More Language Features and Windows Forms

C# Programming

January 12
Part I

Some Language Features
Inheritance

- To extend a class A: `class B : A { ... }`
- B inherits all instance variables and methods of A
- Which ones it can access depends on the visibility levels
- Unlike in Java, method overriding is explicit
- To allow a method to be overridden, define the method as `virtual` in the base class
- To override the method, define the method as `override` in the derived class
- To `hide` a function of the base class, define the method as `new` in the derived class

In the following examples,

```
A a = new A();
B b = new B();
```
class A {
    ...
    public string m1() { return "a1"; }  
    ...
}

class B {
    ...
}

b.m1(); // "a1"

• B has inherited the method m1 from A
Inheritance

class A {
    ...
    public virtual string m2() { return "a2"; }
    ...
}
class B {
    ...
}

b.m2(); // "a2"

- Even though m1 is defined to be virtual, since B does not override it, the definition in A gets executed
class A {
    ...
    public virtual string m3() { return "a3"; }
    ...
}

class B {
    ...
    public override string m3() { return "b3"; }
    ...
}

b.m3(); // "b3"

- B has overridden m3, so its execution is dynamically dispatched
Inheritance

class A {
    ...
    public string m4() { return "a4"; }
    ...
}
class B {
    ...
    public new string m4() { return "b4"; }
    ...
}

b.m4(); // "b4"

- B has hidden A’s definition of m1 (but this is not dynamic dispatch)
Inheritance

- m4 is **statically dispatched**
- ((A)b).m4(); // "a4"

- On the other hand...
- ((A)b).m3(); // "b3"
- ...since b’s type at runtime is B
Inheritance

• To require that a subclass provide an implementation for a method, declare it as `abstract`

• An abstract method declaration does not provide an implementation, just the method signature

• A class with one or more abstract methods must be declared `abstract` and cannot be instantiated

• To prevent a class from being extended, mark the class as `sealed` (like a final class in Java)
Interfaces

- An interface is a collection of abstract definitions, of events, methods, properties, and indexers (we won’t talk about indexers)

```csharp
interface IGoo {
    string Text {
        get;
        set;
    }
    void PrintText();
}
```
Interfaces

• An implementing class would be declared
class MyGoo : IGoo { ... }

• MyGoo would need to provide concrete definitions for all
  abstract members defined in IGoo

• A class can implement multiple interfaces
Arrays

- As in Java, arrays are reference types

- `int[] arr1 = new int[5];`
- `arr1.Length` is 5

- Possible ways to initialize:
  - `int[] arr1 = new int[5]{ 1, 2, 3, 4, 5 };`
  - `int[] arr1 = new int[]{ 1, 2, 3, 4, 5 };`
  - `int[] arr1 = { 1, 2, 3, 4, 5 };`
Multidimensional Arrays

• Unlike Java, there is a syntactical difference between rectangular arrays and jagged arrays
Rectangular Arrays

- `int[,] arr2 = new int[3,2];`
- `arr2.Length` is 6
- `arr2.GetLength(0)` is 3
- `arr2.GetLength(1)` is 2

- Possible way to initialize:
  - `int[,] arr2 = { { 1, 2 }, { 3, 4 }, { 5, 6 } };`
Jagged Arrays

- int[][] arr3 = int[3][];
- arr3[0] = new int[1];
- arr3[1] = new int[4];
- arr3[2] = new int[2];
- arr3.Length is 3
- arr3[0].Length is 1
- arr3[1].Length is 4
- arr3[2].Length is 2
Jagged Arrays

- Possible way to initialize:

```java
int[][] arr3 = new int[][] {
    new int[] { 1 },
    new int[] { 1, 2, 3, 4 },
    new int[] { 1, 2 } 
};
```
Boxing / Unboxing

- **Boxing** is supplying a value type where a reference type is expected
- Boxing is implicit in C#

  ```csharp
  object o = 5;
  ```

- **Unboxing** is supplying a reference type where a value type is expected
- Unboxing must be explicit in C#

  ```csharp
  int i = (int)o;
  ```
Parsing Numbers

- To parse a string into an integer:
  ```csharp
  int i = Int32.Parse("13");
  ```
- Parsing other types of numbers is similar
- `Int32.Parse` can throw a `System.FormatException`
Exception Handling Example

```csharp
int i;
try
{
    i = Int32.Parse("1a3");
}
catch (FormatException)
{
    Console.WriteLine("Error parsing");
    i = -1;
}
```
Part II

Event Arguments
Event Arguments

- When an object raises an event, it can send arguments along with it
- From looking at the event handlers that get attached to control events, we see that these events get packaged with two arguments
  - `object sender` – a reference to the control that fired the event
  - `EventArgs e` – or a subclass of `EventArgs` depending on the type of event
MouseDown Arguments

• As an example, let’s look at some of the information that is contained in e when the MouseDown event is fired

• We notice two properties, X and Y that represent the coordinates of the cursor when the mouse was clicked

```csharp
void Form1_MouseDown(object sender, MouseEventArgs e) {
    label1.Text =
        e.X.ToString() + ""," + e.Y.ToString();
}
```
Part III

Custom Controls
Custom Controls

- Here is a short demonstration of how to define a custom control
- Create a **Windows Control Library** project
• Choose an existing control class to extend
• Define the custom behavior

```csharp
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Drawing;
using System.Data;
using System.Text;
using System.Windows.Forms;
	namespace CustomCalcButton
{
    public partial class CustomCalcButton : Button
    {
        public CustomCalcButton()
        {
            InitializeComponent();
            this.Click += new EventHandler(CustomCalcButton_Click);
        }

        void CustomCalcButton_Click(object sender, EventArgs e)
        {
            MessageBox.Show("custom control!");
        }
    }
}
To use this from a Windows Forms application, you need to add a reference to the compiled .dll from your custom control project.
Or if you want to be able to drag-and-drop your custom control from the Toolbox, add your control to it.
Part IV

Maintaining State
Maintaining State

• It is a good idea to maintain a state variable
• What should the type of this be?
• A good option is to define an `enum` whose values are all possible states your application can be in
• The state variable can be an instance of this `enum`
• Code to update the GUI can perform a `switch` on the state variable
A trivial example

- Consider a simple application to model a traffic light
- The empty form’s background color changes from red to green to yellow according to a fixed timer
- We start by defining the states of the application, and an instance variable to hold the current state:

```csharp
public partial class Form1 : Form {
    public enum State { RED, GREEN, YELLOW }
    private State state = State.RED;
    ...
}
```

- Now we define a method to transition from state to state...
private void ChangeColor() {
    switch (this.state) {
    case State.RED:
        this.BackColor = Color.Green;
        this.state = State.GREEN;
        break;
    case State.YELLOW:
        this.BackColor = Color.Red;
        this.state = State.RED;
        break;
    case State.GREEN:
        this.BackColor = Color.Yellow;
        this.state = State.YELLOW;
        break;
    }
}
• And finally create a timer to drive state transitions

```csharp
public Form1() {
    InitializeComponent();
    Timer timer1 = new Timer();
timer1.Interval = 2000;
timer1.Tick += new EventHandler(timer1_Tick);
timer1.Start();
}

void timer1_Tick(object sender, EventArgs e) {
    ChangeColor();
}
```
Maintaining State

- Since this is such a simple example, it is hardly worth the effort to explicitly define each state in an enum.
- For applications that can be in several complicated states, however, organizing the GUI update logic in this manner can be very useful.
- Also note that since the logic for updating the GUI (changing from red to green to yellow) would be the same no matter how we chose to “run” the traffic light, we placed that logic in a separate function.
- If we wanted to change the application so that, say, a user clicked a button to change the state of the traffic light color, we would only have to make a call to ChangeColor() in the button’s event handler (instead of having to copy-and-paste the color update logic).