XAM312

Customizing the ListView in Xamarin Forms

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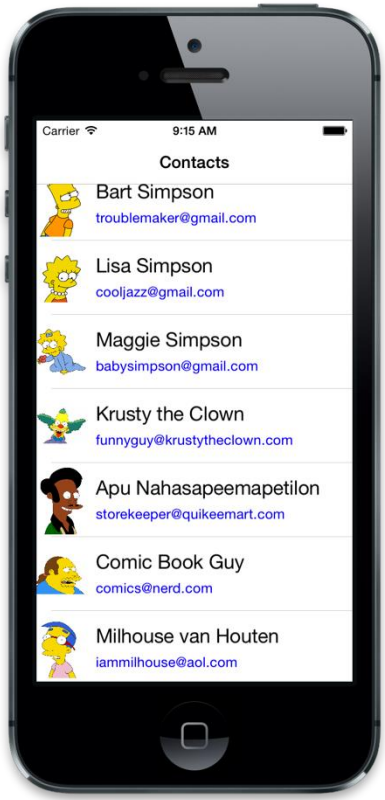
Objectives

1. Creating custom cell definitions
2. Adding headers and footers
3. Separating your data into Groups
4. Performance Tuning your ListViews



Creating Custom Cell Definitions

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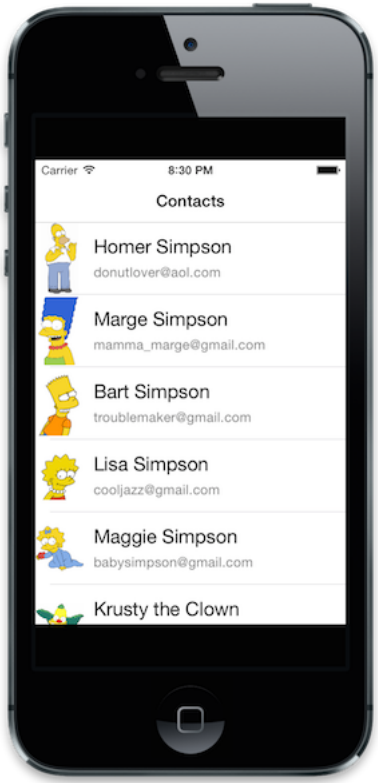
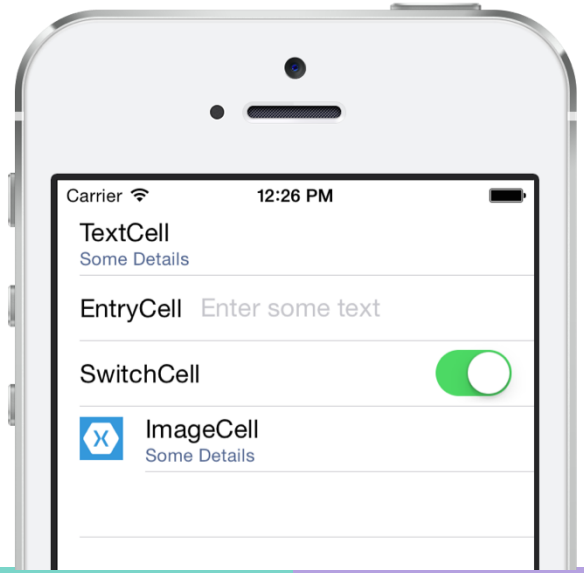
Tasks

1. Using ViewCells
2. Creating Data Templates in code
3. Creating Unique Row Visuals



Reminder: Cell Styles

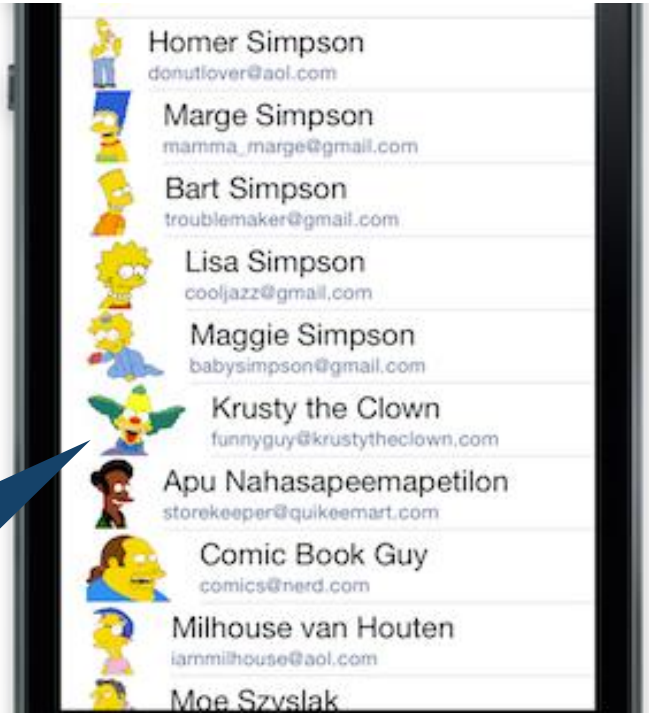
- `ListView` lets you define the visuals for each row through a cell style – there are several built-in variations



Customizing the cells

- Sometimes we need to customize the cell template
  - does not fit the data
  - need custom layout or colors
  - maybe you want something unique!

Images are different sizes and it pushes the text over – no way to control that in the `ImageCell`, would have to alter the image sizes which might not be possible



Introducing: ViewCell

- Can define a **`ViewCell`** to create a custom cell visualization of any type to display your data in a **`ListView`**

```
<DataTemplate>
   <ViewCell>
      <StackLayout Padding="5">
         <Label FontSize="20" TextColor="Black" Text="{Binding Name}" />
         <Label FontSize="14" TextColor="Blue" Text="{Binding Email}" />
      </StackLayout>
   </ViewCell>
</DataTemplate>
```

You define custom XAML to represent a row

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      </StackLayout>
   </ViewCell>
</DataTemplate>
```

`BindingContext` for the generated row will be a single item from the **`ItemsSource`**

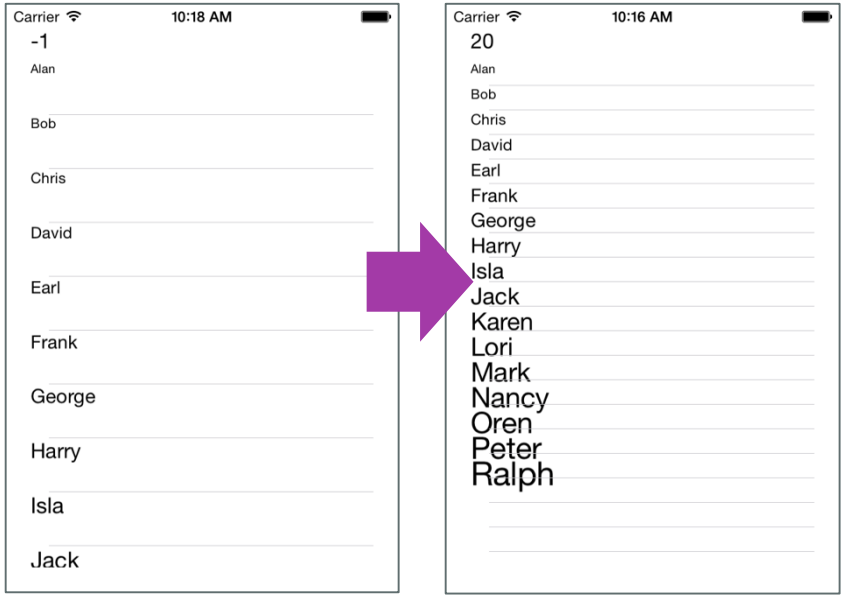
ViewCells in code

- Can define custom cells programmatically by deriving from **`ViewCell`**

```
public class NameViewCell : ViewCell
{
   public NameViewCell() {
      Label name = new Label();
      name.SetBinding(Label.TextProperty, new Binding("Name"));
      Switch toggle = new Switch();
      toggle.SetBinding(Switch.IsToggledProperty,
                        new Binding("Favorite"));
      View = new StackLayout { Children = { name, switch } };
   }
}
```

Controlling the row height

- By default, the **`ListView`** uses the same height for every cell – it's fixed in size for each default cell style
- For **`ViewCell`**, it will attempt to *estimate* the required height based on content; results will vary
- Can specify the height to be used for all rows explicitly by setting the **`ListView.RowHeight`** property



default behavior

`RowHeight` = 20

Individual Exercise

Providing a custom cell template for our ListView

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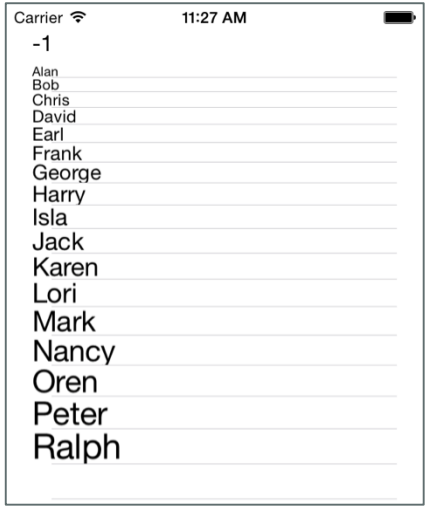
Variable-sized rows

- If the content size changes on a row-by-row basis, can set the **`HasUnevenRows`** property to get the **`ListView`** to size for each row
- Uses **`Cell.Height`** property instead of **`RowHeight`** if > 0
- Generally requires derived **`ViewCell`** class to set **`Height`** property based on the data




```
<ListView ... HasUnevenRows="True">
   <ListView.ItemTemplate>
      <DataTemplate>
         <local:TextViewCell />
      </DataTemplate>
   </ListView.ItemTemplate>
</ListView>
```

```
public class TextViewCell : ViewCell
{
   static MyFontSizeConverter fontConverter = new MyFontSizeConverter();

   public TextViewCell() {
      Label text = new Label();
      text.SetBinding(Label.TextProperty, new Xamarin.Forms.Binding("."));
      text.SetBinding(Label.FontSizeProperty,
             new Xamarin.Forms.Binding(".", converter: fontConverter));
      View = text;
   }

   protected override void OnBindingContextChanged() {
      base.OnBindingContextChanged();
      string text = BindingContext.ToString();
      Height = 10 + ((int)(text[0]) - 65);
   }
}
```

Runtime row resizing

- Individual **ListView** rows can be resized programmatically at runtime using the **ForceUpdateSize** method on the cell

```
void OnImageTapped(object sender, EventArgs args)
{
    var image = sender as Image;
    var viewCell = image.Parent.Parent as ViewCell;

    if (image.HeightRequest < 250)
    {
        image.HeightRequest = image.Height + 100;
        viewCell.ForceUpdateSize();
    }
}
```

Update the height of the child elements

Call **ForceUpdateSize** to update the cell

HasUnevenRows on the **ListView** must be set to **true** to resize at runtime

Using DataTriggers to customize rows

- By default, every row *shares* the same Data Template definition, can use *data triggers* in your template definition to change visuals at runtime

Default value assigned to property

```
<Label Text="{Binding Name}" TextColor="#008080">
   <Label.Triggers>
      <DataTrigger TargetType="Label" Binding="{Binding Gender}"
                   Value="Female">
         <Setter Property="TextColor" Value="#800080" />
      </DataTrigger>
   </Label.Triggers>
</Label>
```

Trigger changes value based on binding evaluation

DataTemplateSelector

- Can use a **`DataTemplateSelector`** to provide a specific **`DataTemplate`** based on the model data being visualized

```
class CharacterSelector : Xamarin.Forms.DataTemplateSelector
{
    public DataTemplate LeadingCharacter { get; set; }
    public DataTemplate SupportingCharacter { get; set; }

    protected override DataTemplate OnSelectTemplate (object item,
                                                       BindableObject container)
    {
        Person p = (Person)item; // Model
        return p.IsMainCharacter ? LeadingCharacter : SupportingCharacter;
    }
}
```

Applying a template selector

- To associate a template selector, set the **`ListView.ItemTemplate`** property to an instance of your **`DataTemplateSelector`**

```
<ContentPage.Resources>
   <ResourceDictionary>
      <local:CharacterSelector x:Key="MyTemplateSelector" />
   </ResourceDictionary>
</ContentPage.Resources>

<ListView x:Name="MessagesListView"
        ItemTemplate="{StaticResource MyTemplateSelector}"
        ItemsSource="{Binding People}"
        HasUnevenRows="True"
        ... />
```

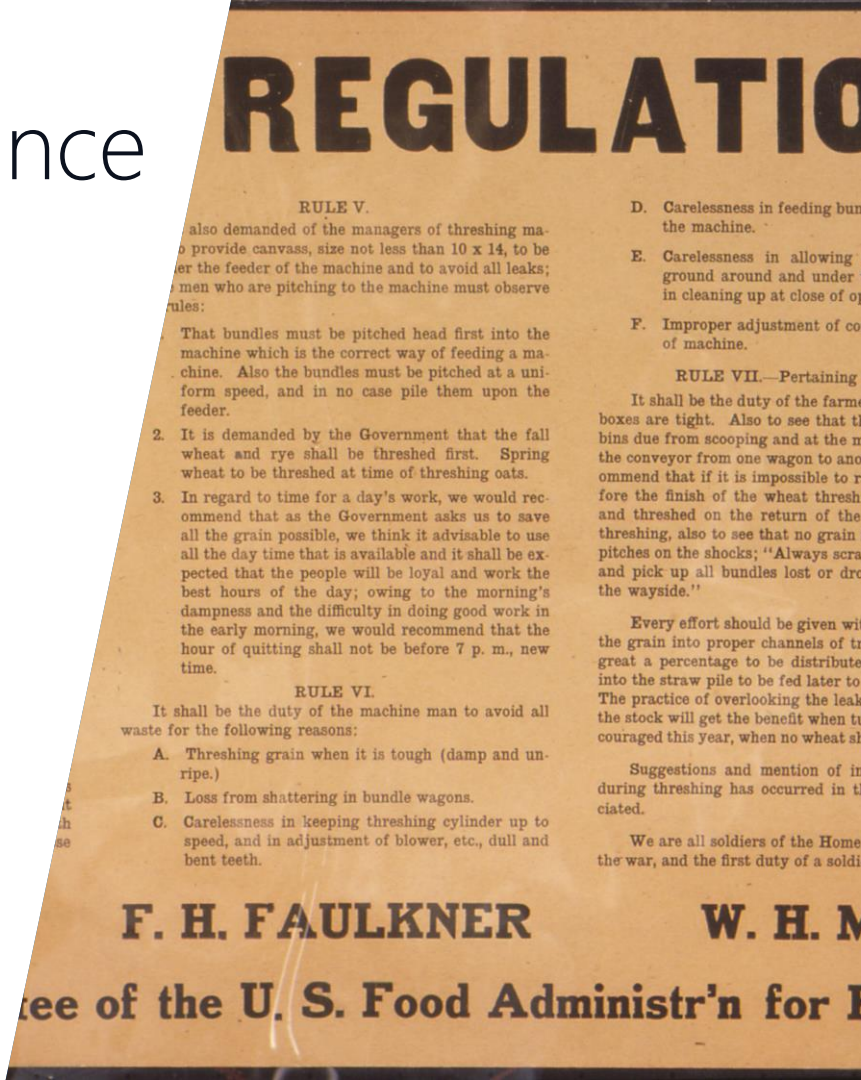
Template selector guidance

1. Minimize the number of returned data templates, particularly on Android

2. Must return the same template for a given model instance

3. Must return a `DataTemplate`, not another selector

4. Always reuse templates – do not allocate new instances each time



Flash Quiz

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Flash Quiz

① When **`HasUnevenRows`** is turned on, the **`ListView`** will use its **`RowHeight`** property if the **`ViewCell.Height`** property is zero

a) True

b) False

Flash Quiz

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a) True

b) False

Flash Quiz

② `DataTemplateSelector`s allow you to _____

a) build `DataTemplate`s in code

b) return a different `DataTemplate` based on the row

c) provide UI selection in your `DataTemplate`

Flash Quiz

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Summary

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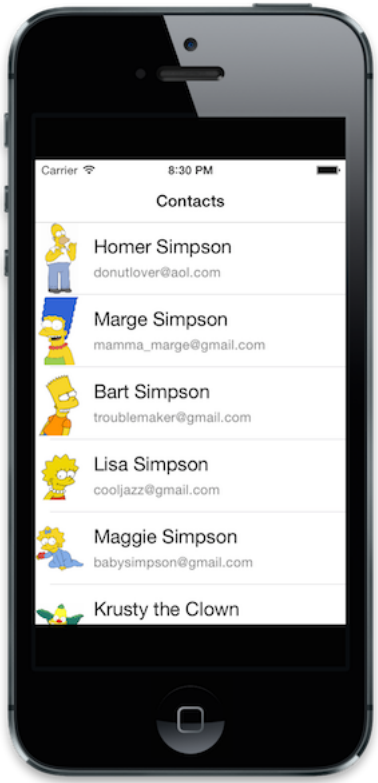

Adding Headers and Footers

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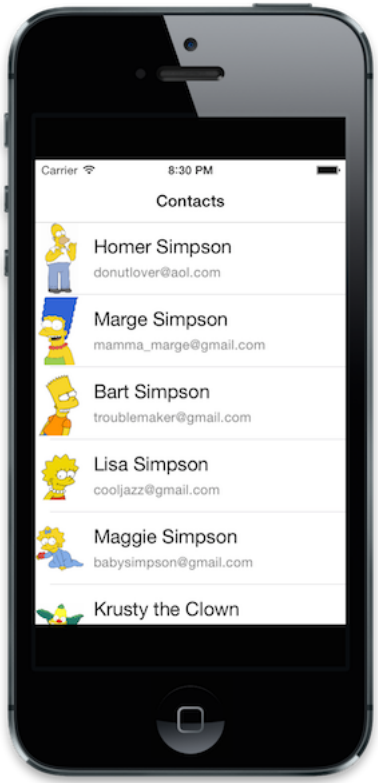
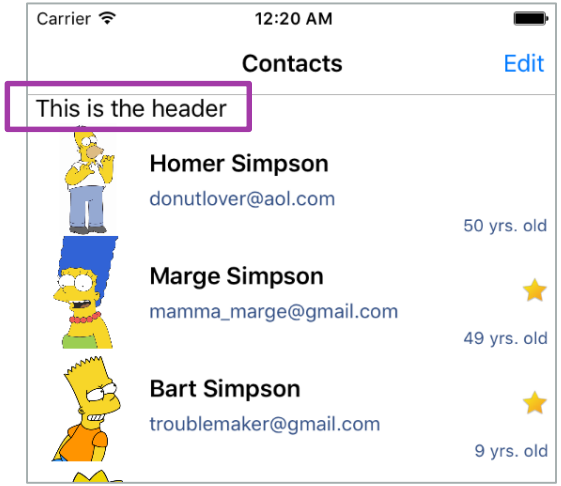
Tasks

1. Defining a header or footer
2. Creating a dynamic header or footer
3. Setting the binding context for a header or footer

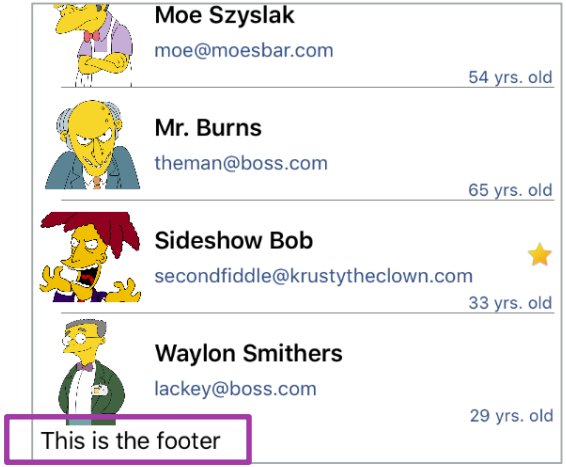


ListView header and footer

- **`ListView`** supports header and footer – which are rendered at the top and bottom of the **`ListView`** control

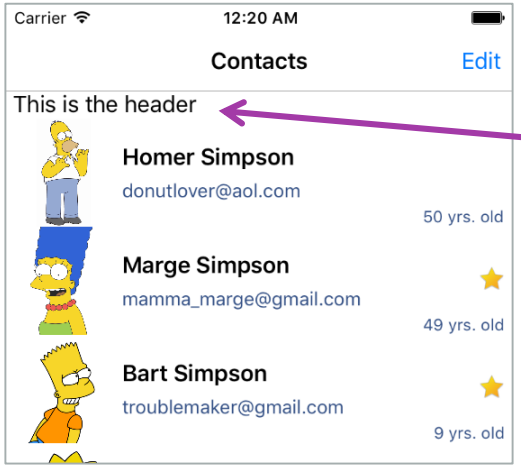


Headers and footers can be simple text or custom views



Setting the header and footer

- **`Header`** and **`Footer`** property define an object which is rendered directly into the **`ListView`** structure



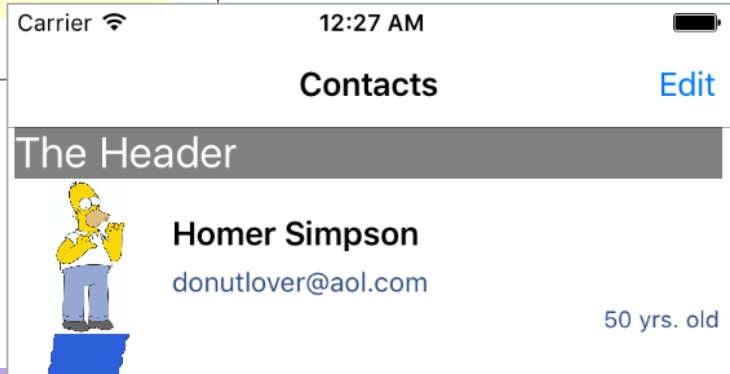

```
<ListView ...
    Header="This is the header"
    Footer="This is the footer">
```

Setting or data binding it to a string value causes a plain **`Label`** to be rendered

Setting the header and footer

- Can set the header or footer to a visual type to display custom visualizations

```
<ListView.Header>
   <ContentView BackgroundColor="Gray">
      <Label FontSize="Large" TextColor="White"
             Text="The Header" />
   </ContentView>
</ListView.Header>
```



Headers and Footers with MVVM

- Can define the header and footer as a **DataTemplate**; in this case, the **Header** and **Footer** properties are used as the **BindingContext**

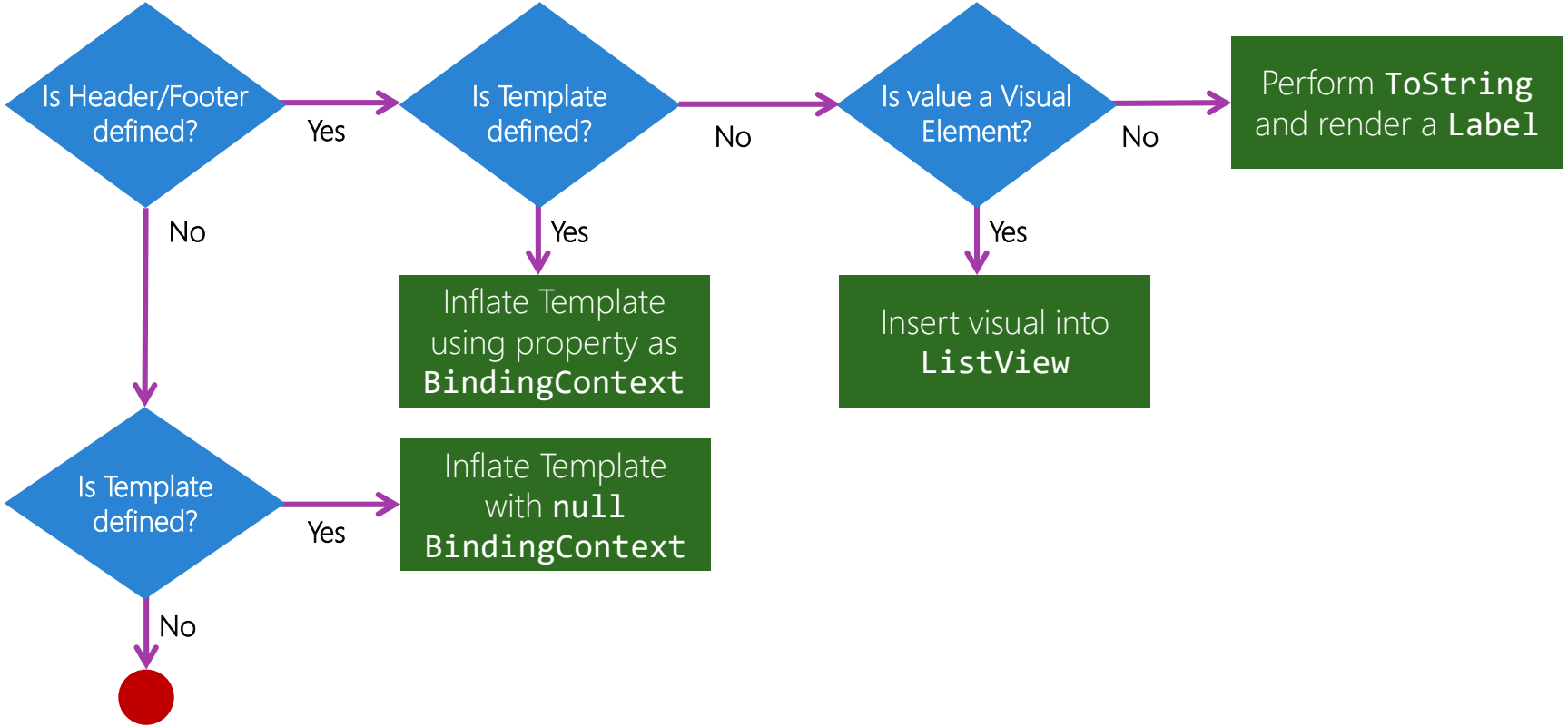
```
<ListView Header="{Binding HeaderText}">
   ...
   <ListView.HeaderTemplate>
      <DataTemplate>
         <Label FontSize="Large" TextColor="Blue"
             Text="{Binding .}" />
      </DataTemplate>
   </ListView.HeaderTemplate >
</ListView>
```

Headers and Footers with MVVM

- **Header** and **Footer** properties are then data bound to VM properties; which then populates the **HeaderTemplate** and **FooterTemplate**

```
public class MyViewModel : INotifyPropertyChanged
{
    string headerText;
    public string HeaderText {
        get { return headerText; }
        set { SetProperty(ref headerText, value); }
    ...
    public MyViewModel() {
        HeaderText = "The Header";
    }
}
```

Populating the header/footer data



Individual Exercise

Add a header and footer to the ListView

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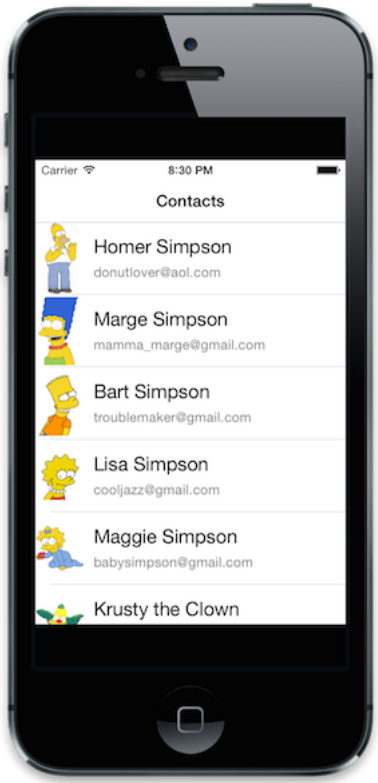
Summary

1. Defining a header or footer
2. Creating a dynamic header or footer
3. Setting the binding context for a header or footer



Separating your data into Groups

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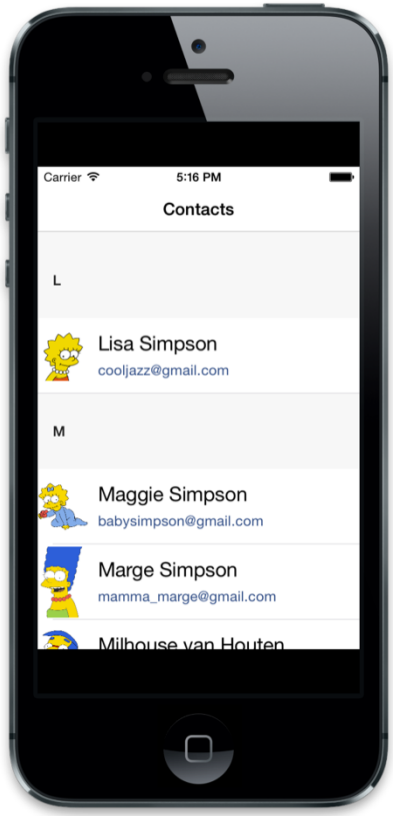
Tasks

1. Sorting
2. Filtering
3. Grouping
4. Group Headers
5. Group Templates



Sorting

- Sorting can be done by modifying the underlying collection, or by replacing the **`ItemsSource`** property value

```
void OnSortAscending(object sender, EventArgs e)
{
    var data = Contacts.All;
    var sortedData = data.OrderBy(p => p.Name).ToList();
    contactList.ItemsSource = sortedData;
}
```

Faster to replace entire collection value than to remove/re-add all items

Filtering

- Filtering can be performed by double-buffering the collection; keeping a "raw" view with all items and a "UI" view with the specific filtered items

```
void OnFilter(object sender, EventArgs e)
{
    var data = Contacts.All;
    var filteredData = data.Where(p => p.Name.StartsWith("A"));
    contactList.ItemsSource = filteredData;
}
```

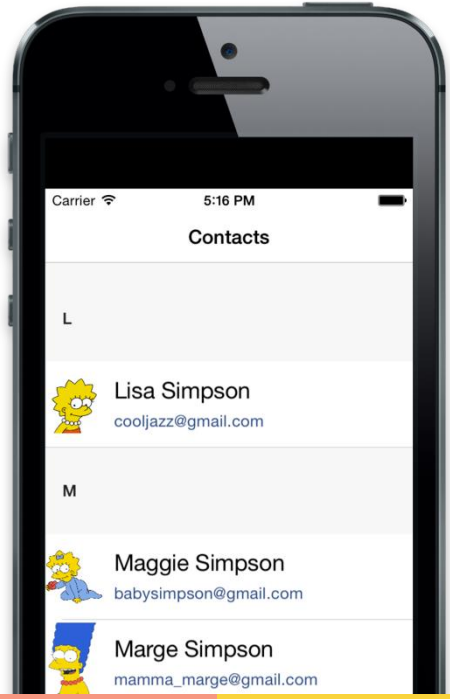
Notice here we are just using the LINQ query directly – e.g. assigning an **`IEnumerable`** to the **`ListView`**

Grouping

- **`ListView`** has built-in support to provide visual grouping of data

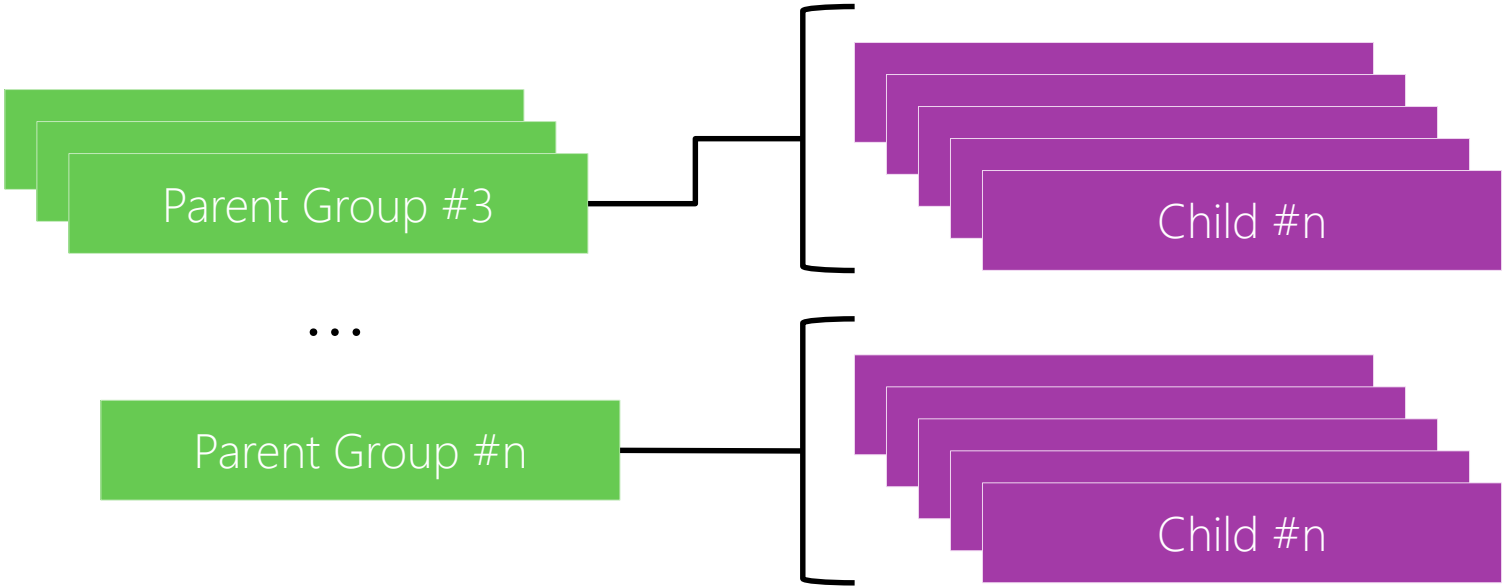
```
<ListView
    IsGroupingEnabled="True" ...>
```

feature is activated by setting the **`IsGroupingEnabled`** property



Supplying Grouped Data

- When grouping is activated, **`ListView`** expects data to be grouped in a parent-child fashion



Supplying Grouped Data

- Parent object must provide grouping property and implement **`IEnumerable`** for the children it owns

```
public class PersonGroup : ObservableCollection<Person>
{
    public string FirstLetter { get; set; }
    public string GroupName { get; set; }
    ...
}
```

Derive from an existing collection to expose the required **`IEnumerable`**

A more generic approach

- Can use a generic class to provide the data directly from LINQ's **GroupBy** expression

```
public class Grouping<K, T> : ObservableCollection<T>
{
    public K Key { get; private set; }
    public Grouping(K key, IEnumerable<T> items)
    {
        Key = key;
        foreach (var item in items)
            this.Items.Add(item);
    }
}
```

Populating with grouped data

- Can then use LINQ to group the data

```
var items = Contacts.All
  .OrderBy(c => c.Name)
  .GroupBy(c => c.Name[0].ToString(), c => c)
  .Select(g => new Grouping<string,Person>(g.Key, g))
  .ToList();

contactList.ItemsSource = items;
contactList.IsGroupingEnabled = true;
```

```
class Grouping<K, T> : ObservableCollection<T>
```

Adding a group header

- It is possible to add a header above each group in a **ListView**; can select a single property used to display a textual **Label**

```
<ListView
   GroupDisplayBinding="{Binding Key}" ...>
```

Value from binding is displayed at the top of the group

```
public class Grouping<K, T> : ObservableCollection<T>
{
   public K Key { get; private set; }
   ...
}
```

Adding a group header

- Can also supply the header as a full **`DataTemplate`** + **`Cell`** to allow for complete visual customization

```
<ListView.GroupHeaderTemplate>
   <DataTemplate>
     <TextCell Text="{Binding Key}"
          Detail="{Binding Count, StringFormat='{0} items'}" />
   </DataTemplate>
</ListView.GroupHeaderTemplate>
```

Group Exercise

Adding Grouping support to our Character List

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Adding a Quick Index

- iOS and WP support a "quick index" feature by setting the **GroupShortNameBinding** property; must supply a binding to a property that returns the string to use as the index

```
<ListView ItemsSource="{Binding .}"
        IsGroupingEnabled="true"
        GroupShortNameBinding="{Binding Key}">
```

String returned from **Binding** will be placed to the right of the **ListView**, tapping on the string will "jump" to that group

Individual Exercise

Add a Quick Index

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Summary

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2. Filtering
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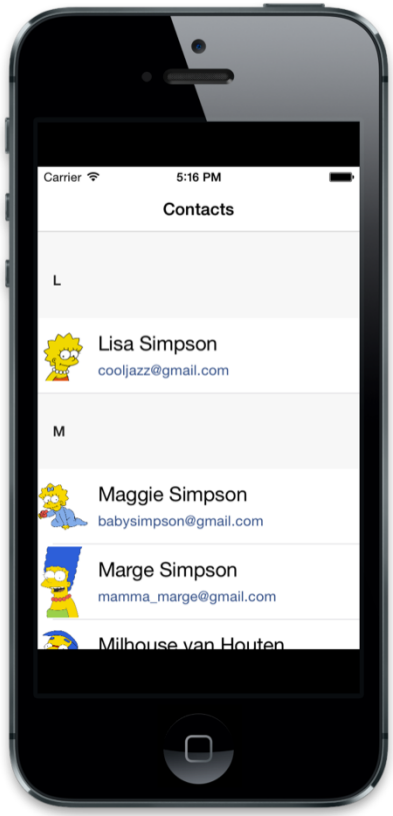
4. Group Headers
5. Group Templates



Performance Tuning the ListView

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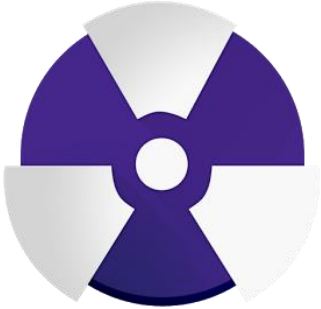
Performance Tips

- Several tweaks you can do to ListView to optimize it's performance based on the amount of data and the visualization being used

- Note that none of these are silver bullets – try each one as needed, but be prepared to profile and benchmark your application

Structure of a ListView row

- Each row is composed of two pieces that work together to display the information



Logical (Model) Information

- Data item from **`ItemsSource`** used as **`BindingContext`**
- **`Cell`**-derived object describes the desired visual layout

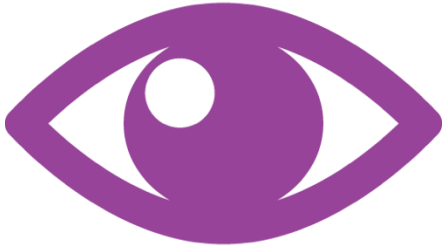
Structure of a ListView row

- Each row is composed of two pieces that work together to display the information

Cell Renderer which creates:

- iOS: `UITableViewCell`
- Android: `View`
- Windows: `ListViewItem`

Content is either native element, or generated from `ViewCell.View`



Visual Information

High performance lists

- Secret to high performance scrolling and visual rendering is *caching* and *reuse*
- Xamarin.Forms always uses native platform visual recycling/reuse
- However the *logical* element caching strategy can be decided by the developer

Configure caching strategy

- Xamarin.Forms 2.0 supports a new performance optimization related to how it generates Cells, called the *caching strategy*

RetainElement

`ListView` generates a **`Cell`** for *every item* in the list and keeps them around ("retains" them)

This is the *default* (old) behavior

Configure caching strategy

- Xamarin.Forms supports a performance optimization related to how it generates **`Cell`**s, called the *caching strategy*

RetainElement

RecycleElement

`ListView` minimizes the memory footprint by recycling cells as you scroll through the list

This is the preferred behavior

Turn on ListView recycling

- Most apps will benefit from recycling cells – new behavior must be set when **`ListView`** is created and cannot be changed at runtime

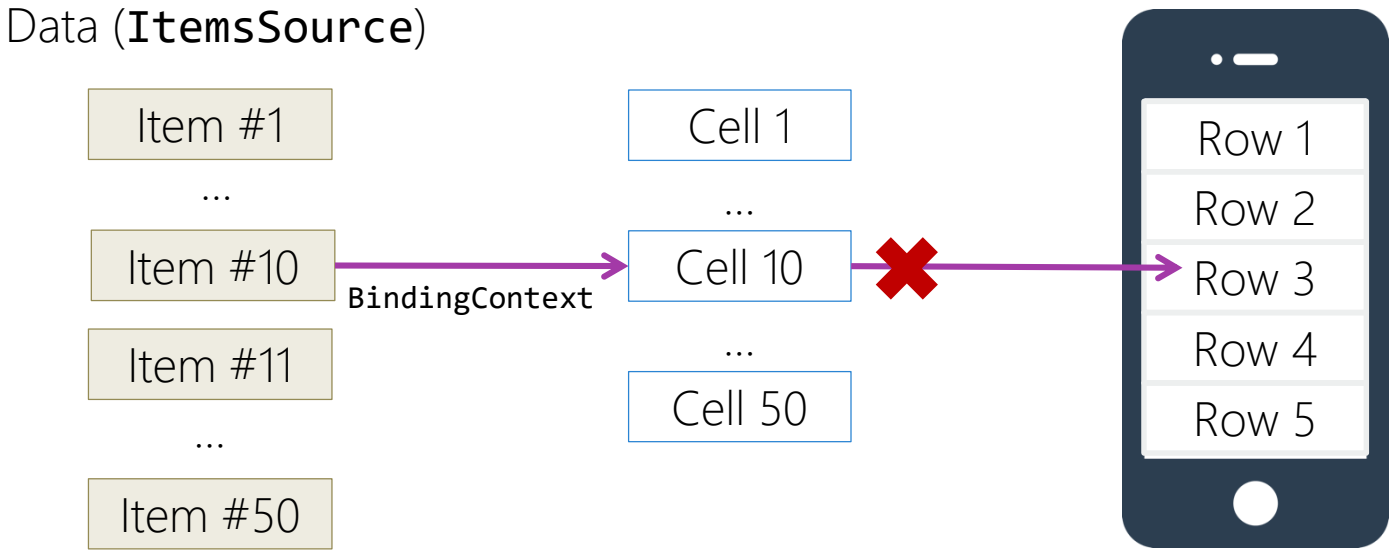
```
<ListView CachingStrategy="RecycleElement" ... />
```

or

```
var lv = new ListView(ListViewCachingStrategy.RecycleElement);
```

When cell recycling is OFF

- When cell recycling is off (default), a unique cell is created for each data item and used to populate the information in a visible row



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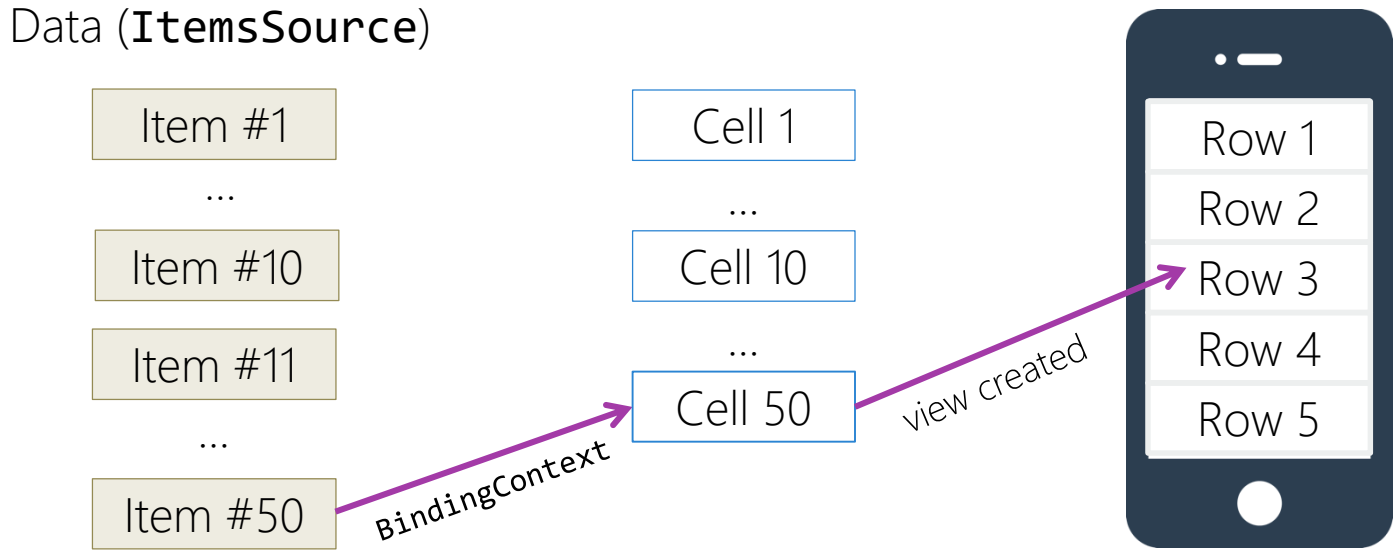
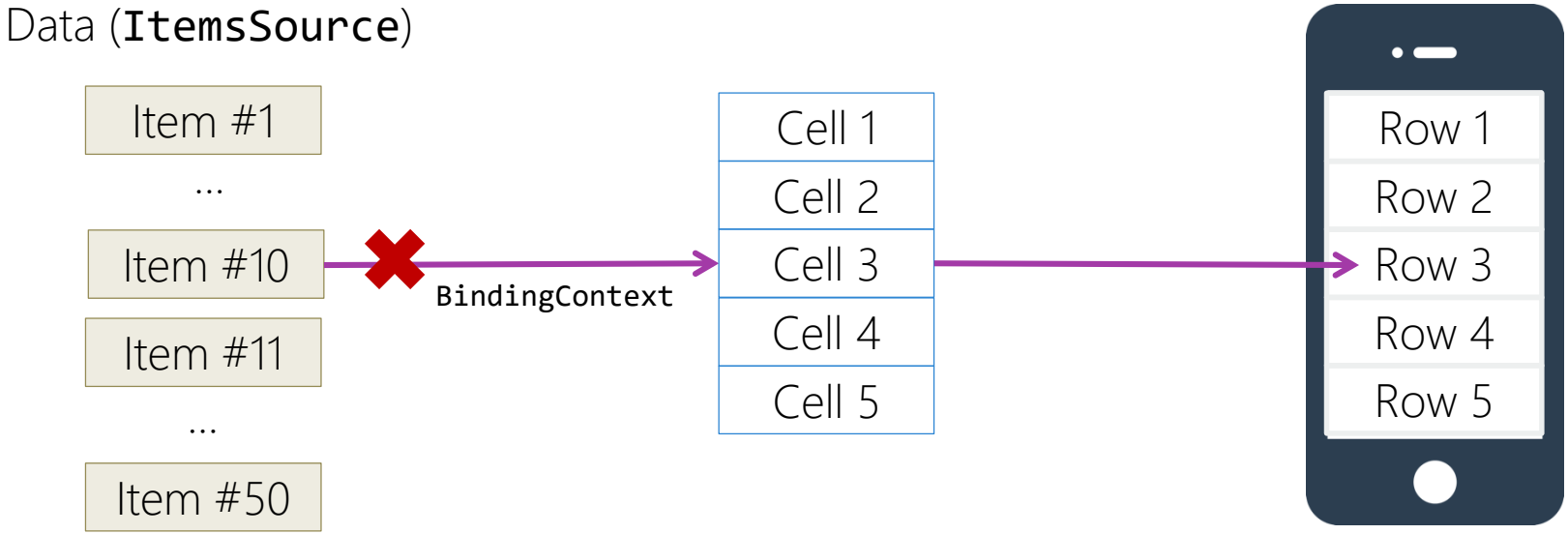


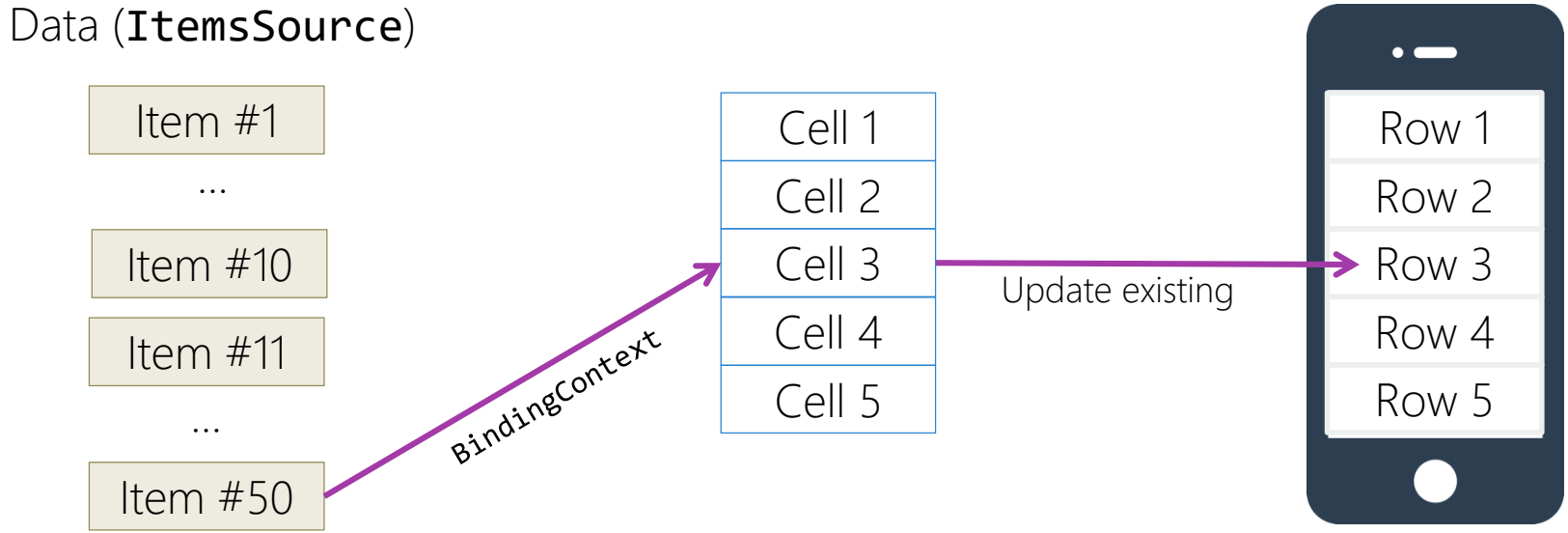
When cell recycling is ON

- When cell recycling is turned on, the cell is associated to a specific visual row and the **`BindingContext`** is changed to supply the data



When cell recycling is ON

- When cell recycling is turned on, the visual cell is kept and *reused* and the **`BindingContext`** is changed to point to the new data to visualize



When cell recycling is ON

- When cell re ... *used* and the **Bindin** ... visualize

Data (**ItemsSo**

Item #1

...

Item #10

Item #11

...

Item #50

BindingConte

Cell 5

Row 1

Row 2

Row 3

Row 4

Row 5

That means:

- All data about the cell must come from the binding context!
- Custom renderers must correctly update visuals from property change notifications

When should I retain vs. recycle

- If you have a large number of bindings on the cell (e.g. > 20)
- .. or if the cell visuals change a lot based on the binding context
- .. or if testing shows that RecycleElement is slower for you

Then prefer RetainElement

Individual Exercise

Turn on recycle caching

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Built-in cells vs. ViewCell

- Built-in cells (**`TextCell`**, **`SwitchCell`**, etc.) are mapped to native styles in each framework and are faster and lighter than using **`ViewCell`**

```
<ViewCell>
  <Label Text="{Binding Name}" ... />
</ViewCell>
```

If you can make it work, always use the built-in cell styles

```
<TextCell Text="{Binding Name}" ...>
```

Think about your data source

- Always prefer **IList<T>** over **IEnumerable<T>**

```
var items = Contacts.All
  .OrderBy(c => c.Name)
  .GroupBy(c => c.Name[0].ToString(), c => c)
  .Select(g => new Grouping<string,Person>(g.Key, g))
  .ToList();
```

LINQ always produces **IEnumerable** expressions – should always take them and use **ToList()** to turn them into a concrete list, or pass the result into as new **ObservableCollection<T>**

Simplify your visual design

- Work on minimizing your visual construction – try to display your UI with as few elements and as few property setters as possible

```
<StackLayout Orientation="Horizontal">
    <Label Margin="10,10,5,10" Text="Hello"/>
    <Label Margin="0,10,5,10" Text="{Binding FirstName}"/>
    <Label Margin="0,10,10,10" Text="{Binding LastName}"/>
</StackLayout>
```

Specifies **Margin** on each **Label** to provide uniform spacing around each of them

Simplify your visual design

- Work on minimizing your visual construction – try to display your UI with as few elements as possible

```
<StackLayout Orientation="Horizontal" Padding="10" Spacing="5">
    <Label Text="Hello"/>
    <Label Text="{Binding FirstName}"/>
    <Label Text="{Binding LastName}"/>
</StackLayout>
```

Know your layout properties! **Spacing** on the **StackLayout** gives us exactly the same result but minimizes the layout pass complexity

Simplify your visual design

- Avoid using expensive layout panels for a single element

```
<ViewCell>
   <Grid Padding="10" BackgroundColor="Gray">
       <Label Text="This is bad"/>
   </Grid>
</ViewCell>
```

Simplify your visual design

- Avoid using expensive layout panels for a single element

```
<ViewCell>
   <ContentView Padding="10" BackgroundColor="Gray">
       <Label Text="This is bad"/>
   </ContentView>
</ViewCell>
```

ContentView is a lighter weight container which can often host your content in exactly the same way as **Grid** or **StackLayout**

Avoid ScrollView

- Do not place **ListViews** into a scrollable control (e.g. **ScrollView**), instead use the **Header** and **HeaderTemplate** property to place scrollable fixed content at the top of the list

```
<ScrollView>
    <Label ... />
    <ListView />
</ScrollView>
```

```
<ListView.Header>
    <Label ... />
</ListView.Header>
```

Cut out unnecessary property setters

- Don't bother to set property values to the "defaults"

```
<ViewCell>
   <ContentView Padding="10">
       <Label Text="..."
          HorizontalTextAlignment="Start"
          VerticalTextAlignment="Start" />
   </ContentView>
</ViewCell>
```

This requires us to set the property (and store the value) to exactly what it was when the Label was created.. *every time we create a ViewCell!*

Optimizing your labels

- Labels are the most common visual element, and can be the most expensive because measuring text is expensive
  - Prefer `LineBreakMode.NoWrap`
  - Don't set `VerticalTextAlignment` unless needed
  - Don't update labels more often than necessary (avoid layout pass)
- Consider using a single `FormattedString` label instead of multiple labels for static text

Optimize your images

- Images are scaled / resized as they are drawn
  - Should use appropriately sized images to improve memory and render performance
  - Prefer .pngs for icons and "pixel-perfect" displays or transparent elements
  - Use .jpgs for larger photos – these are compressed and load faster
  - Use async task for background image downloads

Optimizing custom layouts (ViewCell)

- ✓ **`Horizontal/VerticalOptions`** should be set to **`Fill`** or **`FillAndExpand`** (these are the defaults)
- ✓ Avoid nesting panels if possible
- ✓ When using **`StackLayout`**, one child ideally will be set to **`FillExpand`**
- ✓ Prefer **`AbsoluteLayout`** - can potentially do layouts in a single pass
- ✓ Avoid **`RelativeLayout`** for now if possible
- ✓ Avoid auto-sized columns/rows with **`Grid`**, fixed-sized are best
- ✓ Transparency is expensive, unless it's "0" or "1"
- ✓ XAMLC helps for XAML-based template when using **`Retain`**

Summary

- Performance is hard
- It's not always the frameworks fault
- Will likely require some testing, benchmarking and changes to optimize your app

Thank You!

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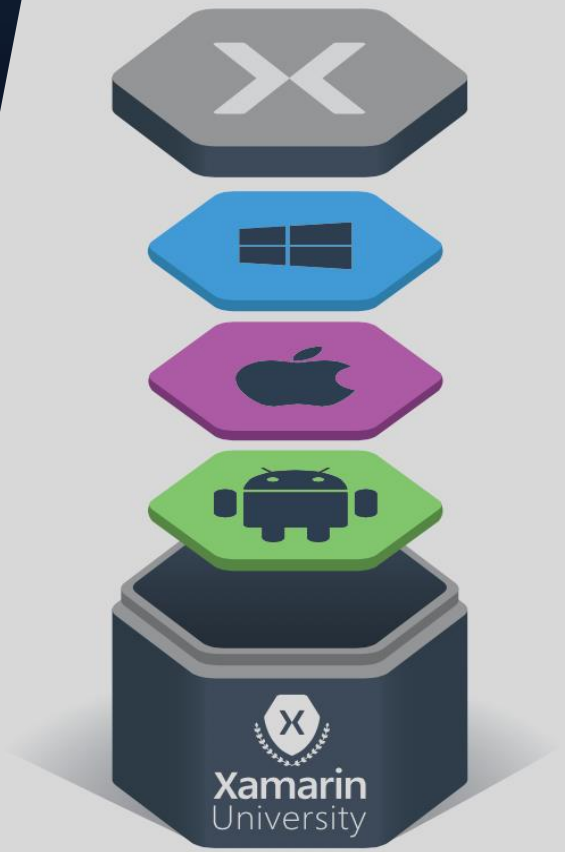

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