Chapter 7

XAML vs. code

C# is undoubtedly one of the greatest programming languages the world has ever seen. You can write entire Xamarin.Forms applications in C#, and it’s conceivable that you’ve found C# to be so ideally suited for Xamarin.Forms that you haven’t even considered using anything else.

But keep an open mind. Xamarin.Forms provides an alternative to C# that has some distinct advantages for certain aspects of program development. This alternative is XAML (pronounced "zammel"), which stands for the Extensible Application Markup Language. Like C#, XAML was developed at Microsoft Corporation, and it is only a few years younger than C#.

As its name suggests, XAML adheres to the syntax of XML, the Extensible Markup Language. This book assumes that you have familiarity with the basic concepts and syntax of XML.

In the most general sense, XAML is a declarative markup language used for instantiating and initializing objects. That definition might seem excessively general, and XAML is indeed quite flexible. But most real-world XAML has been used for defining tree-structured visual user interfaces characteristic of graphical programming environments. The history of XAML-based user interfaces begins with the Windows Presentation Foundation (WPF) and continues with Silverlight, Windows Phone 7 and 8, and Windows 8 and 10. Each of these XAML implementations supports a somewhat different set of visual elements defined by the particular platform. Likewise, the XAML implementation in Xamarin.Forms supports the visual elements defined by Xamarin.Forms, such as `Label`, `BoxView`, `Frame`, `Button`, `StackLayout`, and `ContentPage`.

As you've seen, a Xamarin.Forms application written entirely in code generally defines the initial appearance of its user interface in the constructor of a class that derives from `ContentPage`. If you choose to use XAML, the markup generally replaces this constructor code. You will find that XAML provides a more succinct and elegant definition of the user interface and has a visual structure that better mimics the tree organization of the visual elements on the page.

XAML is also generally easier to maintain and modify than equivalent code. Because XAML is XML, it is also potentially toolable: XAML can more easily be parsed and edited by software tools than the equivalent C# code. Indeed, an early impetus behind XAML was to facilitate a collaboration between programmers and designers: Designers can use design tools that generate XAML, while programmers focus on the code that interacts with the markup. While this vision has perhaps only rarely been fulfilled to perfection, it certainly suggests how applications can be structured to accommodate XAML. You use XAML for the visuals and code for the underlying logic.

Yet, XAML goes beyond that simple division of labor. As you’ll see in a future chapter, it’s possible to define bindings right in the XAML that link user-interface objects with underlying data.

When creating XAML for Microsoft platforms, some developers use interactive design tools such as Microsoft Blend, but many others prefer to handwrite XAML. No design tools are available for Xamarin.Forms, so handwriting is the only option. Obviously, all the XAML examples in this book are handwritten. But even when design tools are available, the ability to handwrite XAML is an important skill.

The prospect of handwriting XAML might cause some consternation among developers for another reason: XML is notoriously verbose. Yet, you'll see almost immediately that XAML is often more concise than the equivalent C# code. The real power of XAML becomes evident only incrementally, however, and won't be fully apparent until Chapter 19, "Collection views," when you use XAML for constructing templates for multiple items displayed in a `ListView`.

It is natural for programmers who prefer strongly typed languages such as C# to be skeptical of a markup language where everything is a text string. But you'll see shortly how XAML is a very strict analog of programming code. Much of what's allowed in your XAML files is defined by the classes and properties that make up the Xamarin.Forms application programming interface. For this reason, you might even begin to think of XAML as a "strongly typed" markup language. The XAML parser does its job in a very mechanical manner based on the underlying API infrastructure. One of the objectives of this chapter and the next is to demystify XAML and illuminate what happens when the XAML is parsed.

Yet, code and markup are very different: Code defines a process while markup defines a state. XAML has several deficiencies that are intrinsic to markup languages: XAML has no loops, no flow control, no algebraic calculation syntax, and no event handlers. However, XAML defines several features that help compensate for some of these deficiencies. You'll see many of these features in future chapters.

If you do not want to use XAML, you don't need to. Anything that can be done in XAML can be done in C#. But watch out: Sometimes developers get a little taste of XAML and get carried away and try to do everything in XAML! As usual, the best rule is "moderation in all things." Many of the best techniques involve combining code and XAML in interactive ways.

Let's begin this exploration with a few snippets of code and the equivalent XAML, and then see how XAML and code fit together in a Xamarin.Forms application.

Properties and attributes

Here is a Xamarin.Forms `Label` instantiated and initialized in code, much as it might appear in the constructor of a page class:

```
new Label
{
    Text = "Hello from Code!",
    IsVisible = true,
    Opacity = 0.75,
    HorizontalTextAlignment = TextAlignment.Center,
    VerticalOptions = LayoutOptions.CenterAndExpand,
    TextColor = Color.Blue,
    BackgroundColor = Color.FromRgb(255, 128, 128),
    FontSize = Device.GetNamedSize(NamedSize.Large, typeof(Label)),
    FontAttributes = FontAttributes.Bold | FontAttributes.Italic
};
```

Here is a very similar `Label` instantiated and initialized in XAML, which you can see immediately is more concise than the equivalent code:

```
<Label Text="Hello from XAML!"
       IsVisible="True"
       Opacity="0.75"
       HorizontalTextAlignment="Center"
       VerticalOptions="CenterAndExpand"
       TextColor="Blue"
       BackgroundColor="#FF8080"
       FontSize="Large"
       FontAttributes="Bold,Italic" />
```

Xamarin.Forms classes such as `Label` become XML elements in XAML. Properties such as `Text`, `IsVisible`, and the rest become XML attributes in XAML.

To be instantiated in XAML, a class such as `Label` must have a public parameterless constructor. (In the next chapter, you'll see that there is a technique to pass arguments to a constructor in XAML, but it's generally used for special purposes.) The properties set in XAML must have public `set` accessors. By convention, spaces surround an equal sign in code but not in XML (or XAML), but you can use as much white space as you want.

The concision of the XAML results mostly from the brevity of the attribute values—for example, the use of the word "Large" rather than a call to the `Device.GetNamedSize` method. These abbreviations are not built into the XAML parser. The XAML parser is instead assisted by various converter classes defined specifically for this purpose.

When the XAML parser encounters the `Label` element, it can use reflection to determine whether Xamarin.Forms has a class named `Label`, and if so, it can instantiate that class. Now it is ready to initialize that object. The `Text` property is of type `string`, and the attribute value is simply assigned to that property.

Because XAML is XML, you can include Unicode characters in the text by using the standard XML syntax. Precede the decimal Unicode value with `&#` (or the hexadecimal Unicode value with `&#x`) and follow it with a semicolon:

```
Text="Cost &#x2014; &#x20AC;123.45"
```

Those are the Unicode values for the em dash and euro symbol. To force a line break, use the line-feed character `&#x000A`, or (because leading zeros aren't required) `&#xA`, or, in decimal, `&#10`.

Angle brackets, ampersands, and quotation marks have a special meaning in XML, so to include those characters in a text string, use one of the standard predefined entities:

- `&lt;` for <

- `&gt;` for >
- `&amp;` for &
- `&apos;` for '
- `&quot;` for "

The HTML predefined entities such as `&nbsp;` are not supported. For a nonbreaking space use `&#xA0;` instead.

In addition, in Chapter 10, "XAML markup extensions," you'll discover that curly braces ({ and }) have a special meaning in XAML. If you need to begin an attribute value with a left curly brace, begin it with a pair of curly braces ({}) and then the left curly brace.

Back to the example: The `IsVisible` and `Opacity` properties of `Label` are of type `bool` and `double`, respectively, and these are as simple as you might expect. The XAML parser uses the `Boolean.Parse` and `Double.Parse` methods to convert the attribute values. The `Boolean.Parse` method is case insensitive, but generally Boolean values are capitalized as "True" and "False" in XAML. The `Double.Parse` method is passed a `CultureInfo.InvariantCulture` argument, so the conversion doesn't depend on the local culture of the programmer or user.

The `HorizontalTextAlignment` property of `Label` is of type `TextAlignment`, which is an enumeration. For any property that is an enumeration type, the XAML parser uses the `Enum.Parse` method to convert from the string to the value.

The `VerticalOptions` property is of type `LayoutOptions`, a structure. When the XAML parser references the `LayoutOptions` structure using reflection, it discovers that the structure has a C# attribute defined:

```
[TypeConverter (typeof(LayoutOptionsConverter))]
public struct LayoutOptions
{
    …
}
```

(Watch out! This discussion involves two types of attributes: XML attributes such as `HorizontalTextAlignment` and C# attributes such as this `TypeConverter`.)

The `TypeConverter` attribute is supported by a class named `TypeConverterAttribute`. This particular `TypeConverter` attribute on `LayoutOptions` references a class named `LayoutOptionsConverter`, which derives from a public abstract class named `TypeConverter` that defines methods named `CanConvertFrom` and `ConvertFrom`. When the XAML parser encounters this `TypeConverter` attribute, it instantiates the `LayoutOptionsConverter`. The `VerticalOptions` attribute in the XAML is assigned the string "Center", so the XAML parser passes that "Center" string to the `ConvertFrom` method of `LayoutOptionsConverter`, and out pops a `LayoutOptions` value. This is assigned to the `VerticalOptions` property of the `Label` object.

Similarly, when the XAML parser encounters the TextColor and BackgroundColor properties, it uses reflection to determine that those properties are of type Color. The Color structure is also adorned with a TypeConverter attribute:

```
[TypeConverter (typeof(ColorTypeConverter))]
public struct Color
{
    …
}
```

You can create an instance of ColorTypeConverter and experiment with it in code if you'd like. It accepts color definitions in several formats: It can convert a string like “Blue” to the Color.Blue value, and the “Default” and “Accent” strings to the Color.Default and Color.Accent values. ColorTypeConverter can also parse strings that encode red-green-blue values, such as “#FF8080”, which is a red value of 0xFF, a green value of 0x80, and a blue value also of 0x80.

All numeric RGB values begin with a number-sign prefix, but that prefix can be followed with eight, six, four, or three hexadecimal digits for specifying color values with or without an alpha channel. Here’s the most extensive syntax:

```
BackgroundColor="#aarrggbb"
```

Each of the letters represents a hexadecimal digit, in the order alpha (opacity), red, green, and blue. For the alpha channel, keep in mind that 0xFF is fully opaque and 0x00 is fully transparent. Here’s the syntax without an alpha channel:

```
BackgroundColor="#rrggbb"
```

In this case the alpha value is set to 0xFF for full opacity.

Two other formats allow you to specify only a single hexadecimal digit for each channel:

```
BackgroundColor="#argb"
BackgroundColor="#rgb"
```

In these cases, the digit is repeated to form the value. For example, #CF3 is the RGB color 0xCC-0xFF-0x33. These short formats are rarely used.

The FontSize property of Label is of type double. This is a little different from properties of type LayoutOptions and Color. The LayoutOptions and Color structures are part of Xamarin.Forms, so they can be flagged with the C# TypeConverter attribute, but it’s not possible to flag the .NET Double structure with a TypeConverter attribute just for font sizes!

Instead, the FontSize property within the Label class has the TypeConverter attribute:

```
public class Label : View, IFontElement
{
    …
    [TypeConverter (typeof (FontSizeConverter))]
    public double FontSize
    {
        …
    }
    …
}
```

The `FontSizeConverter` class determines whether the string passed to it is one of the members of the `NamedSize` enumeration. If not, `FontSizeConverter` assumes the value is a `double`.

The last attribute set in the example is `FontAttributes`. The `FontAttributes` property is an enumeration named `FontAttributes`, and you already know that the XAML parser handles enumeration types automatically. However, the `FontAttributes` enumeration has a C# `Flags` attribute set like so:

```
[Flags]
public enum FontAttributes
{
    None = 0,
    Bold = 1,
    Italic = 2
}
```

The XAML parser therefore allows multiple members separated by commas:

```
FontAttributes="Bold,Italic"
```

This demonstration of the mechanical nature of the XAML parser should be very good news. It means that you can include custom classes in XAML, and these classes can have properties of custom types, or the properties can be of standard types but allow additional values. All you need is to flag these types or properties with a C# `TypeConverter` attribute and provide a class that derives from `TypeConverter`.

Property-element syntax

Here is some C# that is similar to the **FramedText** code in Chapter 4. In one statement it instantiates a `Frame` and a `Label` and sets the `Label` to the `Content` property of the `Frame`:

```
new Frame
{
    OutlineColor = Color.Accent,
    HorizontalOptions = LayoutOptions.Center,
    VerticalOptions = LayoutOptions.Center,
    Content = new Label
    {
        Text = "Greetings, Xamarin.Forms!"
    }
};
```

But when you start to duplicate this in XAML, you might become a little stymied at the point where you set the `Content` attribute:

```
<Frame OutlineColor="Accent"
```

```
       HorizontalOptions="Center"
       VerticalOptions="Center"
       Content=" what goes here? " />
```

How can that `Content` attribute be set to an entire `Label` object?

The solution to this problem is the most fundamental feature of XAML syntax. The first step is to separate the `Frame` tag into start and end tags:

```
<Frame OutlineColor="Accent"
       HorizontalOptions="Center"
       VerticalOptions="Center">

</Frame>
```

Within those tags, add two more tags that consist of the element (`Frame`) and the property you want to set (`Content`) connected with a period:

```
<Frame OutlineColor="Accent"
       HorizontalOptions="Center"
       VerticalOptions="Center">
    <Frame.Content>

    </Frame.Content>
</Frame>
```

Now put the `Label` within those tags:

```
<Frame OutlineColor="Accent"
       HorizontalOptions="Center"
       VerticalOptions="Center">
    <Frame.Content>
        <Label Text="Greetings, Xamarin.Forms!" />
    </Frame.Content>
</Frame>
```

That syntax is how you set a `Label` to the `Content` property of the `Frame`.

You might wonder if this XAML feature violates XML syntax rules. It does not. The period has no special meaning in XML, so `Frame.Content` is a perfectly valid XML tag. However, XAML imposes its own rules about these tags: The `Frame.Content` tags must appear within `Frame` tags, and no attributes can be set in the `Frame.Content` tag. The object set to the `Content` property appears as the XML content of those tags.

Once this syntax is introduced, some terminology becomes necessary. In the final XAML snippet shown above:

- `Frame` and `Label` are C# objects expressed as XML elements. They are called *object elements*.
- `OutlineColor`, `HorizontalOptions`, `VerticalOptions`, and `Text` are C# properties expressed as XML attributes. They are called *property attributes*.

- `Frame.Content` is a C# property expressed as an XML element, and it is therefore called a *property element*.

Property elements are very common in real-life XAML. You'll see numerous examples in this chapter and future chapters, and you'll soon find property elements becoming second nature to your use of XAML. But watch out: Sometimes developers must remember so much that we forget the basics. Even after you've been using XAML for a while, you'll probably encounter a situation where it doesn't seem possible to set a particular object to a particular property. The solution is very often a property element.

You can also use property-element syntax for simpler properties, for example:

```
<Frame HorizontalOptions="Center">
    <Frame.VerticalOptions>
        Center
    </Frame.VerticalOptions>
    <Frame.OutlineColor>
        Accent
    </Frame.OutlineColor>
    <Frame.Content>
        <Label>
            <Label.Text>
                Greetings, Xamarin.Forms!
            </Label.Text>
        </Label>
    </Frame.Content>
</Frame>
```

Now the `VerticalOptions` and `OutlineColor` properties of `Frame` and the `Text` property of `Label` have all become property elements. The value of these attributes is always the content of the property element without quotation marks.

Of course, it doesn't make much sense to define these properties as property elements. It's unnecessarily verbose. But it works as it should.

Let's go a little further: Instead of setting `HorizontalOptions` to "Center" (corresponding to the static property `LayoutOptions.Center`), you can express `HorizontalOptions` as a property element and set it to a `LayoutOptions` value with its individual properties set:

```
<Frame>
    <Frame.HorizontalOptions>
        <LayoutOptions Alignment="Center"
                       Expands="False" />
    </Frame.HorizontalOptions>
    <Frame.VerticalOptions>
        Center
    </Frame.VerticalOptions>
    <Frame.OutlineColor>
        Accent
    </Frame.OutlineColor>
    <Frame.Content>
```

```
        <Label>
            <Label.Text>
                Greetings, Xamarin.Forms!
            </Label.Text>
        </Label>
    </Frame.Content>
</Frame>
```

And you can also express these properties of `LayoutOptions` as property elements:

```
<Frame>
    <Frame.HorizontalOptions>
        <LayoutOptions>
            <LayoutOptions.Alignment>
                Center
            </LayoutOptions.Alignment>
            <LayoutOptions.Expands>
                False
            </LayoutOptions.Expands>
        </LayoutOptions>
    </Frame.HorizontalOptions>
    …
</Frame>
```

You can't set the same property as a property attribute and a property element. That's setting the property twice, and it's not allowed. And remember that nothing else can appear in the property-element tags. The value being set to the property is always the XML content of those tags.

Now you should know how to use a `StackLayout` in XAML. First express the `Children` property as the property element `StackLayout.Children`, and then include the children of the `StackLayout` as XML content of the property-element tags. Here's an example where each child of the first `StackLayout` is another `StackLayout` with a horizontal orientation:

```
<StackLayout>
    <StackLayout.Children>
        <StackLayout Orientation="Horizontal">
            <StackLayout.Children>
                <BoxView Color="Red" />
                <Label Text="Red"
                       VerticalOptions="Center" />
            </StackLayout.Children>
        </StackLayout>

        <StackLayout Orientation="Horizontal">
            <StackLayout.Children>
                <BoxView Color="Green" />
                <Label Text="Green"
                       VerticalOptions="Center" />
            </StackLayout.Children>
        </StackLayout>

        <StackLayout Orientation="Horizontal">
            <StackLayout.Children>
```

```
                <BoxView Color="Blue" />
                <Label Text="Blue"
                       VerticalOptions="Center" />
            </StackLayout.Children>
        </StackLayout>
    </StackLayout.Children>
</StackLayout>
```

Each horizontal `StackLayout` has a `BoxView` with a color and a `Label` with that color name.

Of course, the repetitive markup here looks rather scary! What if you wanted to display 16 colors? Or 140? You might succeed at first with a lot of copying and pasting, but if you then needed to refine the visuals a bit, you'd be in bad shape. In code you'd do this in a loop, but XAML has no such feature.

When markup threatens to be overly repetitious, you can always use code. Defining some of a user interface in XAML and the rest in code is perfectly reasonable. But there are other solutions, as you'll see in later chapters.

Adding a XAML page to your project

Now that you've seen some snippets of XAML, let's look at a whole XAML page in the context of a complete program. First, create a Xamarin.Forms solution named **CodePlusXaml** using the Portable Class Library solution template.

Now add a XAML `ContentPage` to the PCL. Here's how: In Visual Studio, right-click the **CodePlusXaml** project in the **Solution Explorer**. Select **Add > New Item** from the menu. In the **Add New Item** dialog, select **Visual C#** and **Cross-Platform** at the left, and **Forms Xaml Page** from the central list. Name it CodePlusXamlPage.cs.

In Xamarin Studio, invoke the drop-down menu on the **CodePlusXaml** project in the **Solution** list, and select **Add > New File**. In the **New File** dialog, select **Forms** at the left and **Forms ContentPage Xaml** in the central list. (Watch out: There's also a **Forms ContentView Xaml** in the list. You want a content *page*.) Name it CodePlusXamlPage.

In either case, two files are created:

- CodePlusXamlPage.xaml, the XAML file; and
- CodePlusXamlPage.xaml.cs, a C# file (despite the odd double extension on the filename).

In the file list, the second file is indented underneath the first, indicating their close relationship. The C# file is often referred to as the *code-behind* of the XAML file. It contains code that supports the markup. These two files both contribute to a class named `CodePlusXamlPage` that derives from `ContentPage`.

Let's examine the code file first. Excluding the `using` directives, it looks like this:

```
namespace CodePlusXaml
{
    public partial class CodePlusXamlPage : ContentPage
    {
        public CodePlusXamlPage()
        {
            InitializeComponent();
        }
    }
}
```

It is indeed a class named `CodePlusXamlPage` that derives from `ContentPage`, just as anticipated. However, the class definition includes a `partial` keyword, which usually indicates that this is only part of the `CodePlusXamlPage` class definition. Somewhere else there should be another partial class definition for `CodePlusXamlPage`. So if it exists, where is it? It's a mystery! (For now.)

Another mystery is the `InitializeComponent` method that the constructor calls. Judging solely from the syntax, it seems as though this method should be defined or inherited by `ContentPage`. Yet you won't find `InitializeComponent` in the API documentation.

Let's set those two mysteries aside temporarily and look at the XAML file. The Visual Studio and Xamarin Studio templates generate two somewhat different XAML files. If you're using Visual Studio, delete the markup for the `Label` and replace it with `ContentPage.Content` property-element tags so that it looks like the version in Xamarin Studio:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="CodePlusXaml.CodePlusXamlPage">
    <ContentPage.Content>
    </ContentPage.Content>
</ContentPage>
```

The root element is `ContentPage`, which is the class that `CodePlusXamlPage` derives from. That tag begins with two XML namespace declarations, both of which are URIs. But don't bother checking the web addresses! There's nothing there. These URIs simply indicate who owns the namespace and what function it serves.

The default namespace belongs to Xamarin. This is the XML namespace for elements in the file with no prefix, such as the `ContentPage` tag. The URI includes the year that this namespace came into being and the word `forms` as an abbreviation for Xamarin.Forms.

The second namespace is associated with a prefix of `x` by convention, and it belongs to Microsoft. This namespace refers to elements and attributes that are intrinsic to XAML and are found in every XAML implementation. The word `winfx` refers to a name once used for the .NET Framework 3.0, which introduced WPF and XAML. The year 2009 refers to a particular XAML specification, which also implies a particular collection of elements and attributes that build upon the original XAML specification, which is dated 2006. However, Xamarin.Forms implements only a subset of the elements and attributes in the 2009 specification.

The next line is one of the attributes that is intrinsic to XAML, called `Class`. Because the `x` prefix is almost universally used for this namespace, this attribute is commonly referred to as `x:Class` and pronounced "x class."

The `x:Class` attribute can appear only on the root element of a XAML file. It specifies the .NET namespace and name of a derived class. The base class of this derived class is the root element. In other words, this `x:Class` specification indicates that the `CodePlusXamlPage` class in the `CodePlusXaml` namespace derives from `ContentPage`. That's exactly the same information as the `CodePlusXamlPage` class definition in the CodePlusXamlPage.xaml.cs file.

Let's add some content to this `ContentPage` in the XAML file. This requires setting something to the `Content` property, which in the XAML file means putting something between `ContentPage.Content` property-element tags. Begin the content with a `StackLayout`, and then add a `Label` to the `Children` property:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="CodePlusXaml.CodePlusXamlPage">
    <ContentPage.Content>
        <StackLayout>
            <StackLayout.Children>
                <Label Text="Hello from XAML!"
                       IsVisible="True"
                       Opacity="0.75"
                       HorizontalTextAlignment="Center"
                       VerticalOptions="CenterAndExpand"
                       TextColor="Blue"
                       BackgroundColor="#FF8080"
                       FontSize="Large"
                       FontAttributes="Bold,Italic" />
            </StackLayout.Children>
        </StackLayout>
    </ContentPage.Content>
</ContentPage>
```

That's the XAML `Label` you saw at the beginning of this chapter.

You'll now need to change the `App` class to instantiate this page just like you do with a code-only derivative of `ContentPage`:

```
namespace CodePlusXaml
{
    public class App : Application
    {
        public App()
        {
            MainPage = new CodePlusXamlPage();
        }
        …
    }
}
```

You can now build and deploy this program. After you do so, it's possible to clear up a couple of mysteries encountered earlier in this section:

In Visual Studio, in the **Solution Explorer**, select the **CodePlusXaml** project, find the icon at the top with the tooltip **Show All Files**, and toggle that on.

In Xamarin Studio, in the **Solution** file list, invoke the drop-down menu for the whole solution, and select **Display Options > Show All Files**.

In the **CodePlusXaml** Portable Class Library project, find the **obj** folder and within that, the **Debug** folder. You'll see a file named CodePlusXamlPage.xaml.g.cs. Notice the *g* in the filename. That stands for *generated*. Here it is, complete with the comment that tells you that this file is generated by a tool:

```
//------------------------------------------------------------------------------
// <auto-generated>
//     This code was generated by a tool.
//     Runtime Version:4.0.30319.42000
//
//     Changes to this file may cause incorrect behavior and will be lost if
//     the code is regenerated.
// </auto-generated>
//------------------------------------------------------------------------------

namespace CodePlusXaml {
    using System;
    using Xamarin.Forms;
    using Xamarin.Forms.Xaml;

    public partial class CodePlusXamlPage : global::Xamarin.Forms.ContentPage {

        [System.CodeDom.Compiler.GeneratedCodeAttribute("Xamarin.Forms.Build.Tasks.XamlG",
                                                        "0.0.0.0")]
        private void InitializeComponent() {
            this.LoadFromXaml(typeof(CodePlusXamlPage));
        }
    }
}
```

During the build process, the XAML file is parsed, and this code file is generated. Notice that it's a partial class definition of `CodePlusXamlPage`, which derives from `ContentPage`, and the class contains a method named `InitializeComponent`.

In other words, it's a perfect fit for the CodePlusXamlPage.xaml.cs code-behind file. After the CodePlusXamlPage.xaml.g.cs file is generated, the two files can be compiled together as if they were just normal C# partial class definitions.

At run time, the `App` class instantiates the `CodePlusXamlPage` class. The `CodePlusXamlPage` constructor (defined in the code-behind file) calls `InitializeComponent` (defined in the generated file), and `InitializeComponent` calls `LoadFromXaml`. This is an extension method for `View` defined in the `Extensions` class in the **Xamarin.Forms.Xaml** assembly. What `LoadFromXaml` does depends on whether you've chosen to compile the XAML or not (as discussed in the next section). But when the `InitializeComponent` method returns, the whole page is in place, just as though everything had been instantiated and initialized in code in the `CodePlusXamlPage` constructor.

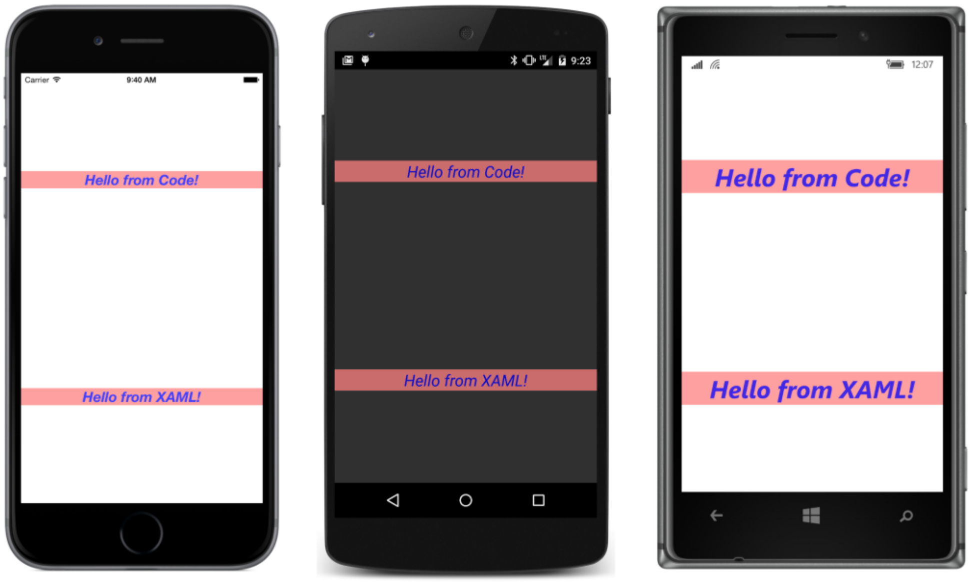
It's possible to continue adding content to the page in the constructor of the code-behind file, but only after the `InitializeComponent` call returns. Let's take this opportunity to create another `Label` by using some code from earlier in this chapter:

```
namespace CodePlusXaml
{
    public partial class CodePlusXamlPage : ContentPage
    {
        public CodePlusXamlPage()
        {
            InitializeComponent();

            Label label = new Label
            {
                Text = "Hello from Code!",
                IsVisible = true,
                Opacity = 0.75,
                HorizontalTextAlignment = TextAlignment.Center,
                VerticalOptions = LayoutOptions.CenterAndExpand,
                TextColor = Color.Blue,
                BackgroundColor = Color.FromRgb(255, 128, 128),
                FontSize = Device.GetNamedSize(NamedSize.Large, typeof(Label)),
                FontAttributes = FontAttributes.Bold | FontAttributes.Italic
            };

            (Content as StackLayout).Children.Insert(0, label);
        }
    }
}
```

The constructor concludes by accessing the `StackLayout` that we know is set to the `Content` property of the page and inserting the `Label` at the top. (In the next chapter, you'll see a much better way to reference objects in the XAML file by using the `x:Name` attribute.) You can create the `Label` prior to the `InitializeComponent` call, but you can't add it to the `StackLayout` at that time because `InitializeComponent` is what causes the `StackLayout` (and all the other XAML elements) to be instantiated. Here's the result:



Aside from the text, the two buttons are identical.

You don't have to spend much time examining the generated code file that the XAML parser creates, but it's helpful to understand how the XAML file plays a role both in the build process and during run time. Also, sometimes an error in the XAML file raises a run-time exception at the `LoadFromXaml` call, so you will probably see the generated code file pop up frequently, and you should know what it is.

The XAML compiler

You have an option whether to compile the XAML during the build process. Compiling the XAML performs validity checks during the build process, reduces the size of the executable, and improves loading time, but it's somewhat newer than the noncompilation approach, so there might be issues sometimes.

To indicate that you want to compile all the XAML files in your application, you can insert the following assembly attribute somewhere in a code file. The most convenient place is the Assembly.cs file in the **Properties** folder of the PCL project:

```
[assembly: XamlCompilation(XamlCompilationOptions.Compile)]
```

You can put it in another C# file, but because it's an assembly attribute, it needs to be outside any `namespace` block. You'll also need a `using` directive for `Xamarin.Forms.Xaml`.

You can alternatively specify that the XAML file for a particular class is compiled:

```
namespace CodePlusXaml
{
    [XamlCompilation(XamlCompilationOptions.Compile)]
    public partial class CodePlusXamlPage : ContentPage
    {
        public CodePlusXamlPage()
        {
            InitializeComponent();

            …
        }
    }
}
```

The `XamlCompilationOptions` enumeration has two members, `Compile` and `Skip`, which means that you can use `XamlCompilation` as an assembly attribute to enable XAML compilation for all classes in the project, but skip XAML compilation for individual classes by using the `Skip` member.

When you do *not* choose to compile the XAML, the entire XAML file is bound into the executable as an embedded resource, just like the Edgar Allan Poe story in the **BlackCat** program in Chapter 4. Indeed, you can get access to the XAML file at run time by using the `GetManifestResourceStream` method. That's similar to what the `LoadFromXaml` call in `InitializeComponent` does. It loads the XAML file and parses it for a second time, instantiating and initializing all the elements in the XAML file except for the root element, which already exists.

When you choose to compile the XAML, this process is streamlined somewhat, but the `LoadFromXaml` method still needs to instantiate all the elements and build a visual tree.

Platform specificity in the XAML file

Here is the XAML file for a program named **ScaryColorList** that's similar to a snippet of XAML that you saw earlier. But now the repetition is even scarier because each color item is surrounded by a `Frame`:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="ScaryColorList.ScaryColorListPage">
    <ContentPage.Content>
        <StackLayout>
            <StackLayout.Children>
                <Frame OutlineColor="Accent">
                    <Frame.Content>
                        <StackLayout Orientation="Horizontal">
                            <StackLayout.Children>
                                <BoxView Color="Red" />
                                <Label Text="Red"
                                       VerticalOptions="Center" />
                            </StackLayout.Children>
                        </StackLayout>
                    </Frame.Content>
                </Frame>

                <Frame OutlineColor="Accent">
                    <Frame.Content>
                        <StackLayout Orientation="Horizontal">
                            <StackLayout.Children>
                                <BoxView Color="Green" />
                                    <Label Text="Green"
                                           VerticalOptions="Center" />
                            </StackLayout.Children>
                        </StackLayout>
                    </Frame.Content>
                </Frame>

                <Frame OutlineColor="Accent">
                    <Frame.Content>
                        <StackLayout Orientation="Horizontal">
                            <StackLayout.Children>
                                <BoxView Color="Blue" />
                                <Label Text="Blue"
                                       VerticalOptions="Center" />
                            </StackLayout.Children>
                        </StackLayout>
                    </Frame.Content>
                </Frame>
            </StackLayout.Children>
        </StackLayout>
    </ContentPage.Content>
</ContentPage>
```

The code-behind file contains only the standard call to `InitializeComponent`.

Aside from the repetitious markup, this program has a more practical problem: When it runs on iOS, the top item overlaps the status bar. This problem can be fixed with a call to `Device.OnPlatform` in the page's constructor (just as you saw in Chapter 2). Because `Device.OnPlatform` sets the `Padding` property on the page and doesn't require anything in the XAML file, it could go either before or after the `InitializeComponent` call. Here's one way to do it:

```
public partial class ScaryColorListPage : ContentPage
{
    public ScaryColorListPage()
    {
        Padding = Device.OnPlatform(new Thickness(0, 20, 0, 0),
                                    new Thickness(0),
                                    new Thickness(0));

        InitializeComponent();
    }
}
```

Or, you could set a uniform `Padding` value for all three platforms right in the root element of the XAML file:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="ScaryColorList.ScaryColorListPage"
             Padding="0, 20, 0, 0">
    <ContentPage.Content>
        …
    </ContentPage.Content>
</ContentPage>
```

That sets the `Padding` property for the page. The `ThicknessTypeConverter` class requires the values to be separated by commas, but you have the same flexibility as with the `Thickness` constructor. You can specify four values in the order left, top, right, and bottom; two values (the first for left and right, and the second for top and bottom); or one value.

However, you can also specify platform-specific values right in the XAML file by using the `OnPlatform` class, whose name suggests that it is similar in function to the `Device.OnPlatform` static method.

`OnPlatform` is a very interesting class, and it's worthwhile to gain a sense of how it works. The class is generic, and it has three properties of type `T`, as well as an implicit conversion of itself to `T` that makes use of the `Device.OS` value:

```
public class OnPlatform<T>
{
    public T iOS { get; set; }

    public T Android { get; set; }

    public T WinPhone { get; set; }

    public static implicit operator T(OnPlatform<T> onPlatform)
    {
        // returns one of the three properties based on Device.OS
    }
}
```

In theory, you might use the `OnPlatform<T>` class in code, perhaps like this in the constructor of a `ContentPage` derivative:

```
Padding = new OnPlatform<Thickness>
{
    iOS = new Thickness(0, 20, 0, 0),
    Android = new Thickness(0),
    WinPhone = new Thickness(0)
};
```

You can set an instance of this `OnPlatform` class directly to the `Padding` property because the `OnPlatform` class defines an implicit conversion of itself to the generic argument (in this case `Thickness`).

However, you shouldn't use OnPlatform in code. Use Device.OnPlatform instead. OnPlatform is designed for XAML, and the only really tricky part is figuring out how to specify the generic type argument.

Fortunately, the XAML 2009 specification includes an attribute designed specifically for generic classes, called TypeArguments. Because it's part of XAML itself, it's used with an x prefix, so it appears as x:TypeArguments. Here's how OnPlatform is used in XAML to select among three Thickness values:

```
<OnPlatform x:TypeArguments="Thickness"
            iOS="0, 20, 0, 0"
            Android="0"
            WinPhone="0" />
```

In this example (and in the previous code example), the Android and WinPhone settings aren't required because they are the defaults. Notice that the Thickness strings can be set directly to the properties because those properties are of type Thickness, and hence the XAML parser will use the ThicknessTypeConverter for converting those strings.

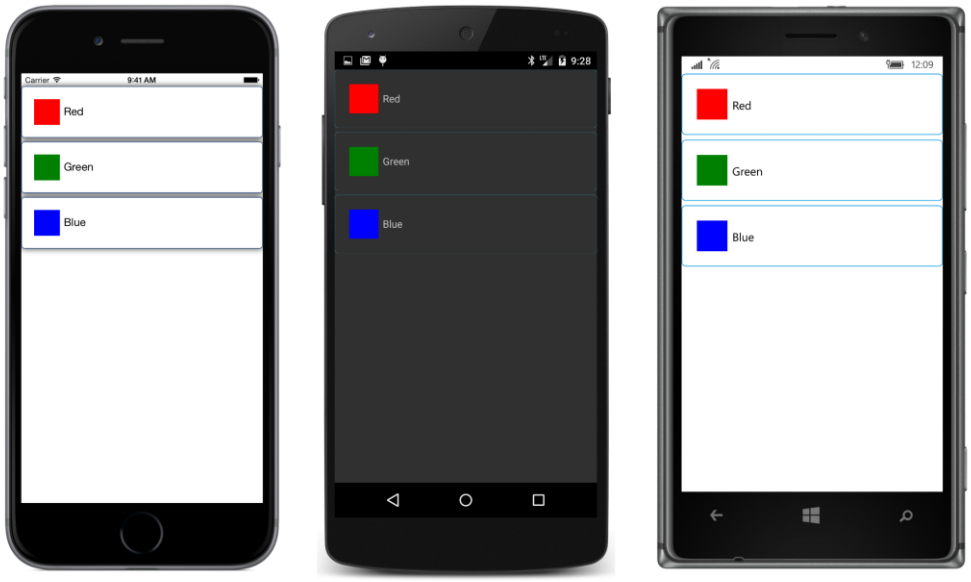
Now that we have the OnPlatform markup, how do we set it to the Padding property of the Page? By expressing Padding using property-element syntax, of course!

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="ScaryColorList.ScaryColorListPage">

    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="0, 20, 0, 0" />
    </ContentPage.Padding>

    <ContentPage.Content>
        …
    </ContentPage.Content>
</ContentPage>
```

This is how the **ScaryColorList** program appears in the collection of samples from this book and here's how it looks:



Similar to `OnDevice`, `OnIdiom` distinguishes between `Phone` and `Tablet`. For reasons that will become apparent in the next chapter, you should try to restrict the use of `OnDevice` and `OnIdiom` to small chunks of markup rather than large blocks. Their use shouldn't become a structural element in your XAML files.

The content property attribute

The XAML file in the **ScaryColorList** program is actually somewhat longer than it needs to be. You can delete the `ContentPage.Content` tags, all the `StackLayout.Children` tags, and all the `Frame.Content` tags, and the program will work the same:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="ScaryColorList.ScaryColorListPage">

    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="0, 20, 0, 0" />
    </ContentPage.Padding>

    <StackLayout>
        <Frame OutlineColor="Accent">
            <StackLayout Orientation="Horizontal">
                <BoxView Color="Red" />
                <Label Text="Red"
                       VerticalOptions="Center" />
            </StackLayout>
        </Frame>

        <Frame OutlineColor="Accent">
            <StackLayout Orientation="Horizontal">
                <BoxView Color="Green" />
                <Label Text="Green"
                       VerticalOptions="Center" />
            </StackLayout>
        </Frame>

        <Frame OutlineColor="Accent">
            <StackLayout Orientation="Horizontal">
                <BoxView Color="Blue" />
                <Label Text="Blue"
                       VerticalOptions="Center" />
            </StackLayout>
        </Frame>
    </StackLayout>
</ContentPage>
```

It looks a lot cleaner now. The only property element left is for the `Padding` property of `ContentPage`.

As with almost everything about XAML syntax, this elimination of some property elements is supported by the underlying classes. Every class used in XAML is allowed to define one property as a *content property* (sometimes also called the class's *default property*). For this content property, the property-element tags are not required, and any XML content within the start and end tags is automatically assigned to this property. Very conveniently, the content property of `ContentPage` is `Content`, the content property of `StackLayout` is `Children`, and the content property of `Frame` is `Content`.

These content properties are documented, but you need to know where to look. A class specifies its content property by using the `ContentPropertyAttribute`. If this attribute is attached to a class, it appears in the online Xamarin.Forms API documentation along with the class declaration. Here's how it appears in the documentation for `ContentPage`:

```
[Xamarin.Forms.ContentProperty("Content")]
public class ContentPage : TemplatedPage
```

If you say it aloud, it sounds a bit redundant: The `Content` property is the content property of `ContentPage`.

The declaration for the `Frame` class is similar:

```
[Xamarin.Forms.ContentProperty("Content")]
public class Frame : ContentView
```

`StackLayout` doesn't have a `ContentProperty` attribute applied, but `StackLayout` derives from `Layout<View>`, and `Layout<T>` has a `ContentProperty` attribute:

```
[Xamarin.Forms.ContentProperty("Children")]
public abstract class Layout<T> : Layout, IViewContainer<T>
where T : View
```

The ContentProperty attribute is inherited by the classes that derive from Layout<T>, so Children is the content property of StackLayout.

Certainly, there's no problem if you include the property elements when they're not required, but in most cases they will no longer appear in the sample programs in this book.

Formatted text

Text displayed by a XAML file might involve just a word or two, but sometimes an entire paragraph is required, perhaps with some embedded character formatting. Specifying character formatting is not always as obvious, or as easy, in XAML as might be suggested by our familiarity with HTML.

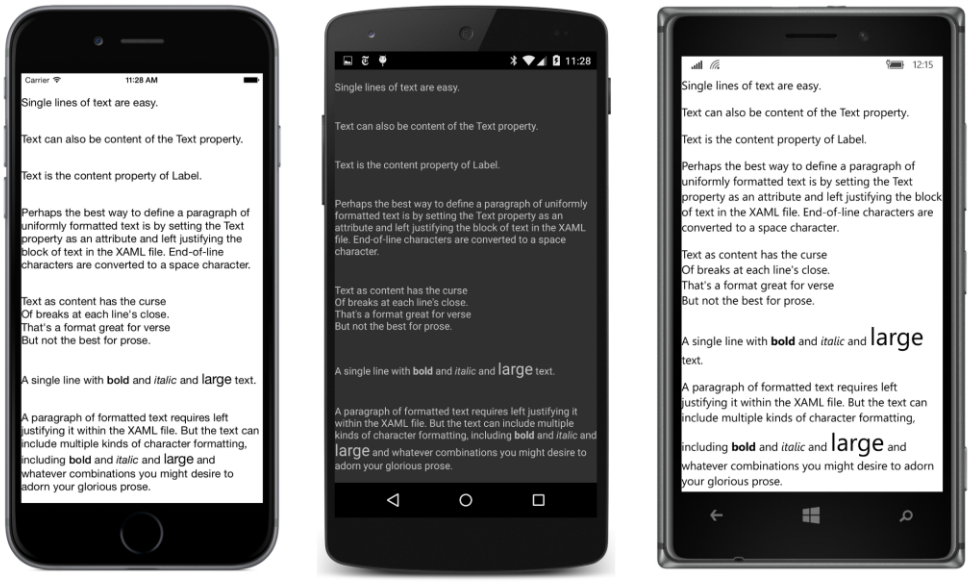
The **TextVariations** solution has a XAML file that contains seven Label views in a scrollable StackLayout:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="TextVariations.TextVariationsPage">

    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="0, 20, 0, 0" />
    </ContentPage.Padding>

    <ScrollView>
        <StackLayout>
            …
        </StackLayout>
    </ScrollView>
</ContentPage>
```

Each of the seven Label views shows a somewhat different way of defining the displayed text. For reference purposes, here's the program running on all three platforms:



Single lines of text are easy.

Text can also be content of the Text property.

Text is the content property of Label.

Perhaps the best way to define a paragraph of uniformly formatted text is by setting the Text property as an attribute and left justifying the block of text in the XAML file. End-of-line characters are converted to a space character.

Text as content has the curse
Of breaks at each line's close.
That's a format great for verse
But not the best for prose.

A single line with **bold** and *italic* and large text.

A paragraph of formatted text requires left justifying it within the XAML file. But the text can include multiple kinds of character formatting, including **bold** and *italic* and large and whatever combinations you might desire to adorn your glorious prose.

11:28

Single lines of text are easy.

Text can also be content of the Text property.

Text is the content property of Label.

Perhaps the best way to define a paragraph of uniformly formatted text is by setting the Text property as an attribute and left justifying the block of text in the XAML file. End-of-line characters are converted to a space character.

Text as content has the curse
Of breaks at each line's close.
That's a format great for verse
But not the best for prose.

A single line with **bold** and *italic* and large text.

A paragraph of formatted text requires left justifying it within the XAML file. But the text can include multiple kinds of character formatting, including **bold** and *italic* and large and whatever combinations you might desire to adorn your glorious prose.

12:15

Single lines of text are easy.

Text can also be content of the Text property.

Text is the content property of Label.

Perhaps the best way to define a paragraph of uniformly formatted text is by setting the Text property as an attribute and left justifying the block of text in the XAML file. End-of-line characters are converted to a space character.

Text as content has the curse
Of breaks at each line's close.
That's a format great for verse
But not the best for prose.

A single line with **bold** and *italic* and large text.

A paragraph of formatted text requires left justifying it within the XAML file. But the text can include multiple kinds of character formatting, including **bold** and *italic* and large and whatever combinations you might desire to adorn your glorious prose.

The simplest approach involves just setting a few words to the `Text` attribute of the `Label` element:

```
<Label VerticalOptions="CenterAndExpand"
       Text="Single lines of text are easy." />
```

You can also set the `Text` property by breaking it out as a property element:

```
<Label VerticalOptions="CenterAndExpand">
    <Label.Text>
        Text can also be content of the Text property.
    </Label.Text>
</Label>
```

`Text` is the content property of `Label`, so you don't need the `Label.Text` tags:

```
<Label VerticalOptions="CenterAndExpand">
    Text is the content property of Label.
</Label>
```

When you set text as the content of the `Label` (whether you use the `Label.Text` tags or not), the text is trimmed: all white space, including carriage returns, is removed from the beginning and end of the text. However, all embedded white space is retained, including end-of-line characters.

When you set the `Text` property as a property attribute, all white space within the quotation marks is retained, but if the text occupies more than one line in the XAML file, each end-of-line character (or character sequence) is converted to a single space.

As a result, displaying a whole paragraph of uniformly formatted text is somewhat problematic. The most foolproof approach is setting `Text` as a property attribute. You can put the whole paragraph as a single line in the XAML file, but if you prefer to use multiple lines, you should left justify the whole paragraph in the XAML file surrounded by quotation marks, like so:

```
            <Label VerticalOptions="CenterAndExpand"
                   Text=
"Perhaps the best way to define a paragraph of
uniformly formatted text is by setting the Text
property as an attribute and left justifying
the block of text in the XAML file. End-of-line
characters are converted to a space character." />
```

The end-of-line characters are converted to space characters so the individual lines are properly concatenated. But watch out: Don't leave any stray characters at the end or beginning of the individual lines. Those will show up as extraneous characters within the paragraph.

When multiple lines of text are specified as content of the `Label`, only white space at the beginning and end of the text is trimmed. All embedded white space is retained, including end-of-line characters:

```
            <Label VerticalOptions="CenterAndExpand">
Text as content has the curse
Of breaks at each line's close.
That's a format great for verse
But not the best for prose.
            </Label>
```

This text is rendered as four separate lines. If you're displaying lists or poetry in your Xamarin.Forms application, that's exactly what you want. Otherwise, probably not.

If your line or paragraph of text requires some nonuniform paragraph formatting, you'll want to use the `FormattedText` property of `Label`. As you might recall, you set this to a `FormattedString` object and then set multiple `Span` objects to the `Spans` collection of the `FormattedString`. In XAML, you need property-element tags for `Label.FormattedString`, but `Spans` is the content property of `FormattedString`:

```
            <Label VerticalOptions="CenterAndExpand">
                <Label.FormattedText>
                    <FormattedString>
                        <Span Text="A single line with " />
                        <Span Text="bold" FontAttributes="Bold" />
                        <Span Text=" and " />
                        <Span Text="italic" FontAttributes="Italic" />
                        <Span Text=" and " />
                        <Span Text="large" FontSize="Large" />
                        <Span Text=" text." />
                    </FormattedString>
                </Label.FormattedText>
            </Label>
```

Notice that the `Text` properties of the nonformatted items have spaces at the end or beginning of the text string, or both, so that the items don't run into each other.

In the general case, however, you might be working with an entire paragraph. You can set the `Text` attribute of `Span` to a long line, or you can wrap it on multiple lines. As with `Label`, keep the entire block left justified in the XAML file:

```
            <Label VerticalOptions="CenterAndExpand">
                <Label.FormattedText>
                    <FormattedString>
                        <Span Text=
"A paragraph of formatted text requires left justifying
it within the XAML file. But the text can include multiple
kinds of character formatting, including " />
                        <Span Text="bold" FontAttributes="Bold" />
                        <Span Text=" and " />
                        <Span Text="italic" FontAttributes="Italic" />
                        <Span Text=" and " />
                        <Span Text="large" FontSize="Large" />
                        <Span Text=
" and whatever combinations you might desire to adorn
your glorious prose." />
                    </FormattedString>
                </Label.FormattedText>
            </Label>
```

You'll notice in the screenshot that the text with the large font size is aligned with the regular text on the baseline, which is the typographically proper approach, and the line spacing is adjusted to accommodate the larger text.

In most Xamarin.Forms programs, neither XAML nor code exist in isolation but work together. Elements in XAML can trigger events handled in code, and code can modify elements in XAML. In the next chapter you'll see how this works.