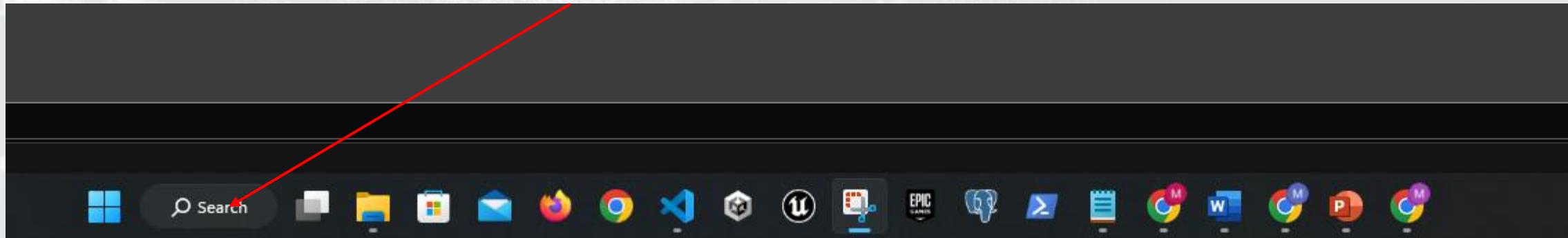




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OPENING VISUAL STUDIO

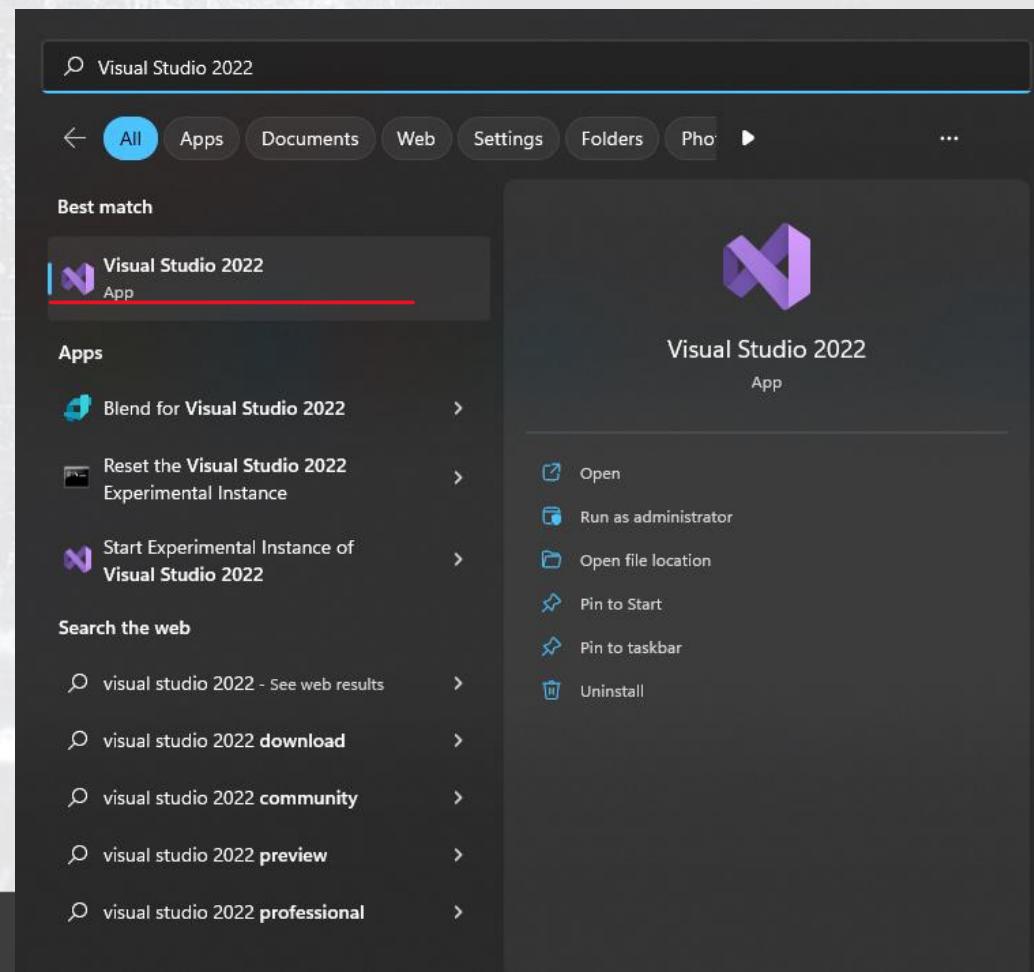




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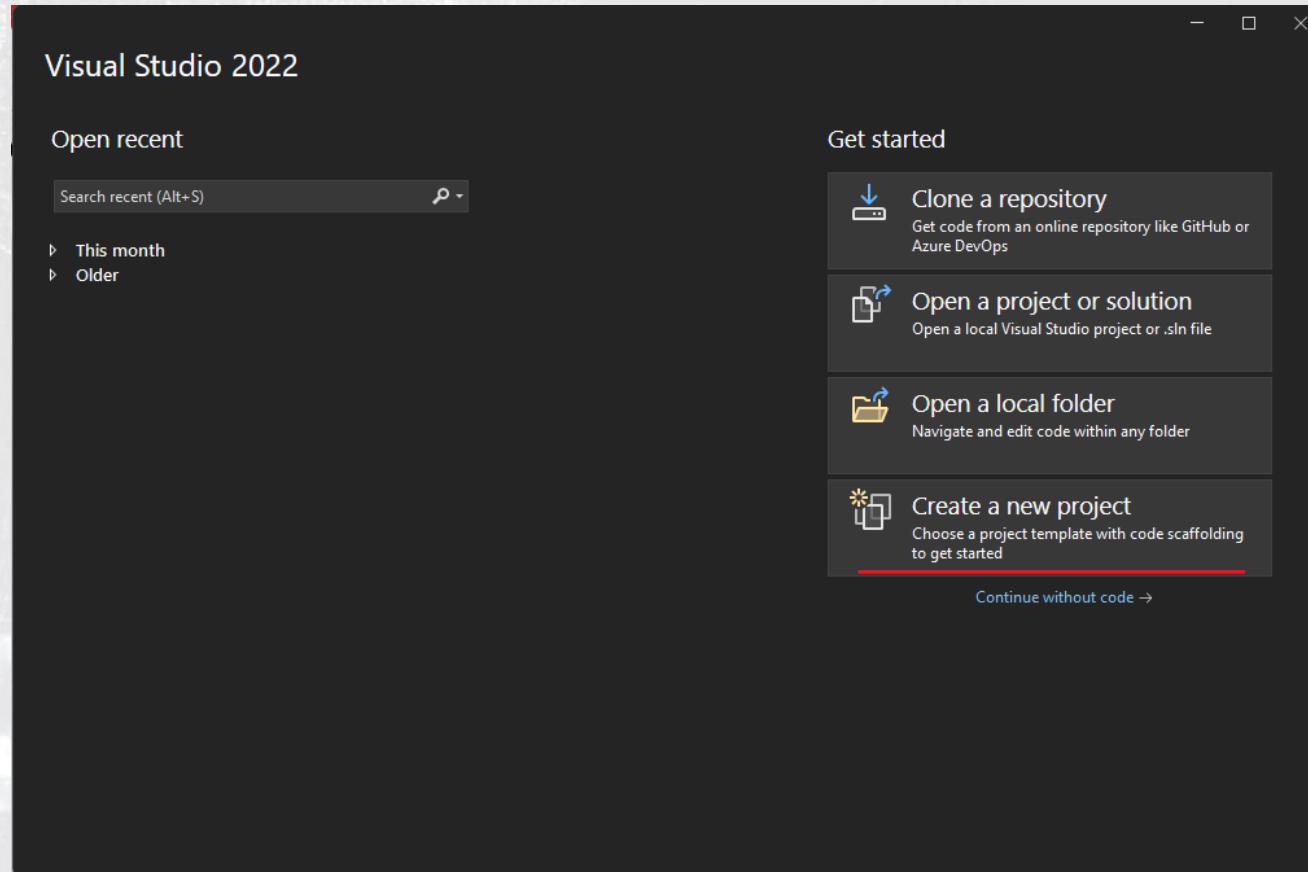




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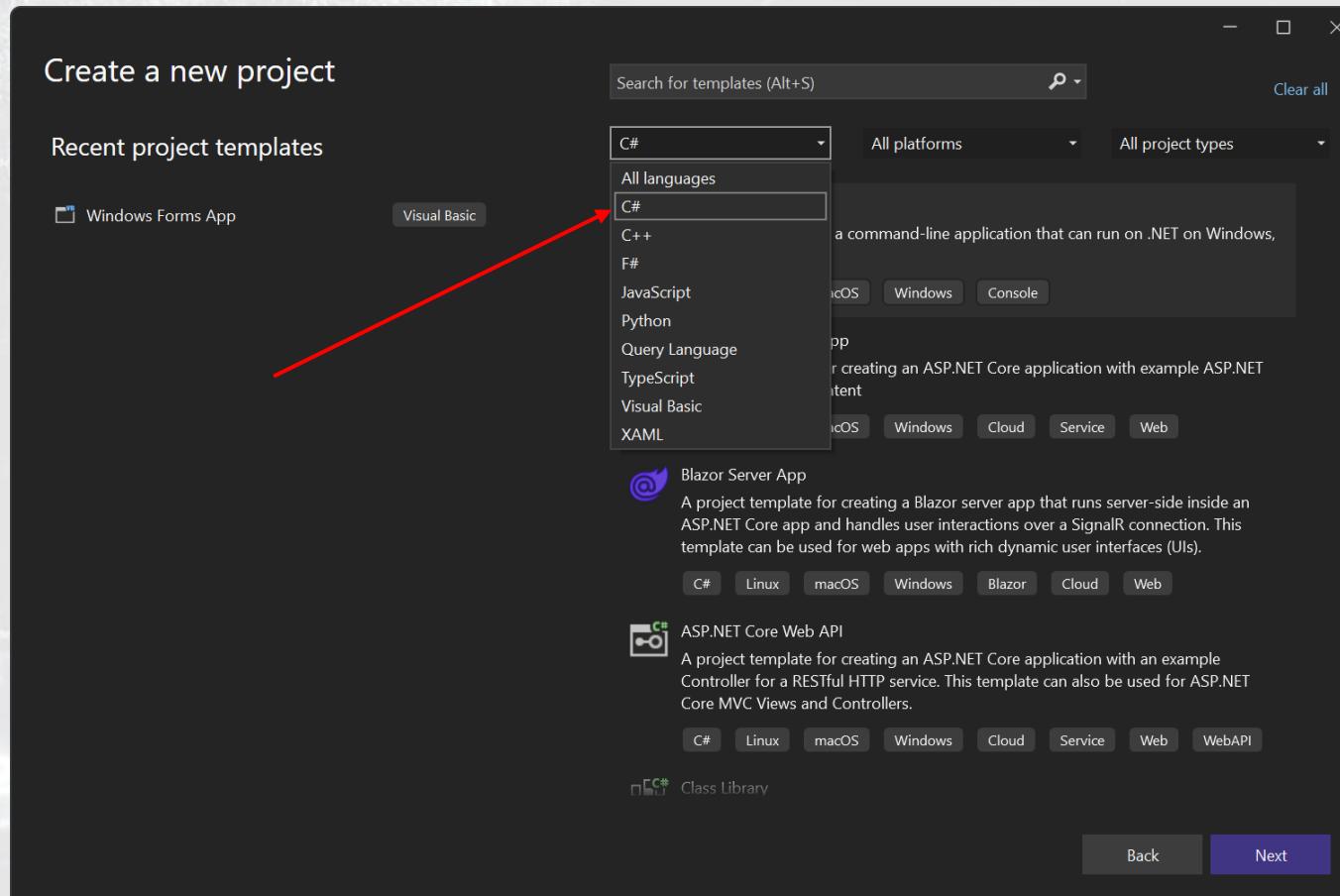




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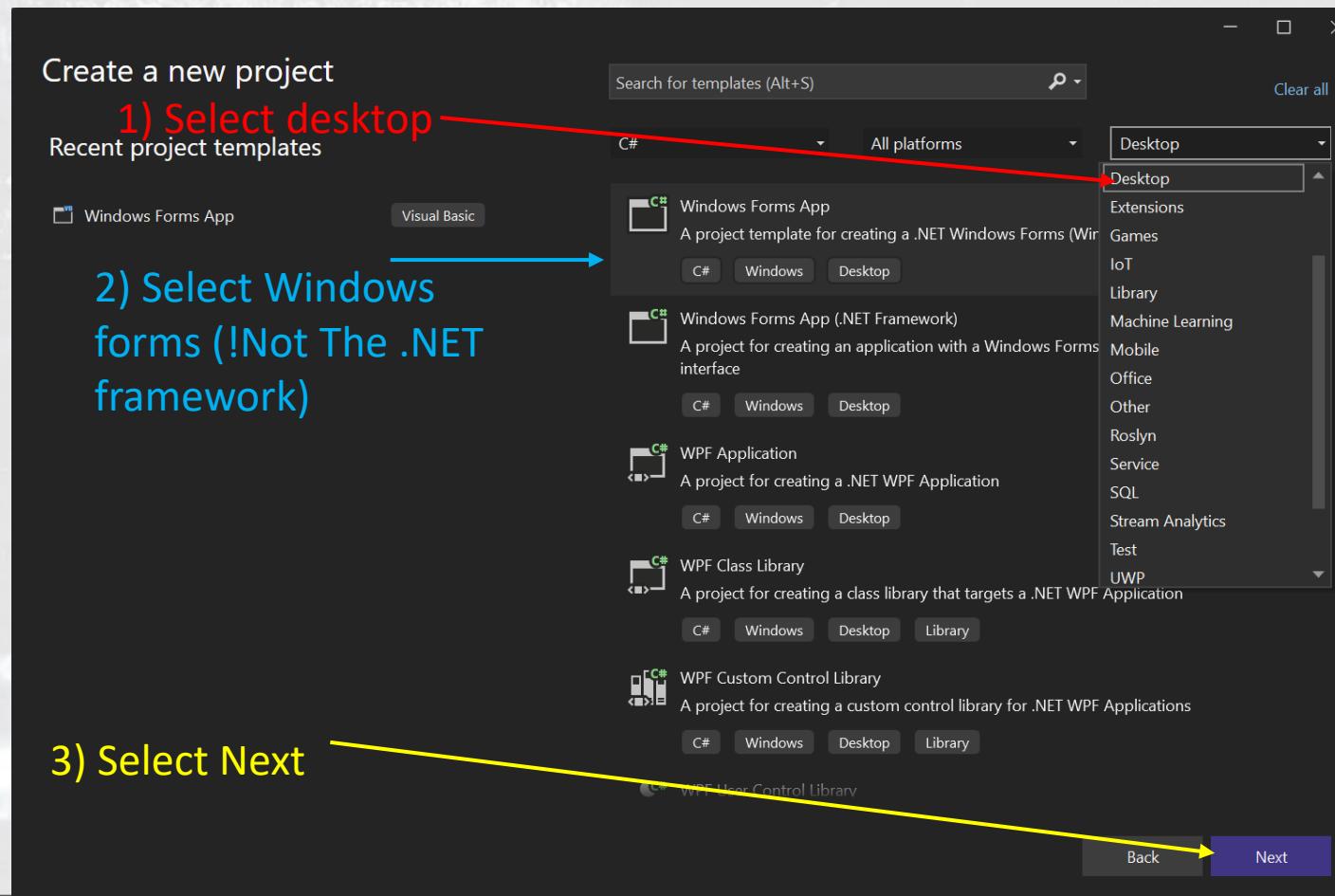




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OPENING VISUAL STUDIO

Configure your new project

Windows Forms App C# Windows Desktop

Project name

MyFirstCSharpApp

Location

C:\repos\Teaching\C#\Winter2023\

Solution name ⓘ

MyFirstCSharpApp

Place solution and project in the same directory

1) Change Name to what you see here
2)Select Next

This is where you are storing your projects. Repos is short for repository.

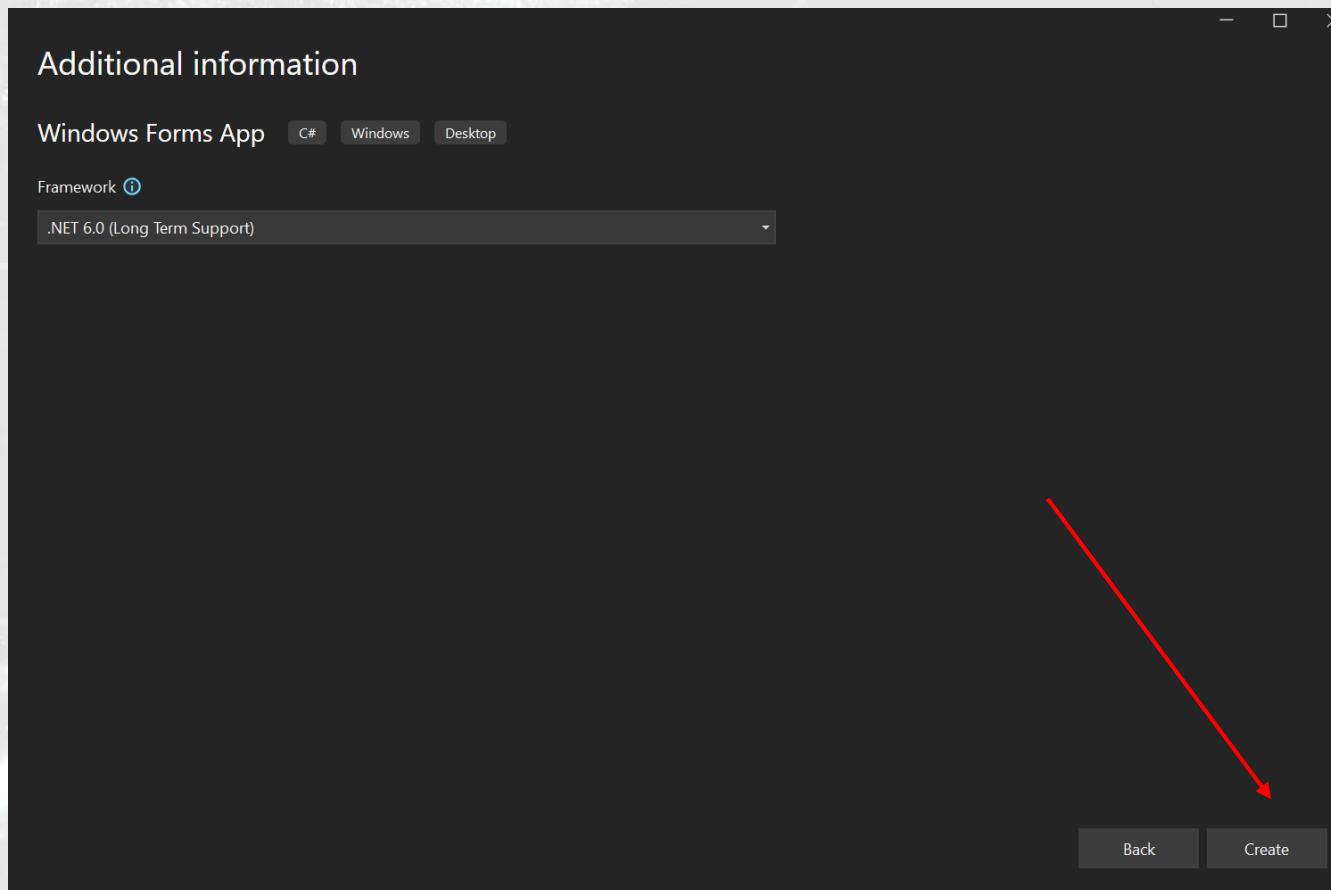
Back Next



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USING VISUAL STUDIO

The screenshot shows the Visual Studio IDE interface with a Windows application project named "MyFirstCSharpApp".

- Solution Explorer:** Shows the solution "MyFirstCSharpApp" containing one project "MyFirstCSharpApp" which includes files like Form1.cs, Form1.Designer.cs, Form1.resx, and Program.cs.
- Properties Window:** Shows properties for the current form "Form1".

AccessibleDescription	
AccessibleName	
AccessibleRole	Default
Appearance	
BackColor	Control
BackgroundImage	(none)
BackgroundImageLayout	Tile
Cursor	Default
Font	Segoe UI, 9pt
ForeColor	ControlText
Text	The text associated with the control.
- Form Designer:** Displays the "Form1.cs [Design]" view with a placeholder text "Click to Run Code".
- Output Window:** Shows the message "Double click to see your code".

Annotations with arrows:

- An orange arrow points from the text "Click to Run Code" to the placeholder text in the Form Designer.
- A blue arrow points from the text "This is your project" to the Solution Explorer window.
- A green arrow points from the text "This is the form you are working on" to the Form Designer window.



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USING VISUAL STUDIO

This is Your Form Tab

This is your code tab

Write code here to run on form load
When you double click on any object it will create a default event for that object

File Edit View Git Project Build Debug Test Analyze Tools Extensions Window Help Search (Ctrl+Q) MyFirstCSharpApp

Form1.cs* Form1.cs [Design]*

```
namespace MyFirstCSharpApp
{
    public partial class Form1 : Form
    {
        public Form1()
        {
            InitializeComponent();
        }

        private void Form1_Load(object sender, EventArgs e)
        {
        }
    }
}
```

Solution Explorer

Search Solution Explorer (Ctrl+Shift+F)

Solution 'MyFirstCSharpApp' (1 of 1 project)

- MyFirstSharpApp
 - Dependencies
 - Form1.cs
 - Form1.Designer.cs
 - Form1.resx
 - Program.cs

Properties

Output

Show output from:

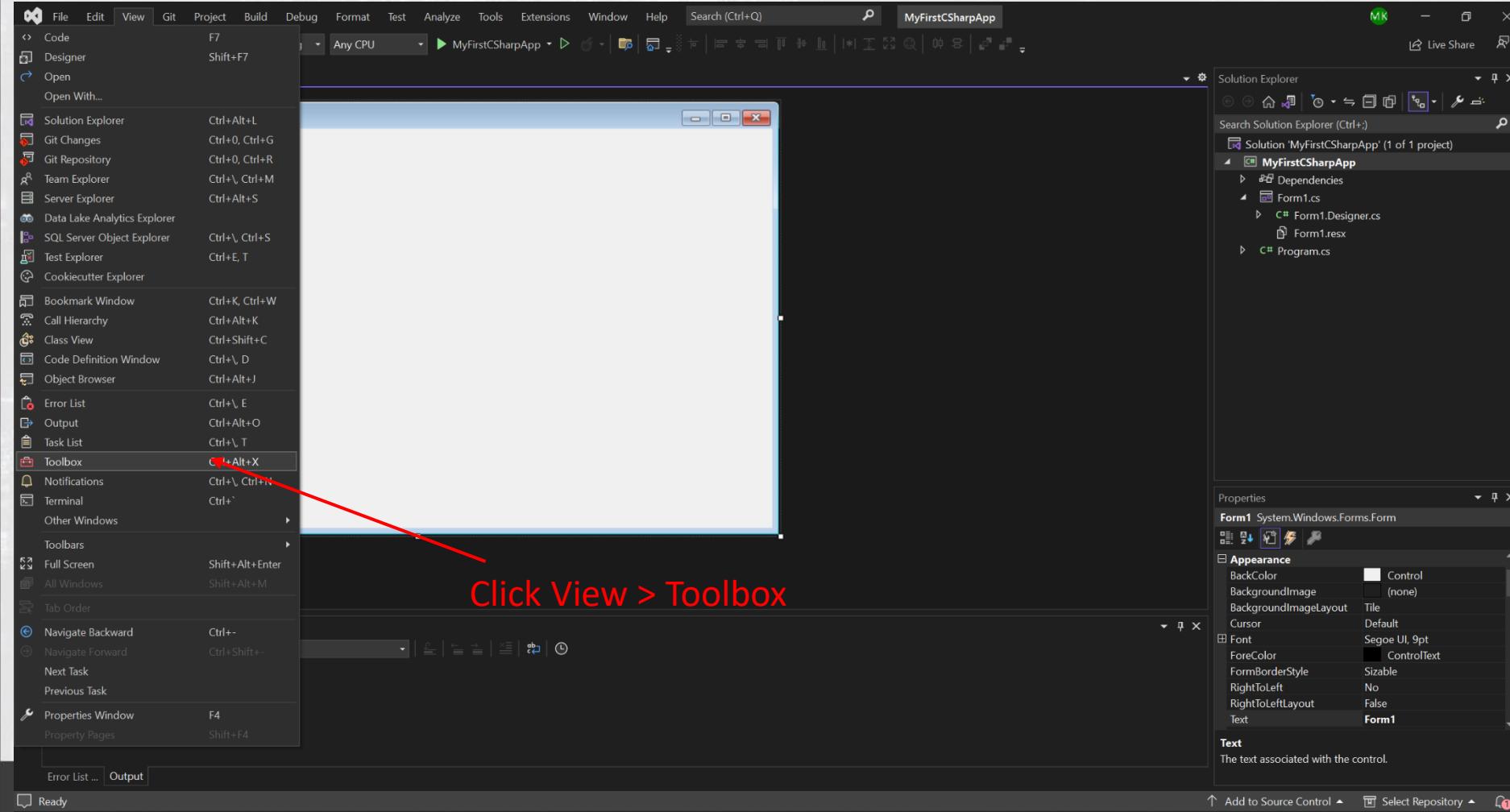
Error List ... Output

Add to Source Control Select Repository



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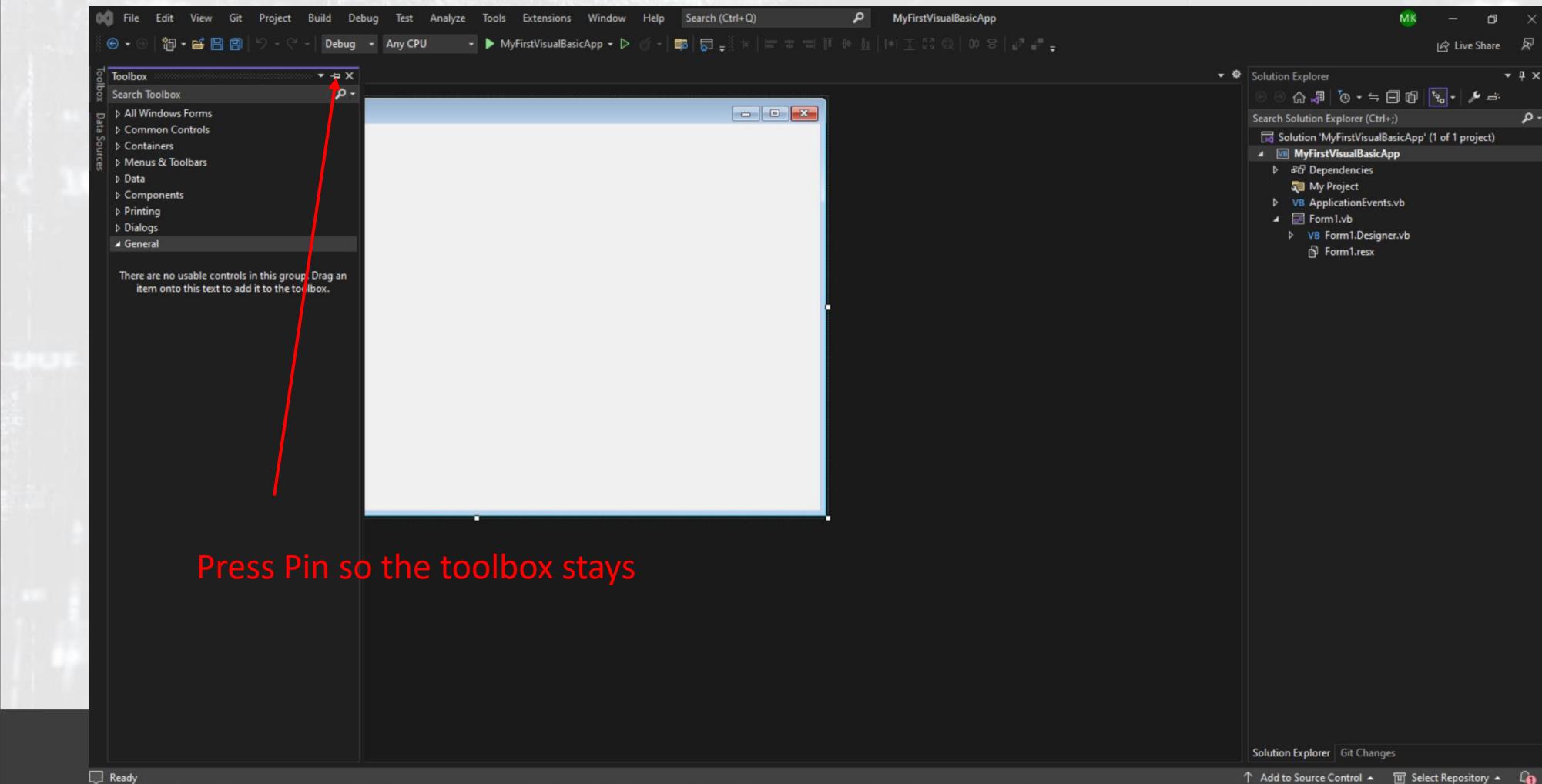
USING VISUAL STUDIO





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The screenshot shows the Visual Studio IDE interface. On the left, the Toolbox is pinned to the window, indicated by a yellow arrow pointing to its pinned icon. The main workspace displays a Windows Form titled 'Form1'. To the right of the form are the Solution Explorer, Properties, and Task List panes. A red arrow points from the text 'Press Pin so the toolbox stays' to the pinned icon on the Toolbox's title bar. Another red arrow points from the text 'If you want it to float to the side just press unpin' to the floating icon on the same title bar.

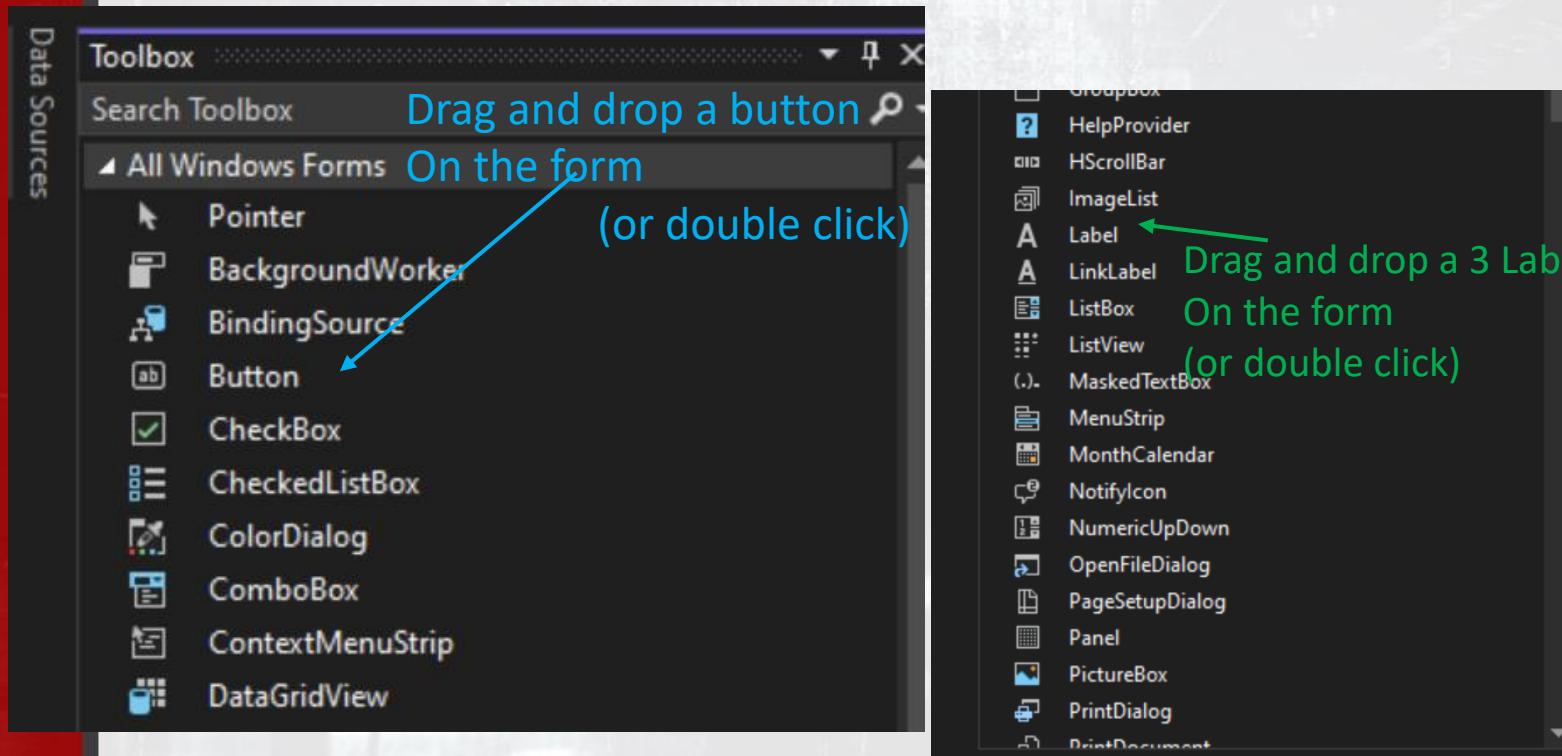
Press Pin so the toolbox stays
If you want it to float to the side just press unpin

Click "All Windows Forms" To see all the tools

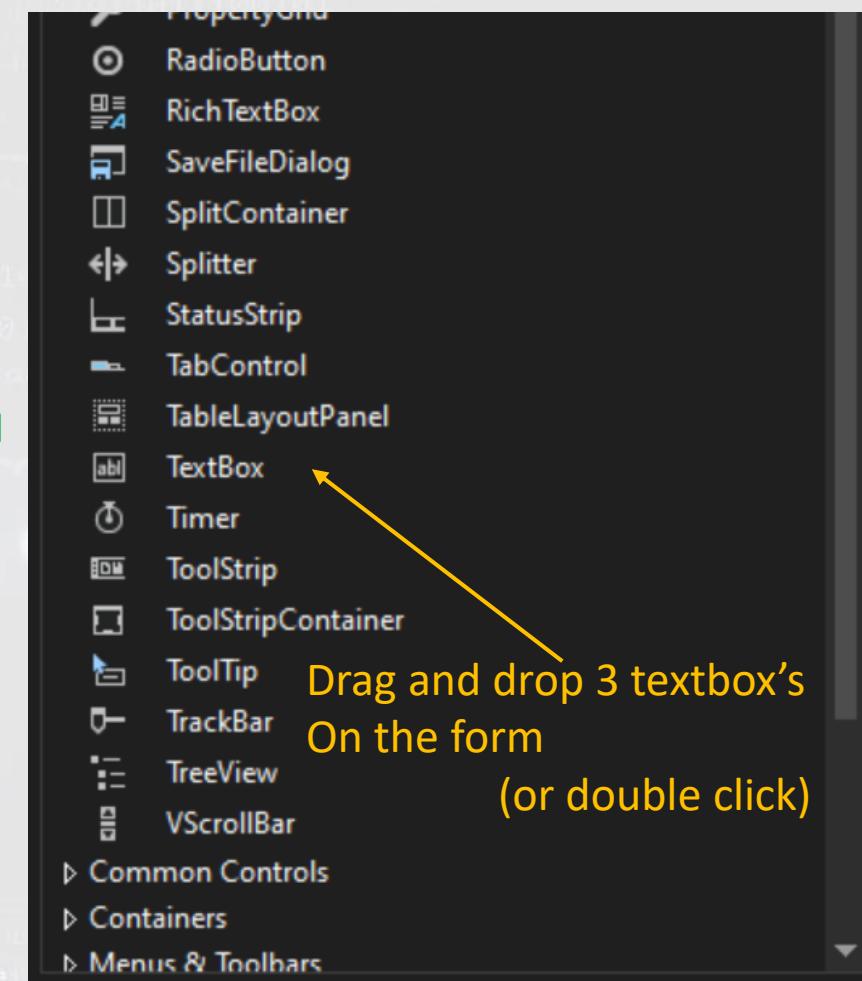


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USING VISUAL STUDIO

1) Right Click on Button select properties

2) Change Button1 to Sum

3) *Single* click on Label1

4) Change text to Num2

5) *Single* click on Label2

6) Change text to Num1

7) *Single* click on Label3

8) Change text to Sum

9) *Single* click on Form1

10) Change text to Arithmetic



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USING VISUAL STUDIO

Double Click on Sum Button

Properties

BackColor	Control
BackgroundImage	(none)
BackgroundImageLayout	Tile
Cursor	Default
Font	Segoe UI, 9pt
ForeColor	ControlText
FormBorderStyle	Sizable
RightToLeft	No
RightToLeftLayout	False
Text	Form1
UraMainCursor	False

The text associated with the control.



USING VISUAL STUDIO

The screenshot shows the Visual Studio IDE with a dark theme. The code editor displays the following C# code:

```
C# MyFirstCSharpApp
MyFirstCSharpApp.Form1
button1_Click(object sender, EventArgs e)

public partial class Form1 : Form
{
    public Form1()
    {
        InitializeComponent();
    }

    private void Form1_Load(object sender, EventArgs e)
    {

    }

    private void button1_Click(object sender, EventArgs e)
    {
        int number1 = Convert.ToInt32(textBox1.Text);
        int number2 = Convert.ToInt32(textBox2.Text);
        textBox3.Text = Convert.ToString(number1 + number2);
    }
}
```

A red box highlights the `button1_Click` event handler. The text "Write your code in the button1_click function. This is an event function built into Windows forms" is displayed in red text to the right of the highlighted code.

Visual Studio status bar: 108 %, No issues found, Ln: 19 Ch: 63, SPC, CRLF



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OPERATORS REFERENCE



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ASSIGNMENT OPERATORS

- = assignment
- $X = 5$
- $X = \text{"Happy"}$



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ARITHMETIC OPERATORS

- + add
- - subtract
- * multiply
- / division
- % Modulus



SHORTHAND OPERATORS

- $x += y$ is shorthand for $x = x + y$
- $x -= y$ is shorthand for $x = x - y$
- $x /= y$ is shorthand for $x = x / y$
- $x *= y$ is shorthand for $x = x * y$
- $x++$ is increment by 1 after
- $++x$ is increment by 1 at the time
- $x--$ is decrement by 1 after
- $--x$ is decrement by 1 at the time



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LOGICAL OPERATORS

- logical operators
- **&&** AND ($x = 5 \ \&\& \ y = 10$)
- **||** OR ($x = 5 \ \text{Or} \ x = 10$)
- **!** NOT ($!x$)



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COMPARISON OPERATORS

- $=$ equal
- \neq not equal
- $>$ greater than
- $<$ less than
- \geq greater than or equal to
- \leq less than or equal to



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VARIABLES



ASSIGNMENT OPERATORS

- = assignment
- X = 5
- X = “Happy”

```
int myNumber = 0;  
string myString = "";  
bool myBool = false;  
double myDouble = 0.0;
```



VARIABLES

When declaring a variable Indicate the type as a prefix to the variables name this allocates memory for a new variable.

`int x` or `string x` or `bool x`

- When we don't give a value to a variable it is called "unassigned". This can create unpredictable behavior in C#

`int x = 5`

- This is giving a value to x

`public int x = 5`

- Public is less commonly used; it is global scoped which means it can be accessed in most places in our program. It is preferable to not use public most cases to prevent scope issues

C# is a *strongly typed* language which means we must declare the specific type like integer, string or Boolean.



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VARIABLE NAMES

- Good
 - camelCase
 - good_name
 - _goodName (for this is used for private data members in objects)
 - goodName1
- Bad
 - \$badName
 - 5badName
 - &badName
 - Bad-name



VARIABLE

Add 3 new buttons to your form difference (subtract), product (multiply) and quotient (divide) use the same three Textboxes you used to for sum (add).

1) Input Difference = 20, 5

Output = 15

2) Input product = 20, 5

Output = 100

3) Input quotient = 20, 5

Output = 4



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SEMICOLON



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SEMICOLON

At the end of a line of code, you will see “;”
This indicates you are at the end of a line. All lines ***must*** end in a semicolon. You will receive errors otherwise



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IDE

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WHAT IS YOUR IDE TRYING TO TELL YOU?

You may see a red underline; this is like spell check in things like Microsoft Word. This is more important than a spelling error because it means your program won't run

`myNumber.ToString()`



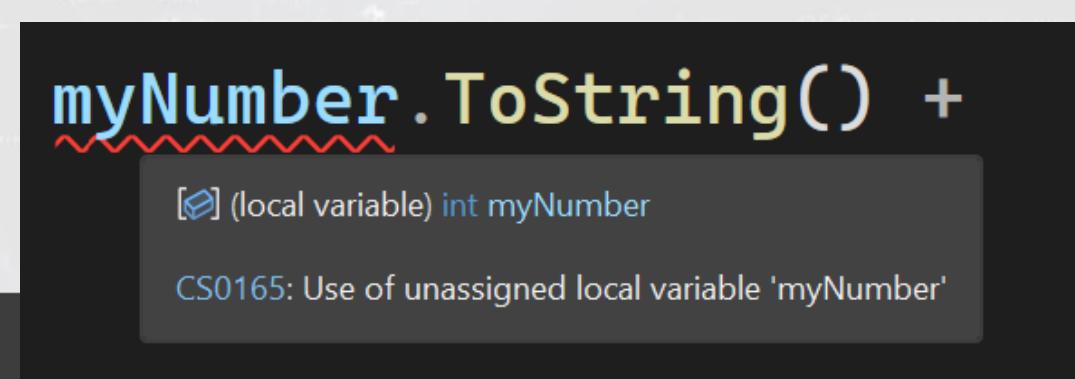
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WHAT IS YOUR IDE TRYING TO TELL YOU?

When you see the red underline, hover over the red line and it will give you suggestions on how to fix the error, though it might not always be the best suggestion, it points you in the right direction.

`myNumber.ToString()`





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OBJECTS PROPERTIES AND METHODS



PROPERTIES

- In Windows forms we use built in objects.
- TextBox1 is and object, Button2 is an object.
- These objects come with different properties.
- If I say; TextBox1.Text, I am accessing the text value in TextBox1
- You can do the same with Button1.Text. This may be less valuable in most cases but as an exercise try to change the text value of the button to “Wow!” when you click on it.



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PROPERTIES

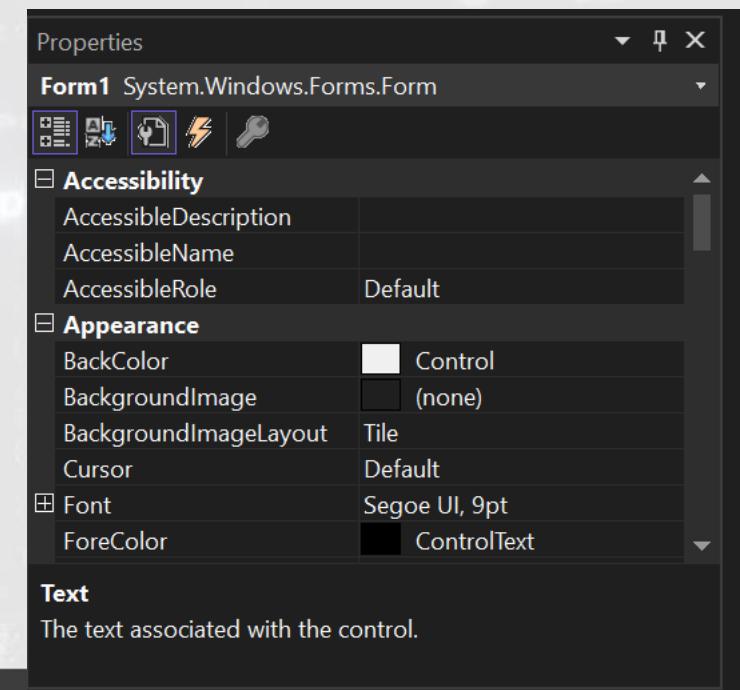
- Button text change:

```
1 reference
private void button1_Click(object sender, EventArgs e)
{
    button1.Text = "Wow";
}
```



PROPERTIES

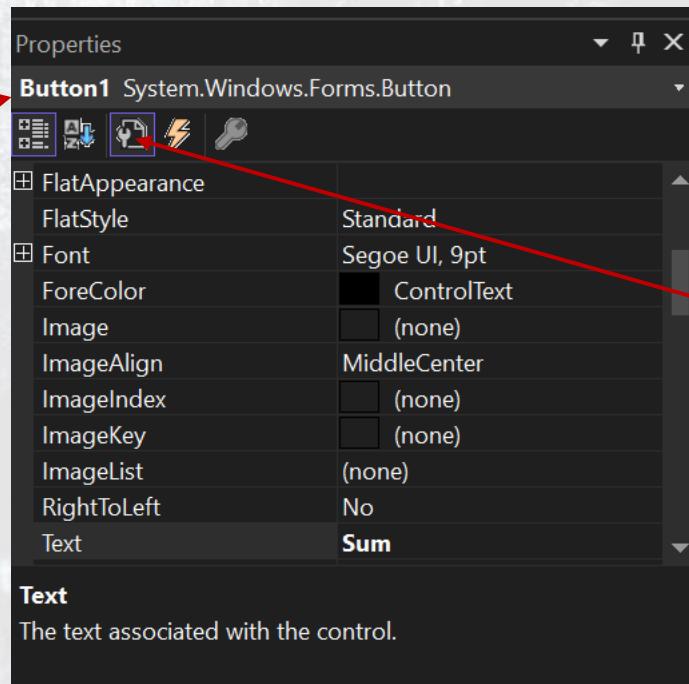
- The properties menu can be found at the bottom right of your screen. We used this already to change the labels and button text





PROPERTIES

This is the object we are working on. You can see it's Button1. If you click on another object like TextBox1 it will show up there



This is where we can find the properties associated with the object we have selected. When clicked on, we can change things like Text, Color, Images.

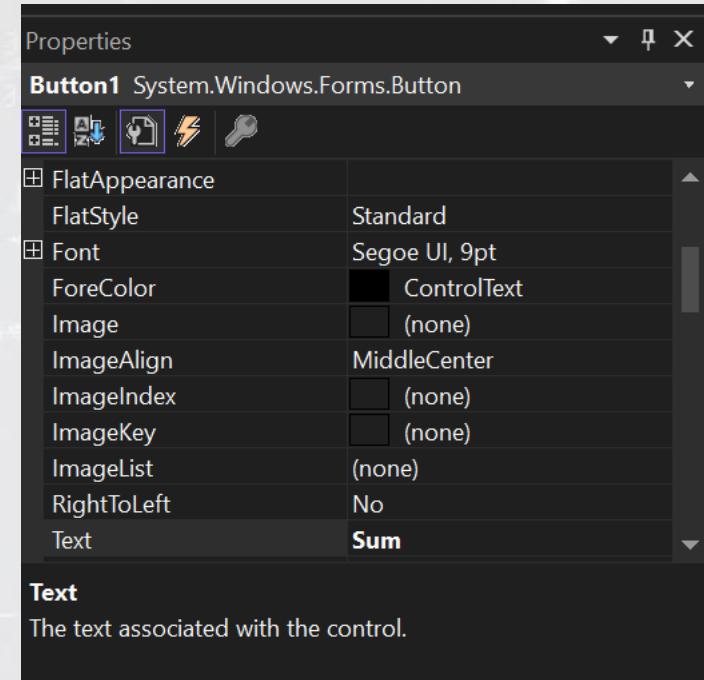


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PROPERTIES

Exercise:
Change the color of your Button to
Blue in the properties menu.

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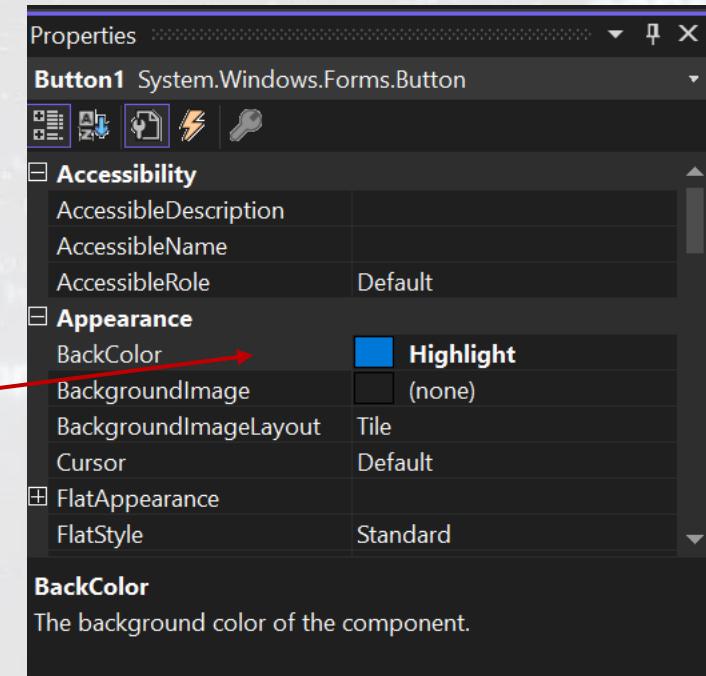




PROPERTIES

Answer:

Click on the column beside BackColor,
And choose the color you want.





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PROPERTIES

Now try to do this programmatically:

Hint 1: If you can't figure it out use google.

Hint 2: If google doesn't help, you have to use another object that comes with windows forms called color.

Write:

Color.TheColorYouWant

```
private void button1_Click(object sender, EventArgs e)
{
    -
}
```



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PROPERTIES

Answer:

1 reference

```
private void button1_Click(object sender, EventArgs e)
{
    button1.BackColor = Color.Blue;
}
```

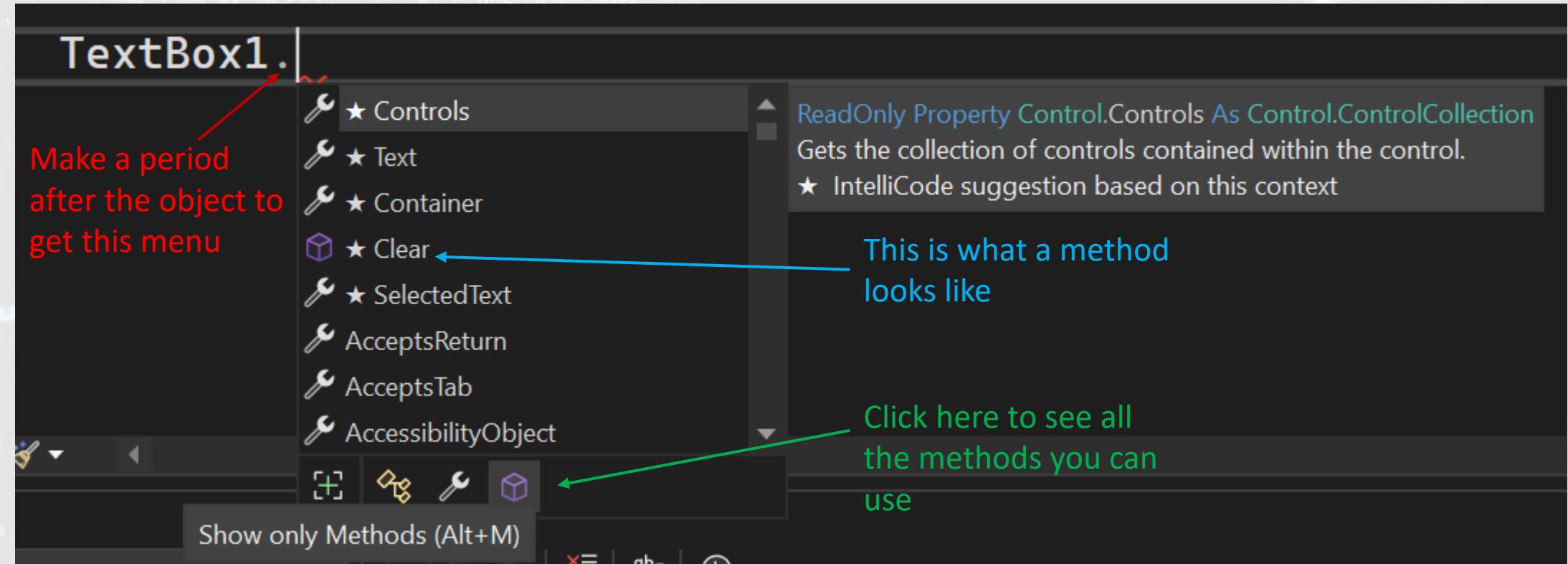


FUNCTIONS/METHODS

- Objects don't just come with properties, they also come with functions (methods)
- Just like you can have `textBox1.text` you can have `textBox1.Clear()`. This will clear the textbox. Give it a try!
- Make a button that clears the textboxes in your form.



FUNCTIONS/METHODS





FUNCTIONS/METHODS

- Other Items like variables have methods you can add. Some common ones are:
- ToLower()
- ToString()
- Convert.ToInt____() you can fill in what you want to convert



FUNCTIONS/METHODS

```
Dim MyVariable As Integer = 55  
MyVariable.ToString()
```

Hover on the
function to see
what it does

Function Integer.ToString() As String (+ 5 overloads)

Converts the numeric value of this instance to its equivalent string representation.

Returns:

The string representation of the value of this instance, consisting of a negative sign if the value is negative, and a sequence of digits ranging from 0 to 9 with no leading zeroes.

This shows what is
returned from the
function



FUNCTIONS/METHODS

```
string myString = "Happy Happy, Joy Hoy";  
textBox3.Text = myString.Substring(1);
```

You can see what parameters are required. This one needs a start index. I started at 1 which is t

string string.Substring(int startIndex) (+ 1 overload)

Retrieves a substring from this instance. The substring starts at a specified character position and continues to the end of the string.

Returns:

A string that is equivalent to the substring that begins at startIndex in this instance, or string.Empty if startIndex is equal to the length of this instance.

Exceptions:

ArgumentOutOfRangeException



FUNCTIONS/METHODS

```
string myString = "Happy Happy, Joy Hoy";  
textBox3.Text = myString.Substring(1);
```

This returns everything from the start index to the end.

You can read more in the documentation

string string.Substring(int startIndex) (+ 1 overload)
Retrieves a substring from this instance. The substring starts at a specified character position and continues to the end of the string.

Returns:
A string that is equivalent to the substring that begins at startIndex in this instance, or string.Empty if startIndex is equal to the length of this instance.

Exceptions:
ArgumentOutOfRangeException



FUNCTIONS/METHODS

```
string myString = "Happy Happy, Joy Hoy";  
textBox3.Text = myString.Substring(1);
```

Print this in a text
box to see what
you get

/string string.Substring(int startIndex) (+ 1 overload)
Retrieves a substring from this instance. The substring starts at a specified character position and continues to the end of the string.

Returns:
A string that is equivalent to the substring that begins at `startIndex` in this instance, or `string.Empty` if `startIndex` is equal to the length of this instance.

Exceptions:
`ArgumentOutOfRangeException`



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INPUT/OUTPUT



BASIC INPUT/OUTPUT

- Common Input/Outputs are:
 - Textbox (I/O)
 - RichTextbox (I/O)
 - MessageBox.Show() (I/O)
- Textbox are generally used for one line of text going in or out.
- RichTextbox are generally used for multiple lines of text going in or out.
- Messageboxes are commonly used to alert users, They can be used for inputs in specific circumstances like returning different variations of Yes No



BASIC INPUT/OUTPUT

- When using both Textboxes and Richtextboxes, treat it like a variable if you want to add more data to the same box:
- `textBox1.Text = MyString`
- `textBox1.Text += MySecondString`



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MORE ADVANCED I/O

There are more Inputs and outputs like different ways to display tabular data and graphs. We will take at these later in the course.



I/O EXERCISE

- 1) Make a New Project like we did in the early slides.
- 2) Call it 2_InputAndOutput
- 3) Add the textboxes labels and button you think you need.
- 4) Take in two strings into variables. One called hello, which takes in “Hello,” one called world which takes in “ world” and concatenate them. Display them in MessageBox.Show() on a button click
- 5) Take in a string “William Blake Said: ” concatenate with another string: “He who binds to himself a joy Does the winged life destroy; But he who kisses the joy as it flies Lives in eternity's sun rise.” Display in a RichTextbox on button click



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I/O EXERCISE OUTPUT

Input Output

Exercise 1:

Hello, Greeting

World Place

Concatenate MessageBox

Exercise 2:

William Blake Author

Quote

He who binds to himself a joy Does
the winged life destroy; But he who
kisses the joy as it flies Lives in
eternity's sun rise.

Concatenate RichTextBox

William Blake Said: He who binds to
himself a joy Does the winged life
destroy; But he who kisses the joy as it
flies Lives in eternity's sun rise.

Author + Quote



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I/O EXERCISE CODE

1 reference

```
private void button1_Click(object sender, EventArgs e)
{
    MessageBox.Show(textBox1.Text + textBox2.Text);
}
```

1 reference

```
private void button2_Click(object sender, EventArgs e)
{
    string author = textBox3.Text;
    string quote = richTextBox1.Text;
    richTextBox2.Text = author + " Said: " + quote;
}
```



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COMMENTS



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COMMENTS

- Comments are declared using // or /* words */
- You can use short cuts (control + k + c) to block out a line or any group you highlighted
- You can uncomment by (ctrl + k + u)



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DATA TYPES



DATA TYPE IN GENERAL

Character

single

a, b, c

'a' 'b' 'c' '%' '7' '|'

string

cat (constant)

"cat"

Numbers

Integer

1,2,3

Real

0, 1 || false, true

Boolean

2.75 != 27.5 != 275.0



C# COMMON PRIMITIVE DATA TYPES

- Integer
- Double
- Long
- String
- Char
- Boolean

For all data types and memory requirements read:

<https://learn.microsoft.com/en-us/dotnet/csharp/language-reference/builtin-types/built-in-types>



C# DATA TYPES

- C# is a strongly typed language; this means we must define the data types we are using. It makes it easy when reading code and prevents type errors.
- When we take in a “5”, which is a string and a 5 which is a number, they are different. We can define them as different when we create our variables.



C# DATA TYPES

1. Make a new project called 3_DataTypes
2. On your form add labels, textboxes and buttons
3. Make a two separate buttons that adds two numbers. One will add integer numbers, one will add numbers that are characters(or strings)
4. Input Integers = 5, 5
Output = 10
5. Input Characters= “5”, “5”
Output = “55”



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C# DATA TYPES

- You can not compare variables of different types.



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VB DATA TYPES - OUTPUT

Data Types

Exercise 1:

<input type="text" value="5"/>	Integer 1
<input type="text" value="5"/>	Integer 2
<input type="button" value="Integer Add"/>	
<input type="text" value="10"/>	Int Sum

Exercise 2:

<input type="text" value="5"/>	Char 1
<input type="text" value="5"/>	Char 2
<input type="button" value="Character Add"/>	
<input type="text" value="55"/>	Char Sum



C# DATA TYPES - CODE

```
1 reference
private void button1_Click(object sender, EventArgs e)
{
    int num1 = Convert.ToInt32(textBox1.Text);
    int num2 = Convert.ToInt32(textBox2.Text);
    textBox3.Text = Convert.ToString(num1 + num2);
}
```

```
1 reference
private void button2_Click(object sender, EventArgs e)
{
    string char1 = textBox4.Text;
    string char2 = textBox5.Text;
    textBox6.Text = char1 + char2;
}
```



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DATA TYPES NUMBERS



NUMBERS

- C# has a multiple types of numbers
 - Integer (int32)
 - Double
 - Decimals
 - float
 - Long
 - Sbyte
 - short
- We will cover two commonly used, Integer and Double, It will be up to you to read further and decide when to use which type



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NUMBERS - INTEGERS

- Integer (int32) are 4bytes number that can be from negative to positive. This is the spectrum -2,147,483,648 through 2,147,483,647**
- Integers can not have a decimal point.

** is from <https://learn.microsoft.com/en-us/dotnet/visual-basic/language-reference/data-types/>



NUMBERS - INTEGERS

- Doubles are 8bytes in size and can go from negative to positive.
- -1.79769313486231570E+308 through
-4.94065645841246544E-324 † for negative values;**
- 4.94065645841246544E-324 through
1.79769313486231570E+308 † for positive values**
- Doubles can have a decimal point; 44.2 will be 44.2

** is from <https://learn.microsoft.com/en-us/dotnet/visual-basic/language-reference/data-types/>



NUMBERS - INTEGERS

- When it comes to using other types you have to think what will be the most efficient on memory. Will you need to allocate an 8 byte double when using whole numbers that go from 1-100? Or should you use an Integer which takes bytes? Or maybe an Sbyte might be better? Depends on if you will need to expand the program to have bigger numbers. Be sagacious and decern what is best when.



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DATA TYPES STRINGS



STRINGS

- There are two different ways to make strings in C#:
 1. Use double quotes. This is great work for strings that don't need to have data added in the middle. If you need to concatenate, take two strings and add them "Hello, " + "World"
 2. Make a Template Literal. This is where you add the dollar sign in front of the first \$. Then you nest the variables in {}. This allows you to format your strings with ease.
- Next page will have demonstrations



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STRINGS

```
private void button1_Click(object sender, EventArgs e)
{
    string hello = textBox1.Text;
    string world = textBox2.Text;
    textBox3.Text = hello + world;           ← Regular String being concatenated
    textBox4.Text = $"{{hello}} {{world}}";   ← Template Literal
}
```



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STRINGS

Data Types

Strings:

Hello	Hello
World	World
Concatenate	
HelloWorld	Without Template Literal
Hello, World	With Template Literal

Regular String being concatenated

Template Literal



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STRINGS EXERCISE 1

Make an input that takes a first name, last name, and age. Use template literals.

Get it to print in the console in one line.

Hello FirstName LastName, you are Age years old.



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STRINGS EXERCISE 2

- Make a form that fills in the blanks:

Hi! Last week I went _____. My friend _____ and I had so much _____. There were _____ and _____. When we saw it we felt really _____. You should come next time!



STRINGS (ARRAYS OF CHARACTERS)

- Each part of a string has an index number

myCode = "Code"

0123

- myCode[3] is not equal to d
- it is e
- Variable.length is used to calculate the number of characters in a string including spaces
- [] Is called subscript operator (myCode address + (char size * index))
- The subscript operator calculates the amount of bits or bytes between two data types stored in an array to find the address.



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STRINGS EXERCISE 3

- What is the value:
- string bday = “Happy Birthday”
- MessageBox.Show(bday[7].ToString())



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STRINGS EXERCISE 3

- What is the value:
- string bday = “Happy Birthday”
- MessageBox.Show(bday[7].ToString())
- Answer:
- i



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DATA TYPES

BOOLEANS



BOOLEANS

- Booleans are true or false statements.
- You can use Booleans in your code as variables

1 reference

```
private void button1_Click(object sender, EventArgs e)
{
    bool myBool = true;
    MessageBox.Show(myBool.ToString());
}
```

- This will print true in the message box



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BOOLEANS

- Change the Boolean in the below image so it prints out false:

```
1 reference
private void button1_Click(object sender, EventArgs e)
{
    bool myBool = true;
    MessageBox.Show(myBool.ToString());
}
```



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BOOLEANS

- Because Booleans are true or false, there are two operator categories we can use to check Booleans
 1. Comparison operator you can compare numbers, strings and Booleans and return true and false
 2. Logical operators can be used to add logic to a Boolean statement



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COMPARISON OPERATORS

- = equal
- != not equal
- > greater than
- < less than
- >= greater than or equal to
- <= less than or equal to



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LOGICAL OPERATORS

- **&&** AND ($x = 5 \&\& y = 10$)
- **||** OR ($x = 5 || x = 10$)
- **!** NOT ($!x$)



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DATA TYPES

DATA WITHOUT DEFINED DATA



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NOTHING

- We must assign values to variables.
- We cannot have variables without data because we will get an error message



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DEBUGGING



WHAT IS A BUG?

- Grace Hopper, who made the first compiler, is attributed with coining the term “Debugging”. This was when she had found a moth in one of the computers in the 1940's.
- The term was commonly used 50 years prior to Grace by Thomas Edison in relation to technical errors in machines.



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TWO COMMON TYPES OF BUGS

1. Syntactical bugs
2. Logical bugs



SYNTACTICAL

- Syntactic bugs are caused by the programmer writing code in the wrong way. This often a small mistake like misspelling something or misplacing if statement endings. Most IDE's have built in features to tell you when you made a mistake, but it might not always catch the mistake.



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LOGICAL BUGS?

- Logical bugs are generally harder to find. Logical bugs are based on errors in the logic. There are tools that allow us to find these bugs such as:
 1. Reading error messages
 2. The Debugger



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WHAT IS DEBUGGING?

- Debugging is a process we can use to go through our programs and find why it crashes, outputs wrong or doesn't do what we want.



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READING ERRORS

- Error messages are basically other programmers communicating with us that we have done incorrect.



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READING ERRORS

This is telling us what line the error is on

System.NullReferenceException: 'Object reference not set to an instance of an object.'

sum was null.

Exception Settings

Break when this exception type is thrown

Except when thrown from:

Exception List

Entire Solution

0 Errors, 2 Warnings, 0 of 2 Messages

CS8600 Converting null literal or possible null value to non-nullable type.

CS8602 Dereference of a possibly null reference.

Call Stack Breakpoints Exception Settings Command Window Immediate Window Output Error List

Autos Locals Watch 1

Ready Add to Source Control Select Repository

```
16
17
18
19 1 reference
private void button1_Click(object sender, EventArgs e)
{
}
20
21
22
23
24 1 reference
private void button2_Click(object sender, EventArgs e)
{
    string sum = null;
    textBox1.Text= sum.ToString(); // Error occurs here
}
25
26
27
28
29
30 }
```



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READING ERRORS

The issue is .ToLower()
doesn't work because
the string doesn't hold
a value

Exception Thrown

System.NullReferenceException: 'Object reference not set to an instance of an object.'

sum was null.

sum

textBox1

textBox1.Text

this

System.Windows.Forms.TextBox

MyFirstCSharpApp.Form1

MyFirstCSharpApp

File Edit View Git Project Build Debug Test Analyze Tools Extensions Window Help

Process: [31412] MyFirstCSharpApp.exe Thread: [5604] Main Thread Stack Frame: MyFirstCSharpApp.Form1.button2_Click

Diagnostic Tools

Diagnostics session: 4 seconds (4.721 s selected)

Events

Process Memory (MB)

CPU (% of all processors)

Summary Events Memory Usage CPU Usage

Events

Memory Usage

CPU Usage

Call Stack Breakpoints Exception Settings Command Window Immediate Window Output Error List

Entire Solution

Code Description Project File Line Suppression State

CS8600 Converting null literal or possible null value to non-nullable type. MyFirstCSharpApp Form1.cs 26 Active

CS8602 Dereference of a possibly null reference. MyFirstCSharpApp Form1.cs 27 Active

Call Stack Breakpoints Exception Settings Command Window Immediate Window Output Error List

Add to Source Control Select Repository



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READING ERRORS

- Reading errors is one of the easiest ways to determine what is wrong with code.
- This feedback is invaluable and is often overlooked by beginners because it can be hard to decipher.



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READING ERRORS

- What to do with an error you are unfamiliar with or don't understand?
- Copy it and paste it into a search engine.
- Generally, stack overflow will pop up and someone will have found the answer.



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THE DEBUGGER

- The debugger slows the program down frame by frame so you can see what is happening
- Let's look at an example of adding the numbers from 1 -100



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THE DEBUGGER

File Edit View Git Project Build Debug Test Analyze Tools Extensions Window Help Search (Ctrl+Q)

Process: [21908] MyFirstCSharpApp.exe Lifecycle Events Thread: [42140] Main Thread Stack Frame: MyFirstCSharpApp.Form1.button2_Click

Form1.cs [Design] Form1.cs

```
10 private void Form1_Load(object sender, EventArgs e)
11 {
12 }
13
14
15 private void button1_Click(object sender, EventArgs e)
16 {
17 }
18
19
20 private void button2_Click(object sender, EventArgs e)
21 {
22     int sum = 0;
23     for (int i = 0; i <= 100; i++)
24     {
25         textBox1.Text = Convert.ToString(i + sum);
26     }
27 }
28
29 }
```

Solution Explorer

- Search Solution Explorer (Ctrl+.)
- MyFirstCSharpApp
 - Dependencies
 - Form1.cs
 - C# Form1.Designer.cs
 - Form1.resx
 - Program.cs

First Click beside the line you want to stop at. A red dot will appear and stay there till you click on it again

Autos

Name	Type
i	int
sum	int
textBox1	System.Windows.Forms.TextBox
textBox1.Text	string
this	MyFirstCSharpApp.Form1

Error List

Code	Description	Project	File	Line	Suppression State

Call Stack Breakpoints Exception Settings Command Window Immediate Window Output Error List

Solution Explorer Git Changes



THE DEBUGGER

When you hover over a variable it will show what value it currently has. Index is at 0 because this is the start of our loop

Name	Type	Value
i	int	0
sum	int	0
textBox1	System.Windows.Forms.TextBox	{Text = ""}
textBox1.Text	string	""
this	MyFirstCSharpApp.Form1	(MyFirstCSharpApp.Form1, Text: Arithmetic)



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THE DEBUGGER

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File Edit View Git Project Build Debug Test Analyze Tools Extensions Window Help Search (Ctrl+Q)

Process: [21908] MyFirstCSharpApp.exe Lifecycle Events Thread: [42140] Main Thread Stack Frame: MyFirstCSharpApp.Form1.button2_Click

Form1.cs [Design] Form1.cs

```
10
11
12
13
14
15     private void button1_Click(object sender, EventArgs e)
16     {
17     }
18
19
20     private void button2_Click(object sender, EventArgs e)
21     {
22         int sum = 0;
23         for (int i = 0; i <= 100; i++)
24         {
25             textBox1.Text = Convert.ToString(i + sum);
26         }
27     }
28 }
```

You can also find variable values down here

Autos

Name	Type	Value
i	int	0
sum	int	0
textBox1	System.Windows.Forms.TextBox	{Text = ""}
textBox1.Text	string	""
this	MyFirstCSharpApp.Form1	{MyFirstCSharpApp.Form1, Text: Arithmetic}

Error List

Entire Solution	0 Errors	0 Warnings	0 of 2 Messages
Code	Description	Project	File
Line	Suppression State		



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THE DEBUGGER

When you want to go to the next line of text, click here or F11 (F11 may not work on some laptops)

```
10     private void Form1_Load(object sender, EventArgs e)
11     {
12     }
13
14
15     private void button1_Click(object sender, EventArgs e)
16     {
17     }
18
19
20     private void button2_Click(object sender, EventArgs e)
21     {
22         int sum = 0;
23         for (int i = 0; i <= 100; i++)
24         {
25             textBox1.Text = Convert.ToString(i + sum);
26             i = 0
27         }
28     }
29 }
```

Solution Explorer

- Search Solution Explorer (Ctrl+.)
- Solution 'MyFirstCSharpApp' (1 of 1 project)
 - External Sources
 - MyFirstCSharpApp
 - Dependencies
 - Form1.cs
 - Form1.Designer.cs
 - Form1.resx
 - Program.cs



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THE DEBUGGER

- An analogy of debugging is Animation. When we slow down animation, we can see each frame like in this short film...
- https://www.youtube.com/watch?v=NLqiY7sJAh0&ab_channel=PedroPaulino
- 4:02 – 4:41



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IF STATEMENTS



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IF STATEMENTS

If statements are used to direct the flow of our programs. They allow the computer to make decisions based on specific conditions.



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IF STATEMENT ANATOMY

- If statements in C# look like this:

```
if (true)
{
    -
}
}
```



ELSE IF STATEMENT

```
string beverage = textBox1.Text;
if (beverage == "Coffee")
{
    MessageBox.Show("We have Coffee!");
}
else if (beverage == "Tea")
{
    MessageBox.Show("We have Tea!");
}
else if (beverage == "Soda")
{
    MessageBox.Show("We have Soda!");
}
else
{
    MessageBox.Show("We don't have that!");
}
```



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IF STATEMENTS COMPARISON



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COMPARISON OPERATORS

- == equal
- != not equal
- > greater than
- < less than
- >= greater than or equal to
- <= less than or equal to



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IF STATEMENTS

COMPARISON OPERATORS

EQUALITY



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EQUALITY

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WEB: WWW.ITDCANADA.CA
EMAIL: STUDYING@ITDCANADA.CA

```
string beverage = textBox1.Text;
if (beverage == "Coffee")
{
    MessageBox.Show("We have Coffee!");
}
else if (beverage == "Tea")
{
    MessageBox.Show("We have Tea!");
}
else if (beverage == "Soda")
{
    MessageBox.Show("We have Soda!");
}
else
{
    MessageBox.Show("We don't have that!");
}
```



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IF STATEMENTS

COMPARISON OPERATORS

GREATER, LESS



GREATER THAN, LESS THAN

```
int x = 55;
if (x > 52 + 3 )
{
    MessageBox.Show($"x is greater than 52 + 3!");
}
else if (x < 52 + 3)
{
    MessageBox.Show($"x is less than 52 + 3!");
}
else if (x <= 52 + 2)
{
    MessageBox.Show($"x is less than or equal to 52 + 3!");
}
else if (x >= 52 + 3)
{
    MessageBox.Show($"x is greater than or equal to than 52 + 3!");
}
```



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IF STATEMENTS COMPARISON OPERATORS INEQUALITY



INEQUALITY

Inequality operator is basically a !=

```
string beverage = textBox1.Text;
if (beverage != "Coffee")
{
    MessageBox.Show($"We don't have {beverage}!");
}
else
{
    MessageBox.Show("We have Coffee!");
}
```



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IF STATEMENTS COMPARISON LOGICAL OPERATORS



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LOGICAL OPERATORS

- **&&** AND ($x == 5 \&\& y == 10$)
- **||** OR ($x == 5 || x == 10$)
- **!** NOT ($!x$)



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LOGICAL OPERATORS

```
string beverageSoda = textBox1.Text.ToLower();
string beverageTea = textBox1.Text.ToLower();
string beverageCoffee = textBox1.Text.ToLower();
if (beverageCoffee == "coffee" && beverageTea == "tea" &&
    beverageSoda == "soda")
{
    MessageBox.Show("Your beverages are all the good ones");
}
else
{
    MessageBox.Show("Your beverages are none of the good ones");
}
```



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LOGICAL OPERATORS

```
string beverage = textBox1.Text.ToLower();
if (beverage == "coffee" || beverage == "tea" || beverage == "soda")
{
    MessageBox.Show($"We have {beverage}!");
}
else
{
    MessageBox.Show($"We don't have {beverage}!");
}
```



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EXERCISE



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IF STATEMENT EXERCISE 1

Take in one number, check if it is even or odd

Case 1) Input = 55

Output = odd

Case 2) input = 22

output = even



IF STATEMENT EXERCISE 2

Determine if a number evenly divisible by 3 or evenly divisible by 5. When the number is evenly divisible by 3 print "fizz". When the number is evenly divisible by 5 print "buzz". When it is evenly divisible by both print "FizzBuzz". In all other circumstances print "No fizz No buzz"

Case1) Input = 25

 output = Buzz

Case 2) Input = 30

 output = FizzBuzz

Case 3) Input = 12

 output = Fizz

Case 4) Input = 11

 output = No fizz No buzz



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IF STATEMENT EXERCISE 3

Make A Full Calculator:



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LOOPS



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LOOPS

- The two most commonly used loops are
 - For loops
 - While loops
- For loops are counter based
- While loops are condition based
- There are variations of these two loops loops that have similar functionality, but are used in different situations



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LOOPS FOR LOOP



LOOPS - FOR

- For loops are counter based loops that allow us to iterate a fixed number of times
- For loops in C# have a variable defined, then a counter condition

```
for (int i = 0; i < 10; i++)  
{  
      
}  
}
```



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LOOPS - FOR

You can add steps if you need to skip numbers

```
for (int i = 0; i < 10; i++)
{
    textBox1.Text += i.ToString() + ", ";
}
```



LOOPS – FOR BROKEN DOWN

- index = 1 // initialize variable as our counter
- index to 5 // set condition
- Next // increment counter by one (or steps indicated)

```
for (int i = 0; i < 5; i++)  
{  
    textBox1.Text += i.ToString() + ", "  
}
```



LOOPS – FOR BROKEN DOWN

index = 1

RichTextBox.Text += index.ToString() + "," //prints out 1,

Next // increments by 1

RichTextBox.Text += index.ToString() + "," //prints out 2,

Next // increments by 1

RichTextBox.Text += index.ToString() + "," //prints out 3,

Next // increments by 1

RichTextBox.Text += index.ToString() + "," //prints out 4,

Next // increments by 1

RichTextBox.Text += index.ToString() + "," //prints out 5,



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LOOPS FOR LOOP EXERCISES



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LOOPS - FOR

Exercise 1:

- Make a program that sums all the numbers from 1 – 100 in the console
- Output = 5050



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LOOPS - FOR

Exercise 2 :

- User inputs two numbers
- The program will print and sum all the even numbers between the user's input.
- Input = 1, 9
- Output = 2, 4, 6, 8
- “The sum of all the even numbers is 20”



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LOOPS - FOR

Exercise 3 :

- Determine if a number is prime number
- Input = 1399
- Output = It is True Your number is prime
- Input = 22
- Output = It is False Your number is prime
- Input = 2
- Output = It is True Your number is prime
- Input = 1
- Output = It is False Your number is prime



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LOOPS WHILE



LOOPS - WHILE

- While loops are a condition-based loop
- While loops can be turned into loop that count, but its best if we specifically use the while loop for conditions that have no numerically defined ending
- Because while loops are based on a condition, they can run forever if the condition isn't met. This may crash whatever platform you are running (Unity will do this, web browsers generally have safety measures in place to prevent this.)
- In windows forms you can just press the stop button if you get into an infinite loop.



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LOOPS - WHILE

```
while (true)
{
    -
}
```



LOOPS - WHILE

This would be a for loop as a while loop

```
int i = 0;
while (i < 10 )
{
    textBox1.Text += i.ToString() + ", ";
    i++;
}
```



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LOOPS

WHILE LOOP

EXERCISES



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LOOPS - WHILE

Exercise 1

- Research the random number generator for C#. Set up a while loop that while true it generates a random number and prints the number onto a RichTextBox. The while loop will stop running when the number 42 is generated by the Random number generator.
- Input = 42 as the stop
- Output = All random numbers generated, including 42



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RANDOM NUMBER GENERATOR



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RANDOM NUMBER GENERATOR

Random number generators are in almost all programming languages. Random number generators are not truly random but pseudo random. This means that even though a number appears random it has a mathematical formula that can be broken down to accurately predict the number being generated.



RANDOM NUMBER GENERATOR

- The way we get a random number in C# is by using the Below Code.

```
Random randomObj = new Random();
int randomNum = randomObj.Next(100);
textBox1.Text = randomNum.ToString();
```



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LOOPS

EXIT AND CONTINUE



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BREAK AND CONTINUE

- Break – terminates the loop
- Continue – terminate the iteration of the loop



BREAK AND CONTINUE IMAGES

- What Will this print out?

```
textBox1.Text = "";
for (int i = 0; i < 10; i++)
{
    if (i == 5)
    {
        continue;
    }
    if (i == 7)
    {
        break;
    }
    textBox1.Text += i.ToString() + ", ";
}
```



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LOOPS

NESTED LOOPS



NESTED LOOPS

```
textBox1.Text = "";
for (int i = 0; i < 10; i++)
{
    for (int j = 0; j < 10; j++)
    {
        richTextBox1.Text += " * ";
    }
    richTextBox1.Text += "\n";
}
```



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ARRAYS



ARRAYS

- An array is a collection of similar data elements stored at contiguous memory locations. It is one of the simplest data structures. Each data element can be accessed directly by using an index.
- Arrays in C# are by default static arrays, which means they cannot change their size.



ARRAYS BROKEN DOWN

- Let's say you have a collection of heights you want to compare
- You could take in one height at a time and look at it then compare it against the last. This could work maybe once but if you need to look at the same data and do something else this would be painful.
- Another thing you could do is store each height in a variable which we will look at on the next page.



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ARRAYS: ARRAYS BROKEN DOWN



ARRAYS BROKEN DOWN

- If we store each height in a variable, we end up with this:

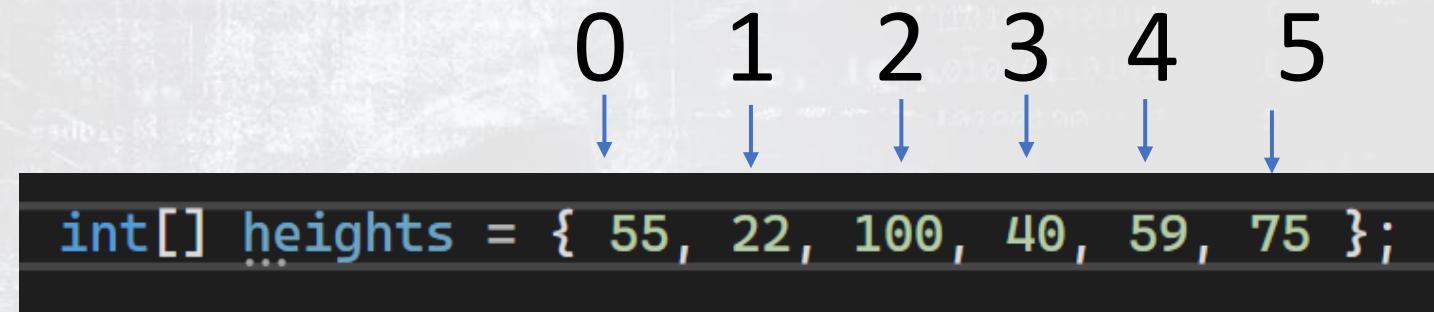
```
int height = 55;
int height1 = 22;
int height2 = 100;
int height3 = 40;
int height4 = 59;
int height5 = 75;
```

- Which isn't great...



ARRAYS BROKEN DOWN

- Array indexes start from 0 and increment by 1



This is like strings, which are just arrays of characters.



ARRAYS BROKEN DOWN

- You can think of arrays as a collection of variable data but stored in a single variable. We access each individual variable by using the subscript operator “[]” and a number called an index.

```
int[] heights = { 55, 22, 100, 40, 59, 75 };  
MessageBox.Show(heights[3].ToString());
```



Index Subscript Operator



ARRAYS BROKEN Down

- On line one we initialize the variable heights using a subscript operator. We can initialize our array with our data or add data to an array.

```
int[] heights = { 55, 22, 100, 40, 59, 75 };  
MessageBox.Show(heights[3].ToString());
```



ARRAYS BROKEN DOWN

- To initialize an array with no data we must define, then amount of data we want, this allocates memory by using new:

```
int[] heights = new int[6];
```



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ARRAYS BROKEN DOWN

In class Exercise 1:

Make an array of five numbers, add all the numbers together. (no loops just use the indexes of array)

Input = 5, 1, 22, 4, 3

Output = 35



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ARRAYS AND LOOPS



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ARRAYS AND LOOPS

- For loops and arrays are best friend
- Why do you think this is?



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ARRAYS AND LOOPS

- For loops and arrays are best friend because when we loop over an array, we can use the counter in our for loops to track the index of the array. This is why for loops in C# auto populate “i” which is short for index



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ARRAY LENGTH PROPERTY

In C# there is an `array.Length` property. This allows you to calculate the size of an array.



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ARRAYS AND LOOPS

In Class Exercise 1:

Create an array of 10 unique numbers from 0 - 20, count how many odd numbers, even numbers (that aren't zero) and zeros there are in the array.

Input = 1, 5, 8, 0, 19, 4, 6, 15, 10, 13

Output = “There are 5 odd, 4 even and 1 zero”



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ARRAYS AND LOOPS

Exercise 2:

Create an array of 100 random numbers, then calculate how many odd numbers, even numbers (even excluding 0) and zeros there are in the array.



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ARRAYS AND LOOPS

Exercise 3:

Use the same array in exercise 2 to check for the largest number, smallest number, add the whole array together, and find the average.



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MULTIDIMENSIONAL ARRAYS



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MULTIDIMENSIONAL ARRAYS

- A multidimensional arrays are arrays in an array.
- A great example of this is an array of strings.



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MULTIDIMENSIONAL ARRAYS

This is an example of an array of strings

```
string[] months = { "Jan", "Feb", "Mar", "April", "May", "June", "July", "Aug", "Sept", "Oct",  
"Nov", "Dec", };
```

```
MessageBox.Show(months[1][1].ToString());
```



ARRAY

Exercise 3:

Create a program that has an array of names when the user enters a name, the program calculates how many times the name is repeated.

Ex. John is input

The output will be:

Name John:2 times

If there is only one name you will have to output:

Name John: 1 time



ARRAY

Exercise 4

Convert a string to camel case:

Input = “Be kind to people”

Output = “beKindToPeople”

Look up:

1. Split()
2. Substring()
3. ToUpper()
4. ToLower()
5. Join()



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SUBPROGRAMS



SUBPROGRAMS

- Modular Programming is a software design technique where you break each part of a program into individual separate modules.
- Subprograms (also known as procedures, methods subroutine and functions) are blocks of code set aside in a reusable bundle.
- You have already been using subprograms in this course. These are built in functions.
- There are three basic types of subprograms:
 1. Predefined
 2. Event driven (While these are still predefined, this can be considered a separate type of predefined)
 3. User Defined /Programmer Defined



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SUBPROGRAMS PREDEFINED



SUBPROGRAMS – PREDEFINED

- Predefined subprograms are procedures that come with our language or from a library.
- Predefined subprograms are subprograms written by other programmers.
- Some examples are:
 - Join()
 - Substring()
 - ToString()



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SUBPROGRAMS PREDEFINED EVENTS

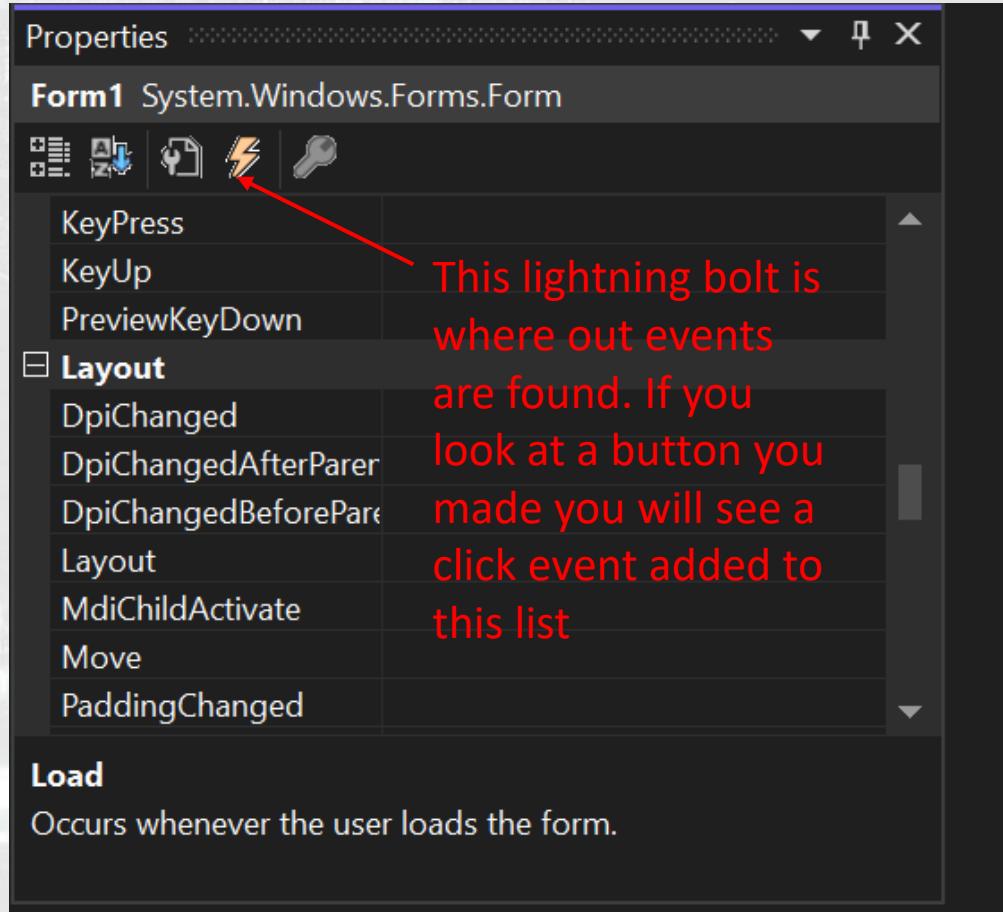


SUBPROGRAMS – PREDEFINED EVENT

- Event subprograms are procedures that allow us to interact with the environment.
- These are common events:
 - Mouse
 - Keyboard
 - Window
 - Input
- There are more you can see in windows forms on the next page:



SUBPROGRAMS – PREDEFINED EVENT





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SUBPROGRAMS

USER DEFINED



SUBPROGRAMS – USER DEFINED

- User defined subprograms are the procedures that we will be focusing on for this portion of the course.
- User defined subprograms at the base level are just code blocks we may want to repeat.
- Think about how tedious it would be if every time we wanted to convert a number to a string, we had to write out the code to do this.



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SUBPROGRAMS

- There are two types of subprograms
 1. Subprograms that return a value
 2. Subprograms that don't return a value



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C# METHODS



C# METHOD WITH NO RETURN

- A method with no return is a block of code that we can use over and over in different places.
- A method with no return would be used for something like drawing a Circle, Printing data to the console. There is no data that is passed from the subroutine back into our main program.



C# METHOD WITH NO RETURN

2 references

```
void MyMethod()  
{ This method is void and returns nothing  
    richTextBox1.Text += "Hello, Method!";  
}
```

This is a method
called MyMethod(),
I gave it that name.

1 reference

```
private void Form1_Load(object sender, EventArgs e)  
{  
    MyMethod();  
}
```

I have “Called” MyMethod
on form load

1 reference

```
private void button1_Click(object sender, EventArgs e)  
{  
    MyMethod();  
}
```

I have “Called”
MyMethod on
Button Click



C# METHOD WITH NO RETURN

- When we “Call” a function this means we are going to be running it on that specific line.
- This function will run twice, Once on the form load, and another time when I click the button.
- It will add to the previous data in the RichTextBox.



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C# METHOD WITH NO RETURN

Subroutines:

Run Sub

Hello, Sub!

This ran on form load

Subroutines:

Run Sub

Hello, Sub! Hello, Sub!

This ran on the
button press and
added to the form
load run



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C#

PARAMETERS AND ARGUMENTS



C# PARAMETERS AND ARGUMENTS

- What if we want to change the value of our “Hello, Method!” ?
- What is we want to use the same function to write “Hello, Form Load!” and “Hello, Button Click!”
- How do you think we can do that?



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C# PARAMETERS AND ARGUMENTS

- We can input different data into our subroutines by defining parameters and inputting arguments.
- Parameters are variables we define so we can pass data into the function
- Arguments are what we define when we call the subroutine.



C# PARAMETERS AND ARGUMENTS

2 references

```
void MyMethod(string place)  
{  
    richTextBox1.Text += $"Hello, {place}!\n";  
}
```

This is a parameter

1 reference

```
private void Form1_Load(object sender, EventArgs e)  
{  
    MyMethod("Form Load");  
}
```

These are
arguments

1 reference

```
private void button1_Click(object sender, EventArgs e)  
{  
    MyMethod("Button");  
}
```



C# PARAMETERS AND ARGUMENTS

- Exercise 1:
- Make a subroutine called sum that has two integer parameters, add the two integers together and print to a RichTextBox
- Call the subroutine on the form load and a button click and fill in the arguments
- Input form load= 10, 5
- Output = “Form load sum arguments $10 + 5 = 15$ ”
- Input button click = 55, 20
- Output = “Button click arguments $55 + 20 = 75$ ”



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C# PARAMETERS AND ARGUMENTS

- Exercise 2:
- Make the product (multiplication), quotient (division) and difference (Subtraction) Subroutines just like sum and add them to the form load and button click
- Input form load = 10, 5
- Output = "Form load product arguments $10 * 5 = 50$ "
- Input button click = 55, 20
- Output = "Button click product arguments $55 * 20 = 1100$ "
- Input form load = 10, 5
- Output = "Form load quotient arguments $10 / 5 = 2$ "
- Input button click = 20, 55
- Output = "Button click quotient arguments $55 / 20 = 1100$ "
- Input form load = 10, 5
- Output = "Form load difference arguments $10 - 5 = 5$ "
- Input button click = 20, 55
- Output = "Button click difference arguments $55 - 20 = 2.75$ "



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C# SCOPE



C# SCOPE

- What is scope?
- Scope can be thought of as what can be seen and accessed in specific locations.
- When we refer to scope in programming, we are referring to the level of access a variable or function has.
- Some levels of Scope:
 - Block
 - Function (procedural)
 - Module
 - Namespace
- Different names for variables based on scope
 - Global
 - Local
 - protected



C# SCOPE

- We can think about the level of access ability like Canadian politics.
- The Federal Government has influence over Provincial and municipal
- Provincial has influence over municipal but very little over Federal
- Municipal has influence over itself but has little say in Provincial or Federal affairs.



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C# SCOPE

3 Levels of Government

Federal

We elect Members of Parliament



Provincial

We elect Members of the Legislative Assembly



Municipal

We elect a Mayor and councilors



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C# SCOPE

- This is like scope. Global variable can influence everything which means that if we aren't careful, it can cause issues with what goes on locally. Local variables can influence very little outside of its own locality.
- Local variables are generally a better choice.



C# SCOPE

```
int myModularVar = 100; This is a Modular scope it can be
1 reference accessed anywhere in the class
private void Form1_Load(object sender, EventArgs e)
{
    int myFunctionalVar = 555; This is procedural scope. It cannot be
    for (int block = 0; block < 10; block++)
    {
        richTextBox1.Text = block.ToString();
    }
    richTextBox1.Text = block.ToString(); accessed outside of the
} procedure it is in
1 reference loop
private void button1_Click(object sender, EventArgs e)
{
    richTextBox1.Text = myModularVar.ToString();
}
```

This is a Block scope. It can only be accessed in the current block like the for loop

This is a Modular scope in action



C# SCOPE

- Now it looks like the modular scope is the winner because it works, but that isn't the case.
- In some circumstances it is good, but its preferable to use a local variable. Here are some reasons
 - We prevent name conflict. You will notice that the for loops all come with index. This is a block variable so if there are no for loops inside our for loops, we can use the index name for all of our loops. In some languages we could be reassigning the variable which would cause even more issues.
 - It saves memory. When we use a variable in a function or block it releases the memory as soon as it is done. If we use a more global scope, it will keep the memory allocated till the program has stopped running .



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SUBROUTINES STACK



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SUBROUTINES - STACK

- What is stack?
- Stack is a place in RAM where data gets stored in contiguously. This means that we “stack” one piece of data on another.
- Think of a tennis ball tube or pringles.



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SUBROUTINES - STACK

- The first ball in is the last one out or the last one in is the first one out.
- (Last In First Out -> LIFO)
- This is stack memory. The first piece of data in is the last piece of data out.



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SUBROUTINES - STACK

- When we run a subroutine, it gets stored in stack memory, when the subroutine finishes, the memory is released.
- So, when you run a subprogram, it does take up memory, this can be useful. We can use a technique called recursion to take advantage of the data being stored, Which we will touch on later.
- It can also cause issues, and that is when we run out of stack space. This is called a Stack Overflow. It's like having too many tennis balls in a tube.



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C#

FUNCTIONS THAT RETURN



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C# - METHODS THAT RETURN

- What is the difference between Return and no return
- As we have seen, a Method can execute a process. But what if we wanted to keep and use that value? How can we do that?
- With functions!



C# - METHODS THAT RETURN

```
1 reference
int MyIntMethod(int x)
{
    return x * x;
}

1 reference
string MyStringMethod(string x)
{
    return $"Hello, {x}";
}

1 reference
double MyDoubleMethod(double x)
{
    return x * 5.99;
}

1 reference
private void Form1_Load(object sender, EventArgs e)
{
    int myReturnIntValue = MyIntMethod(55);
    string myReturnStringValue = MyStringMethod("World");
    double myReturnDoubleValue = MyDoubleMethod(8.5);
}
```

Here is the function that returns $x * x$

You have to return the data type the function will return

We can store the return value



C# - METHODS THAT RETURN

- Make a one function called arithmetic.
- Create three parameters
 1. Operator (string)
 2. Number1 (Integer)
 3. Number2 (Integer)
- Pass in (+ or - or * or /) as your string arguments and 2 numbers for integers, do the relevant arithmetic based on the operator input and return the value.
- Input = *, 5 , 10 --> Output = 50
- Input = +, 10, 55 --> Output = 65
- Input = -, 42, 2 --> Output = 40
- Input = /, 100, 20 --> Output = 5



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METHODS

EARLY RETURNS



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METHODS – EARLY RETURNS

- When using functions, you can only return once.
- This means that once you leave the function you can't go back.
- When you return and there is still code this is called an early return.



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METHODS – EARLY RETURNS

```
2 references
void Orders(string beverage)
{
    if (beverage == "coffee")
    {
        MessageBox.Show($"Here is your, {beverage}");
        return;
    }
    MessageBox.Show($"We only have Water");

}
1 reference
private void Form1_Load(object sender, EventArgs e)
{
    Orders("coffee");
}
1 reference
private void button1_Click(object sender, EventArgs e)
{
    Orders("tea");
}
```



METHODS – EARLY RETURNS

- This can be useful in events if the user doesn't input the correct data

```
Private Sub Button2_Click(sender As Object, e As EventArgs) Handles Button2.Click
    If TextBox1.Text = "" Then
        MessageBox.Show("Please input data into the text box")
        Return
    End If
    MessageBox.Show(TextBox1.Text)
End Sub
```



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METHOD EXERCISES



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METHODS

Exercise:

- Look back at the 100 random number array we made.
- Move the find largest, find smallest, sum, average, and the (even, odd, zero counter) into separate subprograms.



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METHODS

Exercise:

- Make a Mini-ATM.
- Using a function and subroutine, use the function to return the amount withdrawn as a messagebox. Use the subroutine to print the balance in a message box. Print the balance when after you withdraw
- Output is on the next page, but feel free to use your own design



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METHODS – ATM - 1

ATM:



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FUNCTIONS – ATM - 2

ATM:

You have \$10000 left

Check Balance

OK

Input Amount to Withdraw:

Withdraw

The screenshot shows a Windows-style application window titled "ATM". Inside, a message box displays the text "You have \$10000 left" with an "OK" button. Below it, there's a text input field labeled "Input Amount to Withdraw:" and a "Withdraw" button. On the left side of the main area, there's a "Check Balance" button.



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METHODS – ATM - 2

The image displays two side-by-side screenshots of an ATM user interface. Both screenshots show a top header with the word "ATM" and a "Check Balance" button. Below this, there is an input field labeled "Input Amount to Withdraw:" containing the value "100". In the first screenshot on the left, a blue-outlined "Withdraw" button is visible. A red callout box with an arrow points from this button to a modal dialog box. The dialog box contains the text "You have \$9900 left" and an "OK" button. In the second screenshot on the right, another blue-outlined "Withdraw" button is visible. A red callout box with an arrow points from this button to a modal dialog box. This dialog box contains the text "Here is your \$100" and an "OK" button.

ATM:

ATM:

Check Balance

Input Amount to Withdraw:
100

Withdraw

You have \$9900 left

OK

These happen successively after one button click

Check Balance

Input Amount to Withdraw:
100

Withdraw

Here is your \$100

OK



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METHODS

RECURSION



METHODS— RECURSION

- What is recursion?
- Functions can be used just like a loop:

```
2 references
int Recursion(int x)
{
    if (x == 10)
    {
        return x;
    }
    richTextBox1.Text += x.ToString() + ", ";
    return Recursion(x + 1);
}
1 reference
private void Form1_Load(object sender, EventArgs e)
{
    Recursion(0);
}
```



METHODS— RECURSION

- This as used in the example below is inefficient for just printing numbers because of 2 things:

```
2 references
int Recursion(int x)
{
    if (x == 10)
    {
        return x;
    }
    richTextBox1.Text += x.ToString() + ", ";
    return Recursion(x + 1);
}
1 reference
private void Form1_Load(object sender, EventArgs e)
{
    Recursion(0);
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```



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METHODS— RECURSION

1. The function looping into itself is slower than a regular iterative loop.
2. When we call a function, it uses up stack memory. For just printing something is a waste of space.



METHODS— RECURSION

- What looping in a function is good for, is when we have a problem that has similar sub problems.
- Take factorials
- $!5 = (1) * (2) * (3) * (4) * (5)$
- $!4 = (1) * (2) * (3) * (4)$
- $!3 = (1) * (2) * (3)$
- $!2 = (1) * (2)$
- $!1 = (1)$



METHODS— RECURSION

- $!5 = (1) * (2) * (3) * (4) * (5)$
- $!4 = (1) * (2) * (3) * (4)$
- $!3 = (1) * (2) * (3)$
- $!2 = (1) * (2)$
- $!1 = (1)$
- If I want to solve factorial 5, I must solve factorial 4, 3, 2 and 1 at the same time



METHODS— RECURSION

- $!5 = (1) * (2) * (3) * (4) * (5)$
- $!4 = (1) * (2) * (3) * (4)$
- $!3 = (1) * (2) * (3)$
- $!2 = (1) * (2)$
- $!1 = (1)$
- If I want to solve factorial 5, I must solve factorial 4 at the same time



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METHODS— RECURSION

- Factorials using iteration:
 - Make a loop to solve the factorial problem



METHODS— RECURSION

- Factorials using iteration:
 - Make a loop to solve the factorial problem

```
1 reference
int Recursion(int factorial)
{
    int products = 1;
    for (int i = 1; i <= factorial; i++)
    {
        products *= i;
    }
    return products;
}
1 reference
private void Form1_Load(object sender, EventArgs e)
{
    richTextBox1.Text = Recursion(5).ToString();
}
```



METHODS— RECURSION BROKEN DOWN

```
int Recursion1(int factorial)
{
    return factorial;
}
1 reference
int Recursion2(int factorial)
{
    return Recursion1(factorial * 1);
}
1 reference
int Recursion3(int factorial)
{
    return Recursion2(factorial * 2);
}
1 reference
int Recursion4(int factorial)
{
    return Recursion3(factorial * 3);
}
1 reference
int Recursion5(int factorial)
{
    return Recursion4(factorial * 4);
}
1 reference
private void Form1_Load(object sender, EventArgs e)
{
    richTextBox1.Text = Recursion5(5).ToString();
}
```

If we want to get factorial 6,
all we must do is multiply 6
by factorial 5



METHODS— RECURSION

- Factorials using Recursion:
 - Try to implement a single recursive function that calculates factorials

```
int Recursion(int factorial)
{
    if (factorial == 1)
    {
        return factorial;
    }
    return Recursion(factorial - 1) * factorial;
}
1 reference
private void Form1_Load(object sender, EventArgs e)
{
    richTextBox1.Text = Recursion(6).ToString();
}
```



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METHODS— RECURSION

- Exercise:
- Find the length of Collatz conjecture, otherwise known as $3n+1$
- Input = int lengthOf3nPlus1(6); Output = 9
- <https://www.dcode.fr/collatz-conjecture>



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METHODS— RECURSION

- Exercise:
- Power Function
- `int recursive_power(int method_base , int power = 2)`
- Input = `int recursive_power(7,3);` Output = 343



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METHODS— RECURSION

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METHODS— RECURSION

- Exercise:
- Find the length of Collatz conjecture, otherwise known as $3n+1$
- Input = `lengthOf3nPlus1(6);` Output = 9
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ARRAYS

OBJECT ARRAYS



ARRAYS OF OBJECTS

- So far, we have looked at arrays of primitive datatypes; Strings, characters and numbers
- How can we make more complex arrays?
- One way is by using arrays of objects
- Because windows forms comes with a library of objects, we can use these objects to build our array



ARRAYS OF OBJECTS

- We are going to be building an airline reservation system which will use a picture box array.
- In our airline reservation system, each seat will be represented by one of two images, when empty the image will have an empty seat, when full the image will have a reserved seat.



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OBJECT ARRAYS

PICTUREBOX (PB)



ARRAYS OF OBJECTS - PB

- First, we must figure out how to dynamically add our picture boxes
- A few steps to figure this out are:
 - Figure out how to instantiate a new object in C#
 - Add the properties when you instantiate the object
 - Figure out how to add a new object to the form dynamically
 - Hint
`(this.controls.someCoolFunctionThatAddsThingsToTheForm(ThingIWantToAdd))`
 - If you have issues, go to google and try to find how to add a picturebox into a windows form dynamically



ARRAYS OF OBJECTS - PB

```
PictureBox[,] economy = new PictureBox[10, 10];
1 reference
private void Form1_Load(object sender, EventArgs e)
{
    int xpos = 45;
    int ypos = 45;
    for (int i = 0; i < economy.GetLength(0); i++)
    {
        for (int j = 0; j < economy.GetLength(1); j++)
        {
            economy[i, j] = new PictureBox
            {
                Name = "pictureBox" + i.ToString(),
                Location = new Point(xpos, ypos),
                Size = new Size(43, 43),
                Visible = true,
                BackColor = Color.Black
            };
            this.Controls.Add(economy[i, j]);
            xpos += 45;
        }
        xpos = 45;
        ypos += 45;
    }
}
```

This is where we
are instantiating
the
PictureBoxObject



ARRAYS OF OBJECTS - PB

- Instantiation in a different way:

```
int xpos = 45;
int ypos = 45;
for (int i = 0; i < economy.GetLength(0); i++)
{
    for (int j = 0; j < economy.GetLength(1); j++)
    {
        economy[i, j] = new PictureBox();
        economy[i, j].Name = "picturebox" + i.ToString();
        economy[i, j].Location = new Point(xpos, ypos);
        economy[i, j].Size = new Size(43, 43);
        economy[i, j].Visible = true;
        this.Controls.Add(economy[i, j]);
        economy[i, j].BackColor = Color.Black;
        xpos += 45;
    }
    xpos = 45;
    ypos += 45;
}
```

This is where we
are instantiating
the
PictureBoxObject



ARRAYS OF OBJECTS - PB

- Adding a picture box:

```
int xpos = 45;
int ypos = 45;
for (int i = 0; i < economy.GetLength(0); i++)
{
    for (int j = 0; j < economy.GetLength(1); j++)
    {
        economy[i, j] = new PictureBox();
        economy[i, j].Name = "pictureBox" + i.ToString();
        economy[i, j].Location = new Point(xpos, ypos);
        economy[i, j].Size = new Size(43, 43);
        economy[i, j].Visible = true;
        this.Controls.Add(economy[i, j]);
        economy[i, j].BackColor = Color.Black;
        xpos += 45;
    }
    xpos = 45;
    ypos += 45;
}
```

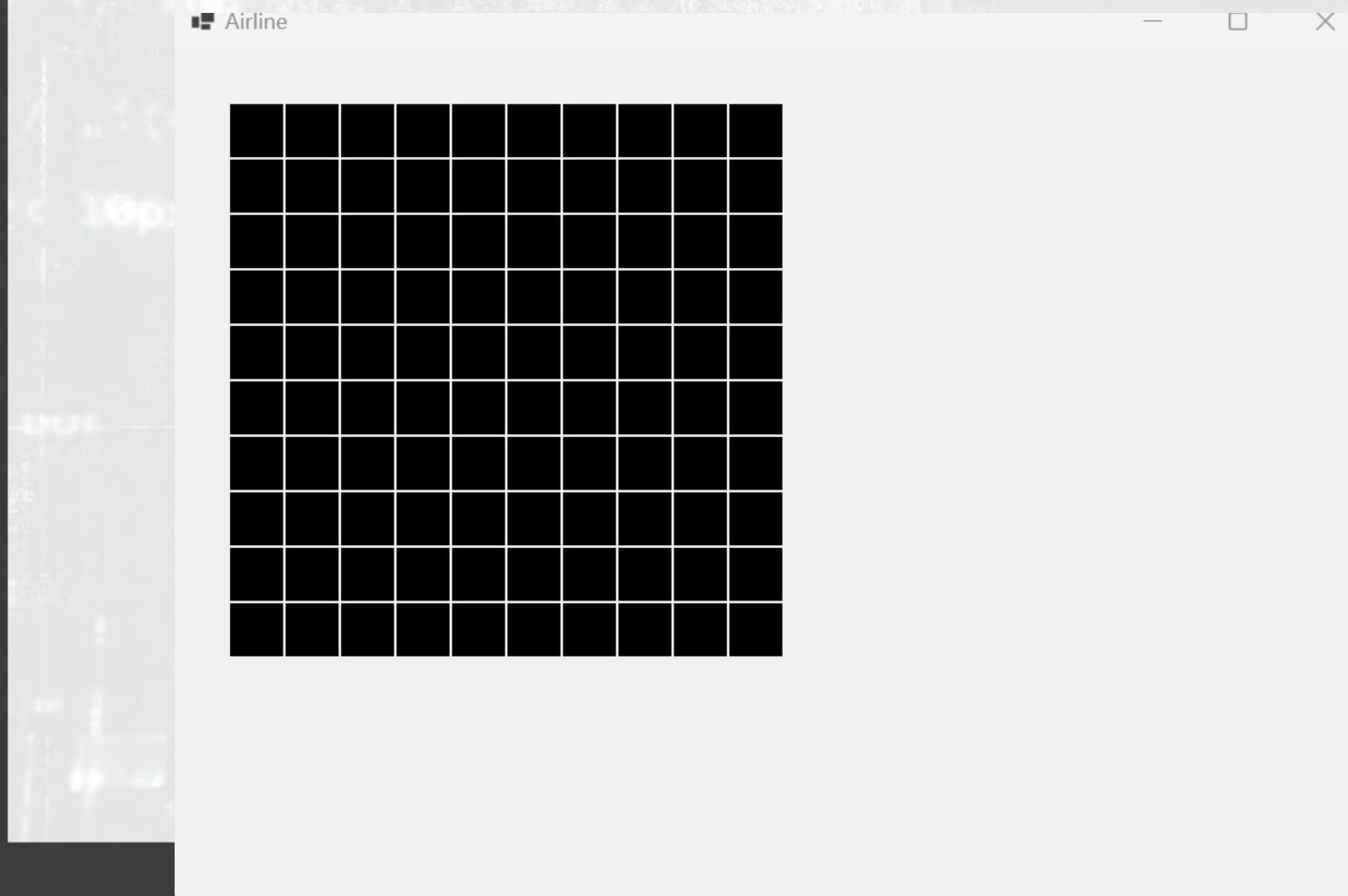
this is a reference to the
form1 class, to translate it
would be
form1.controls.Add(MyBox)
This adds MyBox to form1



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ARRAYS OF OBJECTS – PB OUTPUT





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ARRAYS OF OBJECTS - PB

- Now turn your picture box into an array of pictureboxes
- Make the array display as 4 by 5 on your form.
- Display the empty seat





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ARRAYS OF OBJECTS - PB

- Research how to add the AddHander, AddressOf, and the associated function.
- One event handler will work for all pictureboxes.
- Check that it works, click on a picture and have a message box pop up saying “It works!!”



ARRAYS OF OBJECTS - PB

1 reference

```
Private Sub PictureBoxClick(sender As Object, e As EventArgs)
    MessageBox.Show("It worked!")
End Sub
```

```
For index = 0 To 19
    BussinessClass(index) = New PictureBox() With {
        .ImageLocation = myImageLocationPrefix + EmptySeatImg,
        .Size = New Size(200, 200),
        .Location = New Point(xLocation, yLocation),
        .Name = "PictureBox" + index.ToString(),
        .Visible = True,
        .Enabled = True,
        .Cursor = Cursors.Hand
    }
    AddHandler BussinessClass(index).Click, AddressOf PictureBoxClick
    Me.Controls.Add(BussinessClass(index))
    xLocation += 210
    If (index + 1) Mod 4 = 0 Then
        xLocation = 10
        yLocation += 210
    End If
```

Next



ARRAYS OF OBJECTS - PB

- The sender parameter is the pictureBox object you clicked on being passed to the function, You can see this by changing the “It works!!” to sender.Name
- You can use the sender directly, but its easier to put it into a pictureBox variable. You’ll see the difference when you try to access the properties of the picture box using the sender vs the Picture box variable.



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ARRAYS OF OBJECTS - PB

- When the picture box is clicked on, change the seat from empty to full, then when it's clicked on again, change it from full to empty



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OBJECT ARRAYS NAMES



ARRAYS OF OBJECTS

- You will need an array of rich textboxes to display the names of the people who have booked the flight.
- Make a textbox to take in first name and last name.
- When the user clicks on a picture and the first and last name are not filled in, it will not allow them to make a reservation.
- When they input their names then click to submit, the names show up in the rich textbox



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ARRAYS OF OBJECTS

PictureBox

Input first name and last name

First Name First

Last Name Last

PictureBox

First name and last name go into the richtextbox

First Name First

Last Name Last

First Name First

Last Name Last

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ARRAYS OF OBJECTS

- Make a second array of 10 by 10 (100) for economy.
You can add this on a new.



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DATABASE CONNECTION



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DATABASE CONNECTIONS

- Make Entity Relationships
- Making the Connections



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BANK ENTITY RELATIONSHIPS



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ER DIAGRAM

- Make a Bank ER Diagram
- Include things like Branches, Customers, Accounts etc
- And think about the relationships between the entities



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SQL CLIENT



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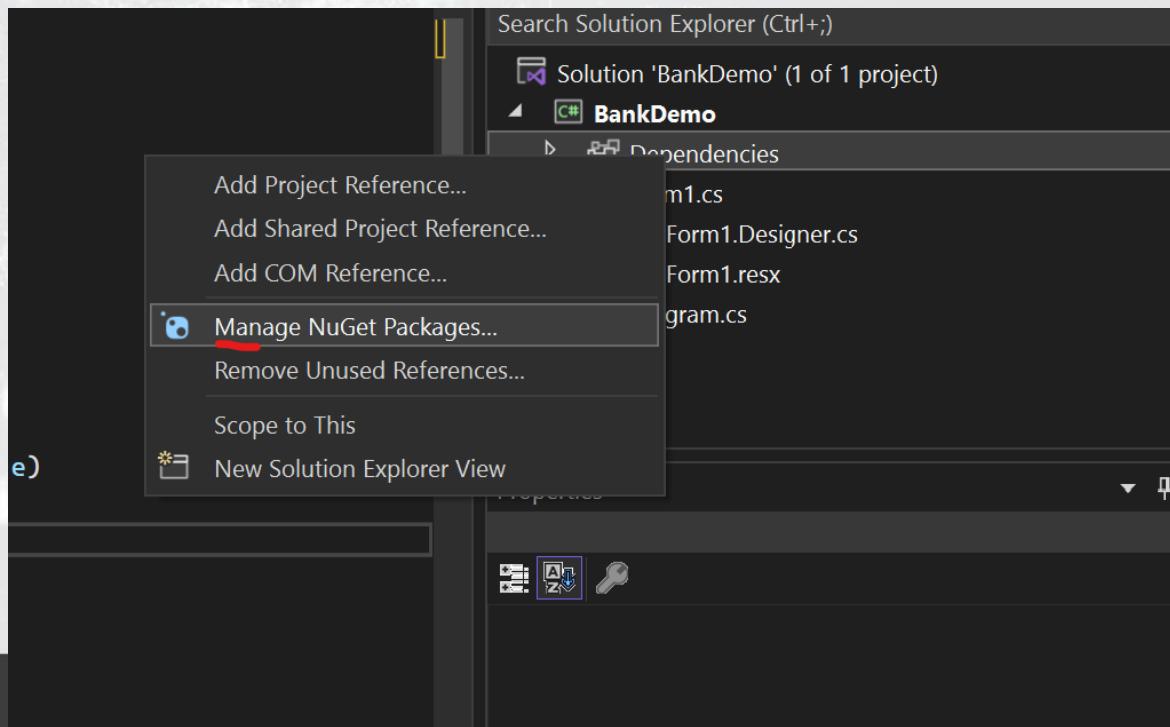
SQL CLIENT

- When you connect to a database you can use many different tools.
- We are going to connect to our database using SQLClient
- <https://learn.microsoft.com/en-us/dotnet/api/system.data.sqlclient.sqlconnection?view=dotnet-plat-ext-7.0>



INSTALLATION

- Make a new C# Windows form application called Bank
- Right click on dependencies and click Manage NuGet Packages...





INSTALLATION

- Under the brows tab search for sql client, then install

The screenshot shows the NuGet Package Manager interface for a project named 'BankDemo'. The 'Browse' tab is selected, and the search bar contains 'sql client'. The results list three packages:

- System.Data.SqlClient** by Microsoft, version 4.8.5. Description: Provides the data provider for SQL Server. These classes provide access to versions of SQL Server and e...
- Microsoft.Data.SqlClient** by Microsoft, version 5.1.0. Description: Provides the data provider for SQL Server. These classes provide access to versions of SQL Server and encaps...
- runtime.native.System.Data.SqlClient.sni** by Microsoft, version 4.7.0. Description: Internal implementation package not meant for direct consumption. Please do not reference directly.

On the right side, the details for the **System.Data.SqlClient** package are shown, indicating it is installed at version 4.8.5. It includes options to Uninstall or Update, and a link to the nuget.org page. The description notes that it provides the data provider for SQL Server and encapsulates database-specific protocols, including tabular data stream (TDS). Commonly used types listed include `System.Data.SqlClient.SqlConnection`, `System.Data.SqlClient.SqlException`, and `System.Data.SqlClient.SqlParameter`.



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ADD LOCAL DATABASE



LOCAL DB

Right click on Project

1) Add
2) Select New Item

Form2.cs [Design] Form1.cs Form1.cs [Design]

BankDemo

```
1  using System.Data.SqlClient;
2  using System.Data;
3  namespace BankDemo
4  {
5      public partial class Form1 : Form
6      {
7          SqlConnection connObj;
8
9          public Form1()
10         {
11             InitializeComponent();
12         }
13
14         private void Form1_Load(object sender, EventArgs e)
15         {
16             connObj = new SqlConnection("Data Source=.\MSSQL\BankDB");
17         }
18
19         private void Form2 se
20
21     }
```

Solution Explorer

- Build
- Rebuild
- Clean
- Analyze and Code Cleanup
- Pack
- Publish...
- Scope to This
- New Solution Explorer View
- File Nesting
- Edit Project File
- Add
 - New Item...
 - Existing Item...
 - New Folder
 - From Cookycutter...
 - Machine Learning Model...
 - Project Reference...
 - Shared Project Reference...
 - COM Reference...
 - Service Reference...
 - Connected Service...
- Manage NuGet Packages...
- Manage User Secrets
- Remove Unused References...
- Sync Namespaces
- Set as Startup Project
- Debug
- Cut
- Remove

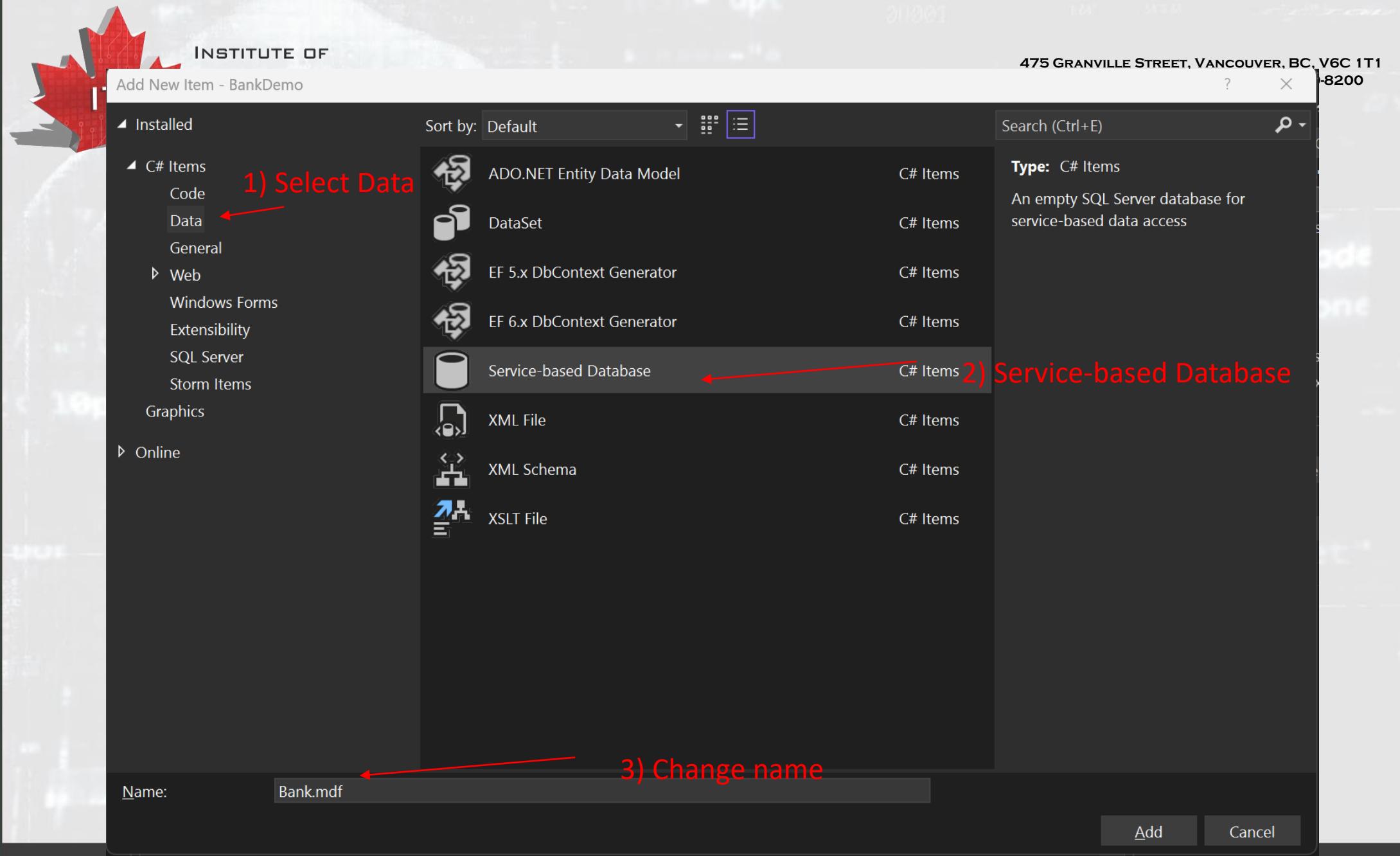
BankDemo (1 of 1 project)

BankDemo.csproj

C:\repos\Teaching\C#\Winter2023\B

C:\repos\Teaching\C#\Winter2023\B

Output





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LOCAL DB

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Solution Explorer

Search Solution Explorer (Ctrl+;)

Solution 'BankDemo' (1 of 1 project)

C# BankDemo

- Dependencies
- Bank.mdf ← You should see this in your solution
- Bank_log.ldf
- Form1.cs
- Form2.cs
- Form2.Designer.cs
- Form2.resx
- Program.cs



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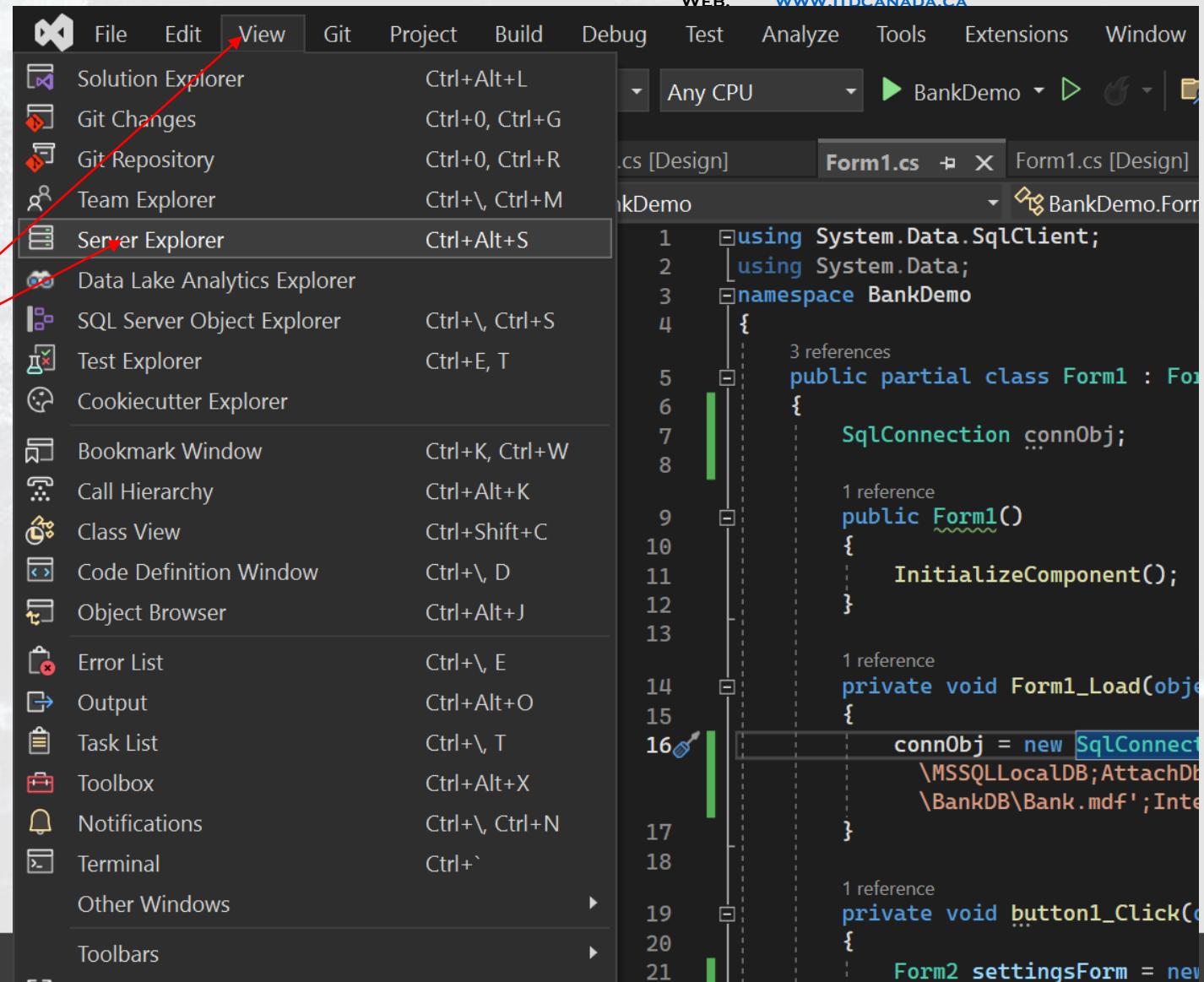
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ADD TABLES



ADD TABLES

- 1) View
- 2) Server Explorer



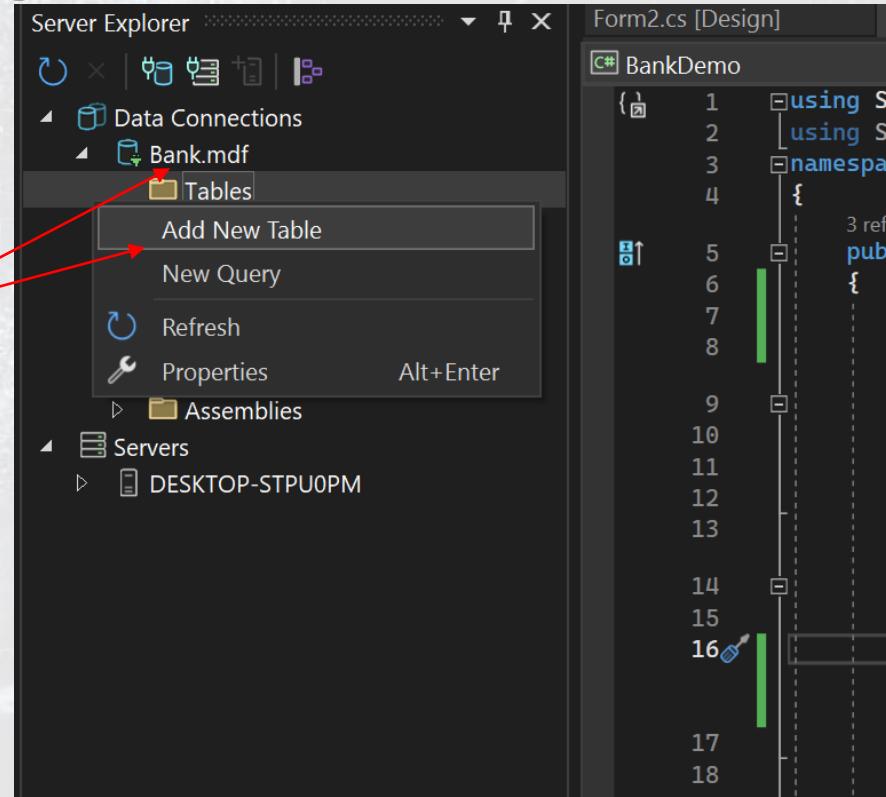
The screenshot shows the Microsoft Visual Studio interface. The 'View' menu is open, highlighting the 'Server Explorer' option. To the right, the code editor displays a C# file named 'Form1.cs' with the following content:

```
using System.Data.SqlClient;
using System.Data;
namespace BankDemo
{
    public partial class Form1 : Form
    {
        SqlConnection connObj;
        public Form1()
        {
            InitializeComponent();
        }
        private void Form1_Load(object sender, EventArgs e)
        {
            connObj = new SqlConnection("MSSQLLocalDB;AttachDbName='C:\BankDB\Bank.mdf';Integrated Security=True");
        }
        private void button1_Click(object sender, EventArgs e)
        {
            Form2 settingsForm = new Form2();
            settingsForm.Show();
        }
    }
}
```



ADD TABLES

- 1) Right click on tables
- 2) Add New Table





Name	Data Type	Allow Nulls	Default
CustomerId	int	<input type="checkbox"/>	
BranchID	int	<input checked="" type="checkbox"/>	
FirstName	varchar(50)	<input type="checkbox"/>	
LastName	varchar(50)	<input type="checkbox"/>	
DOB	date	<input type="checkbox"/>	
StreetNo	int	<input type="checkbox"/>	
StreetName	varchar(50)	<input type="checkbox"/>	
City	varchar(50)	<input type="checkbox"/>	
Province	varchar(50)	<input type="checkbox"/>	
PostalCode	varchar(6)	<input type="checkbox"/>	
Country	varchar(50)	<input type="checkbox"/>	
PhoneNo	varchar(50)	<input type="checkbox"/>	
Email	varchar(50)	<input type="checkbox"/>	
		<input type="checkbox"/>	

◀ Keys (1)

<unnamed> (Primary Key, Clustered: CustomerId)

Check Constraints (0)

Indexes (0)

Foreign Keys (0)

Triggers (0)

- 1) Change Table Name
- 2) Add fields above

Design T-SQL

```
1 CREATE TABLE [dbo].[Customer] (
2     [CustomerId] INT          IDENTITY (1, 1) NOT NULL,
3     [BranchID]   INT          NULL,
4     [FirstName]  VARCHAR (50) NOT NULL,
5     [LastName]   VARCHAR (50) NOT NULL,
6     [DOB]        DATE         NOT NULL,
7     [StreetNo]   INT          NOT NULL,
8     [StreetName] VARCHAR (50) NOT NULL,
9     [City]       VARCHAR (50) NOT NULL,
10    [Province]   VARCHAR (50) NOT NULL,
11    [PostalCode] VARCHAR (6)  NOT NULL,
12    [Country]    VARCHAR (50) NOT NULL,
13    [PhoneNo]    VARCHAR (50) NOT NULL,
14    [Email]      VARCHAR (50) NOT NULL,
15    PRIMARY KEY CLUSTERED ([CustomerId] ASC)
16 );
17 
```



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ADD TABLES

The screenshot shows the Microsoft SQL Server Management Studio (SSMS) interface. The title bar indicates the current database is 'master'. The main window displays the 'dbo.Customer [Design]' table. The table has five columns: 'Name', 'Data Type', 'Allow Nulls', and 'Default'. The rows contain the following data:

Name	Data Type	Allow Nulls	Default
CustomerId	int	<input type="checkbox"/>	
BranchID	int	<input checked="" type="checkbox"/>	
FirstName	varchar(50)	<input type="checkbox"/>	
LastName	varchar(50)	<input type="checkbox"/>	
DOB	date	<input type="checkbox"/>	

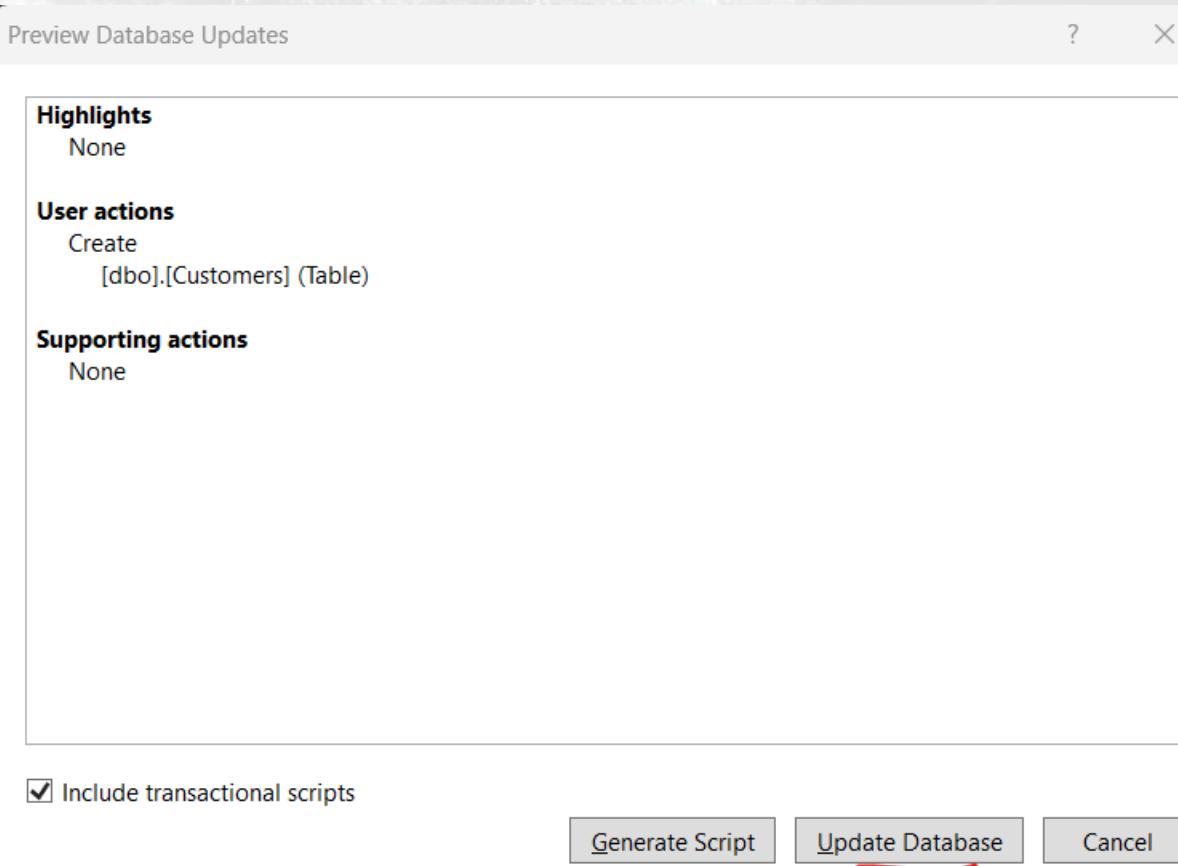


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ADD TABLES

Preview Database Updates





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DATABASE CONNECTION



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CONNECTING TO A DATABASE

- When connecting to a database from a front-end application there are two things to consider:
 1. How to connect to the database
 2. How to changing data in the database



MAKING THE CONNECTION

```
using System.Data.SqlClient;
using System.Data;
namespace BankDemo
{
    3 references
    public partial class Form1 : Form
    {
        SqlConnection connObj;
        1 reference
        public Form1()
        {
            InitializeComponent();
        }

        1 reference
        private void Form1_Load(object sender, EventArgs e)
        {
            connObj = new SqlConnection(@"Data Source=(LocalDB)
                \MSSQLLocalDB;AttachDbFilename='C:\repos\Teaching\C#\C# summer 2022\BankDB
                \BankDB\Bank.mdf';Integrated Security=True");
        }
    }
}
```

Add Using to access the SQL Client and Data libraries

Make a Variable for the connection object and instantiate on the form load

** you can make a global variable which can establish a single connection while the program is running or make a connection every time you do a CRUD



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SQLCLIENT OBJECTS



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SQL CLIENT OBJECTS

- The objects we are going to use are
- SqlConnection
- SqlCommand
- SqlDataAdapter
- DataTable
- SqlDataReader



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SQL CONNECTION



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MAKING THE CONNECTION

- SqlConnection is an object that takes in a Data string as the constructor.

```
connObj = new SqlConnection(@"Data Source=(LocalDB)
    \MSSQLLocalDB;AttachDbFilename=C:\repos\Teaching\C#\Winter2023\BankDemo\BankDemo
    \Bank.mdf;Integrated Security=True");
connObj.Open();
SqlCommand command = new SqlCommand("select * from Customers;", connObj);
```



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SQL COMMAND



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SQLDATADAPTER



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DATA TABLE



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DATA READER



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OBJECT ORIENTED PROGRAMMING



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OBJECT ORIENTED PROGRAMMING

- Topics Covered:

1. What is OOP
2. Why we use Object Oriented Programming
3. Objects In the real World
4. Four Fundamentals of OOP
5. Classes, Objects, Instantiation
6. Class Components
7. Object Composition



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WHAT IS OBJECT ORIENTED PROGRAMMING



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WHAT IS OOP?

- Object oriented programming is a design for programming.
- OOP allows us to make one template that creates similar objects
- OOP was created back in the 1950's, but wasn't popularized until the late 70's early 80's



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WHY OOP



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WHY OOP?

- Objects are made from a reusable template that allows us to organize our code
- OOP allows us to store objects in memory and use them in unique ways
- Instead of procedural programming, which breaks down tasks to smaller portions such as functions, We use building blocks to write code
- These building blocks are called objects
- Objects are created from templates we make
- The templates are called classes, which we will talk about later



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WHY OOP

- Can you use objects made in one language in another language?
- Yes!
- By using a DLL(Dynamic Link Library) you can make a class in Java and use it in Python or any OOP language into another.
- Windows Forms has objects that are both used in VB and C#.
- These are objects that are written C# but can be used in both languages.
- Database objects like from SQL Client can be used in many different languages



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REAL WORLD OBJECTS



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OBJECT IN THE REAL WORLD

- Objects in the real world have two things that define them
 1. They have properties
 2. They have functions
- Lets look at a phone



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PROPERTIES - PHONE

- A property for a phone can be things like:
 - Color
 - Brand
 - RAM
 - Camera
 - Apps



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FUNCTIONS

- Functions for a phone can be things like:
 - Texting
 - Calling
 - Connect to the Internet
 - Harvest your data
 - Take picture
 - Charge Battery



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OBJECT IN THE REAL WORLD

- Tell me About a restaurant...
- What are its Properties
- What are its Functions



OBJECT IN THE REAL WORLD

- Tell me About a restaurant...
- Properties: chairs, tables, cash register, menus, building, stove, lights, oven, equipment, website
- Functions: taking the orders, preparing the meal, deliver the meal, the payment process, Server customers, online order taker, food prep, create waste, create employment, buy materials, pay tax



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OBJECT IN THE REAL WORLD

- Tell me About a Dog:
- Properties: Tail, four legs, Nose, Eyes, Fur, Ears, Teeth, Body,
- Functions: Bark, sit, jump, wag tail, run, sleep, eat, play.



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DEPENDENCY PRINCIPAL

- Dependency Principal



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CLASSES INSTANTIATION AND OBJECTS



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CLASSES AND INSTANCE

- In OOP we can use classes as templates
- To make an object “come to life” it is called instantiation
- A class is abstract, intangible and has no real substance
- An object is real, physical and can be worked with



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CLASSES



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CLASSES

- Classes are templates for objects
- Classes are like a blueprint for a car. A car has specific properties and functions defined in the blueprint but the template is not the car itself.
- Classes are where we define properties and functions



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MAKING A CLASS



OOP

- Objects are held in a class
- Objects have two defining features:
 1. They have properties (Data Member Properties)
 2. They can do things (Member Function Methods)
- Data members are the variables for the class
- Member functions are the method for the class
- Both Data members and member functions have access modifiers which define the accessibility of the property/function
 - Public
 - Private



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STATIC MEMBERS

- If I make a variable in my class and change the variables value in the My first Object it will not affect the other objects
- The only time this is not true is when you are using static members
- Static members go out of scope



CONSTRUCTOR AND DESTRUCTOR

- We have two special functions
 1. Constructor(initializer)
 2. Destructor(finalizer)
- They run automatically
- We don't call these functions, they run at the time the object is created or destroyed
- We don't always need a destructor, but you always need a constructor
- As sad as it sounds you always have a day of your birth, but not everyone has a funeral
- In different languages they have different names



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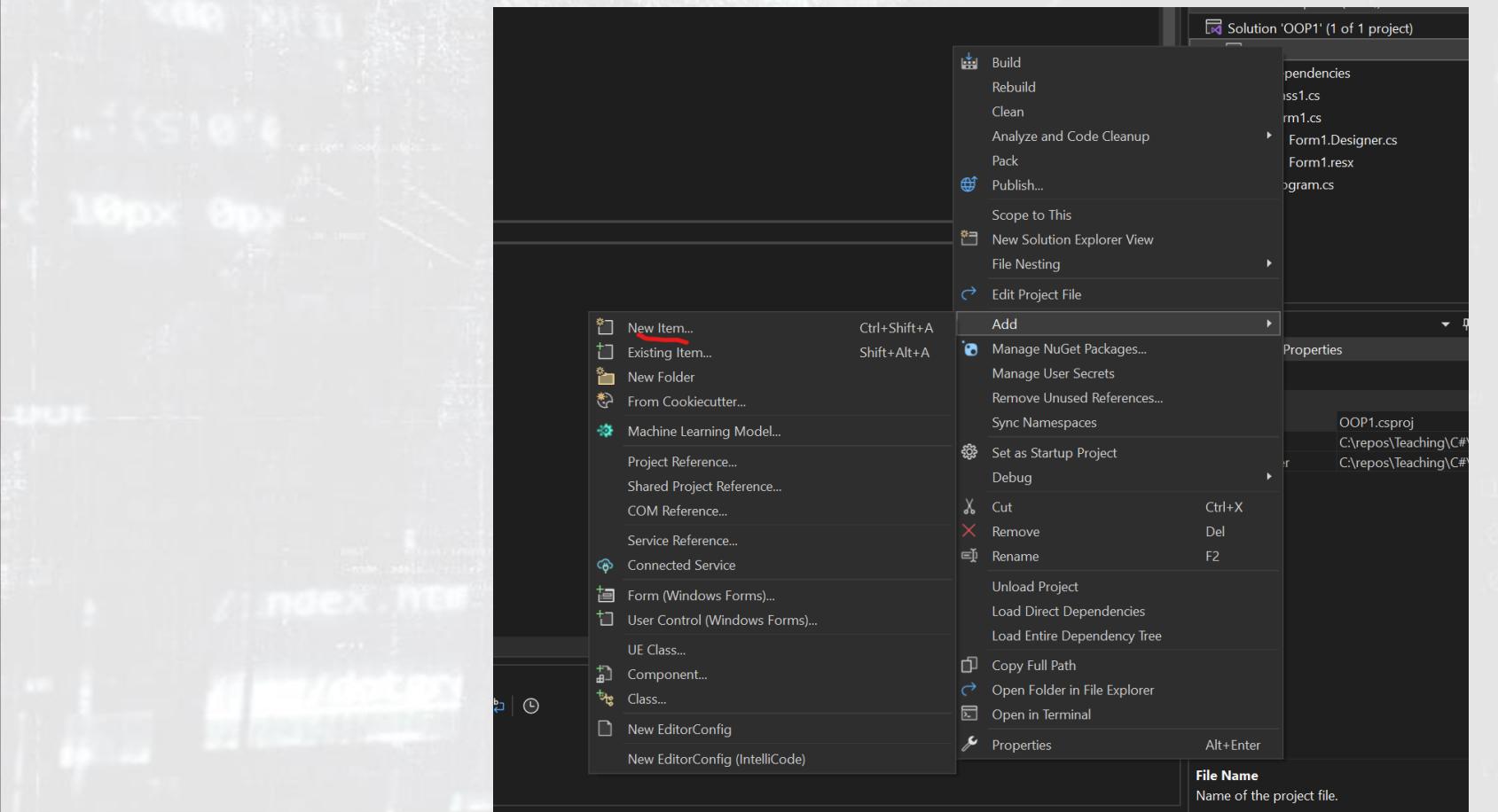
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ADDING CLASSES



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CLASSES



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CLASSES

Add New Item - OOP1

The screenshot shows the 'Add New Item' dialog in Visual Studio. The left sidebar lists categories: 'Installed' (C# Items: Code, Data, General; Web: Windows Forms, Extensibility, SQL Server, Storm Items; Graphics), 'Online' (Windows Forms, Extensibility, SQL Server, Storm Items). The main area is titled 'Choose class' and shows a list of C# items:

Item Type	Description	Count
C# Class	Class	C# Items
C# Class	Class for U-SQL	C# Items
Interface	Interface	C# Items
Form	Form (Windows Forms)	C# Items
User Control	User Control (Windows Forms)	C# Items
Component	Component Class	C# Items
About Box	About Box (Windows Forms)	C# Items
ADO.NET Entity Data Model	ADO.NET Entity Data Model	C# Items
File	Application Configuration File	C# Items
File	Application Manifest File (Windows Only)	C# Items
File	Assembly Information File	C# Items
Image	Bitmap File	C# Items
Code Analysis Rule Set	Code Analysis Rule Set	C# Items

At the bottom, the 'Name:' field contains 'Class2.cs' and the 'Change name' button is highlighted in red. The 'Add' and 'Cancel' buttons are also visible.



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00001

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CLASSES

The screenshot shows a code editor window with a dark theme. The code is written in C# and defines a class named 'Dog' within a namespace 'OOP1'. The code includes several 'using' statements at the top and a single-line comment '0 references' inside the namespace block.

```
{\` 1  \b[using System;\n 2  \b[using System.Collections.Generic;\n 3  \b[using System.Linq;\n 4  \b[using System.Text;\n 5  \b[using System.Threading.Tasks;\n\n 6\n 7  \b[namespace OOP1\n 8  {\n 9    \b[internal class Dog\n10   {\n11\n12  }\n13}
```



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INSTANTIATION

- Take a look at the Related Dog code for more details



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INSTANTIATION



INSTANTIATION

- Instantiation is the process of making or creating an object
- When you have finished making the blueprint of a car, you can make or *instantiate* the car in the factory
- When we instantiate or “create” an object, memory is allocated in RAM and all the data for the object is stored in memory
- Instantiation will allow our properties to be defined
- This would be like when you pick a color for a car, in the factory they make that car the color you picked



INSTANTIATION

```
1  namespace OOP1
2  {
3      public partial class Form1 : Form
4  {
5      public Form1()
6  {
7      InitializeComponent();
8  }
9
10     private void Form1_Load(object sender, EventArgs e)
11  {
12      Dog Sparky= new Dog("Sparky");
13      richTextBox1.Text = Sparky.Bark();
14  }
15  }
16 }
```



OOP IMPLEMENTATIONS

- Step 1:
 - Define your data members
- Step 2:
 - Default constructor 100% necessary
 - Optional: overloaded constructors, these are similar to default but they take arguments
 - Copy constructor takes one argument from its own type; this is for when you create an object from already existing objects(you build an object from an existing one)
- Step 3:
 - Develop your access functions (Sets and gets)
- Sept 4:
 - Develop your Utility functions, sometimes called helper functions, that do things to data members
- Step 5:
 - Instantiate



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OOP

- Assignment
- Make a Class Called My Date
- With data members Day Month Year
- Methods CheckDay(), CheckMonth(), IsLeap()



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OOP

- Assignment
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FOUR FUNDAMENTALS OF OOP



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FOUR FUNDAMENTALS OF OOP

- The Four Fundamentals of OOP are:
 1. Abstraction
 2. Inheritance
 3. Encapsulation
 4. Polymorphism



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ENCAPSULATION



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ENCAPSULATION

- Encapsulation is the containment of our data members and member functions in a class.
- We use encapsulation to make our software more manageable, reduce bugs, and organize our code
- Think about medicine or fish oil. They are put into capsules to prevent the compounds from being mixed together. This is what encapsulation does.
- Encapsulation is a product of using classes





ENCAPSULATION VS DATA HIDING

- Encapsulation it is commonly thought to be the process of “Data or Information Hiding”, but that is a common misconception. Data hiding is a feature of encapsulation but you can encapsulate without hiding data
- Think about the fish oil capsule. You can see the fish oil, so it is not hidden but it is still encapsulated



DATA HIDING

- Data hiding is where we set the level of accessibility an objects properties and functions have.
- You as a human have an age, I can't change your age or even know your age without the proper security clearance. This is an encapsulated property you have that is hidden from the world.
- A game enemy has a numerical location. As the player you cannot see the enemy numerical location. This data is hidden.



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TAKE AWAYS FROM ENCAPSULATION

- Encapsulation keeps data member and member functions together
- Encapsulation is not data hiding
- Data hiding is a feature of encapsulation
- Encapsulation helps organize code to prevent bugs and increase manageability



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ABSTRACTION



ABSTRACTION

- Abstraction is the process of abstracting processes from users.
- Abstraction hides processes and implementations
- Abstraction keeps what isn't important to the users abstracted away from them.
- It allows users to use the interface vs having to understand how the interface works.
- You don't need to know how a combustion engine works to drive a car. The engine is abstracted away from the driver.



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ABSTRACTION

- With abstraction its better to have a simple interface with high abstraction vs a complex interface with minimal abstraction.
- Google search has a lot going on behind the scenes. But we only see a search bar and a few buttons



ABSTRACTION

- Abstraction is a design concept and a process of implementation
- There are abstract classes that we can use that can not be instantiated and are used as high level classes which many other classes are inherited from



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TAKE AWAYS FROM ABSTRACTION

- Abstraction hides implementation from the end user
- Abstraction is different than Data hiding



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ABSTRACTION VS ENCAPSULATION

- <http://www.tonymarston.co.uk/php-mysql/abstraction.txt>



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SETTERS AND GETTERS



GETTERS AND SETTERS

- When we encapsulate and make data members private, the objects data members can't be accessed from the outside of the object.
- By using getters and setters the object can have its data modified. Think about `Textbox1.text`. The `.text` is a getter and setter that allows us to change or get the text value of a `Textbox`.
- Getters get data from the object
- Setters set data in the object
- Getters are also known as Accessors
- Setters are also known as Mutators



GETTERS AND SETTERS

- Getters and Setters are a feature of abstraction and encapsulation.
(depending who you ask)
- When we encapsulate and make data members private, the objects data members can't be accessed from the outside of the object.
- We could make the data members public but this reduces data integrity
- Getters and setters allow us to get information from the user and process the data without expectations from the user
- Let say you want to get some data from a user about their age and they input their age as -1 or 500 that could cause issues. When we use getters and setters we can process the data based on the parameters we define



GETTERS AND SETTERS

- Should we use Getters and Setters?
- Getters and setters technically break encapsulation.
- Its like taking a tiny needle and extracting some of the fish oil from our fish oil capsule.
- Generally speaking its good to use them, but be mindful with them
- Don't make give every data member a getter and setter. This can cause vulnerabilities in you objects.
- Getters can expose the data you want to hide
- Setters can have unwanted data injections into them
- Do the logic for your user, make your functions work for them vs having them doing the work for you



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INHERITANCE AND COMPOSITION



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REUSABILITY

- When we are making an OOP project there are two ways we can reuse our code
 - 1) Inheritance
 - 2) Object Composition



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INHERITANCE



INHERITANCE

- Inheritance is done when we have one class that gives some of its properties and functions to another class
- Think about the dog class we made. The dog class is an animal. All animals have some similar characteristics, they eat, sleep, age, etc....



INHERITANCE

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INHERITANCE

- The way a class inherits from another is by using a colon

```
internal class Dog : Animal
```



INHERITANCE

- One of the challenges when making an inherited class is accessing the data members
- That is why instead of using a public access modifier, we can use protected.
- Protected can make a data members accessible to the children classes.



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INHERITANCE

- Make an animal class that gives its properties to a dog and cat class



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OBJECT COMPOSITION



OBJECT COMPOSITION

- Object composition is when you instantiate an object in another object
- Object composition is useful if you want to use characteristics from another object.
- Think about a customer and employee. Both of these have names, addresses, DOB
- By using an object that defines these general characteristics you can make



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OBJECT COMPOSITION

- Make a person class with properties that can be used for employees



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POLYMORPHISM



POLYMORPHISM(MORE THEN ONE SHAPE)

- Polymorphism broken down means:
- Poly is many
- Morph (as suffix) is to have a specified form
- Polymorphism is to have many forms
- We can create similar yet different objects



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POLYMORPHISM(MORE THEN ONE SHAPE)

- Animals are a great example
- All the animals can eat, but they don't eat the same things. We can use polymorphism to make an eat function, but give each animal different food



POLYMORPHISM – DYNAMIC BINDING

- Static binding is when an object function is defined when we compile.
- Dynamic binding is when an object function is defined at runtime
- This allows us to use superclasses as a type, rather than a predefined type



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