Part 4. Data Binding Basics

Linking Properties in XAML Files

Data Bindings

Data bindings connect properties of two objects, called the *source* and the *target*. In code, two steps are required: The `BindingContext` property of the target object must be set to the source object, and the `SetBinding` method (often used in conjunction with the `Binding` class) must be called on the target object to bind a property of that object to a property of the source object.

The target property must be a bindable property, which means that the target object must derive from `BindableObject`. The online Xamarin.Forms documentation indicates which properties are bindable properties.

In markup, these same two steps are also required, except that the `Binding` markup extension takes the place of the `SetBinding` call and the `Binding` class.

However, there is no single technique to set the `BindingContext` of the target object. Sometimes it's set from the code-behind file, sometimes using a `StaticResource` or `x:Static` markup extension, and sometimes as the content of `BindingContext` property-element tags.

Bindings are used most often to connect the visuals of a program with an underlying data model, usually in a realization of the MVVM (Model-View-ViewModel) application architecture, as discussed in Part 5. From Data Bindings to MVVM. But other scenarios are possible.

View-to-View Bindings

Data bindings can be defined to link properties of two views on the same page. In this case, you

set the `BindingContext` of the target object using the `x:Reference` markup extension.

Here's a XAML file that contains a `Slider` and two `Label` views, one of which is rotated by the `Slider` value and another which displays the `Slider` value:

```
<?xml version="1.0" encoding="utf-8" ?>
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="XamlSamples.SliderBindingsPage"
             Title="Slider Bindings Page">

  <StackLayout>
    <Label Text="ROTATION"
           BindingContext="{x:Reference Name=slider}"
           Rotation="{Binding Path=Value}"
           FontAttributes="Bold"
           FontSize="Large"
           HorizontalOptions="Center"
           VerticalOptions="CenterAndExpand" />

    <Slider x:Name="slider"
            Maximum="360"
            VerticalOptions="CenterAndExpand" />

    <Label BindingContext="{x:Reference slider}"
          Text="{Binding Value,
                         StringFormat='The angle is {0:F0} degrees'}"
          FontAttributes="Bold"
          FontSize="Large"
          HorizontalOptions="Center"
          VerticalOptions="CenterAndExpand" />
  </StackLayout>
</ContentPage>
```

The `Slider` contains an `x:Name` attribute that is referenced by the two `Label` views using the

`x:Reference` markup extension.

The `x:Reference` binding extension defines a property named `Name` to set to the name of the referenced element, in this case `slider`. However, the `ReferenceExtension` class that defines the `x:Reference` markup extension also defines a `ContentProperty` attribute for `Name`, which means that it isn't explicitly required. Just for variety, the first `x:Reference` includes "Name=" but the second does not:

```
BindingContext="{x:Reference Name=slider}"
…
BindingContext="{x:Reference slider}"
```

The `Binding` markup extension itself can have several properties, just like the `BindingBase` and `Binding` class. The `ContentProperty` for `Binding` is `Path`, but the "Path=" part of the markup extension can be omitted only if it's the first item in the `Binding` markup extension. The first example has "Path=" but the second omits it:

```
Rotation="{Binding Path=Value}"
…
Text="{Binding Value,
               StringFormat='The angle is {0:F0} degrees'}"
```

The properties can all be on one line or separated into multiple lines. Whatever's convenient.

Notice the `StringFormat` in the second `Binding` markup extension. In Xamarin.Forms, bindings do not perform any implicit type conversions, and if you need to display a non-string object as a string you must provide a type converter or use `StringFormat`. Behind the scenes, the string specified in the `StringFormat` is used in the static `String.Format` method. That's potentially a problem, because .NET formatting specifications involve curly braces, which are also used to delimit markup extensions and hence have the danger of confusing the XAML parser. To avoid that, put the entire formatting string in single quotation marks:

```
Text="{Binding Value,
               StringFormat='The angle is {0:F0} degrees'}"
```

Here's the running program:

Backwards Bindings

A single view can have data bindings on several of its properties. However, each view can have only one `BindingContext`, so multiple data bindings on that view must all reference properties of the same object.

To get around this restriction, sometimes it's necessary to define view-to-view bindings using the `OneWayToSource` or `TwoWay` modes. Here's an example:

The following program has four `Slider` views intended to control the `Scale`, `Rotate`, `RotateX`, and `RotateY` properties of a `Label`. At first, it seems as if these four properties of the `Label` should be data-binding targets because each is being set by a `Slider`. However, the `BindingContext` of `Label` can be only one object, and there are four different sliders.

For that reason, all the bindings are flipped around and seemingly backwards: The `BindingContext` of each of the four sliders is set to the `Label`, and the bindings are set on the `Value` properties of the sliders. By using the `OneWayToSource` and `TwoWay` modes, these `Value` property are used to set the source properties, which are the `Scale`, `Rotate`, `RotateX`,

and `RotateY` properties of the `Label`.

```
<?xml version="1.0" encoding="utf-8" ?>
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="XamlSamples.SliderTransformsPage"
             Title="Slider Transforms Page">
  <Grid>
    <Grid.RowDefinitions>
      <RowDefinition Height="*" />
      <RowDefinition Height="Auto" />
      <RowDefinition Height="Auto" />
      <RowDefinition Height="Auto" />
      <RowDefinition Height="Auto" />
    </Grid.RowDefinitions>

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

    <StackLayout Grid.Row="0" Grid.Column="0" Grid.ColumnSpan="2">

      <!-- Scaled and rotated Label -->
      <Label x:Name="label"
             Text="TEXT"
             HorizontalOptions="Center"
             VerticalOptions="CenterAndExpand" />

    </StackLayout>

    <!-- Slider and identifying Label for Scale -->
    <Slider x:Name="scaleSlider"
            BindingContext="{x:Reference label}"
```

```
            Grid.Row="1" Grid.Column="1"
            Maximum="10"
            Value="{Binding Scale, Mode=TwoWay}" />

    <Label BindingContext="{x:Reference scaleSlider}"
           Text="{Binding Value, StringFormat='Scale = {0:F1}'}"
           Grid.Row="1" Grid.Column="0"
           VerticalTextAlignment="Center" />

    <!-- Slider and identifying Label for Rotation -->
    <Slider x:Name="rotationSlider"
            BindingContext="{x:Reference label}"
            Grid.Row="2" Grid.Column="1"
            Maximum="360"
            Value="{Binding Rotation, Mode=OneWayToSource}" />

    <Label BindingContext="{x:Reference rotationSlider}"
           Text="{Binding Value, StringFormat='Rotation = {0:F0}'}"
           Grid.Row="2" Grid.Column="0"
           VerticalTextAlignment="Center" />

    <!-- Slider and identifying Label for RotationX -->
    <Slider x:Name="rotationXSlider"
            BindingContext="{x:Reference label}"
            Grid.Row="3" Grid.Column="1"
            Maximum="360"
            Value="{Binding RotationX, Mode=OneWayToSource}" />

    <Label BindingContext="{x:Reference rotationXSlider}"
           Text="{Binding Value, StringFormat='RotationX = {0:F0}'}"
           Grid.Row="3" Grid.Column="0"
           VerticalTextAlignment="Center" />
```

```
    <!-- Slider and identifying Label for RotationY -->
    <Slider x:Name="rotationYSlider"
            BindingContext="{x:Reference label}"
            Grid.Row="4" Grid.Column="1"
            Maximum="360"
            Value="{Binding RotationY, Mode=OneWayToSource}" />

    <Label BindingContext="{x:Reference rotationYSlider}"
           Text="{Binding Value, StringFormat='RotationY = {0:F0}'}"
           Grid.Row="4" Grid.Column="0"
           VerticalTextAlignment="Center" />
  </Grid>
</ContentPage>
```

The bindings on three of the `Slider` views are `OneWayToSource`, meaning that the `Slider` value causes a change in the property of its `BindingContext`, which is the `Label` named `label`. These three `Slider` views cause changes to the `Rotate`, `RotateX`, and `RotateY` properties of the `Label`.

However, the binding for the `Scale` property is `TwoWay`. This is because the `Scale` property has a default value of 1, and using a `TwoWay` binding causes the `Slider` initial value to be set at 1 rather than 0.

If that binding were `OneWayToSource`, the `Scale` property would initially be set to 0 from the `Slider` default value. The `Label` would not be visible, and that might cause some confusion to the user.

Notice that the labels to the left of each `Slider` indicate the current value. These are normal `OneWay` bindings on each `Label`, but the `BindingContext` on the `Label` needs to reference the `Slider`.

This means that each `Slider` must appear in the XAML file lexically prior to its corresponding `Label`, which is not the way they appear visually. The program manages this feat using a `Grid` in which the `Slider` appears first in column 1, followed by the `Label` in column 0.

Bindings and Collections

Nothing illustrates the power of XAML and data bindings better than a templated `ListView`.

`ListView` defines an `ItemsSource` property of type `IEnumerable`, and it displays the items in that collection. These items can be objects of any type. By default, `ListView` uses the `ToString` method of each item to display that item. Sometimes this is just what you want, but in many cases the `ToString` returns only the fully-qualified class name of the object.

However, the items in the `ListView` collection can be displayed any way you want through the use of a template, which involves a class that derives from `Cell`. The template is cloned for every item in the `ListView`, and data bindings that have been set on the template are transferred to the individual clones.

Very often, you'll want to create a custom cell for these items using the `ViewCell` class. This process is somewhat messy in code, but in XAML it becomes very straightforward.

Included in the XamlSamples project is a class called `NamedColor`. Each `NamedColor` object has `Name` and `FriendlyName` properties of type `string`, and a `Color` property of type

`Color`. In addition, `NamedColor` has 147 static read-only fields of type `Color` corresponding to the colors defined in the CSS 3 specification. A static constructor then creates an `IEnumerable<NamedColor>` collection that contains `NamedColor` objects corresponding to these static fields, and assigns it to its public static `All` property.

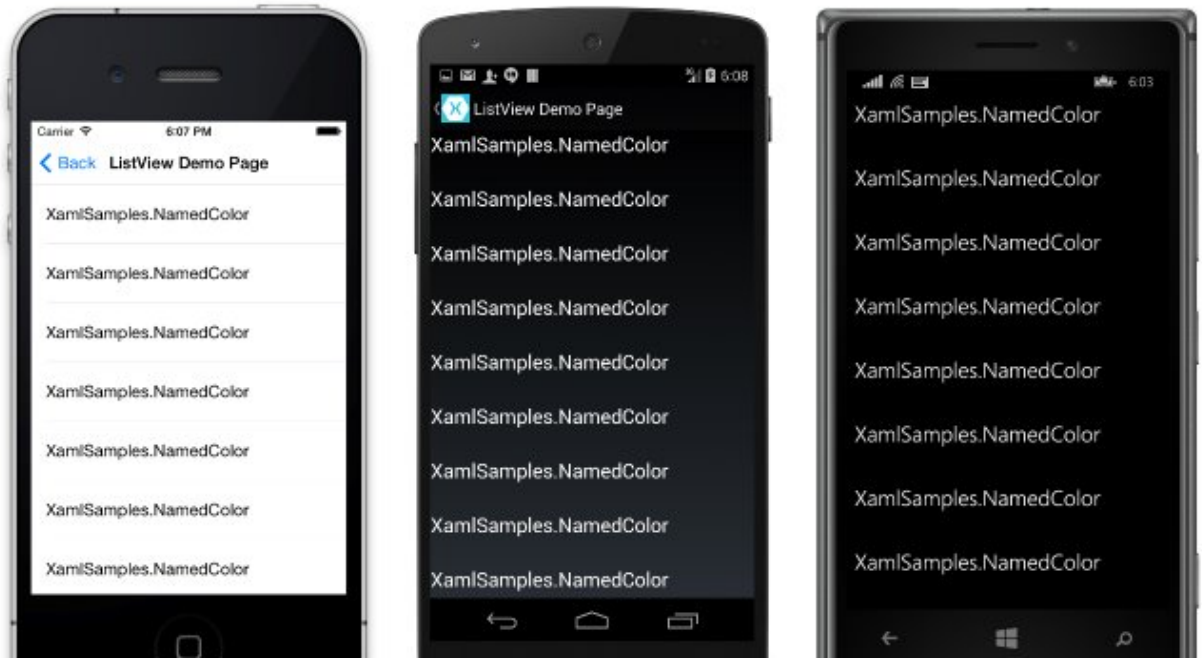
Setting the static `NamedColor.All` property to the `ItemsSource` of a `ListView` is easy using the `x:Static` markup extension:

```
<?xml version="1.0" encoding="utf-8" ?>
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:local="clr-
namespace:XamlSamples;assembly=XamlSamples"
             x:Class="XamlSamples.ListViewDemoPage"
             Title="ListView Demo Page">

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

</ContentPage>
```

The resultant display establishes that the items are truly of type `XamlSamples.NamedColor`:

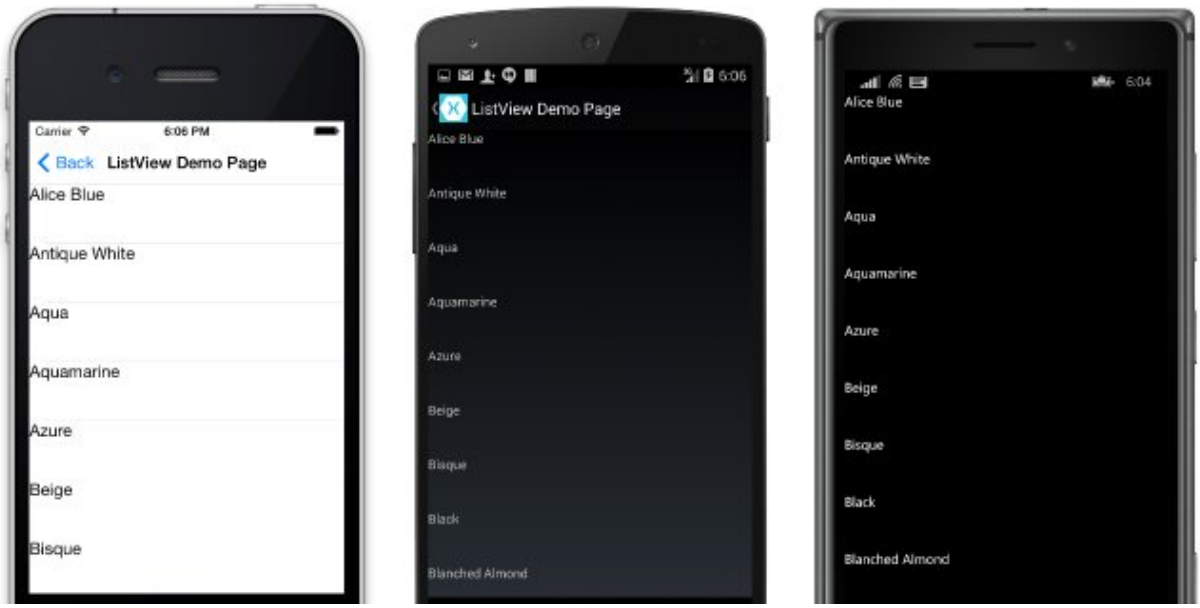


It's not much information, but the `ListView` is scrollable and selectable.

To define a template for the items, you'll want to break out the `ItemTemplate` property as a property element, and set it to a `DataTemplate`, which then references a `ViewCell`. To the `View` property of the `ViewCell` you can define a layout of one or more views to display each item. Here's a simple example:

```
<ListView ItemsSource="{x:Static local:NamedColor.All}">
    <ListView.ItemTemplate>
      <DataTemplate>
        <ViewCell>
          <ViewCell.View>
            <Label Text="{Binding FriendlyName}" />
          </ViewCell.View>
        </ViewCell>
      </DataTemplate>
    </ListView.ItemTemplate>
  </ListView>
```

This displays the `FriendlyName` property of each `NamedColor` object:



Much better. Now all that's needed is to spruce up the item template with more information and the actual color. To support this template, some values and objects have been defined in the page's resource dictionary:

```
<?xml version="1.0" encoding="utf-8" ?>
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:local="clr-
namespace:XamlSamples;assembly=XamlSamples"
             x:Class="XamlSamples.ListViewDemoPage"
             Title="ListView Demo Page">

  <ContentPage.Resources>
    <ResourceDictionary>
      <OnPlatform x:Key="boxSize"
                  x:TypeArguments="x:Double"
                  iOS="50"
                  Android="50"
                  WinPhone="75" />

      <!-- This is only an issue on the iPhone; Android and
           WinPhone auto size the row height to the contents. -->
      <OnPlatform x:Key="rowHeight"
                  x:TypeArguments="x:Int32"
                  iOS="60"
                  Android="60"
                  WinPhone="85" />

      <local:DoubleToIntConverter x:Key="intConverter" />

    </ResourceDictionary>
```

```
  </ContentPage.Resources>

  <ListView ItemsSource="{x:Static local:NamedColorGroup.All}"
            RowHeight="{StaticResource rowHeight}">
    <ListView.ItemTemplate>
      <DataTemplate>
        <ViewCell>
          <ViewCell.View>
            <StackLayout Padding="5, 5, 0, 5"
                         Orientation="Horizontal"
                         Spacing="15">

              <BoxView WidthRequest="{StaticResource boxSize}"
                       HeightRequest="{StaticResource boxSize}"
                       Color="{Binding Color}" />

              <StackLayout Padding="5, 0, 0, 0"
                           VerticalOptions="Center">

                <Label Text="{Binding FriendlyName}"
                       FontAttributes="Bold"
                       FontSize="Medium" />

                <StackLayout Orientation="Horizontal"
                             Spacing="0">
                  <Label Text="{Binding Color.R,
                                        Converter={StaticResource
intConverter},
                                        ConverterParameter=255,
                                        StringFormat='R={0:X2}'}" />
                  <Label Text="{Binding Color.G,
                                        Converter={StaticResource
intConverter},
```

```
                                    ConverterParameter=255,
                                    StringFormat=', G={0:X2}'}" />
                    <Label Text="{Binding Color.B,
                                    Converter={StaticResource
intConverter},
                                    ConverterParameter=255,
                                    StringFormat=', B={0:X2}'}" />
                  </StackLayout>
                </StackLayout>
              </StackLayout>
            </ViewCell.View>
          </ViewCell>
        </DataTemplate>
      </ListView.ItemTemplate>
    </ListView>
</ContentPage>
```

Notice the use of `OnPlatform` to define the size of a `BoxView` that's roughly visually equivalent on all three platforms. Because the iPhone doesn't automatically size the row height of these `ListView` items, another `OnPlatform` for the `RowHeight` was also added.

The `R`, `G`, and `B` properties of the Xamarin.Forms `Color` structure are of type `double` and range from 0 to 1. If you want to display the hexadecimal values, you can't simply use `StringFormat` with an "X2" formatting specification. That only works for integers and besides, the `double` values need to be multiplied by 255.

This little problem was solved with a binding converter:

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

namespace XamlSamples
{
    class DoubleToIntConverter : IValueConverter
```

```
    {
        public object Convert(object value, Type targetType,
                              object parameter, CultureInfo culture)
        {
            double multiplier;

            if (!Double.TryParse(parameter as string, out multiplier))
                multiplier = 1;

            return (int)Math.Round(multiplier * (double)value);
        }

        public object ConvertBack(object value, Type targetType,
                                  object parameter, CultureInfo
culture)
        {
            double divider;

            if (!Double.TryParse(parameter as string, out divider))
                divider = 1;

            return ((double)(int)value) / divider;
        }
    }
}
```

Although the `ConvertBack` method is included, it does not play a role in this program because the bindings are only one way from source to target. For some versatility, the binding converter checks the converter parameter for a valid `double` value that functions as a multiplier.

The converter is included in the resource dictionary. The three data bindings share this single instance. Notice that the `Binding` markup extension contains an embedded `StaticResource` markup extension:

```
<Label Text="{Binding Color.R,
```

```
                Converter={StaticResource intConverter},
                ConverterParameter=255,
                StringFormat='R={0:X2}'}" />
```

Here's the result:

The `ListView` is quite sophisticated in handling changes that might dynamically occur in the underlying data, but only if you help out. If the collection of items assigned to the `ItemsSource` property of the `ListView` changes during runtime—that is, if items are added to or removed from the collection—use an `ObservableCollection` class for these items. `ObservableCollection` implements the `INotifyCollectionChanged` interface, and `ListView` will install a handler for the `CollectionChanged` event.

If properties of the items themselves change during runtime, then the items in the collection should implement the `INotifyPropertyChanged` interface and signal changes to property values using the `PropertyChanged` event. This is demonstrated in the next part of this series, Part 5. From Data Binding to MVVM.

Summary

Data bindings provide a powerful mechanism for linking properties between two objects within a page, or between visual objects and underlying data. But once the application begins working with data sources, a popular application architectural pattern begins to emerge as a useful paradigm. This is covered in Part 5. From Data Bindings to MVVM.