Chapter 19

# Collection views

Many of the views in Xamarin.Forms correspond to basic C# and .NET data types: The `Slider` and `Stepper` are visual representations of a `double`, the `Switch` is a `bool`, and an `Entry` allows the user to edit text exposed as a `string`. But can this correspondence also apply to *collection* types in C# and .NET?

Collections of various sorts have always been essential in digital computing. Even the oldest of high-level programming languages support both arrays and structures. These two archetypal collections complement each other: An array is a collection of values or objects generally of the same type, while a structure is an assemblage of related data items generally of a variety of types.

To supplement these basic collection types, .NET added several useful classes in the `System.Collections` and `System.Collections.Generic` namespaces, most notably `List` and `List<T>`, which are expandable collections of objects of the same type. Underlying these collection classes are three important interfaces that you'll encounter in this chapter:

- `IEnumerable` allows iterating through the items in a collection.
- `ICollection` derives from `IEnumerable` and adds a count of the items in the collection.
- `IList` derives from `ICollection` and supports indexing as well as adding and removing items.

Xamarin.Forms defines three views that maintain collections of various sorts, sometimes also allowing the user to select an item from the collection or interact with the item. The three views discussed in this chapter are:

- `Picker`: A list of text items that lets the user choose one. The `Picker` usually maintains a *short* list of items, generally no more than a dozen or so.
- `ListView`: Very often a long list of data items of the same type rendered in a uniform (or nearly uniform) manner that is specified by a visual tree described by an object called a *cell*.
- `TableView`: A collection of cells, usually of various sorts, to display data or to manage user input. A `TableView` might take the form of a menu, or a fill-out form, or a collection of application settings.

All three of these views provide built-in scrolling.

At first encounter these three views might seem somewhat similar. The purpose of this chapter is to provide enough examples of how these views are used so that you shouldn't have any difficulty choosing the right tool for the job.

Both `Picker` and `ListView` allow selection, but `Picker` is restricted to strings, while `ListView` can display any object rendered in whatever way you want. `Picker` is generally a short list, while `ListView` can maintain must longer lists.

The relationship between `ListView` and `TableView` is potentially confusing because both involve the use of cells, which are derivatives of the `Cell` class. `Cell` derives from `Element` but not `VisualElement`. A cell is not a visual element itself, but instead provides a description of a visual element. These cells are used by `ListView` and `TableView` in two different ways: `ListView` generally displays a list of objects of the same type, the display of which is specified by a single cell. A `TableView` is a collection of multiple cells, each of which displays an individual item in a collection of related items.

If you like to equate Xamarin.Forms views with C# and .NET data types, then:

- `Picker` is a visual representation of an array of `string`.
- `ListView` is a more generalized array of objects, often a `List<T>` collection. The individual items in this collection often implement the `INotifyPropertyChanged` interface.
- `TableView` could be a structure, but it is more likely a class, and possibly a class that implements `INotifyPropertyChanged`, otherwise known as a ViewModel.

Let's begin with the simplest of these three, which is the `Picker`.

# Program options with Picker

`Picker` is a good choice when you need a view that allows the user to choose one item among a small collection of several items. `Picker` is implemented in a platform-specific manner and has the limitation that each item is identified solely by a text string.

## The Picker and event handling

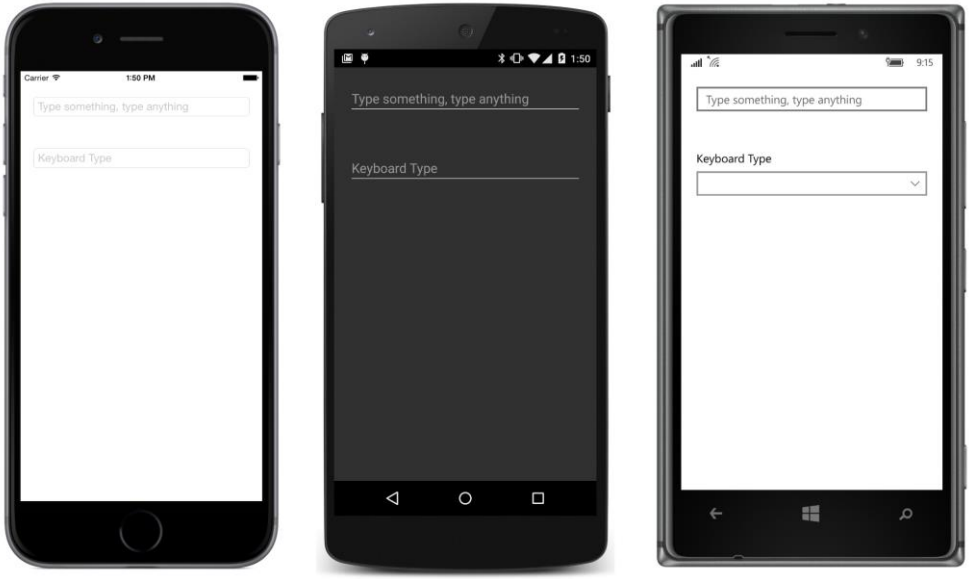
Here's a program named **PickerDemo** that implements a `Picker` to allow you to choose a specialized keyboard for an `Entry` view. In the XAML file, the `Entry` and the `Picker` are children of a `StackLayout`, and the `Picker` is initialized to contain a list of the various keyboard types supported by the `Keyboard` class:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="PickerDemo.PickerDemoPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="0, 20, 0, 0" />
    </ContentPage.Padding>

    <StackLayout Padding="20"
                 Spacing="50">
```

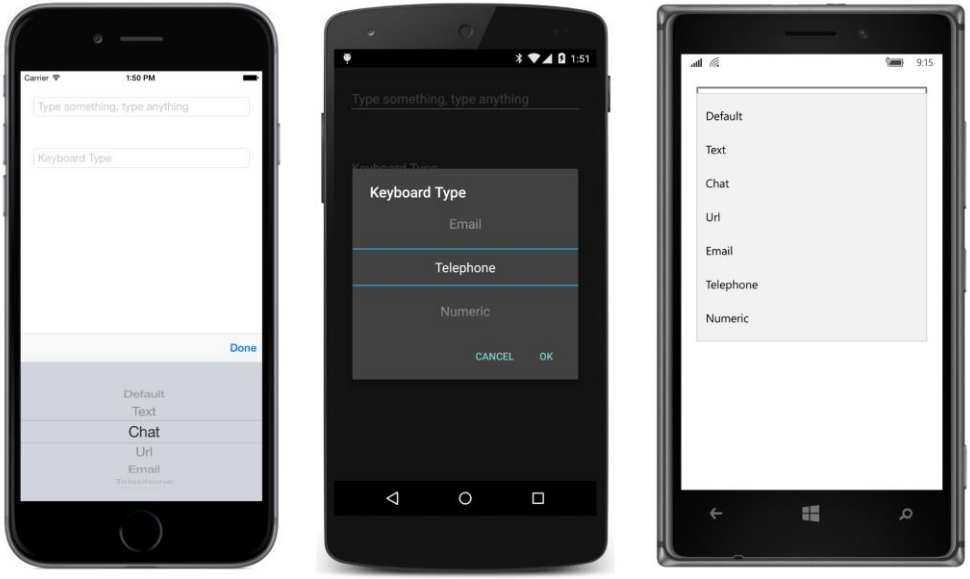
```
        <Entry x:Name="entry"
               Placeholder="Type something, type anything" />

        <Picker Title="Keyboard Type"
                SelectedIndexChanged="OnPickerSelectedIndexChanged">
            <Picker.Items>
                <x:String>Default</x:String>
                <x:String>Text</x:String>
                <x:String>Chat</x:String>
                <x:String>Url</x:String>
                <x:String>Email</x:String>
                <x:String>Telephone</x:String>
                <x:String>Numeric</x:String>
            </Picker.Items>
        </Picker>
    </StackLayout>
</ContentPage>
```

The program sets two properties of `Picker`: The `Title` property is a string that identifies the function of the `Picker`. The `Items` property is of type `IList<string>`, and generally you initialize it with a list of `x:String` tags in the XAML file. (`Picker` has no content property attribute, so the explicit `Picker.Items` tags are required.) In code, you can use the `Add` or `Insert` method defined by `IList<string>` to put `string` items into the collection.

Here's what you'll see when you first run the program:




The visual representation of the `Picker` is quite similar to the `Entry` but with the `Title` property displayed. Tapping the `Picker` invokes a platform-specific scrollable list of items:



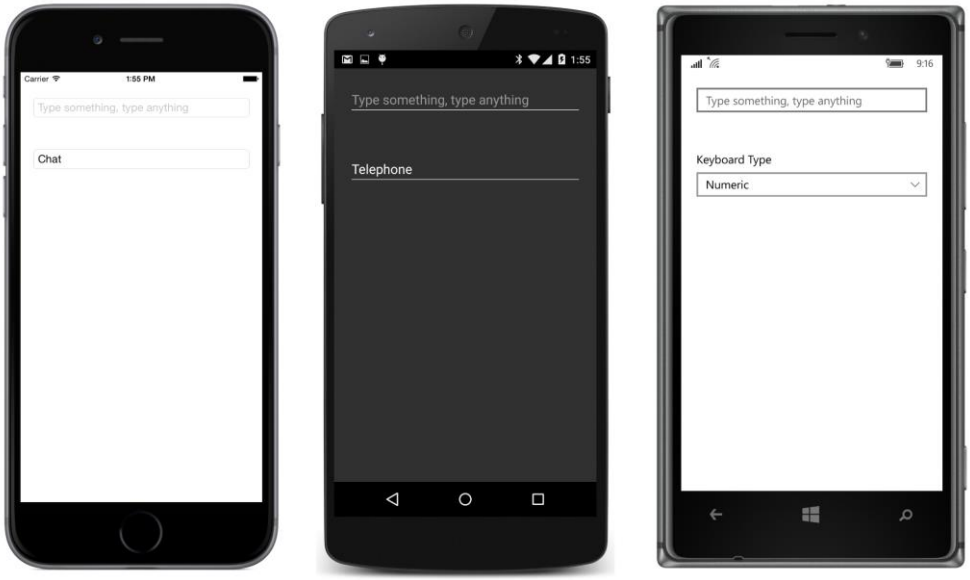

When you press **Done** on the iOS screen, or **OK** on the Android screen, or just tap an item on the Windows list, the `Picker` fires a `SelectedIndexChanged` event. The `SelectedIndex` property of `Picker` is a zero-based number indicating the particular item the user selected. If no item is selected—which is the case when the `Picker` is first created and initialized—`SelectedIndex` equals –1.

The **PickerDemo** program handles the `SelectedIndexChanged` event in the code-behind file. It obtains the `SelectedIndex` from the `Picker`, uses that number to index the `Items` collection of the `Picker`, and then uses reflection to obtain the corresponding `Keyboard` object, which it sets to the `Keyboard` property of the `Entry`:

```
public partial class PickerDemoPage : ContentPage
{
    public PickerDemoPage()
    {
        InitializeComponent();
    }

    void OnPickerSelectedIndexChanged(object sender, EventArgs args)
    {
        if (entry == null)
            return;

        Picker picker = (Picker)sender;
        int selectedIndex = picker.SelectedIndex;

        if (selectedIndex == -1)
            return;

        string selectedItem = picker.Items[selectedIndex];
        PropertyInfo propertyInfo = typeof(Keyboard).GetRuntimeProperty(selectedItem);
```

```
        entry.Keyboard = (Keyboard)propertyInfo.GetValue(null);
    }
}
```

At the same time, the interactive `Picker` display is dismissed, and the `Picker` now displays the selected item:




On iOS and Android, the selection replaces the `Title` property, so in a real-life program you might want to provide a simple `Label` on these two platforms to remind the user of the function of the `Picker`.

You can initialize the `Picker` to display a particular item by setting the `SelectedIndex` property. However, you must set `SelectedIndex` *after* filling the `Items` collection, so you'll probably do it from code or use property-element syntax:

```
<Picker Title="Keyboard Type"
        SelectedIndexChanged="OnPickerSelectedIndexChanged">
    <Picker.Items>
        <x:String>Default</x:String>
        <x:String>Text</x:String>
        <x:String>Chat</x:String>
        <x:String>Url</x:String>
        <x:String>Email</x:String>
        <x:String>Telephone</x:String>
        <x:String>Numeric</x:String>
    </Picker.Items>

    <Picker.SelectedIndex>
        6
    </Picker.SelectedIndex>
```

```
</Picker>
```

## Data binding the Picker

The `Items` property of `Picker` is not backed by a bindable property; hence, it cannot be the target of a data binding. You cannot bind a collection to a `Picker`. If you need that facility, you'll probably want to use `ListView` instead.

On the other hand, the `SelectedIndex` property of the `Picker` is backed by a `BindableProperty` and has a default binding mode of `TwoWay`. This seems to suggest that you can use `SelectedIndex` in a data binding, and that is true. However, an integer index is usually not what you want in a data binding.

Even if `Picker` had a `SelectedItem` property that provided the actual item rather than the index of the item, that wouldn't be optimum either. This hypothetical `SelectedItem` property would be of type `string`, and usually that's not very useful in data bindings either.

After contemplating this problem—and perhaps being exposed to the `ListView` coming up next—you might try to create a class named `BindablePicker` that derives from `Picker`. Such a class could have an `ObjectItems` property of type `IList<object>` and a `SelectedItem` property of type `object`. However, without any additional information, this `BindablePicker` class would be forced to convert each object in the collection to a string for the underlying `Picker`, and the only generalized way to convert an object to a string is with the object's `ToString` method. Perhaps the string obtained from `ToString` is useful; perhaps not. (You'll see shortly how the `ListView` solves this problem in a very flexible manner.)

Perhaps a better solution for data binding a `Picker` is a value converter that converts between the `SelectedIndex` property of the `Picker` and an object corresponding to each text string in the `Items` collection. To accomplish this conversion, the value converter can maintain its own collection of objects that correspond to the strings displayed by the `Picker`. This means that you'll have two lists associated with the `Picker`—one list of strings displayed by the `Picker` and another list of objects associated with these strings. These two lists must be in exact correspondence, of course, but if the two lists are defined close to each other in the XAML file, there shouldn't be much confusion, and the scheme will have the advantage of being very flexible.

Such a value converter might be called `IndexToObjectConverter`.

Or maybe not. In the general case, you'll want the `SelectedIndex` property of the `Picker` to be the *target* of the data binding. If `SelectedIndex` is the data-binding target, then the `Picker` can be used with a ViewModel as the data-binding source. For that reason, the value converter is better named `ObjectToIndexConverter`. Here's the class in the **Xamarin.FormsBook.Toolkit** library:

```
using System;
using System.Collections.Generic;
using System.Globalization;
using Xamarin.Forms;
```

```
namespace Xamarin.FormsBook.Toolkit
{
    [ContentProperty("Items")]
    public class ObjectToIndexConverter<T> : IValueConverter
    {
        public IList<T> Items { set; get; }

        public ObjectToIndexConverter()
        {
            Items = new List<T>();
        }

        public object Convert(object value, Type targetType,
                              object parameter, CultureInfo culture)
        {
            if (value == null || !(value is T) || Items == null)
                return -1;

            return Items.IndexOf((T)value);
        }

        public object ConvertBack(object value, Type targetType,
                                  object parameter, CultureInfo culture)
        {
            int index = (int)value;

            if (index < 0 || Items == null || index >= Items.Count)
                return null;

            return Items[index];
        }
    }
}
```

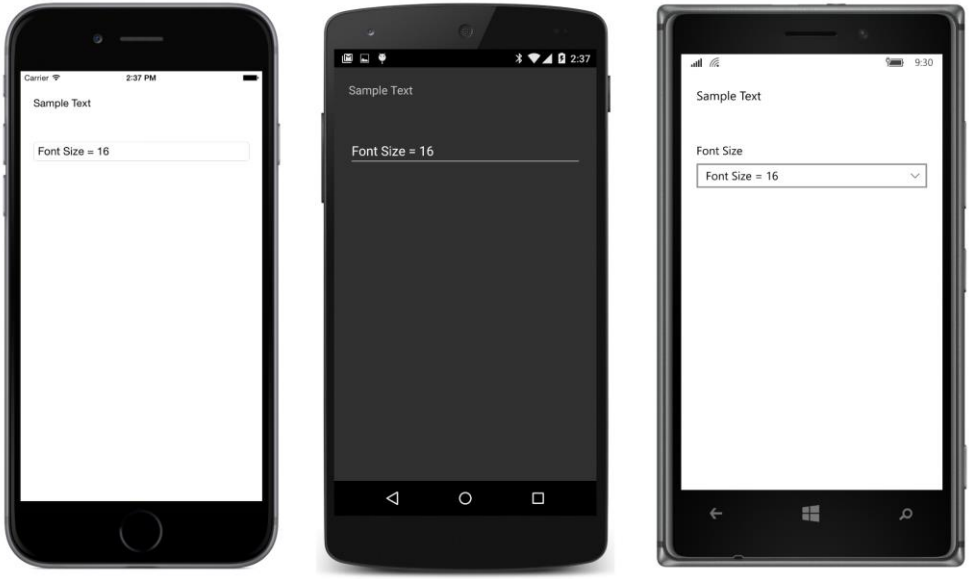
This is a generic class, and it defines a public `Items` property of type `IList<T>`, which is also defined as the content property of the converter. The `Convert` method assumes that the `value` parameter is an object of type `T` and returns the index of that object within the collection. The `ConvertBack` method assumes that the `value` parameter is an index into the `Items` collection and returns that object.

The **PickerBinding** program uses the `ObjectToIndexConverter` to define a binding that allows a `Picker` to be used for selecting a font size for a `Label`. The `Picker` is the data-binding target and the `FontSize` property of the `Label` is the source. The `Binding` object is instantiated in element tags to allow the `ObjectToIndexConverter` to be instantiated and initialized locally and provide an easy visual confirmation that the two lists correspond to the same values:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:toolkit=
                 "clr-namespace:Xamarin.FormsBook.Toolkit;assembly=Xamarin.FormsBook.Toolkit"
             x:Class="PickerBinding.PickerBindingPage">
```

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

    <StackLayout Padding="20"
                 Spacing="50">

        <Label x:Name="label"
               Text="Sample Text"
               FontSize="16" />

        <Picker Title="Font Size">
            <Picker.Items>
                <x:String>Font Size = 8</x:String>
                <x:String>Font Size = 10</x:String>
                <x:String>Font Size = 12</x:String>
                <x:String>Font Size = 14</x:String>
                <x:String>Font Size = 16</x:String>
                <x:String>Font Size = 20</x:String>
                <x:String>Font Size = 24</x:String>
                <x:String>Font Size = 30</x:String>
            </Picker.Items>

            <Picker.SelectedIndex>
                <Binding Source="{x:Reference label}"
                         Path="FontSize">
                    <Binding.Converter>
                        <toolkit:ObjectToIndexConverter x:TypeArguments="x:Double">
                            <x:Double>8</x:Double>
                            <x:Double>10</x:Double>
                            <x:Double>12</x:Double>
                            <x:Double>14</x:Double>
                            <x:Double>16</x:Double>
                            <x:Double>20</x:Double>
                            <x:Double>24</x:Double>
                            <x:Double>30</x:Double>
                        </toolkit:ObjectToIndexConverter>
                    </Binding.Converter>
                </Binding>
            </Picker.SelectedIndex>
        </Picker>
    </StackLayout>
</ContentPage>
```

By maintaining separate lists of strings and objects, you can make the strings whatever you want. In this case, they include some text to indicate what the number actually means. The `Label` itself is initialized with a `FontSize` setting of 16, and the binding picks up that value to display the corresponding string in the `Picker` when the program first starts up:




The implementations of `Picker` on these three platforms should make it obvious that you don't want to use the `Picker` for more than (say) a dozen items. It's convenient and easy to use, but for lots of items, you want a view made for the job—a view that is designed to display objects not just as simple text strings but with whatever visuals you want.

## Rendering data with ListView

Let's move to `ListView`, which is the primary view for displaying collections of items, usually of the same type. The `ListView` always displays the items in a vertical list and implements scrolling if necessary.

`ListView` is the only class that derives from `ItemsView<T>`, but from that class it inherits its most important property: `ItemsSource` of type `IEnumerable`. To this property a program sets an enumerable collection of data, and it can be any type of data. For that reason, `ListView` is one of the backbones of the View part of the Model-View-ViewModel architectural pattern.

`ListView` also supports single-item selection. The `ListView` highlights the selected item and makes it available as the `SelectedItem` property. Notice that this property is named `SelectedItem` rather than `SelectedIndex`. The property is of type `object`. If no item is currently selected in the `ListView`, the property is `null`. `ListView` fires an `ItemSelected` event when the selected item changes, but often you'll be using data binding in connection with the `SelectedItem` property.

`ListView` defines more properties by far than any other single view in Xamarin.Forms. The discussion in this chapter begins with the most important properties and then progressively covers the more obscure and less common properties.

## Collections and selections

The **ListViewList** program defines a `ListView` that displays 17 Xamarin.Forms `Color` values. The XAML file instantiates the `ListView` but leaves the initialization to the code-behind file:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="ListViewList.ListViewListPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 20, 10, 0"
                    Android="10, 0"
                    WinPhone="10, 0" />
    </ContentPage.Padding>

    <ListView x:Name="listView" />

</ContentPage>
```

The bulk of this XAML file is devoted to setting a `Padding` so that the `ListView` doesn't extend to the left and right edges of the screen. In some cases, you might want to set an explicit `WidthRequest` for the `ListView` based on the width of the widest item that you anticipate.

The `ItemsSource` property of `ListView` is of type `IEnumerable`, an interface implemented by arrays and the `List` class, but the property is `null` by default. Unlike the `Picker`, the `ListView` does not provide its own collection object. That's your responsibility. The code-behind file of **ListViewList** sets the `ItemsSource` property to an instance of `List<Color>` that is initialized with `Color` values:

```
public partial class ListViewListPage : ContentPage
{
    public ListViewListPage()
    {
        InitializeComponent();

        listView.ItemsSource = new List<Color>
        {
            Color.Aqua, Color.Black, Color.Blue, Color.Fuchsia,
            Color.Gray, Color.Green, Color.Lime, Color.Maroon,
            Color.Navy, Color.Olive, Color.Pink, Color.Purple,
            Color.Red, Color.Silver, Color.Teal, Color.White, Color.Yellow
        };
    }
}
```

When you run this program, you'll discover that you can scroll through the items and select one item by tapping it. These screenshots show how the selected item is highlighted on the three platforms:

Tapping an item also causes the `ListView` to fire both an `ItemTapped` and an `ItemSelected` event. If you tap the same item again, the `ItemTapped` event is fired again but not the `ItemSelected` event. The `ItemSelected` event is fired only if the `SelectedItem` property changes.

Of course, the items themselves aren't very attractive. By default, the `ListView` displays each item by calling the item's `ToString` method, and that's what you see in this `ListView`. But do not fret: Much of the discussion about the `ListView` in this chapter focuses on making the items appear exactly how you'd like!

## The row separator

Look closely at the iOS and Android displays and you'll see a thin line separating the rows. You can suppress the display of that row by setting the `SeparatorVisibility` property to the enumeration member `SeparatorVisibility.None`. The default is `SeparatorVisibility.Default`, which means that a separator line is displayed on the iOS and Android screens but not Windows Phone.

For performance reasons, you should set the `SeparatorVisibility` property before adding items to the `ListView`. You can try this in the **ListViewList** program by setting the property in the XAML file:

```
<ListView x:Name="listView"
          SeparatorVisibility="None" />
```

Here's how it looks:

You can also set the separator line to a different color with the `SeparatorColor` property; for example:

```
<ListView x:Name="listView"
          SeparatorColor="Red" />
```

Now it shows up in red:

The line is rendered in a platform-specific manner. On iOS, that means it doesn't extend fully to the left edge of the `ListView`, and on the Windows platforms, that means that there's no separator line at all.

## Data binding the selected item

One approach to working with the selected item involves handling the `ItemSelected` event of the `ListView` in the code-behind file and using the `SelectedItem` property to obtain the new selected item. (An example is shown later in this chapter.) But in many cases you'll want to use a data binding with the `SelectedItem` property. The **ListViewArray** program defines a data binding between the `SelectedItem` property of the `ListView` with the `Color` property of a `BoxView`:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="ListViewArray.ListViewArrayPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 20, 10, 0"
                    Android="10, 0"
                    WinPhone="10, 0" />
    </ContentPage.Padding>

    <StackLayout>
        <ListView x:Name="listView"
                  SelectedItem="{Binding Source={x:Reference boxView},
                                         Path=Color,
                                         Mode=TwoWay}">
            <ListView.ItemsSource>
                <x:Array Type="{x:Type Color}">
```

```
                    <x:Static Member="Color.Aqua" />
                    <x:Static Member="Color.Black" />
                    <x:Static Member="Color.Blue" />
                    <x:Static Member="Color.Fuchsia" />
                    <x:Static Member="Color.Gray" />
                    <x:Static Member="Color.Green" />
                    <x:Static Member="Color.Lime" />
                    <x:Static Member="Color.Maroon" />
                    <Color>Navy</Color>
                    <Color>Olive</Color>
                    <Color>Pink</Color>
                    <Color>Purple</Color>
                    <Color>Red</Color>
                    <Color>Silver</Color>
                    <Color>Teal</Color>
                    <Color>White</Color>
                    <Color>Yellow</Color>
                </x:Array>
            </ListView.ItemsSource>
        </ListView>

        <BoxView x:Name="boxView"
                 Color="Lime"
                 HeightRequest="100" />

    </StackLayout>
</ContentPage>
```

This XAML file sets the `ItemsSource` property of the `ListView` directly from an array of items. `ItemsSource` is *not* the content property of `ListView` (in fact, `ListView` has no content property at all), so you'll need explicit `ListView.ItemsSource` tags. The `x:Array` element requires a `Type` attribute indicating the type of the items in the array. For the sake of variety, two different approaches of specifying a `Color` value are shown. You can use anything that results in a value of type `Color`.

The `ItemsSource` property of `ListView` is always populated with objects rather than visual elements. For example, if you want to display strings in the `ListView`, use `string` objects from code or `x:String` elements in the XAML file. Do not fill the `ItemsSource` collection with `Label` elements!

The `ListView` is scrollable, and normally when a scrollable view is a child of a `StackLayout`, a `VerticalOptions` setting of `FillAndExpand` is required. However, the `ListView` itself sets its `HorizontalOptions` and `VerticalOptions` properties to `FillAndExpand`.

The data binding targets the `SelectedItem` property of the `ListView` from the `Color` property of the `BoxView`. You might be more inclined to reverse the source and target property of that binding like this:

```
<BoxView x:Name="boxView"
         Color="{Binding Source={x:Reference listView},
                         Path=SelectedItem}"
         HeightRequest="100" />
```

However, the `SelectedItem` property of the `ListView` is `null` by default, which indicates that nothing is selected, and the binding will fail with a `NullReferenceException`. To make the binding on the `BoxView` work, you would need to initialize the `SelectedItem` property of the `ListView` after the items have been added:

```
<ListView x:Name="listView">
    <ListView.ItemsSource>
        <x:Array Type="{x:Type Color}">
            …
        </x:Array>
    </ListView.ItemsSource>

    <ListView.SelectedItem>
        <Color>Lime</Color>
    </ListView.SelectedItem>
</ListView>
```

A better approach—and one that you'll be using in conjunction with MVVM—is to set the binding on the `SelectedItem` property of the `ListView`. The default binding mode for `SelectedItem` is `OneWayToSource`, which means that the following binding sets the `Color` of the `BoxView` to whatever item is selected in the `ListView`:

```
<ListView x:Name="listView"
          SelectedItem="{Binding Source={x:Reference boxView},
                                 Path=Color}">
    …
</ListView>
```

However, if you also want to initialize the `SelectedItem` property from the binding source, use a `TwoWay` binding as shown in the XAML file in the **ListViewArray** program:

```
<StackLayout>
    <ListView x:Name="listView"
              SelectedItem="{Binding Source={x:Reference boxView},
                                     Path=Color,
                                     Mode=TwoWay}">
        …
    </ListView>

    <BoxView x:Name="boxView"
             Color="Lime"
             HeightRequest="100" />
</StackLayout>
```

You'll see that the "Lime" entry in the `ListView` is selected when the program starts up:

Actually, it's hard to tell whether that really is the "Lime" entry without examining the RGB values. Although the `Color` structure defines a bunch of static fields with color names, `Color` values themselves are not identifiable by name. When the data binding sets a `Lime` color value to the `SelectedItem` property of the `ListView`, the `ListView` probably finds a match among its contents using the `Equals` method of the `Color` structure, which compares the components of the two colors.

The improvement of the `ListView` display is certainly a high priority!

If you examine the **ListViewArray** screen very closely, you'll discover that the `Color` items are not displayed in the same order in which they are defined in the array. The **ListViewArray** program has another purpose: to demonstrate that the `ListView` does not make a copy of the collection set to its `ItemsSource` property. Instead, it uses that collection object directly as a source of the items. In the code-behind file, after the `InitializeComponent` call returns, the constructor of `ListViewArrayPage` performs an in-place array sort to order the items by `Hue`:

```
public partial class ListViewArrayPage : ContentPage
{
    public ListViewArrayPage()
    {
        InitializeComponent();

        Array.Sort<Color>((Color[])listView.ItemsSource,
            (Color color1, Color color2) =>
            {
                if (color1.Hue == color2.Hue)
                    return Math.Sign(color1.Luminosity - color2.Luminosity);

                return Math.Sign(color1.Hue - color2.Hue);
            });
```

```
    }
}
```

This sorting occurs after the `ItemsSource` property is set, which occurs when the XAML is parsed by the `InitializeComponent` call, but before the `ListView` actually displays its contents during the layout process.

This code implies that you can change the collection used by the `ListView` dynamically. However, if you want a `ListView` to change its display when the collection changes, the `ListView` must somehow be notified that changes have occurred in the collection that is referenced by its `ItemsSource` property.

Let's examine this problem in more detail.

## The ObservableCollection difference

The `ItemsSource` property of `ListView` is of type `IEnumerable`. Arrays implement the `IEnumerable` interface, and so do the `List` and `List<T>` classes. The `List` and `List<T>` collections are particularly popular for `ListView` because these classes can dynamically reallocate memory to accommodate a collection of almost any size.

You've seen that a collection can be modified after it's been assigned to the `ItemsSource` property of a `ListView`. It should be possible to add items or remove items from the collection referenced by `ItemsSource`, and for the `ListView` to update itself to reflect those changes.

Let's try it. This **ListViewLogger** program instantiates a `ListView` in its XAML file:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="ListViewLogger.ListViewLoggerPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 20, 10, 0"
                    Android="10, 0"
                    WinPhone="10, 0" />
    </ContentPage.Padding>

    <ListView x:Name="listView" />
</ContentPage>
```

The code-behind file sets the `ItemsSource` property of the `ListView` to a `List<DateTime>` object and adds a `DateTime` value to this collection every second:

```
public partial class ListViewLoggerPage : ContentPage
{
    public ListViewLoggerPage()
    {
        InitializeComponent();

        List<DateTime> list = new List<DateTime>();
```

```
        listView.ItemsSource = list;

        Device.StartTimer(TimeSpan.FromSeconds(1), () =>
        {
            list.Add(DateTime.Now);
            return true;
        });
    }
}
```

When you first run this program, it will seem as if nothing is happening. But if you turn the phone or emulator sideways, all the items that have been added to the collection since the program started will be displayed. But you won't see any more until you turn the phone's orientation again.

What's happening? When the `ListView` needs to redraw itself—which is the case when you change the orientation of the phone or emulator—it will use the current `IEnumerable` collection. (This is how the **ListViewArray** program displayed the sorted array. The array was sorted before the `ListView` displayed itself for the first time.)

However, if the `ListView` does not need to redraw itself, there is no way for the `ListView` to know when an item has been added to or removed from the collection. This is not the fault of `ListView`. It's really the fault of the `List` class. The `List` and `List<T>` classes don't implement a notification mechanism that signals the `ListView` when the collection has changed.

To persuade a `ListView` to keep its display updated with newly added data, we need a class very much like `List<T>`, but which includes a notification mechanism.

We need a class exactly like `ObservableCollection`.

`ObservableCollection` is a .NET class. It is defined in the `System.Collections.ObjectModel` namespace, and it implements an interface called `INotifyCollectionChanged`, which is defined in the `System.Collections.Specialized` namespace. In implementing this interface, an `ObservableCollection` fires a `CollectionChanged` event whenever items are added to or removed from the collection, or when items are replaced or reordered.

How does `ListView` know that an `ObservableCollection` object is set to its `ItemsSource` property? When the `ItemsSource` property is set, the `ListView` checks whether the object set to the property implements `INotifyCollectionChanged`. If so, the `ListView` attaches a `CollectionChanged` handler to the collection to be notified of changes. Whenever the collection changes, the `ListView` updates itself.

The **ObservableLogger** program is identical to the **ListViewLogger** program except that it uses an `ObservableCollection<DateTime>` rather than a `List<DateTime>` to maintain the collection:

```
public partial class ObservableLoggerPage : ContentPage
{
    public ObservableLoggerPage()
    {
        InitializeComponent();
```

```
        ObservableCollection<DateTime> list = new ObservableCollection<DateTime>();
        listView.ItemsSource = list;

        Device.StartTimer(TimeSpan.FromSeconds(1), () =>
        {
            list.Add(DateTime.Now);
            return true;
        });
    }
}
```

Now the `ListView` updates itself every second.

Of course, not every application needs this facility, and `ObservableCollection` is overkill for those that don't. But it's an essential part of versatile `ListView` usage.

Sometimes you'll be working with a collection of data items, and the collection itself does not change dynamically—in other words, it always contains the same objects—but properties of the individual items change. Can the `ListView` respond to changes of that sort?

Yes it can, and you'll see an example later in this chapter. Enabling a `ListView` to respond to property changes in the individual items does not require `ObservableCollection` or `INotifyCollectionChanged`. But the data items must implement `INotifyPropertyChanged`, and the `ListView` must display the items using an object called a *cell*.

## Templates and cells

The purpose of `ListView` is to display data. In the real world, data is everywhere, and we are compelled to write computer programs to deal with this data. In programming tutorials such as this book, however, data is harder to come by. So let's invent a little bit of data to explore `ListView` in more depth, and if the data turns out to be otherwise useful, so much the better!

As you know, the colors supported by the Xamarin.Forms `Color` structure are based on the 16 colors defined in the HTML 4.01 standard. Another popular collection of colors is defined in the Cascading Style Sheets (CSS) 3.0 standard. That collection contains 147 named colors (seven of which are duplicates for variant spellings) that were originally derived from color names in the X11 windowing system but converted to camel case.

The `NamedColor` class included in the **Xamarin.FormsBook.Toolkit** library lets your Xamarin.Forms program get access to those 147 colors. The bulk of `NamedColor` is the definition of 147 public static read-only fields of type `Color`. Only a few are shown in an abbreviated list toward the end of the class:

```
public class NamedColor
{
    // Instance members.
    private NamedColor()
    {
```

```
}

public string Name { private set; get; }

public string FriendlyName { private set; get; }

public Color Color { private set; get; }

public string RgbDisplay { private set; get; }

// Static members.
static NamedColor()
{
    List<NamedColor> all = new List<NamedColor>();
    StringBuilder stringBuilder = new StringBuilder();

    // Loop through the public static fields of type Color.
    foreach (FieldInfo fieldInfo in typeof(NamedColor).GetRuntimeFields ())
    {
        if (fieldInfo.IsPublic &&
            fieldInfo.IsStatic &&
            fieldInfo.FieldType == typeof (Color))
        {
            // Convert the name to a friendly name.
            string name = fieldInfo.Name;
            stringBuilder.Clear();
            int index = 0;

            foreach (char ch in name)
            {
                if (index != 0 && Char.IsUpper(ch))
                {
                    stringBuilder.Append(' ');
                }
                stringBuilder.Append(ch);
                index++;
            }

            // Instantiate a NamedColor object.
            Color color = (Color)fieldInfo.GetValue(null);

            NamedColor namedColor = new NamedColor
            {
                Name = name,
                FriendlyName = stringBuilder.ToString(),
                Color = color,
                RgbDisplay = String.Format("{0:X2}-{1:X2}-{2:X2}",
                                           (int)(255 * color.R),
                                           (int)(255 * color.G),
                                           (int)(255 * color.B))
            };

            // Add it to the collection.
            all.Add(namedColor);
```

```
            }
        }
        all.TrimExcess();
        All = all;
    }

    public static IList<NamedColor> All { private set; get; }

    // Color names and definitions from http://www.w3.org/TR/css3-color/
    // (but with color names converted to camel case).
    public static readonly Color AliceBlue = Color.FromRgb(240, 248, 255);
    public static readonly Color AntiqueWhite = Color.FromRgb(250, 235, 215);
    public static readonly Color Aqua = Color.FromRgb(0, 255, 255);
    …
    public static readonly Color WhiteSmoke = Color.FromRgb(245, 245, 245);
    public static readonly Color Yellow = Color.FromRgb(255, 255, 0);
    public static readonly Color YellowGreen = Color.FromRgb(154, 205, 50);
}
```

If your application has a reference to **Xamarin.FormsBook.Toolkit** and a `using` directive for the `Xamarin.FormsBook.Toolkit` namespace, you can use these fields just like the static fields in the `Color` structure. For example:

```
BoxView boxView = new BoxView
{
   Color = NamedColor.Chocolate
};
```

You can also use them in XAML without too much more difficulty. If you have an XML namespace declaration for the **Xamarin.FormsBook.Toolkit** assembly, you can reference `NamedColor` in an `x:Static` markup extension:

```
<BoxView Color="{x:Static toolkit:NamedColor.CornflowerBlue}" />
```

But that's not all: In its static constructor, `NamedColor` uses reflection to create 147 instances of the `NamedColor` class that it stores in a list that is publicly available from the static `All` property. Each instance of the `NamedColor` class has a `Name` property, a `Color` property of type `Color`, a `FriendlyName` property that is the same as the `Name` except with some spaces inserted, and an `RgbDisplay` property that formats the hexadecimal color values.

The `NamedColor` class does not derive from `BindableObject` and does not implement `INotifyPropertyChanged`. Regardless, you can use this class as a binding source. That's because these properties remain constant after each `NamedColor` object is instantiated. Only if these properties later changed would the class need to implement `INotifyPropertyChanged` to serve as a successful binding source.

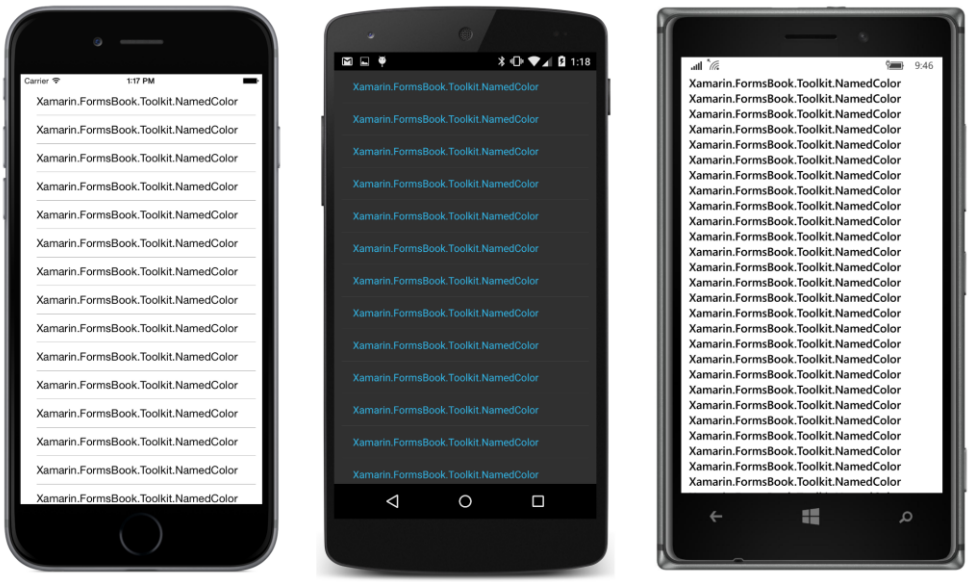
The `NamedColor.All` property is defined to be of type `IList<NamedColor>`, so we can set it to the `ItemsSource` property of a `ListView`. This is demonstrated by the **NaiveNamedColorList** program:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
```

```
            xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
            xmlns:toolkit=
                "clr-namespace:Xamarin.FormsBook.Toolkit;assembly=Xamarin.FormsBook.Toolkit"
            x:Class="NaiveNamedColorList.NaiveNamedColorListPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 20, 10, 0"
                    Android="10, 0"
                    WinPhone="10, 0" />
    </ContentPage.Padding>

    <ListView ItemsSource="{x:Static toolkit:NamedColor.All}" />

</ContentPage>
```

Because this program accesses the `NamedColor` class solely from the XAML file, the program calls `Toolkit.Init` from its `App` constructor.

You'll discover that you can scroll this list and select items, but the items themselves might be a little disappointing, for what you'll see is a list of 147 fully qualified class names:




This might seem disappointing, but in your future real-life programming work involving `ListView`, you'll probably cheer when you see something like this display because it means that you've successfully set `ItemsSource` to a valid collection. The objects are there. You just need to display them a little better.

This particular `ListView` displays the fully qualified class name of `NamedColor` because `NamedColor` does not define its own `ToString` method, and the default implementation of `ToString` displays the class name. One simple solution is to add a `ToString` method to `NamedColor`:

```
public override string ToString()
{
    return FriendlyName;
}
```

Now the `ListView` displays the friendly names of all the colors. Simple enough.

However, in real-life programming, you might not have the option to add code to your data classes because you might not have access to the source code. So let's pursue solutions that are independent of the actual implementation of the data.

`ListView` derives from `ItemsView`, and besides defining the `ItemsSource` property, `ItemsView` also defines a property named `ItemTemplate` of type `DataTemplate`. The `DataTemplate` object gives you (the programmer) the power to display the items of your `ListView` in whatever way you want.

When used in connection with `ListView`, the `DataTemplate` references a `Cell` class to render the items. The `Cell` class derives from `Element`, from which it picks up support for parent/child relationships. But unlike `View`, `Cell` does not derive from `VisualElement`. A `Cell` is more like a *description* of a tree of visual elements rather than a visual element itself.

Here's the class hierarchy showing the five classes that derive from `Cell`:

```
Object
    BindableObject
        Element
            Cell
                TextCell — two Label views
                    ImageCell — derives from TextCell and adds an Image view
                EntryCell — an Entry view with a Label
                SwitchCell — a Switch with a Label
                ViewCell — any View (likely with children)
```

The descriptions of `Cell` types are conceptual only: For performance reasons, the actual composition of a `Cell` is defined within each platform.

As you begin exploring these `Cell` classes and contemplating their use in connection with `ListView`, you might question the relevance of a couple of them. But they're not all intended solely for `ListView`. As you'll see later in this chapter, the `Cell` classes also play a major role in the `TableView`, where they are used in somewhat different ways.

The `Cell` derivatives that have the most applicability to `ListView` are probably `TextCell`, `ImageCell`, and the powerful `ViewCell`, which lets you define your own visuals for the items.

Let's look at `TextCell` first, which defines six properties backed by bindable properties:

- `Text` of type `string`

- `TextColor` of type `Color`
- `Detail` of type `string`
- `DetailColor` of type `Color`
- `Command` of type `ICommand`
- `CommandParameter` of type `Object`

The `TextCell` incorporates two `Label` views that you can set to two different strings and colors. The font characteristics are fixed in a platform-dependent way.

The **TextCellListCode** program contains no XAML. Instead, it demonstrates how to use a `TextCell` in code to display properties of all the `NamedColor` objects:

```
public class TextCellListCodePage : ContentPage
{
    public TextCellListCodePage()
    {
        // Define the DataTemplate.
        DataTemplate dataTemplate = new DataTemplate(typeof(TextCell));
        dataTemplate.SetBinding(TextCell.TextProperty, "FriendlyName");
        dataTemplate.SetBinding(TextCell.DetailProperty,
            new Binding(path: "RgbDisplay", stringFormat: "RGB = {0}"));

        // Build the page.
        Padding = new Thickness(10, Device.OnPlatform(20, 0, 0), 10, 0);

        Content = new ListView
        {
            ItemsSource = NamedColor.All,
            ItemTemplate = dataTemplate
        };
    }
}
```

The first step in using a `Cell` in a `ListView` is to create an object of type `DataTemplate`:

```
DataTemplate dataTemplate = new DataTemplate(typeof(TextCell));
```

Notice that the argument to the constructor is not an *instance* of `TextCell` but the *type* of `TextCell`.

The second step is to call a `SetBinding` method on the `DataTemplate` object, but notice how these `SetBinding` calls actually target bindable properties of the `TextCell`:

```
dataTemplate.SetBinding(TextCell.TextProperty, "FriendlyName");
dataTemplate.SetBinding(TextCell.DetailProperty,
    new Binding(path: "RgbDisplay", stringFormat: "RGB = {0}"));
```

These `SetBinding` calls are identical to bindings that you might set on a `TextCell` object, but at the time of these calls, there are no instances of `TextCell` on which to set the bindings!

If you'd like, you can also set some properties of the `TextCell` to constant values by calling the `SetValue` method of the `DataTemplate` class:

```
dataTemplate.SetValue(TextCell.TextColorProperty, Color.Blue);
dataTemplate.SetValue(TextCell.DetailColorProperty, Color.Red);
```

These `SetValue` calls are similar to calls you might make on visual elements instead of setting properties directly.

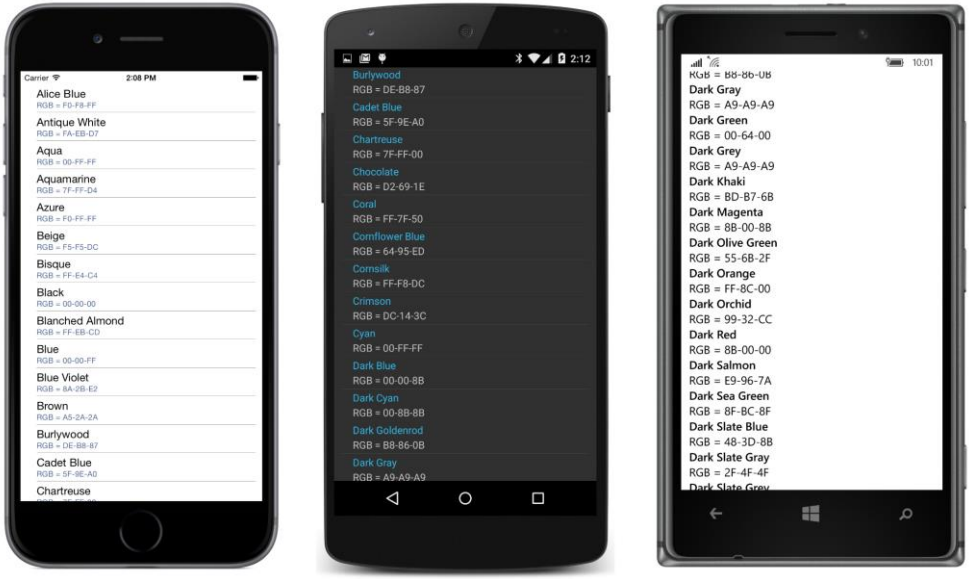
The `SetBinding` and `SetValue` methods should be very familiar to you because they are defined by `BindableObject` and inherited by very many classes in Xamarin.Forms. However, `DataTemplate` does not derive from `BindableObject` and instead defines its own `SetBinding` and `SetValue` methods. The purpose of these methods is *not* to bind or set properties of the `DataTemplate` instance. Because `DataTemplate` doesn't derive from `BindableObject`, it has no bindable properties of its own. Instead, `DataTemplate` simply saves these settings in two internal dictionaries that are publicly accessible through two properties that `DataTemplate` defines, named `Bindings` and `Values`.

The third step in using a `Cell` with `ListView` is to set the `DataTemplate` object to the `ItemTemplate` property of the `ListView`:

```
Content = new ListView
{
    ItemsSource = NamedColor.All,
    ItemTemplate = dataTemplate
};
```

Here's what happens (conceptually anyway):

When the `ListView` needs to display a particular item (in this case, a `NamedColor` object), it instantiates the type passed to the `DataTemplate` constructor, in this case a `TextCell`. Any bindings or values that have been set on the `DataTemplate` are then transferred to this `TextCell`. The `BindingContext` of each `TextCell` is set to the particular item being displayed, which in this case is a particular `NamedColor` object, and that's how each item in the `ListView` displays properties of a particular `NamedColor` object. Each `TextCell` is a visual tree with identical data bindings, but with a unique `BindingContext` setting. Here's the result:




In general, the `ListView` will not create all the visual trees at once. For performance purposes, it will create them only as necessary as the user scrolls new items into view. You can get some sense of this if you install handlers for the `ItemAppearing` and `ItemDisappearing` events defined by `ListView`. You'll discover that these events don't exactly track the visuals—items are reported as appearing before they scroll into view, and are reported as disappearing after they scroll out of view—but the exercise is instructive nevertheless.

You can also get a sense of what's going on with an alternative constructor for `DataTemplate` that takes a `Func` object:

```
DataTemplate dataTemplate = new DataTemplate(() =>
{
    return new TextCell();
});
```

The `Func` object is called only as the `TextCell` objects are required for the items, although these calls actually are made somewhat in advance of the items scrolling into view.

You might want to include code that actually counts the number of `TextCell` instances being created and displays the result in the **Output** window of Visual Studio or Xamarin Studio:

```
int count = 0;
DataTemplate dataTemplate = new DataTemplate(() =>
    {

        System.Diagnostics.Debug.WriteLine("Text Cell Number " + (++count));
        return new TextCell();
    });
```

As you scroll down to the bottom, you'll discover that a maximum of 147 `TextCell` objects are created for the 147 items in the `ListView`. The `TextCell` objects are cached, but not reused as items scroll in and out of view. However, on a lower level—in particular, involving the platform-specific `TextCellRenderer` objects and the underlying platform-specific visuals created by these renderers—the visuals are reused.

This alternative `DataTemplate` constructor with the `Func` argument might be handy if you need to set some properties on the cell object that you can't set using data bindings. Perhaps you've created a `ViewCell` derivative that requires an argument in its constructor. In general, however, use the constructor with the `Type` argument or define the data template in XAML.

In XAML, the binding syntax somewhat distorts the actual mechanics used to generate visual trees for the `ListView` items, but at the same time the syntax is conceptually clearer and visually more elegant. Here's the XAML file from the **TextCellListXaml** program that is functionally identical to the **TextCellListCode** program:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:toolkit=
                 "clr-namespace:Xamarin.FormsBook.Toolkit;assembly=Xamarin.FormsBook.Toolkit"
             x:Class="TextCellListXaml.TextCellListXamlPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 20, 10, 0"
                    Android="10, 0"
                    WinPhone="10, 0" />
    </ContentPage.Padding>

    <ListView ItemsSource="{x:Static toolkit:NamedColor.All}">
        <ListView.ItemTemplate>
            <DataTemplate>
                <TextCell Text="{Binding FriendlyName}"
                          Detail="{Binding RgbDisplay, StringFormat='RGB = {0}'}" />
            </DataTemplate>
        </ListView.ItemTemplate>
    </ListView>
</ContentPage>
```

In XAML, set a `DataTemplate` to the `ItemTemplate` property of the `ListView` and define `TextCell` as a child of `DataTemplate`. Then simply set the data bindings on the `TextCell` properties as if the `TextCell` were a normal visual element. These bindings don't need `Source` settings because a `BindingContext` has been set on each item by the `ListView`.

You'll appreciate this syntax even more when you define your own custom cells.

## Custom cells

One of the classes that derives from `Cell` is named `ViewCell`, which defines a single property named `View` that lets you define a custom visual tree for the display of items in a `ListView`.

There are several ways to define a custom cell, but some are less pleasant than others. Perhaps the greatest amount of work involves mimicking the existing `Cell` classes, which doesn't involve `ViewCell` at all but instead requires that you create platform-specific cell renderers. You can alternatively derive a class from `ViewCell`, define several bindable properties of that class similar to the bindable properties of `TextCell` and the other `Cell` derivatives, and define a visual tree for the cell in either XAML or code, much as you would do for a custom view derived from `ContentView`. You can then use that custom cell in code or XAML just like `TextCell`.

If you want to do the job entirely in code, you can use the `DataTemplate` constructor with the `Func` argument and build the visual tree in code as each item is requested. This approach allows you to define the data bindings as the visual tree is being built instead of setting bindings on the `DataTemplate`.

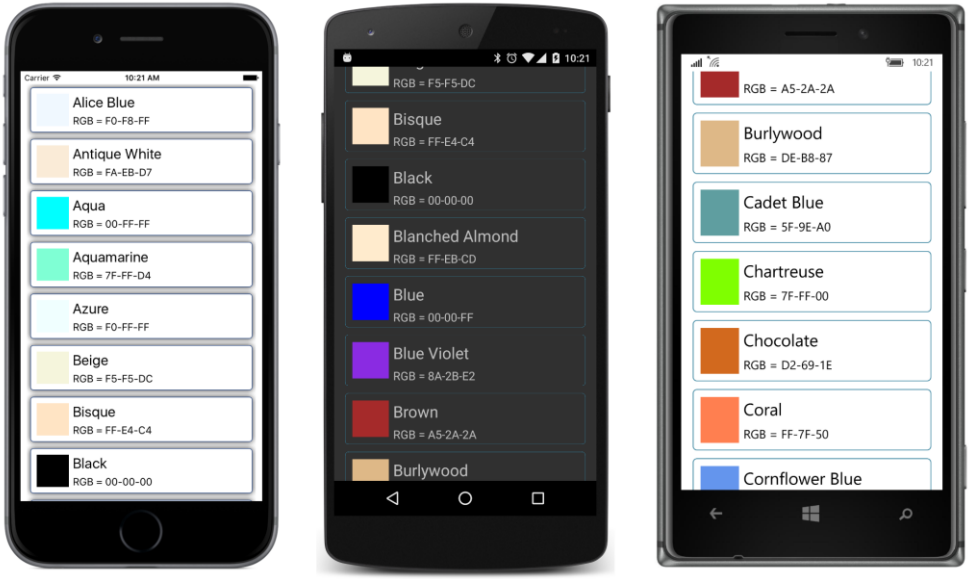
But certainly the easiest approach is defining the visual tree and bindings of the cell right in XAML within the `ListView` element. The **CustomNamedColorList** program demonstrates this technique. Everything is in the XAML file:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:toolkit=
                 "clr-namespace:Xamarin.FormsBook.Toolkit;assembly=Xamarin.FormsBook.Toolkit"
             x:Class="CustomNamedColorList.CustomNamedColorListPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 20, 10, 0"
                    Android="10, 0"
                    WinPhone="10, 0" />
    </ContentPage.Padding>

    <ListView SeparatorVisibility="None"
              ItemsSource="{x:Static toolkit:NamedColor.All}">
        <ListView.RowHeight>
            <OnPlatform x:TypeArguments="x:Int32"
                        iOS="80"
                        Android="80"
                        WinPhone="90" />
        </ListView.RowHeight>

        <ListView.ItemTemplate>
            <DataTemplate>
                <ViewCell>
                    <ContentView Padding="5">
                        <Frame OutlineColor="Accent"
                               Padding="10">
                            <StackLayout Orientation="Horizontal">
                                <BoxView x:Name="boxView"
                                         Color="{Binding Color}"
                                         WidthRequest="50"
                                         HeightRequest="50" />
                                <StackLayout>
                                    <Label Text="{Binding FriendlyName}"
```

```
                    FontSize="22"
                    VerticalOptions="StartAndExpand" />
                <Label Text="{Binding RgbDisplay, StringFormat='RGB = {0}'}"
                    FontSize="16"
                    VerticalOptions="CenterAndExpand" />
            </StackLayout>
        </StackLayout>
    </Frame>
</ContentView>
</ViewCell>
</DataTemplate>
</ListView.ItemTemplate>
</ListView>
</ContentPage>
```

Within the `DataTemplate` property-element tags is a `ViewCell`. The content property of `ViewCell` is `View`, so you don't need `ViewCell.View` tags. Instead, a visual tree within the `ViewCell` tags is implicitly set to the `View` property. The visual tree begins with a `ContentView` to add a little padding, then a `Frame` and a pair of nested `StackLayout` elements with a `BoxView` and two `Label` elements. When the `ListView` renders its items, the `BindingContext` for each displayed item is the item itself, so the `Binding` markup extensions are generally very simple.

Notice that the `RowHeight` property of the `ListView` is set with property element tags for platform-dependent values. These values here were obtained empirically by trial and error, and result in the following displays:

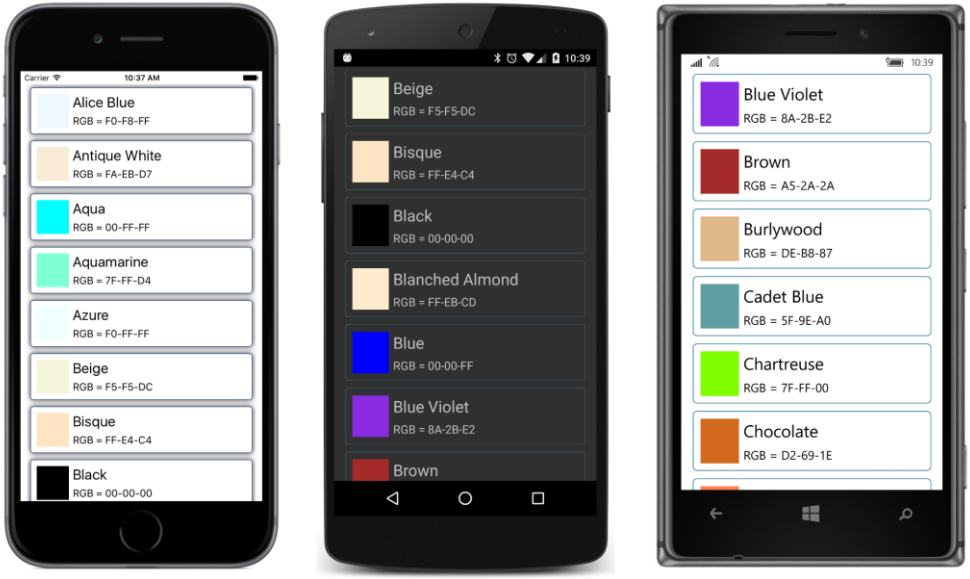



Throughout this book, you have seen several scrollable lists of colors, such as the **ColorBlocks** program in Chapter 4, "Scrolling the stack," and the **ColorViewList** program in Chapter 8, "Code and XAML in harmony," but I think you'll agree that this is the most elegant solution to the problem.

Explicitly setting the `RowHeight` property of the `ListView` is one of two ways to set the height of the rows. You can experiment with another approach by removing the `RowHeight` setting and instead setting the `HasUnevenRows` property to `True`. Here's a variation of the **CustomNamedColorList** program:

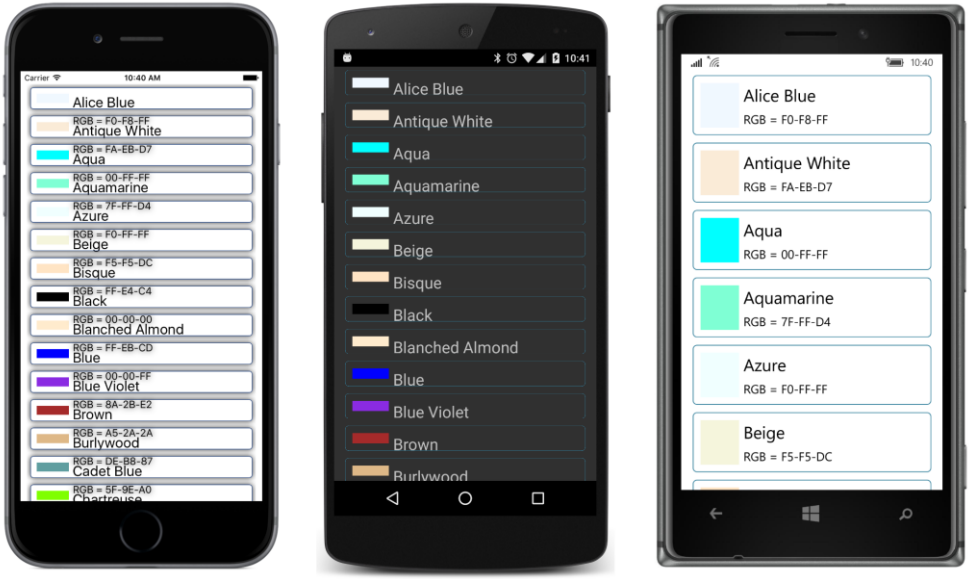
```
<ListView SeparatorVisibility="None"
          ItemsSource="{x:Static toolkit:NamedColor.All}"
          HasUnevenRows="True">

    <ListView.ItemTemplate>
        …
    </ListView.ItemTemplate>
</ListView>
```

The `HasUnevenRows` property is designed specifically to handle cases when the heights of the cells in the `ListView` are not uniform. However, you can also use it for cases when all the cells are the same height but you don't know precisely what that height is. With this setting, the heights of the individual rows are calculated based on the visual tree, and that height is used to space the rows. In this example, the heights of the cells are governed by the heights of the two `Label` elements. The rows are just a little different than the heights explicitly set from the `RowHeight` property:




Although the `HasUnevenRows` property seems to provide an easier approach to sizing cell heights than `RowHeight`, it does have a performance penalty and you should avoid it unless you need it.

But for iOS and Android, you must use one or the other of the two properties when defining a custom cell. Here's what happens when neither property is set:




Only the Windows platforms automatically use the rendered size of the visual tree to determine the row height.

In summary, for best `ListView` performance, use one of the predefined `Cell` classes. If you can't, use `ViewCell` and define your own visual tree. Try your best to supply a specific `RowHeight` property setting with `ViewCell`. Use `HasUnevenRows` only when that is not possible.

## Grouping the ListView items

It's sometimes convenient for the items in a `ListView` to be grouped in some way. For example, a `ListView` that lists the names of a user's friends or contacts is easily navigable if the items are in alphabetical order, but it's even more navigable if all the A's, B's, C's, and so forth are in separate groups, and a few taps are all that's necessary to navigate to a particular group.

The `ListView` supports such grouping and navigation.

As you've discovered, the object you set to the `ItemsSource` property of `ListView` must implement `IEnumerable`. This `IEnumerable` object is a collection of items.

When using `ListView` with the grouping feature, the `IEnumerable` collection you set to `ItemsSource` contains one item for each group, and these items themselves implement `IEnumerable` and contain the objects in that group. In other words, you set the `ItemsSource` property of `ListView` to a collection of collections.

One easy way for the group class to implement `IEnumerable` is to derive from `List` or `ObservableCollection`, depending on whether items can be dynamically added to or removed from the collection. However, you'll want to add a couple of other properties to this class: One property (typically

called `Title`) should be a text description of the group. Another property is a shorter text description that's used to navigate the list. Based on how this text description is used on Windows 10 Mobile, you should keep this short text description to three letters or fewer.

For example, suppose you want to display a list of colors but divided into groups indicating the dominant hue (or lack of hue). Here are seven such groups: grays, reds, yellows, greens, cyans, blues, and magentas.

The `NamedColorGroup` class in the **Xamarin.FormsBook.Toolkit** library derives from `List<NamedColor>` and hence is a collection of `NamedColor` objects. It also defines text `Title` and `ShortName` properties and a `ColorShade` property intended to serve as a pastel-like representative color of the group:

```
public class NamedColorGroup : List<NamedColor>
{
    // Instance members.
    private NamedColorGroup(string title, string shortName, Color colorShade)
    {
        this.Title = title;
        this.ShortName = shortName;
        this.ColorShade = colorShade;
    }

    public string Title { private set; get; }

    public string ShortName { private set; get; }

    public Color ColorShade { private set; get; }

    // Static members.
    static NamedColorGroup()
    {
        // Create all the groups.
        List<NamedColorGroup> groups = new List<NamedColorGroup>
        {
            new NamedColorGroup("Grays", "Gry", new Color(0.75, 0.75, 0.75)),
            new NamedColorGroup("Reds", "Red", new Color(1, 0.75, 0.75)),
            new NamedColorGroup("Yellows", "Yel", new Color(1, 1, 0.75)),
            new NamedColorGroup("Greens", "Grn", new Color(0.75, 1, 0.75)),
            new NamedColorGroup("Cyans", "Cyn", new Color(0.75, 1, 1)),
            new NamedColorGroup("Blues", "Blu", new Color(0.75, 0.75, 1)),
            new NamedColorGroup("Magentas", "Mag", new Color(1, 0.75, 1))
        };

        foreach (NamedColor namedColor in NamedColor.All)
        {
            Color color = namedColor.Color;
            int index = 0;

            if (color.Saturation != 0)
            {
                index = 1 + (int)((12 * color.Hue + 1) / 2) % 6;
```

```
            }
            groups[index].Add(namedColor);
        }

        foreach (NamedColorGroup group in groups)
        {
            group.TrimExcess();
        }

        All = groups;
    }

    public static IList<NamedColorGroup> All { private set; get; }
}
```

A static constructor assembles seven `NamedColorGroup` instances and sets the static `All` property to the collection of these seven objects.

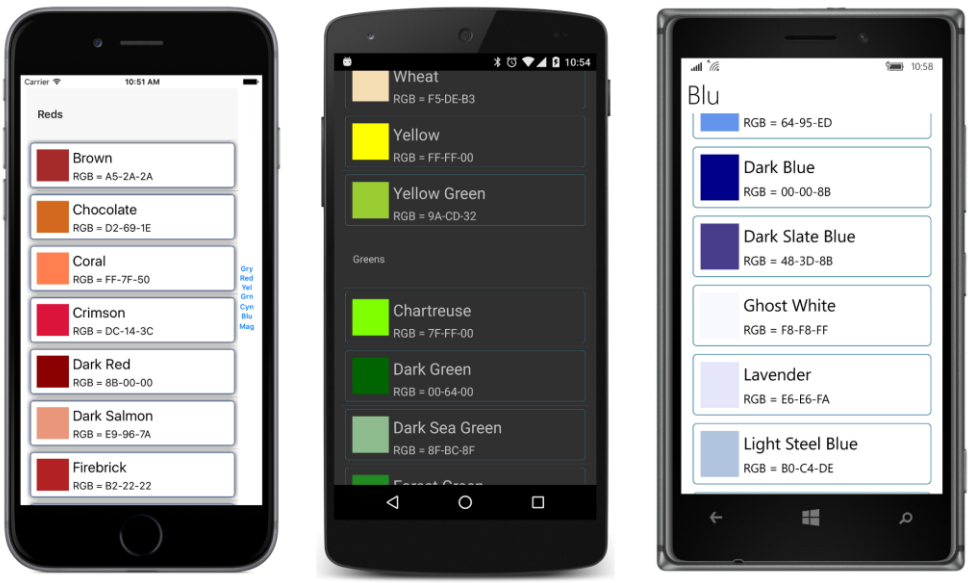
The **ColorGroupList** program uses this new class for its `ListView`. Notice that the `ItemsSource` is set to `NamedColorGroup.All` (a collection of seven items) rather than `NamedColor.All` (a collection of 147 items).

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:toolkit=
                 "clr-namespace:Xamarin.FormsBook.Toolkit;assembly=Xamarin.FormsBook.Toolkit"
             x:Class="ColorGroupList.ColorGroupListPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 20, 10, 0"
                    Android="10, 0"
                    WinPhone="10, 0" />
    </ContentPage.Padding>

    <ListView ItemsSource="{x:Static toolkit:NamedColorGroup.All}"
              IsGroupingEnabled="True"
              GroupDisplayBinding="{Binding Title}"
              GroupShortNameBinding="{Binding ShortName}">
        <ListView.RowHeight>
            <OnPlatform x:TypeArguments="x:Int32"
                        iOS="80"
                        Android="80"
                        WinPhone="90" />
        </ListView.RowHeight>

        <ListView.ItemTemplate>
            <DataTemplate>
                <ViewCell>
                    <ContentView Padding="5">
                        <Frame OutlineColor="Accent"
                               Padding="10">
                            <StackLayout Orientation="Horizontal">
                                <BoxView x:Name="boxView"
```

```
                                    Color="{Binding Color}"
                                    WidthRequest="50"
                                    HeightRequest="50" />
                            <StackLayout>
                                <Label Text="{Binding FriendlyName}"
                                       FontSize="22"
                                       VerticalOptions="StartAndExpand" />
                                <Label Text="{Binding RgbDisplay, StringFormat='RGB = {0}'}"
                                       FontSize="16"
                                       VerticalOptions="CenterAndExpand" />
                            </StackLayout>
                        </StackLayout>
                    </Frame>
                </ContentView>
            </ViewCell>
        </DataTemplate>
    </ListView.ItemTemplate>
</ListView>
</ContentPage>
```

Setting `IsGroupingEnabled` to `True` is very important. Remove that (as well as the `ItemTemplate` setting), and the `ListView` displays seven items identified by the fully qualified class name "Xamarin.FormsBook.Toolkit.NamedColorGroup".

The `GroupDisplayBinding` property is a `Binding` referencing the name of a property in the group items that contains a heading or title for the group. This is displayed in the `ListView` to identify each group:




The `GroupShortNameBinding` property is bound to another property in the group objects that displays a condensed version of the header. If the group headings are just the letters A, B, C, and so

forth, you can use the same property for the short names.

On the iPhone screen, you can see the short names at the right side of the screen. In iOS terminology, this is called an *index* for the list, and tapping one moves to that part of the list.

On the Windows 10 Mobile screen, the headings incorrectly use the `ShortName` rather than the `Title` property. Tapping a heading goes to a navigation screen (called a *jump list*) where all the short names are arranged in a grid. Tapping one goes back to the `ListView` with the corresponding header at the top of the screen.

Android provides no navigation.

Even though the `ListView` is now really a collection of `NamedColorGroup` objects, `SelectedItem` is still a `NamedColor` object.

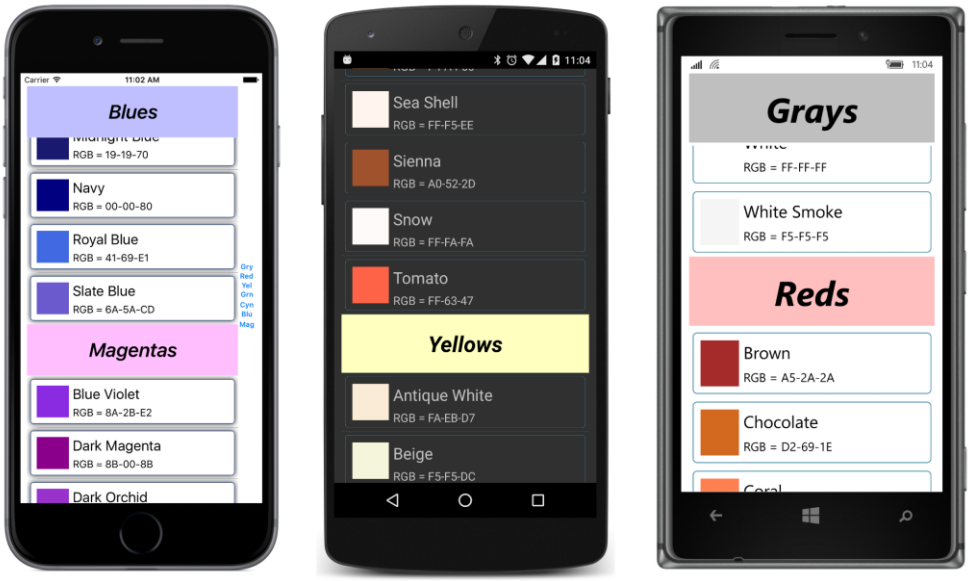
In general, if an `ItemSelected` handler needs to determine the group of a selected item, you can do that "manually" by accessing the collection set to the `ItemsSource` property and using one of the `Find` methods defined by `List`. Or you can store a group identifier within each item. The `Tapped` handler provides the group as well as the item.

## Custom group headers

If you don't like the particular style of the group headers that Xamarin.Forms supplies, there's something you can do about it. Rather than setting a binding to the `GroupDisplayBinding` property, set a `DataTemplate` to the `GroupHeaderTemplate` property:

```
<ListView ItemsSource="{x:Static toolkit:NamedColorGroup.All}"
          IsGroupingEnabled="True"
          GroupShortNameBinding="{Binding ShortName}">
    …
    <ListView.GroupHeaderTemplate>
        <DataTemplate>
            <ViewCell>
                <Label Text="{Binding Title}"
                       BackgroundColor="{Binding ColorShade}"
                       TextColor="Black"
                       FontAttributes="Bold,Italic"
                       HorizontalTextAlignment="Center"
                       VerticalTextAlignment="Center">
                    <Label.FontSize>
                        <OnPlatform x:TypeArguments="x:Double"
                                    iOS="30"
                                    Android="30"
                                    WinPhone="45" />
                    </Label.FontSize>
                </Label>
            </ViewCell>
        </DataTemplate>
    </ListView.GroupHeaderTemplate>
</ListView>
```

Notice that the `Label` has a fixed text color of black, so the `BackgroundColor` property should be set to something light that provides a good contrast with the text. Such a color is available from the `NamedColorGroup` class as the `ColorShade` property. This allows the background of the header to reflect the dominant hue associated with the group:




Notice how the header for the topmost item remains fixed at the top on iOS and Windows 10 Mobile and scrolls off the top of the screen only when another header replaces it.

## ListView and interactivity

An application can interact with its `ListView` in a variety of ways: If the user taps an item, the `ListView` fires an `ItemTapped` event and, if the item is previously not selected, also an `ItemSelected` event. A program can also define a data binding by using the `SelectedItem` property. The `ListView` has a `ScrollTo` method that lets a program scroll the `ListView` to make a particular item visible. Later in this chapter you'll see a refresh facility implemented by `ListView`.

`Cell` itself defines a `Tapped` event, but you'll probably use that event in connection with `TableView` rather than `ListView`. `TextCell` defines the same `Command` and `CommandParameter` properties as `Button` and `ToolbarItem`, but you'll probably use those properties in connection with `TableView` as well. You can also define a context menu on a cell; this is demonstrated in the section "Context menus" later in this chapter.

It is also possible for a `Cell` derivative to contain some interactive views. The `EntryCell` and `SwitchCell` allow the user to interact with an `Entry` or a `Switch`. You can also include interactive views in a `ViewCell`.

The **InteractiveListView** program contains in its XAML file a `ListView` named `listView`. The code-behind file sets the `ItemsSource` property of that `ListView` to a collection of type `List<ColorViewModel>`, containing 100 instances of `ColorViewModel`—a class described in Chapter 18, "MVVM," and which can be found in the **Xamarin.FormsBook.Toolkit** library. Each instance of `ColorViewModel` is initialized to a random color:

```
public partial class InteractiveListViewPage : ContentPage
{
    public InteractiveListViewPage()
    {
        InitializeComponent();

        const int count = 100;
        List<ColorViewModel> colorList = new List<ColorViewModel>(count);
        Random random = new Random();

        for (int i = 0; i < count; i++)
        {
            ColorViewModel colorViewModel = new ColorViewModel();
            colorViewModel.Color = new Color(random.NextDouble(),
                                             random.NextDouble(),
                                             random.NextDouble());
            colorList.Add(colorViewModel);
        }
        listView.ItemsSource = colorList;
    }
}
```

The `ListView` in the XAML file contains a data template using a `ViewCell` that contains three `Slider` views, a `BoxView`, and a few `Label` elements to display the hue, saturation, and luminosity values, all of which are bound to properties of the `ColorViewModel` class:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:toolkit=
                 "clr-namespace:Xamarin.FormsBook.Toolkit;assembly=Xamarin.FormsBook.Toolkit"
             x:Class="InteractiveListView.InteractiveListViewPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 20, 10, 0"
                    Android="10, 0"
                    WinPhone="10, 0" />
    </ContentPage.Padding>

    <ContentPage.Resources>
        <ResourceDictionary>
            <toolkit:ColorToContrastColorConverter x:Key="contrastColor" />
        </ResourceDictionary>
    </ContentPage.Resources>

    <ListView x:Name="listView"
              HasUnevenRows="True">
        <ListView.ItemTemplate>
```

```
            <DataTemplate>
                <ViewCell>
                    <Grid Padding="0, 5">
                        <Grid.RowDefinitions>
                            <RowDefinition Height="Auto" />
                            <RowDefinition Height="Auto" />
                            <RowDefinition Height="Auto" />
                        </Grid.RowDefinitions>

                        <Grid.ColumnDefinitions>
                            <ColumnDefinition Width="*" />
                            <ColumnDefinition Width="Auto" />
                        </Grid.ColumnDefinitions>

                        <Slider Value="{Binding Hue, Mode=TwoWay}"
                                Grid.Row="0" Grid.Column="0" />

                        <Slider Value="{Binding Saturation, Mode=TwoWay}"
                                Grid.Row="1" Grid.Column="0" />

                        <Slider Value="{Binding Luminosity, Mode=TwoWay}"
                                Grid.Row="2" Grid.Column="0" />

                        <ContentView BackgroundColor="{Binding Color}"
                                     Grid.Row="0" Grid.Column="1" Grid.RowSpan="3"
                                     Padding="10">

                            <StackLayout Orientation="Horizontal"
                                         VerticalOptions="Center">
                                <Label Text="{Binding Hue, StringFormat='{0:F2}, '}"
                                       TextColor="{Binding Color,
                                                   Converter={StaticResource contrastColor}}" />

                                <Label Text="{Binding Saturation, StringFormat='{0:F2}, '}"
                                       TextColor="{Binding Color,
                                                   Converter={StaticResource contrastColor}}" />

                                <Label Text="{Binding Luminosity, StringFormat='{0:F2}'}"
                                       TextColor="{Binding Color,
                                                   Converter={StaticResource contrastColor}}" />
                            </StackLayout>
                        </ContentView>
                    </Grid>
                </ViewCell>
            </DataTemplate>
        </ListView.ItemTemplate>
    </ListView>
</ContentPage>
```

The `Label` elements sit on top of the `BoxView`, so they should be made a color that contrasts with the background. This is accomplished with the `ColorToContrastColorConverter` class (also in **Xamarin.FormsBook.Toolkit**), which calculates the luminance of the color by using a standard formula and then converts to `Color.Black` for a light color and `Color.White` for a dark color:

```
namespace Xamarin.FormsBook.Toolkit
{
    public class ColorToContrastColorConverter : IValueConverter
    {
        public object Convert(object value, Type targetType,
                              object parameter, CultureInfo culture)
        {
            return ColorToContrastColor((Color)value);
        }

        public object ConvertBack(object value, Type targetType,
                                  object parameter, CultureInfo culture)
        {
            return ColorToContrastColor((Color)value);
        }

        Color ColorToContrastColor(Color color)
        {
            // Standard luminance calculation.
            double luminance = 0.30 * color.R +
                               0.59 * color.G +
                               0.11 * color.B;

            return luminance > 0.5 ? Color.Black : Color.White;
        }
    }
}
```

Here's the result:


Each of the items independently lets you manipulate the three `Slider` elements to select a new

color, and while this example might seem a little artificial, a real-life example involving a collection of identical visual trees is not inconceivable. Even if there are just a few items in the collection, it might make sense to use a `ListView` that displays all the items on the screen and doesn't scroll. `ListView` is one of the most powerful tools that XAML provides to compensate for its lack of programming loops.

# ListView and MVVM

`ListView` is one of the major players in the `View` part of the Model-View-ViewModel architecture. Whenever a ViewModel contains a collection, a `ListView` generally displays the items.

## A collection of ViewModels

Let's explore the use of `ListView` in MVVM with some data that more closely approximates a real-life example. This is a collection of information about 65 fictitious students of the fictitious School of Fine Art, including images of their overly spherical heads. These images and an XML file containing the student names and references to the bitmaps are in a website at http://xamarin.github.io/xamarin-forms-book-samples/SchoolOfFineArt. This website is hosted from the same GitHub repository as the source code for this book, and the contents of the site can be found in the **gh-pages** branch of that repository.

The Students.xml file at that site contains information about the school and students. Here's the beginning and the end with abbreviated URLs of the photos.

```
<StudentBody xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
             xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <School>School of Fine Art</School>
  <Students>
    <Student>
      <FullName>Adam Harmetz</FullName>
      <FirstName>Adam</FirstName>
      <MiddleName />
      <LastName>Harmetz</LastName>
      <Sex>Male</Sex>
      <PhotoFilename>http://xamarin.github.io/.../.../AdamHarmetz.png</PhotoFilename>
      <GradePointAverage>3.01</GradePointAverage>
    </Student>
    <Student>
      <FullName>Alan Brewer</FullName>
      <FirstName>Alan</FirstName>
      <MiddleName />
      <LastName>Brewer</LastName>
      <Sex>Male</Sex>
      <PhotoFilename>http://xamarin.github.io/.../.../AlanBrewer.png</PhotoFilename>
      <GradePointAverage>1.17</GradePointAverage>
    </Student>
    ...
    <Student>
```

```
      <FullName>Tzipi Butnaru</FullName>
      <FirstName>Tzipi</FirstName>
      <MiddleName />
      <LastName>Butnaru</LastName>
      <Sex>Female</Sex>
      <PhotoFilename>http://xamarin.github.io/.../.../TzipiButnaru.png</PhotoFilename>
      <GradePointAverage>3.76</GradePointAverage>
    </Student>
    <Student>
      <FullName>Zrinka Makovac</FullName>
      <FirstName>Zrinka</FirstName>
      <MiddleName />
      <LastName>Makovac</LastName>
      <Sex>Female</Sex>
      <PhotoFilename>http://xamarin.github.io/.../.../ZrinkaMakovac.png</PhotoFilename>
      <GradePointAverage>2.73</GradePointAverage>
    </Student>
  </Students>
</StudentBody>
```

The grade point averages were randomly generated when this file was created.

In the **Libraries** directory among the source code for this book, you'll find a library project named **SchoolOfFineArt** that accesses this XML file and uses XML deserialization to convert it into classes named `Student`, `StudentBody`, and `SchoolViewModel`. Although the `Student` and `StudentBody` classes don't have the words `ViewModel` in their names, they qualify as ViewModels regardless.

The `Student` class derives from `ViewModelBase` (a copy of which is included in the **SchoolOfFine-Art** library) and defines the seven properties associated with each `Student` element in the XML file. An eighth property is used in a future chapter. The class also defines four additional properties of type `ICommand` and a final property named `StudentBody`. These final five properties are not set from the XML deserialization, as the `XmlIgnore` attributes indicate:

```
namespace SchoolOfFineArt
{
    public class Student : ViewModelBase
    {
        string fullName, firstName, middleName;
        string lastName, sex, photoFilename;
        double gradePointAverage;
        string notes;

        public Student()
        {
            ResetGpaCommand = new Command(() => GradePointAverage = 2.5m);
            MoveToTopCommand = new Command(() => StudentBody.MoveStudentToTop(this));
            MoveToBottomCommand = new Command(() => StudentBody.MoveStudentToBottom(this));
            RemoveCommand = new Command(() => StudentBody.RemoveStudent(this));
        }

        public string FullName
        {
```

```
        set { SetProperty(ref fullName, value); }
        get { return fullName; }
    }

    public string FirstName
    {
        set { SetProperty(ref firstName, value); }
        get { return firstName; }
    }

    public string MiddleName
    {
        set { SetProperty(ref middleName, value); }
        get { return middleName; }
    }

    public string LastName
    {
        set { SetProperty(ref lastName, value); }
        get { return lastName; }
    }

    public string Sex
    {
        set { SetProperty(ref sex, value); }
        get { return sex; }
    }

    public string PhotoFilename
    {
        set { SetProperty(ref photoFilename, value); }
        get { return photoFilename; }
    }

    public double GradePointAverage
    {
        set { SetProperty(ref gradePointAverage, value); }
        get { return gradePointAverage; }
    }

    // For program in Chapter 25.
    public string Notes
    {
        set { SetProperty(ref notes, value); }
        get { return notes; }
    }

    // Properties for implementing commands.
    [XmlIgnore]
    public ICommand ResetGpaCommand { private set; get; }

    [XmlIgnore]
    public ICommand MoveToTopCommand { private set; get; }
```

```
        [XmlIgnore]
        public ICommand MoveToBottomCommand { private set; get; }

        [XmlIgnore]
        public ICommand RemoveCommand { private set; get; }

        [XmlIgnore]
        public StudentBody StudentBody { set; get; }
    }
}
```

The four properties of type `ICommand` are set in the `Student` constructor and associated with short methods, three of which call methods in the `StudentBody` class. These will be discussed in more detail later.

The `StudentBody` class defines the `School` and `Students` properties. The constructor initializes the `Students` property as an `ObservableCollection<Student>` object. In addition, `StudentBody` defines three methods called from the `Student` class that can remove a student from the list or move a student to the top or bottom of the list:

```
namespace SchoolOfFineArt
{
    public class StudentBody : ViewModelBase
    {
        string school;
        ObservableCollection<Student> students = new ObservableCollection<Student>();

        public string School
        {
            set { SetProperty(ref school, value); }
            get { return school; }
        }

        public ObservableCollection<Student> Students
        {
            set { SetProperty(ref students, value); }
            get { return students; }
        }

        // Methods to implement commands to move and remove students.
        public void MoveStudentToTop(Student student)
        {
            Students.Move(Students.IndexOf(student), 0);
        }

        public void MoveStudentToBottom(Student student)
        {
            Students.Move(Students.IndexOf(student), Students.Count - 1);
        }

        public void RemoveStudent(Student student)
        {
            Students.Remove(student);
```

```
        }
    }
}
```

The `SchoolViewModel` class is responsible for loading the XML file and deserializing it. It contains a single property named `StudentBody`, which corresponds to the root tag of the XAML file. This property is set to the `StudentBody` object obtained from the `Deserialize` method of the `XmlSerializer` class.

```
namespace SchoolOfFineArt
{
    public class SchoolViewModel : ViewModelBase
    {
        StudentBody studentBody;
        Random rand = new Random();

        public SchoolViewModel() : this(null)
        {
        }

        public SchoolViewModel(IDictionary<string, object> properties)
        {
            // Avoid problems with a null or empty collection.
            StudentBody = new StudentBody();
            StudentBody.Students.Add(new Student());

            string uri = "http://xamarin.github.io/xamarin-forms-book-samples" +
                         "/SchoolOfFineArt/students.xml";

            HttpWebRequest request = WebRequest.CreateHttp(uri);

            request.BeginGetResponse((arg) =>
            {
                // Deserialize XML file.
                Stream stream = request.EndGetResponse(arg).GetResponseStream();
                StreamReader reader = new StreamReader(stream);
                XmlSerializer xml = new XmlSerializer(typeof(StudentBody));
                StudentBody = xml.Deserialize(reader) as StudentBody;

                // Enumerate through all the students
                foreach (Student student in StudentBody.Students)
                {
                    // Set StudentBody property in each Student object.
                    student.StudentBody = StudentBody;

                    // Load possible Notes from properties dictionary
                    //      (for program in Chapter 25).
                    if (properties != null && properties.ContainsKey(student.FullName))
                    {
                        student.Notes = (string)properties[student.FullName];
                    }
                }
            }, null);
```

```
            // Adjust GradePointAverage randomly.
            Device.StartTimer(TimeSpan.FromSeconds(0.1),
                () =>
                {
                    if (studentBody != null)
                    {
                        int index = rand.Next(studentBody.Students.Count);
                        Student student = studentBody.Students[index];
                        double factor = 1 + (rand.NextDouble() - 0.5) / 5;
                        student.GradePointAverage = Math.Round(
                            Math.Max(0, Math.Min(5, factor * student.GradePointAverage)), 2);
                    }
                    return true;
                });
        }

        // Save Notes in properties dictionary for program in Chapter 25.
        public void SaveNotes(IDictionary<string, object> properties)
        {
            foreach (Student student in StudentBody.Students)
            {
                properties[student.FullName] = student.Notes;
            }
        }

        public StudentBody StudentBody
        {
            protected set { SetProperty(ref studentBody, value); }
            get { return studentBody; }
        }
    }
}
```

Notice that the data is obtained asynchronously. The properties of the various classes are not set until sometime after the constructor of this class completes. But the implementation of the `INotifyPropertyChanged` interface should allow a user interface to react to data that is acquired sometime after the program starts up.

The callback to `BeginGetResponse` runs in the same secondary thread of execution that is used to download the data in the background. This callback sets some properties that cause `PropertyChanged` events to fire, which result in updates to data bindings and changes to user-interface objects. Doesn't this mean that user-interface objects are being accessed from a second thread of execution? Shouldn't `Device.BeginInvokeOnMainThread` be used to avoid that?

Actually, it's not necessary. Changes in ViewModel properties that are linked to properties of user-interface objects via data bindings don't need to be marshalled to the user-interface thread.

The `SchoolViewModel` class is also responsible for randomly modifying the `GradePointAverage` property of the students, in effect simulating dynamic data. Because `Student` implements `INotify-`

`PropertyChanged` (by virtue of deriving from `ViewModelBase`), we should be able to see these values change dynamically when displayed by the `ListView`.

The **SchoolOfFineArt** library also has a static `Library.Init` method that your program should call if it's referring to the library only from XAML to ensure that the assembly is properly bound to the application.

You might want to play around with the `StudentViewModel` class to get a feel for the nested properties and how they are expressed in data bindings. You can create a new Xamarin.Forms project (named **Tryout**, for example), include the **SchoolOfFineArt** project in the solution, and add a reference from **Tryout** to the **SchoolOfFineArt** library. Then create a `ContentPage` that looks something like this:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:school="clr-namespace:SchoolOfFineArt;assembly=SchoolOfFineArt"
             x:Class="Tryout.TryoutListPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="0, 20, 0, 0" />
    </ContentPage.Padding>

    <ContentPage.BindingContext>
        <school:SchoolViewModel />
    </ContentPage.BindingContext>

    <Label />
</ContentPage>
```

The `BindingContext` of the page is set to the `SchoolViewModel` instance, and you can experiment with bindings on the `Text` property of the `Label`. For example, here's an empty binding:

```
<Label Text="{Binding StringFormat='{0}'}" />
```

That displays the fully qualified class name of the inherited `BindingContext`:

**SchoolOfFineArt.SchoolViewModel**

The `SchoolViewModel` class has one property named `StudentBody`, so set the `Path` of the `Binding` to that:

```
<Label Text="{Binding Path=StudentBody, StringFormat='{0}'}" />
```

Now you'll see the fully-qualified name of the `StudentBody` class:

**SchoolOfFineArt.StudentBody**

The `StudentBody` class has two properties, named `School` and `Students`. Try the `School` property:

```
<Label Text="{Binding Path=StudentBody.School,
                      StringFormat='{0}'}" />
```

Finally, some actual data is displayed rather than just a class name. It's the string from the XML file set to the `School` property:

**School of Fine Art**

The `StringFormat` isn't required in the `Binding` expression because the property is of type `string`. Now try the `Students` property:

```
<Label Text="{Binding Path=StudentBody.Students,
                      StringFormat='{0}'}" />
```

This displays the fully qualified class name of `ObservableCollection` with a collection of `Student` objects:

**System.Collections.ObjectModel.ObservableCollection`1[SchoolOfFineArt.Student]**

It should be possible to index this collection, like so:

```
<Label Text="{Binding Path=StudentBody.Students[0],
                      StringFormat='{0}'}" />
```

That is an object of type `Student`:

**SchoolOfFineArt.Student**

If the entire `Students` collection is loaded at the time of this binding, you should be able to specify any index on the `Students` collection, but an index of 0 is always safe.

You can then access a property of that `Student`, for example:

```
<Label Text="{Binding Path=StudentBody.Students[0].FullName,
                      StringFormat='{0}'}" />
```

And you'll see that student's name:

**Adam Harmetz**

Or, try the `GradePointAverage` property:

```
<Label Text="{Binding Path=StudentBody.Students[0].GradePointAverage,
                      StringFormat='{0}'}" />
```

Initially you'll see the randomly generated value stored in the XML file:

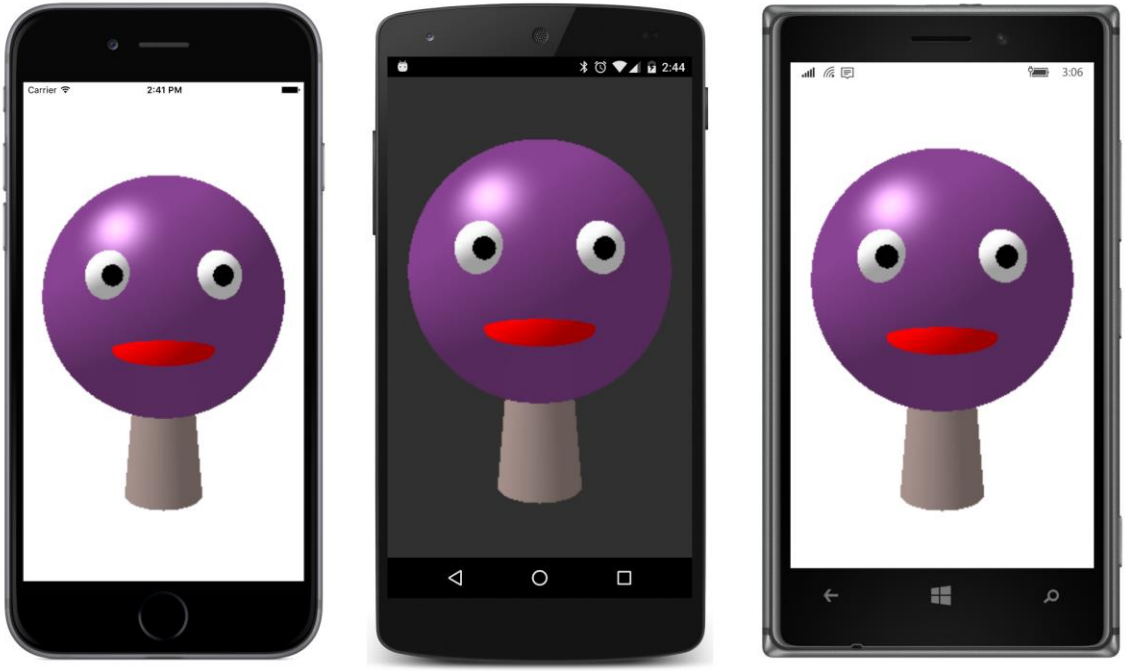
**3.01**

But wait a little while and you should see it change.

Would you like to see a picture of Adam Harmetz? Just change the `Label` to an `Image`, and change the target property to `Source` and the source path to `PhotoFilename`:

```
<Image Source="{Binding Path=StudentBody.Students[0].PhotoFilename}" />
```

And there he is, from the class of 2019:



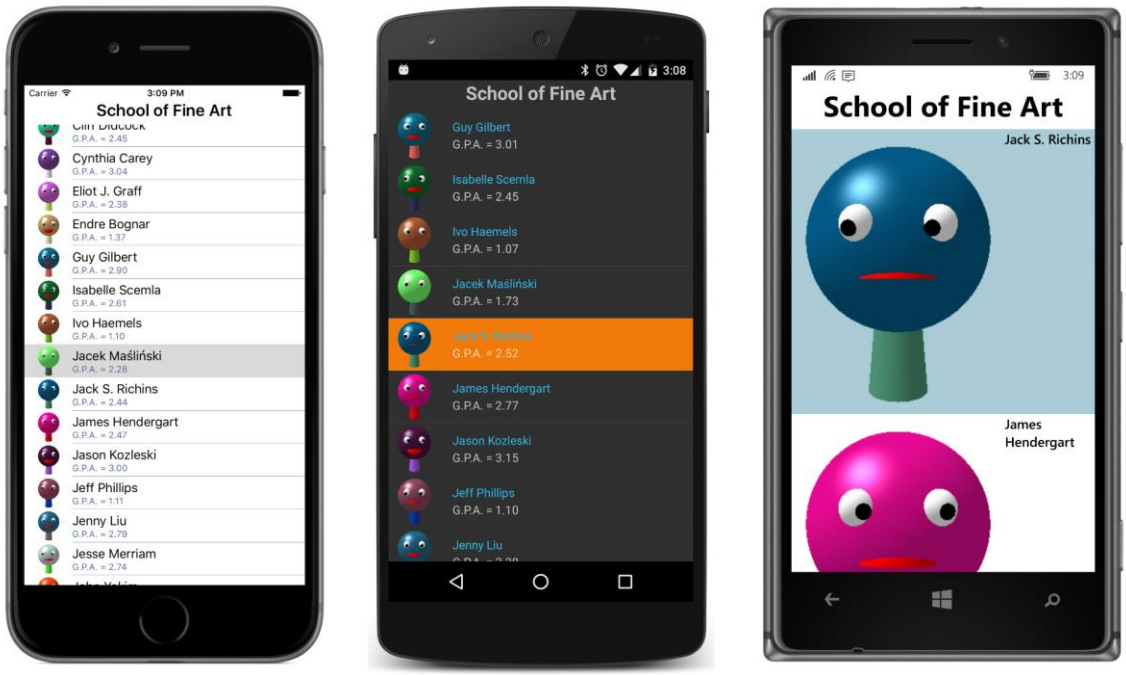

With that understanding of data-binding paths, it should be possible to construct a page that contains both a `Label` that displays the name of the school and a `ListView` that displays all the students with their full names, grade-point averages, and photos. Each item in the `ListView` must display two pieces of text and an image. This is ideal for an `ImageCell`, which derives from `TextCell` and adds an image to the two text items. Here is the **StudentList** program:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:school="clr-namespace:SchoolOfFineArt;assembly=SchoolOfFineArt"
             x:Class="StudentList.StudentListPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="0, 20, 0, 0" />
    </ContentPage.Padding>

    <ContentPage.BindingContext>
        <school:SchoolViewModel />
    </ContentPage.BindingContext>

    <StackLayout BindingContext="{Binding StudentBody}">
        <Label Text="{Binding School}"
               FontSize="Large"
               FontAttributes="Bold"
```

```
                HorizontalTextAlignment="Center" />

        <ListView ItemsSource="{Binding Students}">
            <ListView.ItemTemplate>
                <DataTemplate>
                    <ImageCell ImageSource="{Binding PhotoFilename}"
                               Text="{Binding FullName}"
                               Detail="{Binding GradePointAverage,
                                               StringFormat='G.P.A. = {0:F2}'}" />
                </DataTemplate>
            </ListView.ItemTemplate>
        </ListView>
    </StackLayout>
</ContentPage>
```

As in the experimental XAML file, the `BindingContext` of the `ContentPage` is the `SchoolViewModel` object. The `StackLayout` inherits that `BindingContext` but sets its own `BindingContext` to the `StudentBody` property, and that's the `BindingContext` inherited by the children of the `StackLayout`. The `Text` property of the `Label` is bound to the `School` property of the `StudentBody` class, and the `ItemsSource` property of the `ListView` is bound to the `Students` collection.

This means that the `BindingContext` for each of the items in the `ListView` is a `Student` object, and the `ImageCell` properties can be bound to properties of the `Student` class. The result is scrollable and selectable, although the selection is displayed in a platform-specific manner:




Unfortunately, the Windows Runtime version of the `ImageCell` works a little differently from those

on the other two platforms. If you don't like the default size of these rows, you might be tempted to set the `RowHeight` property, but it doesn't work in the same way across the platforms, and the only consistent solution is to switch to a custom `ViewCell` derivative, perhaps one much like the one in **CustomNamedColorList** but with an `Image` rather than a `BoxView`.

The `Label` at the top of the page shares the `StackLayout` with the `ListView` so that the `Label` stays in place as the `ListView` is scrolled. However, you might want such a header to scroll with the contents of the `ListView`, and you might want to add a footer as well. The `ListView` has `Header` and `Footer` properties of type `object` that you can set to a `string` or an object of any type (in which case the header will display the results of that object's `ToString` method) or to a binding.

Here's one approach: The `BindingContext` of the page is set to the `SchoolViewModel` as before, but the `BindingContext` of the `ListView` is set to the `StudentBody` property. This means that the `ItemsSource` property can reference the `Students` collection in a binding, and the `Header` can be bound to the `School` property:

```
<ContentPage … >
    …
    <ContentPage.BindingContext>
        <school:SchoolViewModel />
    </ContentPage.BindingContext>

    <ListView BindingContext="{Binding StudentBody}"
              ItemsSource="{Binding Students}"
              Header="{Binding School}">
        …
    </ListView>
</ContentPage>
```

That displays the text "School of Fine Art" in a header that scrolls with the `ListView` content.

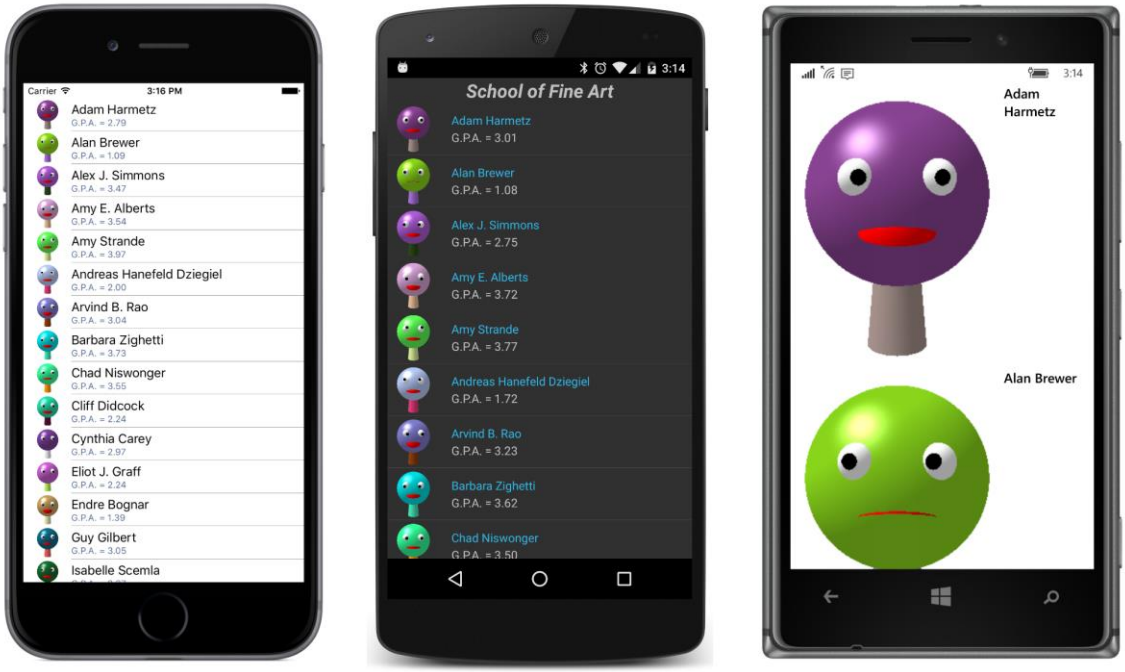
If you'd like to format that header, you can do that as well. Set the `HeaderTemplate` property of the `ListView` to a `DataTemplate`, and within the `DataTemplate` tags define a visual tree. The `BindingContext` for that visual tree is the object set to the `Header` property (in this example, the string with the name of the school).

In the **ListViewHeader** program shown below, the `Header` property is bound to the `School` property. Within the `HeaderTemplate` is a visual tree consisting solely of a `Label`. This `Label` has an empty binding so the `Text` property of that `Label` is bound to the text set to the `Header` property:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:school="clr-namespace:SchoolOfFineArt;assembly=SchoolOfFineArt"
             x:Class="ListViewHeader.ListViewHeaderPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="0, 20, 0, 0" />
    </ContentPage.Padding>

    <ContentPage.BindingContext>
```

```
        <school:SchoolViewModel />
    </ContentPage.BindingContext>

    <ListView BindingContext="{Binding StudentBody}"
              ItemsSource="{Binding Students}"
              Header="{Binding School}">

        <ListView.HeaderTemplate>
            <DataTemplate>
                <Label Text="{Binding}"
                       FontSize="Large"
                       FontAttributes="Bold, Italic"
                       HorizontalTextAlignment="Center" />
            </DataTemplate>
        </ListView.HeaderTemplate>

        <ListView.ItemTemplate>
            <DataTemplate>
                <ImageCell ImageSource="{Binding PhotoFilename}"
                           Text="{Binding FullName}"
                           Detail="{Binding GradePointAverage,
                                            StringFormat='G.P.A. = {0:F2}'}" />
            </DataTemplate>
        </ListView.ItemTemplate>
    </ListView>
</ContentPage>
```

The header shows up only on the Android platform:




## Selection and the binding context

The `StudentBody` class doesn't have a property for the selected student. If it did, you could create a data binding between the `SelectedItem` property of the `ListView` and that selected-student property in `StudentBody`. As usual with MVVM, the property of the view is the data-binding target and the property in the ViewModel is the data-binding source.

However, if you want a detailed view of a student directly, without the intermediary of a ViewModel, then the `SelectedItem` property of the `ListView` can be the binding source. The **SelectedStudentDetail** program shows how this might be done. The `ListView` now shares the screen with a `StackLayout` that contains the detail view. To accommodate landscape and portrait orientations, the `ListView` and `StackLayout` are children of a `Grid` that is manipulated in the code-behind file. The code-behind file also sets the `BindingContext` of the page to an instance of the `SchoolViewModel` class.

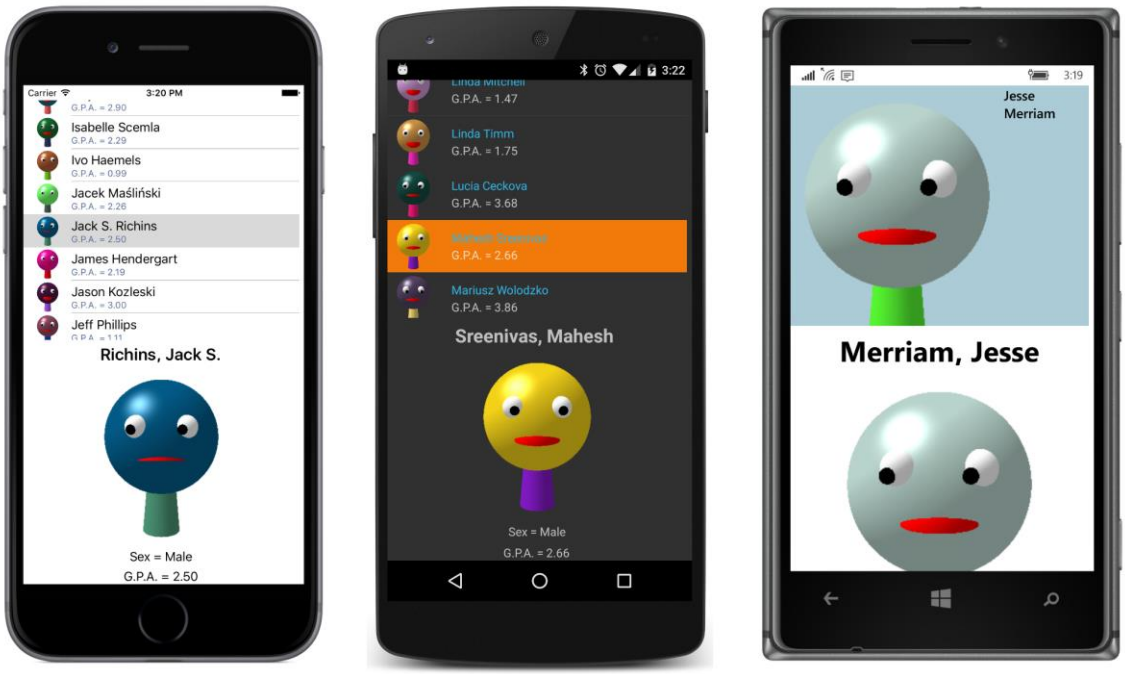
The `BindingContext` of the `StackLayout` named "detailLayout" is bound to the `SelectedItem` property of the `ListView`. Because the `SelectedItem` property is of type `Student`, bindings within the `StackLayout` can simply refer to properties of the `Student` class:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="SelectedStudentDetail.SelectedStudentDetailPage"
             SizeChanged="OnPageSizeChanged">
    <ContentPage.Padding>
```

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

    <Grid x:Name="mainGrid">
        <Grid.RowDefinitions>
            <RowDefinition Height="*" />
            <RowDefinition Height="*" />
        </Grid.RowDefinitions>

        <Grid.ColumnDefinitions>
            <ColumnDefinition Width="*" />
            <ColumnDefinition Width="0" />
        </Grid.ColumnDefinitions>

        <ListView x:Name="listView"
                  Grid.Row="0"
                  Grid.Column="0"
                  ItemsSource="{Binding StudentBody.Students}">
            <ListView.ItemTemplate>
                <DataTemplate>
                    <ImageCell ImageSource="{Binding PhotoFilename}"
                               Text="{Binding FullName}"
                               Detail="{Binding GradePointAverage,
                                                StringFormat='G.P.A. = {0:F2}'}" />
                </DataTemplate>
            </ListView.ItemTemplate>
        </ListView>

        <StackLayout x:Name="detailLayout"
                     Grid.Row="1"
                     Grid.Column="0"
                     BindingContext="{Binding Source={x:Reference listView},
                                              Path=SelectedItem}">
            <StackLayout Orientation="Horizontal"
                         HorizontalOptions="Center"
                         Spacing="0">
                <StackLayout.Resources>
                    <ResourceDictionary>
                        <Style TargetType="Label">
                            <Setter Property="FontSize" Value="Large" />
                            <Setter Property="FontAttributes" Value="Bold" />
                        </Style>
                    </ResourceDictionary>
                </StackLayout.Resources>

                <Label Text="{Binding LastName}" />
                <Label Text="{Binding FirstName, StringFormat=', {0}'}" />
                <Label Text="{Binding MiddleName, StringFormat=' {0}'}" />
            </StackLayout>

            <Image Source="{Binding PhotoFilename}"
                   VerticalOptions="FillAndExpand" />
```

```
            <Label Text="{Binding Sex, StringFormat='Sex = {0}'}"
                   HorizontalOptions="Center" />
            <Label Text="{Binding GradePointAverage, StringFormat='G.P.A. = {0:F2}'}"
                   HorizontalOptions="Center" />
        </StackLayout>
    </Grid>
</ContentPage>
```

When you first run the program, the `ListView` occupies the top half of the page and the entire bottom half of the page is empty. When you select one of the students, the bottom half displays a different formatting of the name, a larger photo (except on the Windows Phone), and additional information:




Notice that all the `Label` elements in the `StackLayout` named "detailLayout" have their `Text` properties set to bindings of properties of the `Student` class. For example, here are the three `Label` elements that display the full name in a horizontal `StackLayout`:

```
<Label Text="{Binding LastName}" />
<Label Text="{Binding FirstName, StringFormat=', {0}'}" />
<Label Text="{Binding MiddleName, StringFormat=' {0}'}" />
```

An alternative approach is to use separate `Label` elements for the text that separate the last name and first name and the first name and middle name:

```
<Label Text="{Binding LastName}" />
<Label Text=", " />
```

```
<Label Text="{Binding FirstName}" />
<Label Text=" " />
<Label Text="{Binding MiddleName}" />
```

Ostensibly, these two approaches seem visually identical. However, if no student is currently selected, the second approach displays a stray comma that looks like an odd speck on the screen. The advantages of using a binding with `StringFormat` is that the `Label` doesn't appear at all if the `BindingContext` is `null`.

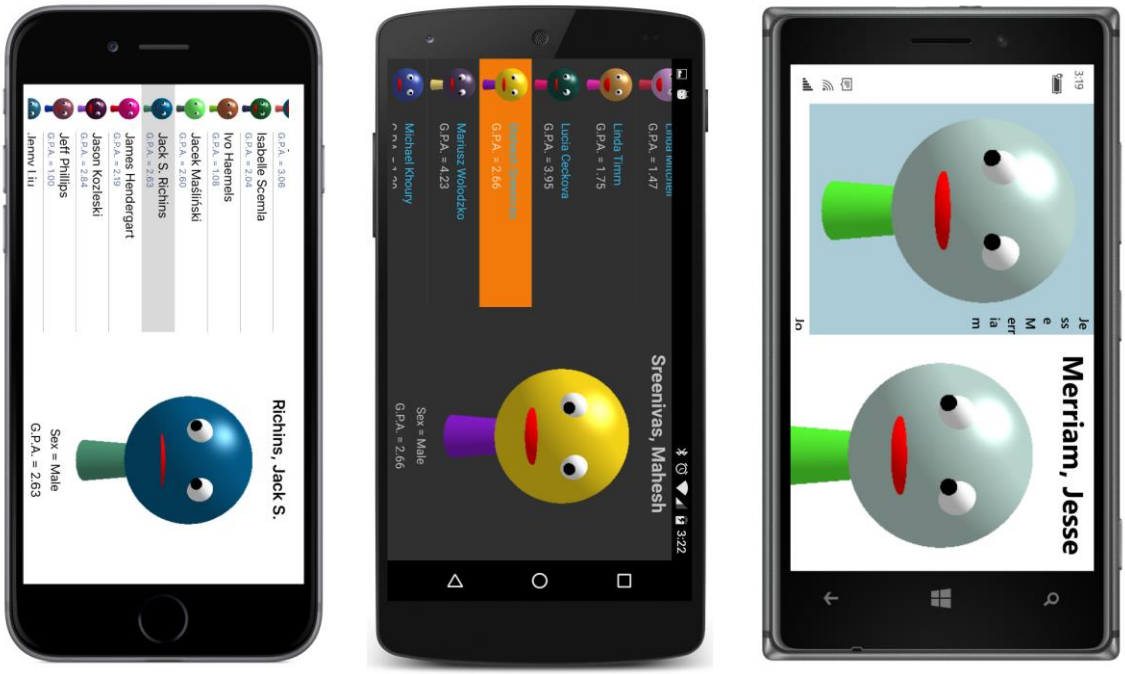
Sometimes it's unavoidable that some spurious text appears in a detail view when the detail view isn't displaying anything otherwise. In such a case you might want to bind the `IsVisible` property of the detail `Layout` object to the `SelectedItem` property of the `ListView` with a binding converter that converts `null` to `false` and non-`null` to `true`.

The code-behind file in the **SelectedStudentDetail** program is responsible for setting the `BindingContext` for the page and also for handling the `SizeChanged` event for the page to adjust the `Grid` and the `detailLayout` object for a landscape orientation:

```
public partial class SelectedStudentDetailPage : ContentPage
{
    public SelectedStudentDetailPage()
    {
        InitializeComponent();

        // Set BindingContext.
        BindingContext = new SchoolViewModel();
    }

    void OnPageSizeChanged(object sender, EventArgs args)
    {
        // Portrait mode.
        if (Width < Height)
        {
            mainGrid.ColumnDefinitions[0].Width = new GridLength(1, GridUnitType.Star);
            mainGrid.ColumnDefinitions[1].Width = new GridLength(0);

            mainGrid.RowDefinitions[0].Height = new GridLength(1, GridUnitType.Star);
            mainGrid.RowDefinitions[1].Height = new GridLength(1, GridUnitType.Star);

            Grid.SetRow(detailLayout, 1);
            Grid.SetColumn(detailLayout, 0);
        }
        // Landscape mode.
        else
        {
            mainGrid.ColumnDefinitions[0].Width = new GridLength(1, GridUnitType.Star);
            mainGrid.ColumnDefinitions[1].Width = new GridLength(1, GridUnitType.Star);

            mainGrid.RowDefinitions[0].Height = new GridLength(1, GridUnitType.Star);
            mainGrid.RowDefinitions[1].Height = new GridLength(0);

            Grid.SetRow(detailLayout, 0);
```

```
            Grid.SetColumn(detailLayout, 1);
        }
    }
}
```

Here's a landscape view:




Unfortunately, the large image in the `ListView` on Windows 10 Mobile crowds out the text.

Dividing a page into a `ListView` and detail view is not the only approach. When the user selects an item in the `ListView`, your program could navigate to a separate page to display the detail view. Or you could make use of a `MasterDetailPage` designed specifically for scenarios such as this. You'll see examples with these solutions in the chapters ahead.

## Context menus

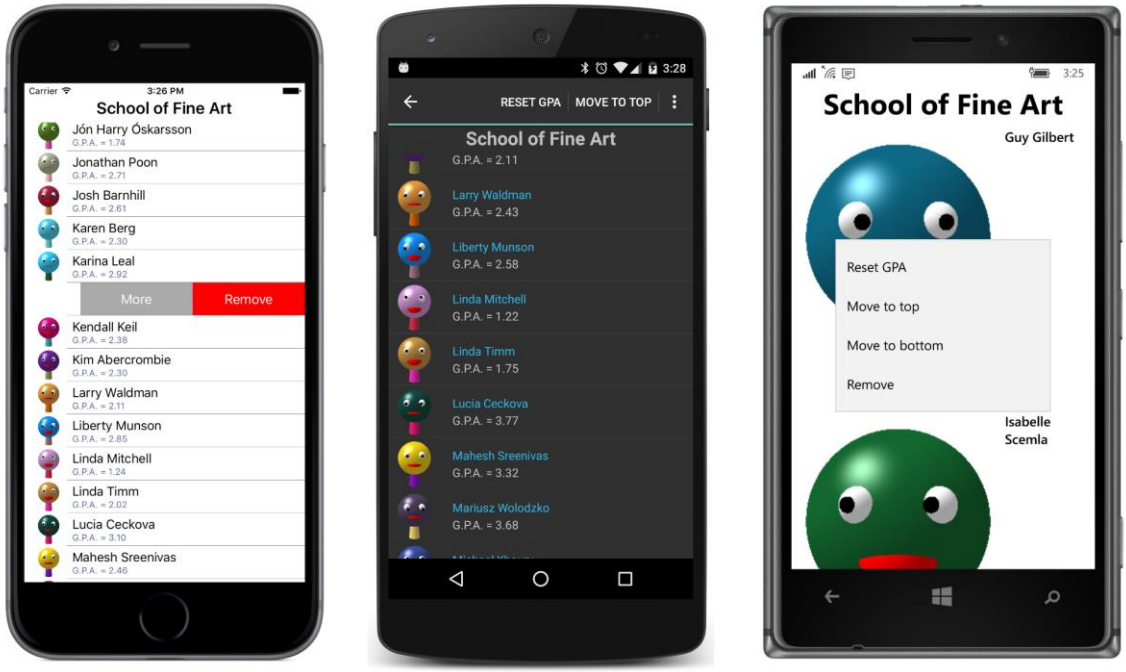
A cell can define a context menu that is invoked in a platform-specific manner. Such a context menu generally allows a user to perform an operation on a specific item in the `ListView`. When used with a `ListView` displaying students, for example, such a context menu allows the user to perform actions on a specific student.

The **CellContextMenu** program demonstrates this technique. It defines a context menu with four items:

- **Reset GPA** (which sets the grade point average of the student to 2.5)

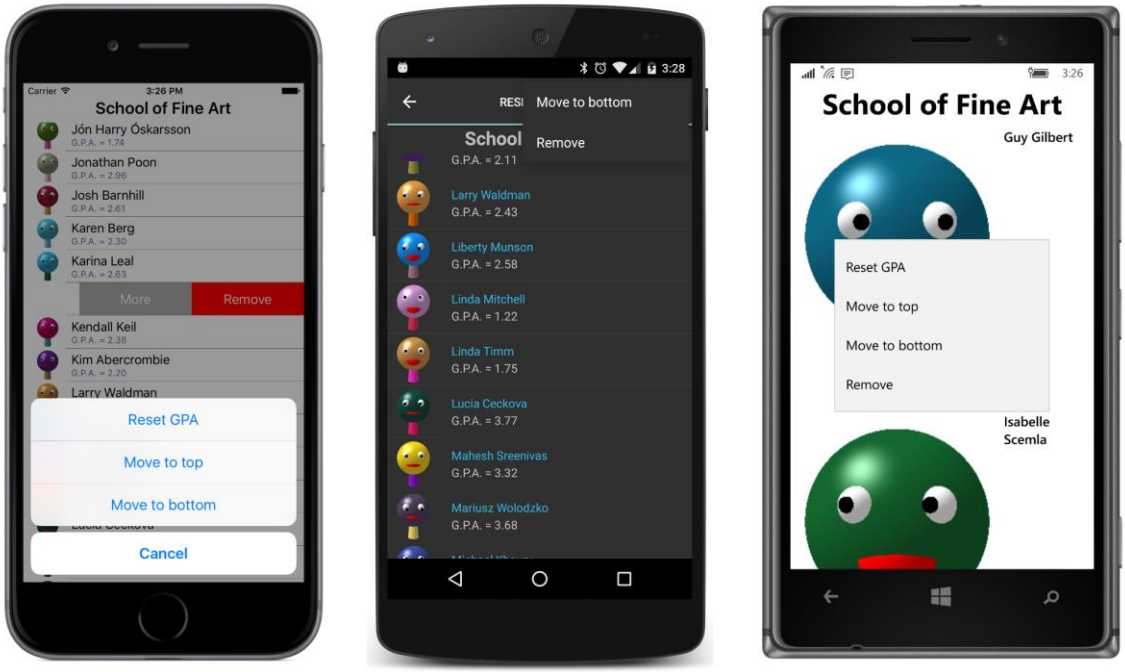
- **Move to Top** (which moves the student to the top of the list)
- **Move to Bottom** (which similarly moves the student to the bottom)
- **Remove** (which removes the student from the list)

On iOS, the context menu is invoked by sliding the item to the left. On Android and Windows 10 Mobile, you press your finger to the item and hold it until the menu appears. Here's the result:




Only one menu item appears on the iOS screen, and that's the item that removes the student from the list. A menu item that removes an entry from the `ListView` must be specially flagged for iOS. The Android screen lists the first two menu items at the top of the screen. Only the Windows Runtime lists them all.

To see the other menu items, you tap the **More** button on iOS and the vertical ellipsis on Android. The other items appear in a list at the bottom of the iOS screen and in a drop-down list at the top right of the Android screen:




Tapping one of the menu items carries out that operation.

To create a context menu for a cell, you add objects of type `MenuItem` to the `ContextActions` collection defined by the `Cell` class. You've already encountered `MenuItem`. It is the base class for the `ToolbarItem` class described in Chapter 13, "Bitmaps."

`MenuItem` defines five properties:

- `Text` of type `string`
- `Icon` of type `FileImageSource` to access a bitmap from a platform project
- `IsDestructive` of type `bool`
- `Command` of type `ICommand`
- `CommandParameter` of type `object`

In addition, `MenuItem` defines a `Clicked` event. You can handle menu actions either in a `Clicked` handler or—if the menu actions are implemented in a ViewModel—an `ICommand` object.

Here's how the `ContextActions` collection is initialized in the **CellContextMenu** program:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:school="clr-namespace:SchoolOfFineArt;assembly=SchoolOfFineArt"
             x:Class="CellContextMenu.CellContextMenuPage">
```

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

    <ContentPage.BindingContext>
        <school:SchoolViewModel />
    </ContentPage.BindingContext>

    <StackLayout BindingContext="{Binding StudentBody}">
        <Label Text="{Binding School}"
               FontSize="Large"
               FontAttributes="Bold"
               HorizontalTextAlignment="Center" />

        <ListView ItemsSource="{Binding Students}">
            <ListView.ItemTemplate>
                <DataTemplate>
                    <ImageCell ImageSource="{Binding PhotoFilename}"
                               Text="{Binding FullName}"
                               Detail="{Binding GradePointAverage,
                                                StringFormat='G.P.A. = {0:F2}'}">
                        <ImageCell.ContextActions>
                            <MenuItem Text="Reset GPA"
                                      Command="{Binding ResetGpaCommand}" />

                            <MenuItem Text="Move to top"
                                      Command="{Binding MoveToTopCommand}" />

                            <MenuItem Text="Move to bottom"
                                      Command="{Binding MoveToBottomCommand}" />

                            <MenuItem Text="Remove"
                                      IsDestructive="True"
                                      Command="{Binding RemoveCommand}" />
                        </ImageCell.ContextActions>
                    </ImageCell>
                </DataTemplate>
            </ListView.ItemTemplate>
        </ListView>
    </StackLayout>
</ContentPage>
```

Notice that the `IsDestructive` property is set to `True` for the **Remove** item. This is the property that causes the item to be displayed in red on the iOS screen, and which by convention deletes the item from the collection.

`MenuItem` defines an `Icon` property that you can set to a bitmap stored in a platform project (much like the icons used with `ToolbarItem`), but it works only on Android, and the bitmap replaces the `Text` description.

The `Command` properties of all four `MenuItem` objects are bound to properties in the `Student` class.

A `Student` object is the binding context for the cell, so it's also the binding context for these `MenuItem` objects. Here's how the properties are defined and initialized in `Student`:

```
public class Student : ViewModelBase
{
    …
    public Student()
    {
        ResetGpaCommand = new Command(() => GradePointAverage = 2.5);
        MoveToTopCommand = new Command(() => StudentBody.MoveStudentToTop(this));
        MoveToBottomCommand = new Command(() => StudentBody.MoveStudentToBottom(this));
        RemoveCommand = new Command(() => StudentBody.RemoveStudent(this));
    }
    …
    // Properties for implementing commands.
    [XmlIgnore]
    public ICommand ResetGpaCommand { private set; get; }

    [XmlIgnore]
    public ICommand MoveToTopCommand { private set; get; }

    [XmlIgnore]
    public ICommand MoveToBottomCommand { private set; get; }

    [XmlIgnore]
    public ICommand RemoveCommand { private set; get; }

    [XmlIgnore]
    public StudentBody StudentBody { set; get; }
}
```

Only the `ResetGpaCommand` can be handled entirely within the `Student` class. The other three commands require access to the collection of students in the `StudentBody` class. For that reason, when first loading in the data, the `SchoolViewModel` sets the `StudentBody` property in each `Student` object to the `StudentBody` object with the collection of students. This allows the **Move** and **Remove** commands to be implemented with calls to the following methods in `StudentBody`:

```
public class StudentBody : ViewModelBase
{
    …
    public void MoveStudentToTop(Student student)
    {
        Students.Move(Students.IndexOf(student), 0);
    }

    public void MoveStudentToBottom(Student student)
    {
        Students.Move(Students.IndexOf(student), Students.Count - 1);
    }

    public void RemoveStudent(Student student)
    {
        Students.Remove(student);
```

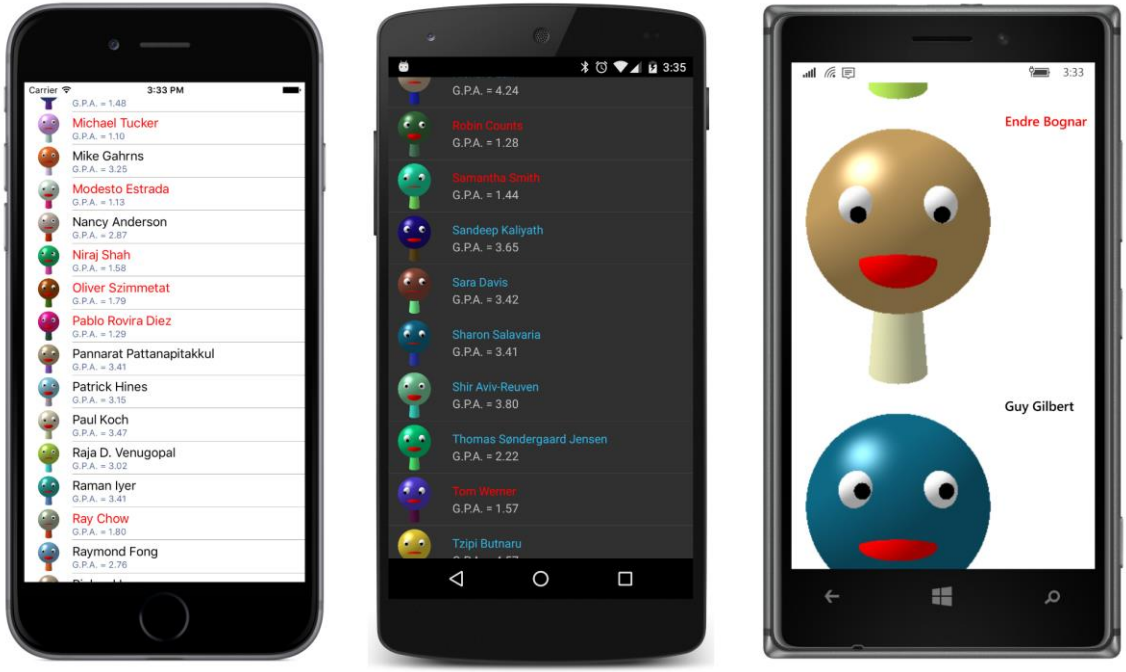
```
    }
}
```

Because the `Students` collection is an `ObservableCollection`, the `ListView` redraws itself to reflect the new number or new ordering of the students.

## Varying the visuals

Sometimes you don't want every item displayed by the `ListView` to be formatted identically. You might want a little different formatting based on the values of some properties. This is generally a job for *triggers*, which you'll be exploring in Chapter 23. However, you can also vary the visuals of items in a `ListView` by using a value converter.

Here's a view of the **ColorCodedStudents** screen. Every student with a grade-point average less than 2.0 is flagged in red, perhaps to highlight the need for some special attention:




In one sense, this is very simple: The `TextColor` property of the `ImageCell` is bound to the `GradePointAverage` property of `Student`. But that's a property of type `Color` bound to a property of type `double`, so a value converter is required, and one that's capable of performing a test on the `GradePointAverage` property to convert to the proper color.

Here is the `ThresholdToObjectConverter` in the **Xamarin.FormsBook.Toolkit** library:

```
namespace Xamarin.FormsBook.Toolkit
{
```

```
    public class ThresholdToObjectConverter<T> : IValueConverter
    {
        public T TrueObject { set; get; }

        public T FalseObject { set; get; }

        public object Convert(object value, Type targetType,
                              object parameter, CultureInfo culture)
        {
            // Code assumes that all input is valid!
            double number = (double)value;
            string arg = parameter as string;
            char op = arg[0];
            double criterion = Double.Parse(arg.Substring(1).Trim());

            switch (op)
            {
                case '<': return number < criterion ? TrueObject : FalseObject;
                case '>': return number > criterion ? TrueObject : FalseObject;
                case '=': return number == criterion ? TrueObject : FalseObject;
            }
            return FalseObject;
        }

        public object ConvertBack(object value, Type targetType,
                                  object parameter, CultureInfo culture)
        {
            return 0;
        }
    }
}
```

Like the `BoolToObjectConverter` described in Chapter 16, "Data binding," the `ThresholdToObjectConverter` is a generic class that defines two properties of type `T`, named `TrueObject` and `FalseObject`. But the choice is based on a comparison of the `value` argument (which is assumed to be of type `double`) and the `parameter` argument, which is specified as the `ConverterParameter` in the binding. This `parameter` argument is assumed to be a string that contains a one-character comparison operator and a number. For purposes of simplicity and clarity, there is no input validation.

Once the value converter is created, the markup is fairly easy:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:school="clr-namespace:SchoolOfFineArt;assembly=SchoolOfFineArt"
             xmlns:toolkit=
                 "clr-namespace:Xamarin.FormsBook.Toolkit;assembly=Xamarin.FormsBook.Toolkit"
             x:Class="ColorCodedStudents.ColorCodedStudentsPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="0, 20, 0, 0" />
    </ContentPage.Padding>

    <ContentPage.Resources>
```

```
        <ResourceDictionary>
            <toolkit:ThresholdToObjectConverter x:Key="thresholdConverter"
                                                x:TypeArguments="Color"
                                                TrueObject="Default"
                                                FalseObject="Red" />
        </ResourceDictionary>
    </ContentPage.Resources>

    <ContentPage.BindingContext>
        <school:SchoolViewModel />
    </ContentPage.BindingContext>

    <ListView ItemsSource="{Binding StudentBody.Students}">
        <ListView.ItemTemplate>
            <DataTemplate>
                <ImageCell ImageSource="{Binding PhotoFilename}"
                           Text="{Binding FullName}"
                           TextColor="{Binding GradePointAverage,
                                               Converter={StaticResource thresholdConverter},
                                               ConverterParameter=>2}"
                           Detail="{Binding GradePointAverage,
                                            StringFormat='G.P.A. = {0:F2}'}" />
            </DataTemplate>
        </ListView.ItemTemplate>
    </ListView>
</ContentPage>
```

When the GPA is greater than or equal to 2, the text is displayed in its default color; otherwise the text is displayed in red.

## Refreshing the content

As you've seen, if you use an `ObservableCollection` as a source for `ListView`, any change to the collection causes `ObservableCollection` to fire a `CollectionChanged` event and the `ListView` responds by refreshing the display of items.

Sometimes this type of refreshing must be supplemented with something controlled by the user. For example, consider an email client or RSS reader. Such an application might be configured to look for new email or an update to the RSS file every 15 minutes or so, but the user might be somewhat impatient and might want the program to check right away for new data.

For this purpose a convention has developed that is supported by `ListView`. If the `ListView` has its `IsPullToRefresh` property set to `true`, and if the user swipes down on the `ListView`, the `ListView` will respond by calling the `Execute` method of the `ICommand` object bound to its `RefreshCommand` property. The `ListView` will also set its `IsRefreshing` property to `true` and display some kind of animation indicating that it's busy.

In reality, the `ListView` is not busy. It's just waiting to be notified that new data is available. You've probably written the code invoked by the `Execute` method of the `ICommand` object to perform an asynchronous operation such as a web access. It must notify the `ListView` that it's finished by setting

the `IsRefreshing` property of the `ListView` back to `false`. At that time, the `ListView` displays the new data and the refresh is complete.

This sounds somewhat complicated, but it gets a lot easier if you build this feature into the View-Model that supplies the data. The whole process is demonstrated with a program called **RssFeed** that accesses an RSS feed from NASA.

The `RssFeedViewModel` class is responsible for downloading the XML with the RSS feed and parsing it. This first happens when the `Url` property is set and the set accessor calls the `LoadRssFeed` method:

```
public class RssFeedViewModel : ViewModelBase
{
    string url, title;
    IList<RssItemViewModel> items;
    bool isRefreshing = true;

    public RssFeedViewModel()
    {
        RefreshCommand = new Command(
            execute: () =>
            {
                LoadRssFeed(url);
            },
            canExecute: () =>
            {
                return !IsRefreshing;
            });
    }

    public string Url
    {
        set
        {
            if (SetProperty(ref url, value) && !String.IsNullOrEmpty(url))
            {
                LoadRssFeed(url);
            }
        }
        get
        {
            return url;
        }
    }
    public string Title
    {
        set { SetProperty(ref title, value); }
        get { return title; }
    }

    public IList<RssItemViewModel> Items
    {
        set { SetProperty(ref items, value); }
```

```
        get { return items; }
    }

    public ICommand RefreshCommand { private set; get; }

    public bool IsRefreshing
    {
        set { SetProperty(ref isRefreshing, value); }
        get { return isRefreshing; }
    }

    public void LoadRssFeed(string url)
    {
        WebRequest request = WebRequest.Create(url);
        request.BeginGetResponse((args) =>
        {
            // Download XML.
            Stream stream = request.EndGetResponse(args).GetResponseStream();
            StreamReader reader = new StreamReader(stream);
            string xml = reader.ReadToEnd();

            // Parse XML to extract data from RSS feed.
            XDocument doc = XDocument.Parse(xml);
            XElement rss = doc.Element(XName.Get("rss"));
            XElement channel = rss.Element(XName.Get("channel"));

            // Set Title property.
            Title = channel.Element(XName.Get("title")).Value;

            // Set Items property.
            List<RssItemViewModel> list =
                channel.Elements(XName.Get("item")).Select((XElement element) =>
                {
                    // Instantiate RssItemViewModel for each item.
                    return new RssItemViewModel(element);
                }).ToList();
            Items = list;

            // Set IsRefreshing to false to stop the 'wait' icon.
            IsRefreshing = false;
        }, null);
    }
}
```

The `LoadRssFeed` method uses the LINQ-to-XML interface in the `System.Xml.Linq` namespace to parse the XML file and set both the `Title` property and the `Items` property of the class. The `Items` property is a collection of `RssItemViewModel` objects that define five properties associated with each item in the RSS feed. For each `item` element in the XML file, the `LoadRssFeed` method instantiates an `RssItemViewModel` object:

```
public class RssItemViewModel
{
    public RssItemViewModel(XElement element)
```

```
    {
        // Although this code might appear to be generalized, it is
        //  actually based on desired elements from the particular
        //  RSS feed set in the RssFeedPage.xaml file.
        Title = element.Element(XName.Get("title")).Value;
        Description = element.Element(XName.Get("description")).Value;
        Link = element.Element(XName.Get("link")).Value;
        PubDate = element.Element(XName.Get("pubDate")).Value;

        // Sometimes there's no thumbnail, so check for its presence.
        XElement thumbnailElement = element.Element(
            XName.Get("thumbnail", "http://search.yahoo.com/mrss/"));

        if (thumbnailElement != null)
        {
            Thumbnail = thumbnailElement.Attribute(XName.Get("url")).Value;
        }
    }

    public string Title { protected set; get; }

    public string Description { protected set; get; }

    public string Link { protected set; get; }

    public string PubDate { protected set; get; }

    public string Thumbnail { protected set; get; }
}
```

The constructor of `RssFeedViewModel` also sets its `RefreshCommand` property equal to a `Command` object with an `Execute` method that also calls `LoadRssFeed`, which finishes by setting the `IsRefreshing` property of the class to `false`. To avoid overlapping web accesses, the `CanExecute` method of `RefreshCommand` returns `true` only if `IsRefreshing` is `false`.

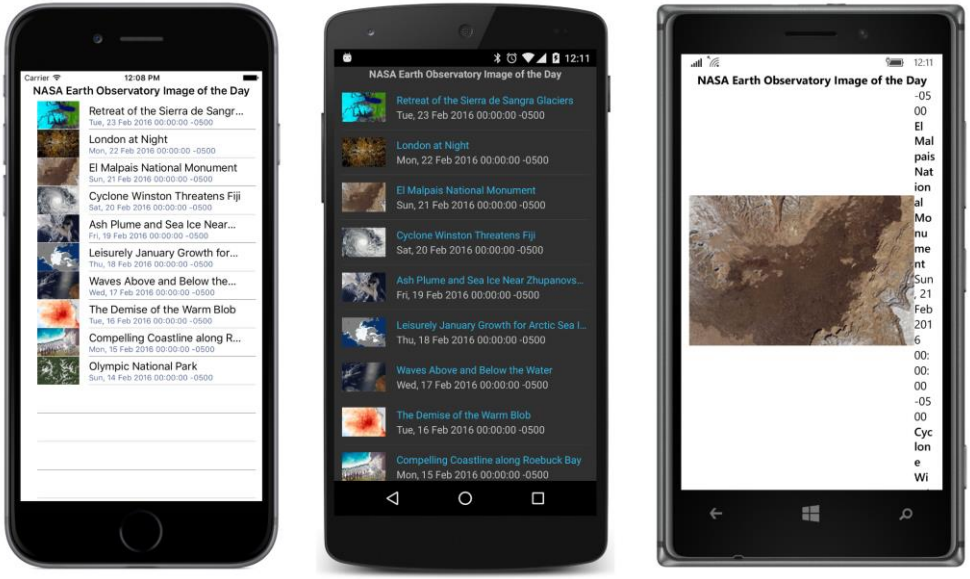
Notice that it's not necessary for the `Items` property in `RssFeedViewModel` to be an `ObservableCollection` because once the `Items` collection is created, the items in the collection never change. When the `LoadRssFeed` method gets new data, it creates a whole new `List` object that it sets to the `Items` property, which results in the firing of a `PropertyChanged` event.

The `RssFeedPage` class shown below instantiates the `RssFeedViewModel` and assigns the `Url` property. This object becomes the `BindingContext` for a `StackLayout` that contains a `Label` to display the `Title` property and a `ListView`. The `ItemsSource`, `RefreshCommand`, and `IsRefreshing` properties of the `ListView` are all bound to properties in the `RssFeedViewModel`:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:local="clr-namespace:RssFeed"
             x:Class="RssFeed.RssFeedPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 20, 10, 0"
```

```
                    Android="10, 0"
                    WinPhone="10, 0" />
    </ContentPage.Padding>

    <ContentPage.Resources>
        <ResourceDictionary>
            <local:RssFeedViewModel x:Key="rssFeed"
                    Url="http://earthobservatory.nasa.gov/Feeds/rss/eo_iotd.rss" />
        </ResourceDictionary>
    </ContentPage.Resources>

    <Grid>
        <StackLayout x:Name="rssLayout"
                     BindingContext="{StaticResource rssFeed}">

            <Label Text="{Binding Title}"
                   FontAttributes="Bold"
                   HorizontalTextAlignment="Center" />

            <ListView x:Name="listView"
                      ItemsSource="{Binding Items}"
                      ItemSelected="OnListViewItemSelected"
                      IsPullToRefreshEnabled="True"
                      RefreshCommand="{Binding RefreshCommand}"
                      IsRefreshing="{Binding IsRefreshing}">
                <ListView.ItemTemplate>
                    <DataTemplate>
                        <ImageCell Text="{Binding Title}"
                                   Detail="{Binding PubDate}"
                                   ImageSource="{Binding Thumbnail}" />
                    </DataTemplate>
                </ListView.ItemTemplate>
            </ListView>
        </StackLayout>

        <StackLayout x:Name="webLayout"
                     IsVisible="False">

            <WebView x:Name="webView"
                     VerticalOptions="FillAndExpand" />

            <Button Text="&lt; Back to List"
                    HorizontalOptions="Center"
                    Clicked="OnBackButtonClicked" />
        </StackLayout>
    </Grid>
</ContentPage>
```

The items are ideally suited for an `ImageCell`, but perhaps not on the Windows 10 Mobile device:




When you swipe your finger down this list, the `ListView` will go into refresh mode by calling the `Execute` method of the `RefreshCommand` object and displaying an animation indicating that it's busy. When the `IsRefreshing` property is set back to `false` by `RssFeedViewModel`, the `ListView` displays the new data. (This is not implemented on the Windows Runtime platforms.)

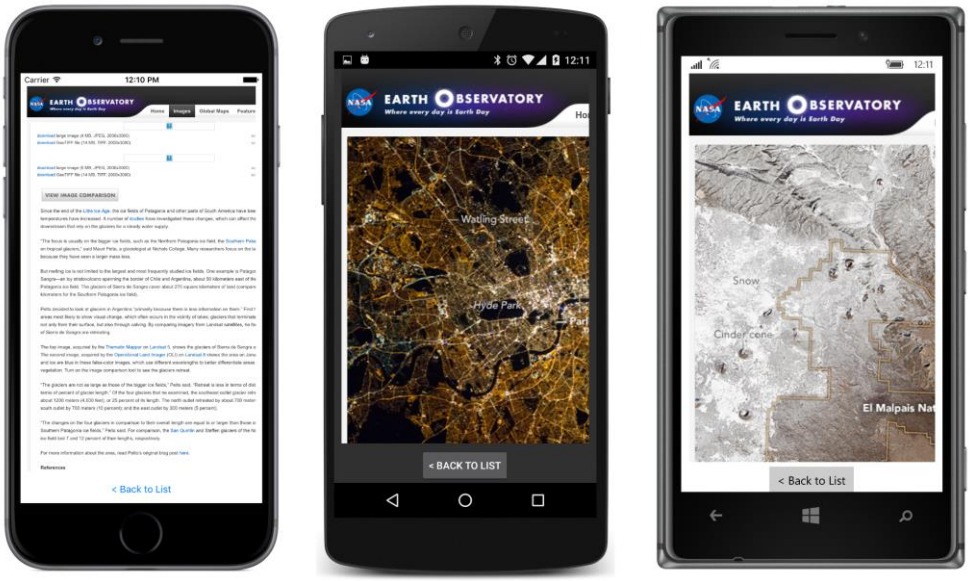
In addition, the page contains another `StackLayout` toward the bottom of the XAML file that has its `IsVisible` property set to `false`. The first `StackLayout` with the `ListView` and this second, hidden `StackLayout` share a single-cell `Grid`, so they both essentially occupy the entire page.

When the user selects an item in the `ListView`, the `ItemSelected` event handler in the code-behind file hides the `StackLayout` with the `ListView` and makes the second `StackLayout` visible:

```
public partial class RssFeedPage : ContentPage
{
    public RssFeedPage()
    {
        InitializeComponent();
    }

    void OnListViewItemSelected(object sender, SelectedItemChangedEventArgs args)
    {
        if (args.SelectedItem != null)
        {
            // Deselect item.
            ((ListView)sender).SelectedItem = null;

            // Set WebView source to RSS item
            RssItemViewModel rssItem = (RssItemViewModel)args.SelectedItem;

            // For iOS 9, a NSAppTransportSecurity key was added to
```

```
            //  Info.plist to allow accesses to EarthObservatory.nasa.gov sites.
            webView.Source = rssItem.Link;

            // Hide and make visible.
            rssLayout.IsVisible = false;
            webLayout.IsVisible = true;
        }
    }

    void OnBackButtonClicked(object sender, EventArgs args)
    {
        // Hide and make visible.
        webLayout.IsVisible = false;
        rssLayout.IsVisible = true;
    }
}
```

This second `StackLayout` contains a `WebView` for a display of the item referenced by the RSS feed item and a button to go back to the `ListView`:




Notice how the `ItemSelected` event handler sets the `SelectedItem` property of the `ListView` to `null`, effectively deselecting the item. (However, the selected item is still available in the `SelectedItem` property of the event arguments.) This is a common technique when using the `ListView` for navigational purposes. When the user returns to the `ListView`, you don't want the item to be still selected. Setting the `SelectedItem` property of the `ListView` to `null` causes another call to the `ItemSelected` event handler, of course, but if the handler begins by ignoring cases when `SelectedItem` is `null`, the second call shouldn't be a problem.

A more sophisticated program would navigate to a second page or use the detail part of a `MasterDetailPage` for displaying the item. Those techniques will be demonstrated in future chapters.

# The TableView and its intents

The third of the three collection views in Xamarin.Forms is `TableView`, and the name might be a little deceptive. When we hear the word "table" in programming contexts, we usually think of a two-dimensional grid, such as an HTML table. The Xamarin.Forms `TableView` is instead a vertical, scrollable list of items that are visually generated from `Cell` classes. This might sound very similar to a `ListView`, but the `ListView` and `TableView` are quite different in use:

The `ListView` generally displays a list of items of the same type, usually instances of a particular data class. These items are in an `IEnumerable` collection. The `ListView` specifies a single `Cell` derivative for rendering these data objects. Items are selectable.

The `TableView` displays a list of items of different types. In real-life programming, often these items are properties of a single class. Each item is associated with its own `Cell` to display the property and often to allow the user to interact with the property. In the general case, the `TableView` displays more than one type of cell.

## Properties and hierarchies

`ListView` and `ItemsView` together define 18 properties, while `TableView` has only four:

- `Intent` of type `TableIntent`.
- `Root` of type `TableRoot`. (This is the content property of `TableView`.)
- `RowHeight` of type `int`.
- `HasUnevenRows` of type `bool`.

The `RowHeight` and `HasUnevenRows` properties play the same role in the `TableView` as in the `ListView`.

Perhaps the most revealing property of the `TableView` class is a property that is *not* guaranteed to have any effect on functionality and appearance. This property is named `Intent`, and it indicates how you're using the particular `TableView` in your program. You can set this property (or not) to a member of the `TableIntent` enumeration:

- `Data`
- `Form`
- `Settings`

- `Menu`

These members suggest the various ways that you can use `TableView`. When used for `Data`, the `TableView` usually displays related items, but items of different types. A `Form` is a series of items that the user interacts with to enter information. A `TableView` used for program `Settings` is sometimes known as a *dialog*. This use is similar to `Form`, except that settings usually have default values. You can also use a `TableView` for a `Menu`, in which case the items are generally displayed using text or bitmaps and initiate an action when tapped.

The `Root` property defines the root of the hierarchy of items displayed by the `TableView`. Each item in a `TableView` is associated with a single `Cell` derivative, and the various cells can be organized into sections. To support this hierarchy of items, several classes are defined:

- `TableSectionBase` is an abstract class that derives from `BindableObject` and defines a `Title` property.
- `TableSectionBase<T>` is an abstract class that derives from `TableSectionBase` and implements the `IList<T>` interface, and hence also the `ICollection<T>` and `IEnumerable<T>` interfaces. The class also implements the `INotifyCollectionChanged` interface; internally it maintains an `ObservableCollection<T>` for this collection. This allows items to be dynamically added to or removed from the `TableView`.
- `TableSection` derives from `TableSectionBase<Cell>`.
- `TableRoot` derives from `TableSectionBase<TableSection>`.

In summary, `TableView` has a `Root` property that you set to a `TableRoot` object, which is a collection of `TableSection` objects, each of which is a collection of `Cell` objects.

Notice that both `TableSection` and `TableRoot` inherit a `Title` property from `TableSectionBase`. Depending on the derived class, this is either a title for the section or a title for the entire table. Both `TableSection` and `TableRoot` have constructors that let you set this `Title` property when creating the object.

The `TableSectionBase<T>` class defines two `Add` methods for adding items to the collection. The first `Add` method is required by the `ICollection` interface; the second is not:

- `public void Add(T item)`
- `public void Add(IEnumerable<T> items)`

This second `Add` method seems to allow you to add one `TableSection` to another `TableSection`, and one `TableRoot` to another `TableRoot`, and that process might seem to imply that you can have a nested series of `TableRoot` or `TableSection` instances. But that is not so. This `Add` method just transfers the items from one collection to another. The hierarchy never gets any deeper than a `TableRoot` that is a collection of `TableSection` objects, which are collections of `Cell` objects.

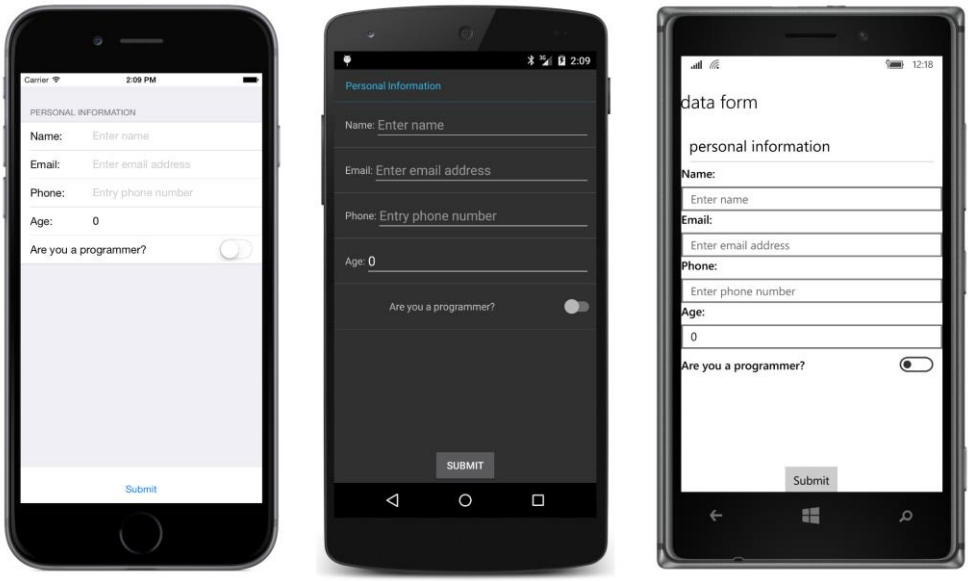
Although the `TableView` makes use of `Cell` objects, it does not use `DataTemplate`. Whether you

define a `TableView` in code or in XAML, you always set data bindings directly on the `Cell` objects. Generally these bindings are very simple because you set a `BindingContext` on the `TableView` that is inherited by the individual items.

Visually and functionally, the `TableView` is not very different from a `StackLayout` in a `ScrollView`, where the `StackLayout` contains a collection of short visual trees with bindings. But generally the `TableView` is more convenient in organizing and arranging the information.

## A prosaic form

Let's make a data-entry form that lets the program's user enter a person's name and some other information. When you first run the **EntryForm** program, it looks like this:



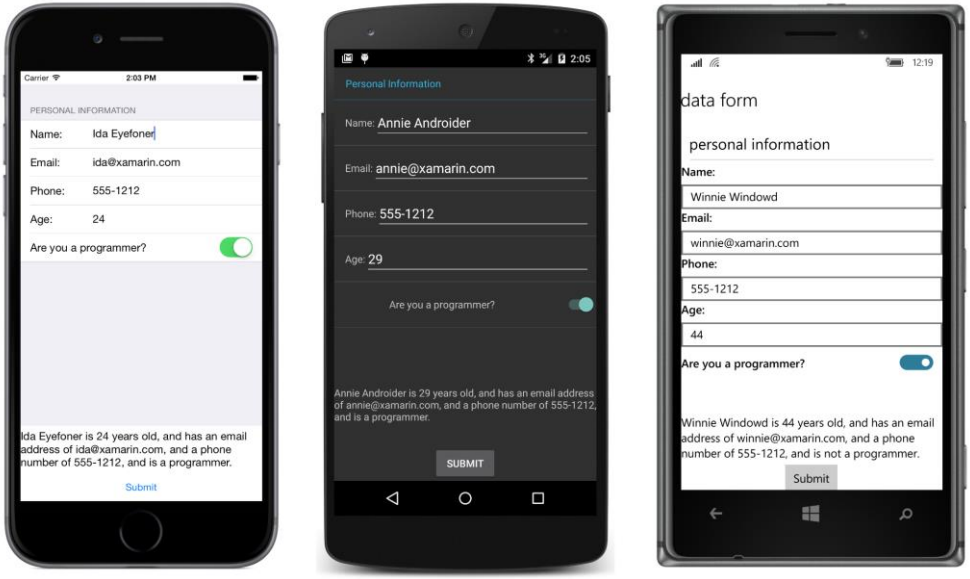

The `TableView` consists of everything on the page except the **Submit** button. This `TableView` has one `TableSection` consisting of five cells—four `EntryCell` elements and one `SwitchCell`. (Those are the only two `Cell` derivatives you haven't seen yet.) The text "Data Form" is the `Title` property of the `TableRoot` object, and it shows up only on the Windows 10 Mobile screen. The text "Personal Information" is the `Title` property for the `TableSection`.

The five cells correspond to five properties of this little class named `PersonalInformation`. Although the class name doesn't explicitly identify this as a ViewModel, the class derives from `ViewModelBase`:

```
class PersonalInformation : ViewModelBase
{
    string name, emailAddress, phoneNumber;
    int age;
```

```
    bool isProgrammer;

    public string Name
    {
        set { SetProperty(ref name, value); }
        get { return name; }
    }

    public string EmailAddress
    {
        set { SetProperty(ref emailAddress, value); }
        get { return emailAddress; }
    }

    public string PhoneNumber
    {
        set { SetProperty(ref phoneNumber, value); }
        get { return phoneNumber; }
    }

    public int Age
    {
        set { SetProperty(ref age, value); }
        get { return age; }
    }

    public bool IsProgrammer
    {
        set { SetProperty(ref isProgrammer, value); }
        get { return isProgrammer; }
    }
}
```

When you fill in the information in the form and press the **Submit** button, the program displays the information from the `PersonalInformation` instance in a little paragraph at the bottom of the screen:




This program maintains just a single instance of `PersonalInformation`. A real application would perhaps create a new instance for each person whose information the user is supplying, and then store each instance in an `ObservableCollection<PersonalInformation>` for display by a `ListView`.

The **EntryForm** XAML file instantiates `PersonalInformation` as the `BindingContext` of the `TableView`. You can see here the `TableRoot`, the `TableSection`, and the five `Cell` objects:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:local="clr-namespace:EntryForm"
             x:Class="EntryForm.EntryFormPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="0, 20, 0, 0" />
    </ContentPage.Padding>

    <StackLayout>
        <TableView x:Name="tableView"
                   Intent="Form">

            <TableView.BindingContext>
                <local:PersonalInformation />
            </TableView.BindingContext>

            <TableRoot Title="Data Form">
                <TableSection Title="Personal Information">
                    <EntryCell Label="Name:"
                               Text="{Binding Name}"
                               Placeholder="Enter name"
                               Keyboard="Text" />
```

```
                    <EntryCell Label="Email:"
                               Text="{Binding EmailAddress}"
                               Placeholder="Enter email address"
                               Keyboard="Email" />

                    <EntryCell Label="Phone:"
                               Text="{Binding PhoneNumber}"
                               Placeholder="Enter phone number"
                               Keyboard="Telephone" />

                    <EntryCell Label="Age:"
                               Text="{Binding Age}"
                               Placeholder="Enter age"
                               Keyboard="Numeric" />

                    <SwitchCell Text="Are you a programmer?"
                                On="{Binding IsProgrammer}" />
                </TableSection>
            </TableRoot>
        </TableView>

        <Label x:Name="summaryLabel"
               VerticalOptions="CenterAndExpand" />

        <Button Text="Submit"
                HorizontalOptions="Center"
                Clicked="OnSubmitButtonClicked" />
    </StackLayout>
</ContentPage>
```

Each of the properties of the `PersonalInformation` class corresponds to a `Cell`. For four of these properties, this is an `EntryCell` that consists (at least conceptually) of an identifying `Label` and an `Entry` view. (In reality, the `EntryCell` consists of platform-specific visual objects, but it's convenient to speak of these objects using Xamarin.Forms names.) The `Label` property specifies the text that appears at the left; the `Placeholder` and `Keyboard` properties of `EntryView` duplicate the same properties in `Entry`. A `Text` property indicates the text in the `Entry` view.

The fifth cell is a `SwitchCell` for the Boolean property `IsProgrammer`. In this case, the `Text` property specifies the text at the left of the cell, and the `On` property indicates the state of the `Switch`.

Because the `BindingContext` of the `TableView` is `PersonalInformation`, the bindings in the `Cell` objects can simply reference the properties of `PersonalInformation`. The binding modes of the `Text` property of the `EntryCell` and the `On` property of the `SwitchCell` are both `TwoWay`. If you only need to transfer data from the view to the data class, this mode can be `OneWayToSource`, but in general you might want to initialize the views from the data class. For example, you can instantiate the `PersonalInformation` instance in the XAML file like this:

```
<TableView.BindingContext>
    <local:PersonalInformation Name="Naomi Name"
                               EmailAddress="naomi@xamarin.com"
                               PhoneNumber="555-1212"
```

```
                                Age="29"
                                IsProgrammer="True" />
</TableView.BindingContext>
```

The cells will then be initialized with that information when the program starts up.

Both `EntryCell` and `SwitchCell` fire events if you prefer obtaining information through event handling rather than data binding.

The code-behind file simply processes the `Clicked` event of the **Submit** button by creating a text string with the information from the `PersonalInformation` instance and displaying it with the `Label`:

```
public partial class EntryFormPage : ContentPage
{
    public EntryFormPage()
    {
        InitializeComponent();
    }

    void OnSubmitButtonClicked(object sender, EventArgs args)
    {
        PersonalInformation personalInfo = (PersonalInformation)tableView.BindingContext;

        summaryLabel.Text = String.Format(
            "{0} is {1} years old, and has an email address " +
            "of {2}, and a phone number of {3}, and is {4}" +
            "a programmer.",
            personalInfo.Name, personalInfo.Age,
            personalInfo.EmailAddress, personalInfo.PhoneNumber,
            personalInfo.IsProgrammer ? "" : "not ");
    }
}
```

## Custom cells

Of course, few people are entirely happy with the first version of an application, and perhaps that is true for the simple **EntryForm** program. Perhaps the revised design requirements eliminate the integer `Age` property from `PersonalInformation` and substitute a text `AgeRange` property with some fixed ranges. Two more properties are added to the class that pertain only to programmers: These are properties of type `string` that indicate the programmer's preferred computer language and platform, choosable from lists of languages and platforms.

Here's the revised ViewModel class, now called `ProgrammerInformation`:

```
class ProgrammerInformation : ViewModelBase
{
    string name, emailAddress, phoneNumber, ageRange;
    bool isProgrammer;
    string language, platform;
```

```
    public string Name
    {
        set { SetProperty(ref name, value); }
        get { return name; }
    }

    public string EmailAddress
    {
        set { SetProperty(ref emailAddress, value); }
        get { return emailAddress; }
    }

    public string PhoneNumber
    {
        set { SetProperty(ref phoneNumber, value); }
        get { return phoneNumber; }
    }

    public string AgeRange
    {
        set { SetProperty(ref ageRange, value); }
        get { return ageRange; }
    }

    public bool IsProgrammer
    {
        set { SetProperty(ref isProgrammer, value); }
        get { return isProgrammer; }
    }

    public string Language
    {
        set { SetProperty(ref language, value); }
        get { return language; }
    }

    public string Platform
    {
        set { SetProperty(ref platform, value); }
        get { return platform; }
    }
}
```

The `AgeRange`, `Language`, and `Platform` properties seem ideally suited for `Picker`, but using a `Picker` inside a `TableView` requires that the `Picker` be part of a `ViewCell`. How do we do this?

When working with a `ListView`, the simplest way to create a custom cell involves defining a visual tree in a `ViewCell` within a `DataTemplate` right in XAML. This approach makes sense because the visual tree that you define is probably tailored specifically to the items in the `ListView` and is probably not going to be reused somewhere else.

You can use that same technique with a `TableView`, but with a `TableView` it's more likely that you'll be reusing particular types of interactive cells. For example, the `ProgrammerInformation` class

has three properties that are suitable for `Picker`. This implies that it makes more sense to create a custom `PickerCell` class that you can use here and elsewhere.

The **Xamarin.FormsBook.Toolkit** library contains a `PickerCell` class that derives from `ViewCell` and is basically a wrapper around a `Picker` view. The class consists of a XAML file and a code-behind file. The code-behind file defines three properties backed by bindable properties: `Label` (which identifies the cell just like the `Label` property in `EntryCell`), `Title` (which corresponds to the `Title` property of `Picker`), and `SelectedValue`, which is the actual string selected in the `Picker`. In addition, a get-only `Items` property exposes the `Items` collection of the `Picker`:

```
namespace Xamarin.FormsBook.Toolkit
{
    [ContentProperty("Items")]
    public partial class PickerCell : ViewCell
    {
        public static readonly BindableProperty LabelProperty =
            BindableProperty.Create(
                "Label", typeof(string), typeof(PickerCell), default(string));

        public static readonly BindableProperty TitleProperty =
            BindableProperty.Create(
                "Title", typeof(string), typeof(PickerCell), default(string));

        public static readonly BindableProperty SelectedValueProperty =
            BindableProperty.Create(
                "SelectedValue", typeof(string), typeof(PickerCell), null,
                BindingMode.TwoWay,
                propertyChanged: (sender, oldValue, newValue) =>
                    {
                        PickerCell pickerCell = (PickerCell)sender;

                        if (String.IsNullOrEmpty(newValue))
                        {
                            pickerCell.picker.SelectedIndex = -1;
                        }
                        else
                        {
                            pickerCell.picker.SelectedIndex =
                                    pickerCell.Items.IndexOf(newValue);
                        }
                    });

        public PickerCell()
        {
            InitializeComponent();
        }

        public string Label
        {
            set { SetValue(LabelProperty, value); }
            get { return (string)GetValue(LabelProperty); }
        }
```

```
        public string Title
        {
            get { return (string)GetValue(TitleProperty); }
            set { SetValue(TitleProperty, value); }
        }

        public string SelectedValue
        {
            get { return (string)GetValue(SelectedValueProperty); }
            set { SetValue(SelectedValueProperty, value); }
        }

        // Items property.
        public IList<string> Items
        {
            get { return picker.Items; }
        }

        void OnPickerSelectedIndexChanged(object sender, EventArgs args)
        {
            if (picker.SelectedIndex == -1)
            {
                SelectedValue = null;
            }
            else
            {
                SelectedValue = Items[picker.SelectedIndex];
            }
        }
    }
}
```

The XAML file defines the visual tree of `PickerCell`, which simply consists of an identifying `Label` and the `Picker` itself. Notice that the root element of the XAML file is `ViewCell`, which is the class that `PickerCell` derives from:

```
<ViewCell xmlns="http://xamarin.com/schemas/2014/forms"
          xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
          x:Class="Xamarin.FormsBook.Toolkit.PickerCell"
          x:Name="cell">
    <ViewCell.View>
        <StackLayout Orientation="Horizontal"
                     BindingContext="{x:Reference cell}"
                     Padding="16, 0">

            <Label Text="{Binding Label}"
                   VerticalOptions="Center" />

            <Picker x:Name="picker"
                    Title="{Binding Title}"
                    VerticalOptions="Center"
                    HorizontalOptions="FillAndExpand"
                    SelectedIndexChanged="OnPickerSelectedIndexChanged" />
```

```
        </StackLayout>
    </ViewCell.View>
</ViewCell>
```

The `Padding` value set on the `StackLayout` was chosen empirically to be visually consistent with the Xamarin.Forms `EntryCell`.

Normally the `ViewCell.View` property element tags wouldn't be required in this XAML file because `View` is the content property of `ViewCell`. However, the code-behind file defines the content property of `PickerCell` to be the `Items` collection, which means that the content property is no longer `View` and the `ViewCell.View` tags are necessary.

The root element of the XAML file has an `x:Name` attribute that gives the object a name of "cell," and the `StackLayout` sets its `BindingContext` to that object, which means that the `BindingContext` for the children of the `StackLayout` is the `PickerCell` instance itself. This allows the `Label` and `Picker` to contain bindings to the `Label` and `Title` properties defined by `PickerCell` in the code-behind file.

The `Picker` fires a `SelectedIndexChanged` event that is handled in the code-behind file so that the code-behind file can convert the `SelectedIndex` of the `Picker` to a `SelectedValue` of the `PickerCell`.

This is not the only way to create a custom `PickerCell` class. You can also create it by defining individual `PickerCellRenderer` classes for each platform.

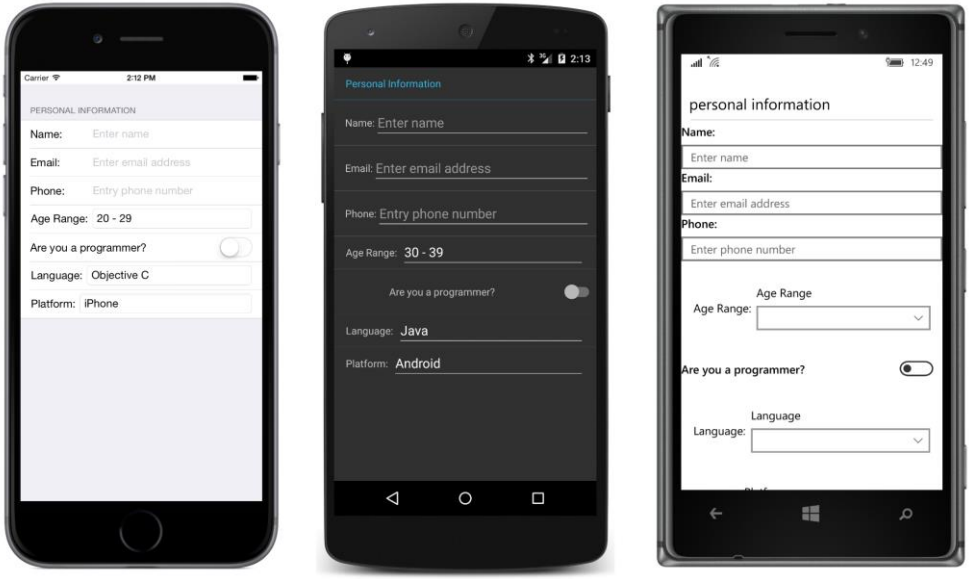
The `TableView` in the **ConditionalCells** program uses this `PickerCell` for three of the properties in the `ProgrammerInformation` class and initializes each `PickerCell` with a collection of strings:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:local="clr-namespace:ConditionalCells"
             xmlns:toolkit=
                 "clr-namespace:Xamarin.FormsBook.Toolkit;assembly=Xamarin.FormsBook.Toolkit"
             x:Class="ConditionalCells.ConditionalCellsPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="0, 20, 0, 0" />
    </ContentPage.Padding>

    <StackLayout>
        <TableView Intent="Form">

            <TableView.BindingContext>
                <local:ProgrammerInformation />
            </TableView.BindingContext>

            <TableRoot Title="Data Form">
                <TableSection Title="Personal Information">
                    <EntryCell Label="Name:"
                               Text="{Binding Name}"
```

```
                        Placeholder="Enter name"
                        Keyboard="Text" />

                <EntryCell Label="Email:"
                        Text="{Binding EmailAddress}"
                        Placeholder="Enter email address"
                        Keyboard="Email" />

                <EntryCell Label="Phone:"
                        Text="{Binding PhoneNumber}"
                        Placeholder="Enter phone number"
                        Keyboard="Telephone" />

                <toolkit:PickerCell Label="Age Range:"
                                    Title="Age Range"
                                    SelectedValue="{Binding AgeRange}">
                    <x:String>10 - 19</x:String>
                    <x:String>20 - 29</x:String>
                    <x:String>30 - 39</x:String>
                    <x:String>40 - 49</x:String>
                    <x:String>50 - 59</x:String>
                    <x:String>60 - 99</x:String>
                </toolkit:PickerCell>

                <SwitchCell Text="Are you a programmer?"
                            On="{Binding IsProgrammer}" />

                <toolkit:PickerCell Label="Language:"
                                    Title="Language"
                                    IsEnabled="{Binding IsProgrammer}"
                                    SelectedValue="{Binding Language}">
                    <x:String>C</x:String>
                    <x:String>C++</x:String>
                    <x:String>C#</x:String>
                    <x:String>Objective C</x:String>
                    <x:String>Java</x:String>
                    <x:String>Other</x:String>
                </toolkit:PickerCell>

                <toolkit:PickerCell Label="Platform:"
                                    Title="Platform"
                                    IsEnabled="{Binding IsProgrammer}"
                                    SelectedValue="{Binding Platform}">
                    <x:String>iPhone</x:String>
                    <x:String>Android</x:String>
                    <x:String>Windows Phone</x:String>
                    <x:String>Other</x:String>
                </toolkit:PickerCell>
            </TableSection>
        </TableRoot>
    </TableView>
  </StackLayout>
</ContentPage>
```

Notice how the `IsEnabled` properties of the `PickerCell` for both the `Platform` and `Language` properties are bound to the `IsProgrammer` property, which means that these cells should be disabled unless the `SwitchCell` is flipped on and the `IsProgrammer` property is `true`. That's why this program is called **ConditionalCells**.

However, it doesn't seem to work, as this screenshot verifies:




Even though the `IsProgrammer` switch is off, and the `IsEnabled` property of each of the last two `PickerCell` elements is set to `false`, those elements still respond and allow selecting a value. Moreover, the `PickerCell` doesn't look or work very well on the Windows 10 Mobile platform.

So let's try another approach.

## Conditional sections

A `TableView` can have multiple sections, and you might want a section to be entirely invisible if it doesn't currently apply. In the previous example, a second section, titled "Programmer Information," might contain the two `PickerCell` elements for the `Language` and `Platform` properties. To make the section visible or hidden, the section can be added to or removed from the `TableRoot` based on the setting of the `IsProgrammer` property. (Recall that the internal collections in `TableView` are of type `ObservableCollection`, so the `TableView` should respond to items added or removed dynamically from these collections.) Unfortunately, this can't be handled entirely in XAML, but the code support is fairly easy.

Here is the XAML file in the **ConditionalSection** program. It is the same as the XAML file in the previous program except that the `BindingContext` is no longer set on the `TableView` (that happens in

the code-behind file) and the last two `PickerCell` elements have been moved into a second section with the heading "Programmer Information":

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:local="clr-namespace:ConditionalSection"
             xmlns:toolkit=
                 "clr-namespace:Xamarin.FormsBook.Toolkit;assembly=Xamarin.FormsBook.Toolkit"
             x:Class="ConditionalSection.ConditionalSectionPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="0, 20, 0, 0" />
    </ContentPage.Padding>

    <StackLayout>
        <TableView x:Name="tableView"
                   Intent="Form">
            <TableRoot Title="Data Form">
                <TableSection Title="Personal Information">
                    <EntryCell Label="Name:"
                               Text="{Binding Name}"
                               Placeholder="Enter name"
                               Keyboard="Text" />

                    <EntryCell Label="Email:"
                               Text="{Binding EmailAddress}"
                               Placeholder="Enter email address"
                               Keyboard="Email" />

                    <EntryCell Label="Phone:"
                               Text="{Binding PhoneNumber}"
                               Placeholder="Enter phone number"
                               Keyboard="Telephone" />

                    <toolkit:PickerCell Label="Age Range:"
                                        Title="Age Range"
                                        SelectedValue="{Binding AgeRange}">
                        <x:String>10 - 19</x:String>
                        <x:String>20 - 29</x:String>
                        <x:String>30 - 39</x:String>
                        <x:String>40 - 49</x:String>
                        <x:String>50 - 59</x:String>
                        <x:String>60 - 99</x:String>
                    </toolkit:PickerCell>

                    <SwitchCell x:Name="isProgrammerSwitch"
                                Text="Are you a programmer?"
                                On="{Binding IsProgrammer}" />

                </TableSection>

                <TableSection x:Name="programmerInfoSection"
                              Title="Programmer Information">
                    <toolkit:PickerCell Label="Language:"
```

```
                                    Title="Language"
                                    SelectedValue="{Binding Language}">
                        <x:String>C</x:String>
                        <x:String>C++</x:String>
                        <x:String>C#</x:String>
                        <x:String>Objective C</x:String>
                        <x:String>Java</x:String>
                        <x:String>Other</x:String>
                    </toolkit:PickerCell>

                    <toolkit:PickerCell Label="Platform:"
                                    Title="Platform"
                                    SelectedValue="{Binding Platform}">
                        <x:String>iPhone</x:String>
                        <x:String>Android</x:String>
                        <x:String>Windows Phone</x:String>
                        <x:String>Other</x:String>
                    </toolkit:PickerCell>
                </TableSection>
            </TableRoot>
        </TableView>
    </StackLayout>
</ContentPage>
```

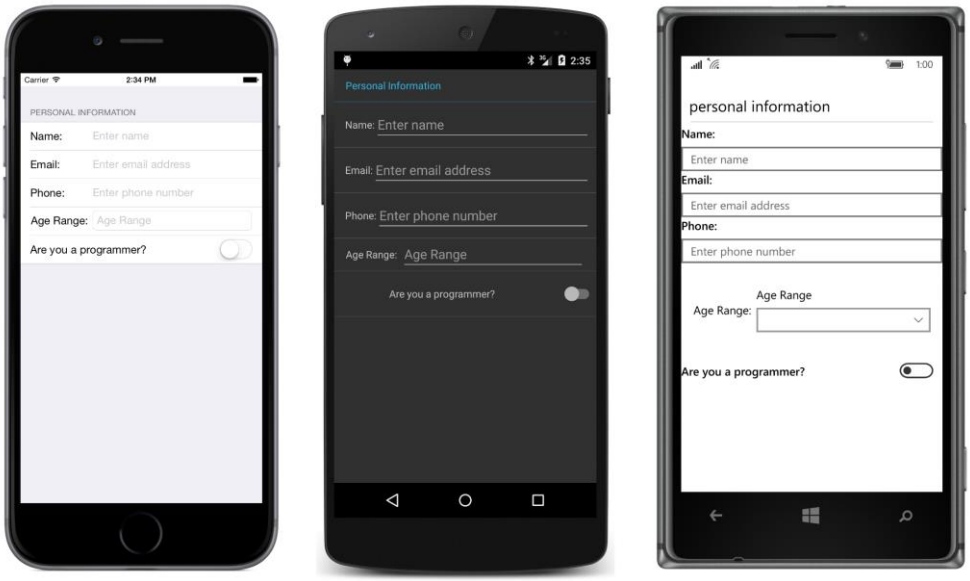
The constructor in the code-behind file handles the rest. It creates the `ProgrammerInformation` object to set to the `BindingContext` of the `TableView` and then removes the second `TableSection` from the `TableRoot`. The page constructor then sets a handler for the `PropertyChanged` event of `ProgrammerInformation` and waits for changes to the `IsProgrammer` property:

```
public partial class ConditionalSectionPage : ContentPage
{
    public ConditionalSectionPage()
    {
        InitializeComponent();

        // Set BindingContext of TableView.
        ProgrammerInformation programmerInfo = new ProgrammerInformation();
        tableView.BindingContext = programmerInfo;

        // Remove programmer-information section!
        tableView.Root.Remove(programmerInfoSection);

        // Watch for changes in IsProgrammer property in ProgrammerInformation.
        programmerInfo.PropertyChanged += (sender, args) =>
        {
            if (args.PropertyName == "IsProgrammer")
            {
                if (programmerInfo.IsProgrammer &&
                    tableView.Root.IndexOf(programmerInfoSection) == -1)
                {
                    tableView.Root.Add(programmerInfoSection);
                }
                if (!programmerInfo.IsProgrammer &&
```

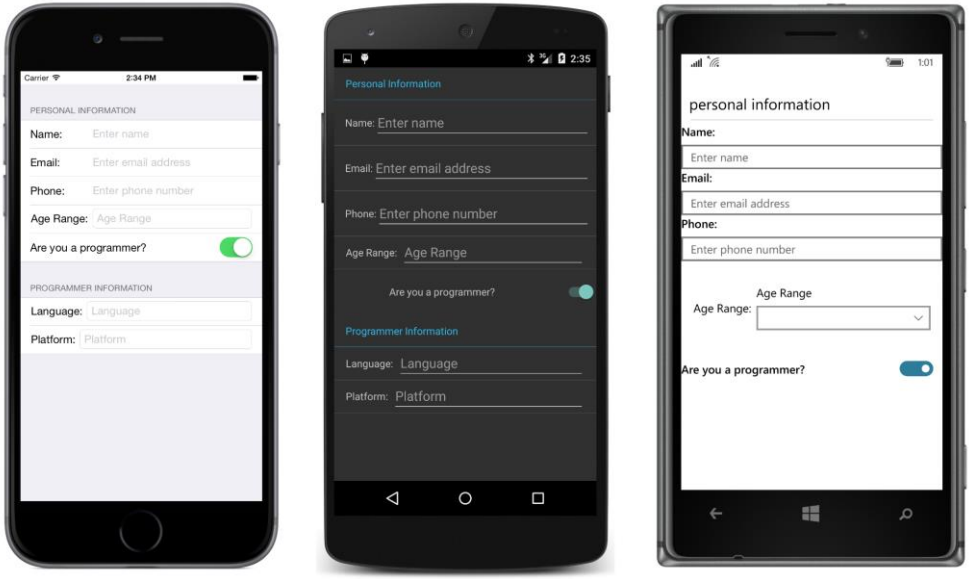
```
                    tableView.Root.IndexOf(programmerInfoSection) != -1)
                {
                    tableView.Root.Remove(programmerInfoSection);
                }
            }
        };
    }
}
```

In theory, the `PropertyChanged` handler doesn't need to check if the `TableSection` is already part of the `TableRoot` collection before adding it, or check if it's not part of the collection before attempting to remove it, but the checks don't hurt.

Here's the program when it first starts up with only one section visible:




Toggling the `SwitchCell` on brings the two additional properties into view:




But not on the Windows 10 Mobile screen.

You don't need to have a single `BindingContext` for the whole `TableView`. Each `TableSection` can have its own `BindingContext`, which means that you can divide your `ViewModels` to coordinate more closely with the `TableView` layout.

## A TableView menu

Besides displaying data or serving as a form or settings dialog, a `TableView` can also be a menu. Functionally, a menu is a collection of buttons, although they might not look like traditional buttons. Each menu item is a command that triggers a program operation.

This is why `TextCell` and `ImageCell` have `Command` and `CommandParameter` properties. These cells can trigger commands defined in a ViewModel, or simply some other property of type `ICommand`.

The XAML file in the **MenuCommands** program binds the `Command` properties of four `TextCell` elements with a property named `MoveCommand`, and passes to that `MoveCommand` arguments named "left", "up", "right", and "down":

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="MenuCommands.MenuCommandsPage"
             x:Name="page">

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

```
    <StackLayout>
        <TableView Intent="Menu"
                   VerticalOptions="Fill"
                   BindingContext="{x:Reference page}">
            <TableRoot>
                <TableSection Title="Move the Box">
                    <TextCell Text="Left"
                              Command="{Binding MoveCommand}"
                              CommandParameter="left" />

                    <TextCell Text="Up"
                              Command="{Binding MoveCommand}"
                              CommandParameter="up" />

                    <TextCell Text="Right"
                              Command="{Binding MoveCommand}"
                              CommandParameter="right" />

                    <TextCell Text="Down"
                              Command="{Binding MoveCommand}"
                              CommandParameter="down" />
                </TableSection>
            </TableRoot>
        </TableView>

        <AbsoluteLayout BackgroundColor="Maroon"
                        VerticalOptions="FillAndExpand">
            <BoxView x:Name="boxView"
                     Color="Blue"
                     AbsoluteLayout.LayoutFlags="All"
                     AbsoluteLayout.LayoutBounds="0.5, 0.5, 0.2, 0.2" />
        </AbsoluteLayout>
    </StackLayout>
</ContentPage>
```

But where is that `MoveCommand` property? If you look at the `BindingContext` of the `TableView`, you'll see that it references the root element of the XAML file, which means that `MoveCommand` property can probably be found as a property in the code-behind file.

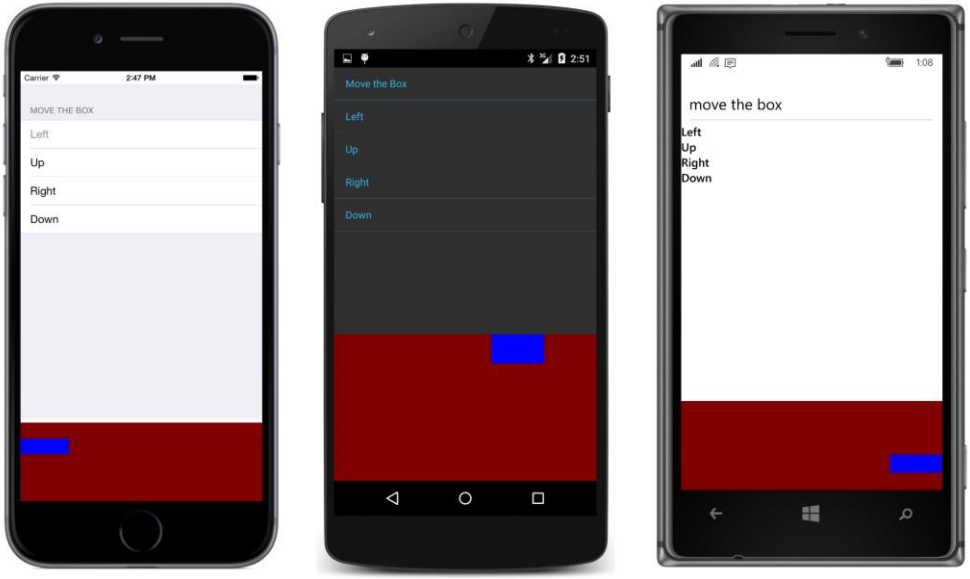
And there it is:

```
public partial class MenuCommandsPage : ContentPage
{
    int xOffset = 0;    // ranges from -2 to 2
    int yOffset = 0;    // ranges from -2 to 2

    public MenuCommandsPage()
    {
        // Initialize ICommand property before parsing XAML.
        MoveCommand = new Command<string>(ExecuteMove, CanExecuteMove);

        InitializeComponent();
    }
```

```
    public ICommand MoveCommand { private set; get; }

    void ExecuteMove(string direction)
    {
        switch (direction)
        {
            case "left": xOffset--; break;
            case "right": xOffset++; break;
            case "up": yOffset--; break;
            case "down": yOffset++; break;
        }

        ((Command)MoveCommand).ChangeCanExecute();

        AbsoluteLayout.SetLayoutBounds(boxView,
            new Rectangle((xOffset + 2) / 4.0,
                          (yOffset + 2) / 4.0, 0.2, 0.2));
    }

    bool CanExecuteMove(string direction)
    {
        switch (direction)
        {
            case "left": return xOffset > -2;
            case "right": return xOffset < 2;
            case "up": return yOffset > -2;
            case "down": return yOffset < 2;
        }
        return false;
    }
}
```

The `Execute` method manipulates the layout bounds of a `BoxView` in the XAML file so that it moves around the `AbsoluteLayout`. The `CanExecute` method disables an operation if the `BoxView` has been moved to one of the edges.

Only on iOS does the disabled `TextCell` actually appear with a typical gray coloring, but on both the iOS and Android platforms the `TextCell` is no longer functional if the `CanExecute` method returns `false`:




You can also use `TableView` as a menu for page navigation or working with master/detail pages, and for these particular applications you might wonder whether a `ListView` or `TableView` is the right tool for the job. Generally it's `ListView` if you have a collection of items that should all be displayed in the same way, or `TableView` for fewer items that might require individual attention.

What is certain is that you'll definitely see more examples in the chapters ahead.