AND101

Introduction to Xamarin.Android

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Objectives

1. Create a Xamarin.Android project
2. Decompose an app into Activities
3. Build an Activity's UI
4. Write an Activity's behavior
5. Update your Android SDK

Demonstration

Preview the finished lab exercise

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Create a Xamarin.Android project

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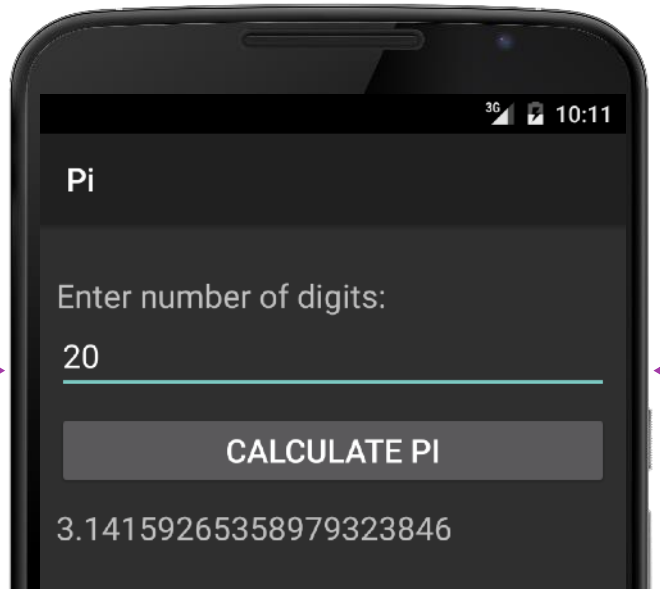
Tasks

1. Choose a Xamarin.Android template to create a new app
2. Create a new project in your IDE

What is a Xamarin.Android app?

- *Xamarin.Android apps* are apps built with Xamarin's tools and libraries

UI is made from Xamarin's wrappers around the native Android views



Code is written in C#

Development environment

- Xamarin.Android apps are coded in C# and built with either  Visual Studio or  Visual Studio for Mac

```
var employees = new List<Employee>();
var seniors = from e in employees where e.Salary > 50000 select e;

var client = new HttpClient();
var result = await client.GetStringAsync("");
```

Supports latest C# features like generics, **async**/**await**, LINQ, lambda expressions, etc.

F# is also supported; however, this course will use C#.

C# idioms

- The Xamarin.Android bindings to Android libraries provide a familiar programming experience for C# developers

```
EditText input = new EditText(this);

String text = input.getText().toString();

input.addTextChangedListener(new TextWatcher() { ... });
```

Java uses get/set methods, listeners, etc.

```
var input = new EditText(this);

string text = input.Text;

input.TextChanged += (sender, e) => { ... };
```

Xamarin.Android uses properties and events

Libraries

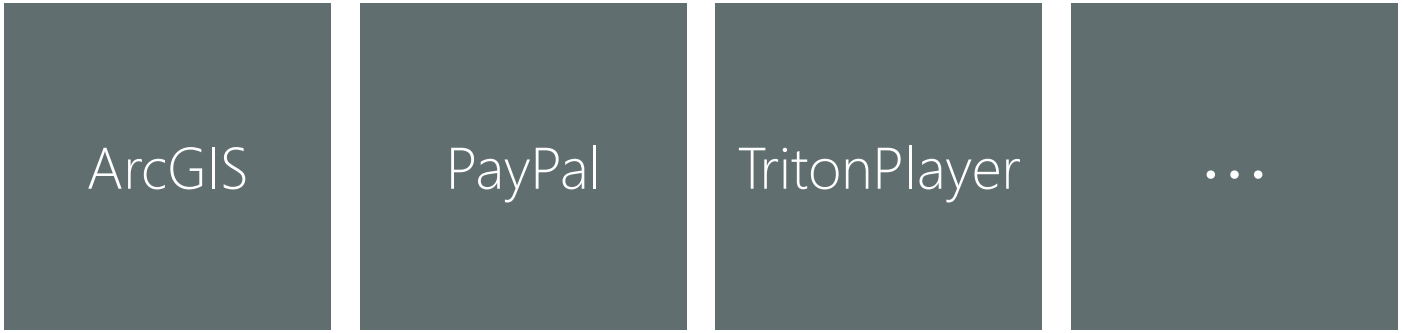
- Xamarin.Android apps can use utility classes from three libraries

java.*	android.*	Mono.NET
Xamarin provides C# wrappers for all Android Java libraries	Xamarin provides C# wrappers for all Android APIs	Includes most .NET types but not the entire Mono library

When a new version of Android is released, the Xamarin wrappers are ready within days.

Third-party Java

- You can use JNI or a Bindings Library to incorporate third-party Java libraries into your Xamarin.Android app

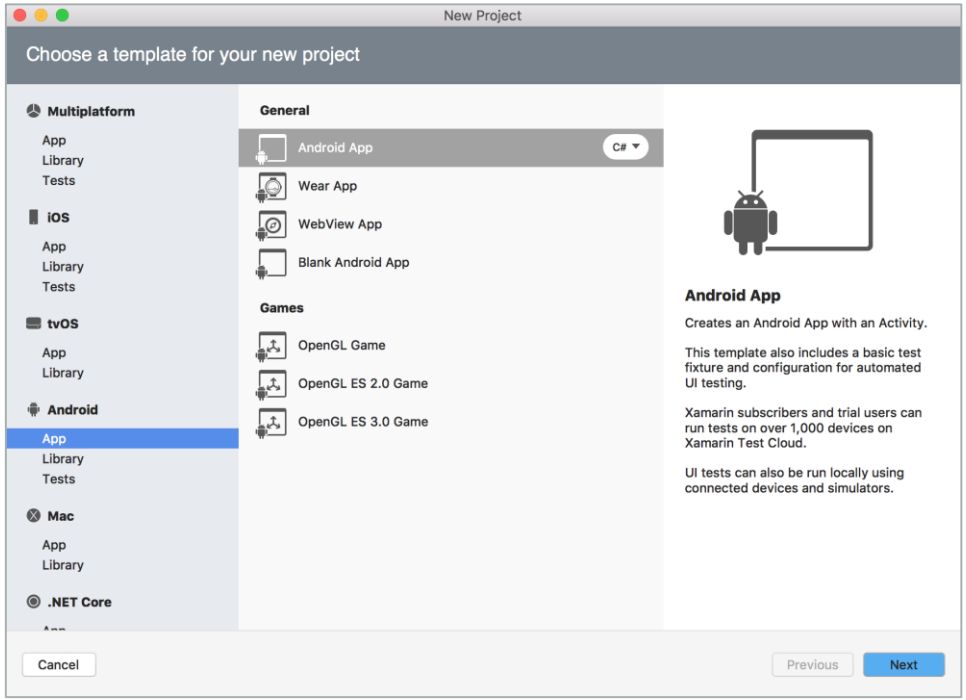


A Bindings Library is built on JNI and take some work to set up but is easier to use.

Xamarin.Android project templates

- Xamarin.Android includes several Android project templates

Visual Studio for Mac shown, Visual Studio has analogous templates



Group Exercise

Create a Xamarin.Android project

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Decompose an app into Activities

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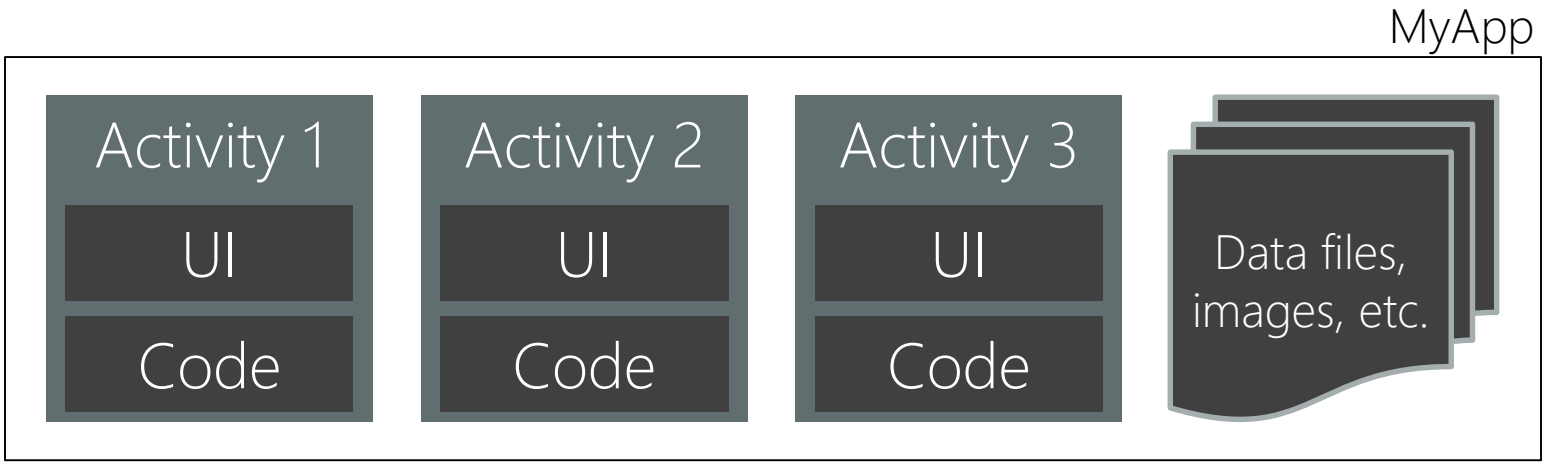
Tasks

1. Define the concept of an Activity
2. Decompose an app into Activities

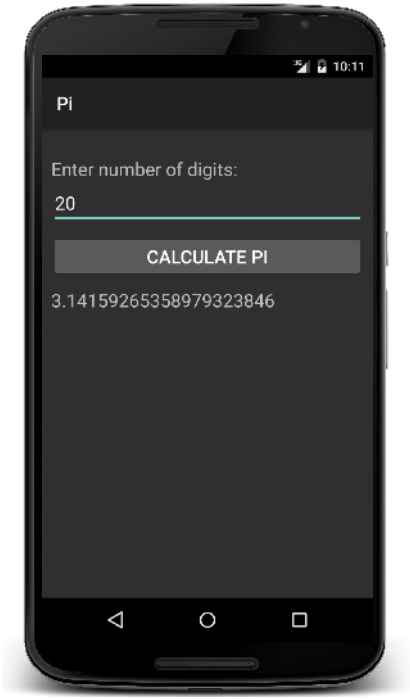
App structure

- An Android app is a collection of collaborating parts, the most common being *Activities*



What is an Activity?

- An *Activity* defines the UI and behavior for a single task

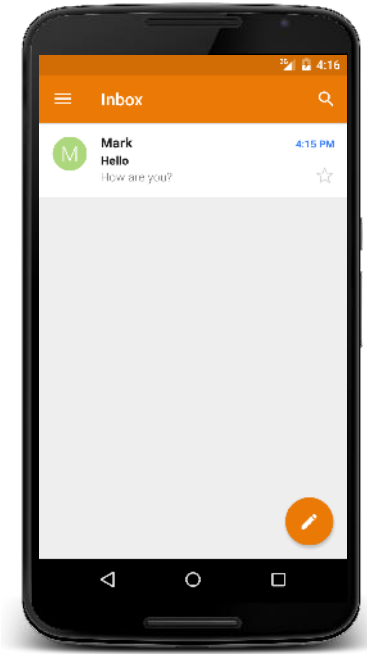


The "Pi" Activity has UI and coded behavior

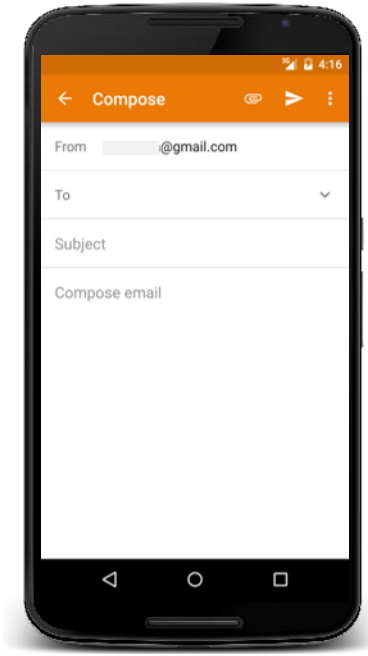
```
void OnClick(object sender, EventArgs e)
{
  int digits = int.Parse(input.Text);

  string result = CalculatePi(digits);

  output.Text = result;
}
```

Activity example: Email

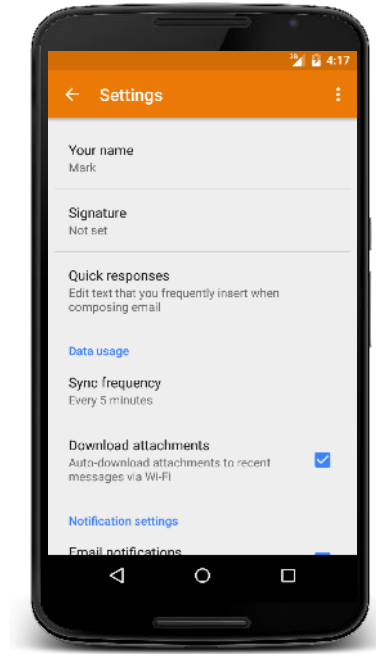
- The Email app has several activities



Messages Activity



Compose Activity



Settings Activity

Flash Quiz

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Flash Quiz

① Name some possible Activities from a *music-player* app

Flash Quiz

① Name some possible Activities from a *music-player* app

a) Playlists
b) Artists
c) Radio
d) Store
e) Currently Playing

Flash Quiz

② Name some possible Activities from a *contacts* app

Flash Quiz

② Name some possible Activities from a *contacts* app

a) All contacts
b) Add new
c) Details
d) Edit

Flash Quiz

③ Which answer best describes the scale of an Activity?

a) The same amount of code as a control such as a button or text box.

b) One entire screen. When you navigate to a new screen you would likely be moving to a new Activity.

c) Several screens. When you navigate between the screens you would stay in the same Activity.

Flash Quiz

③ Which answer best describes the scale of an Activity?

a) The same amount of code as a control such as a button or text box.

b) One entire screen. When you navigate to a new screen you would likely be moving to a new Activity.

c) Several screens. When you navigate between the screens you would stay in the same Activity.

Summary

1. Define the concept of an Activity
2. Decompose an app into Activities

Build an Activity's UI

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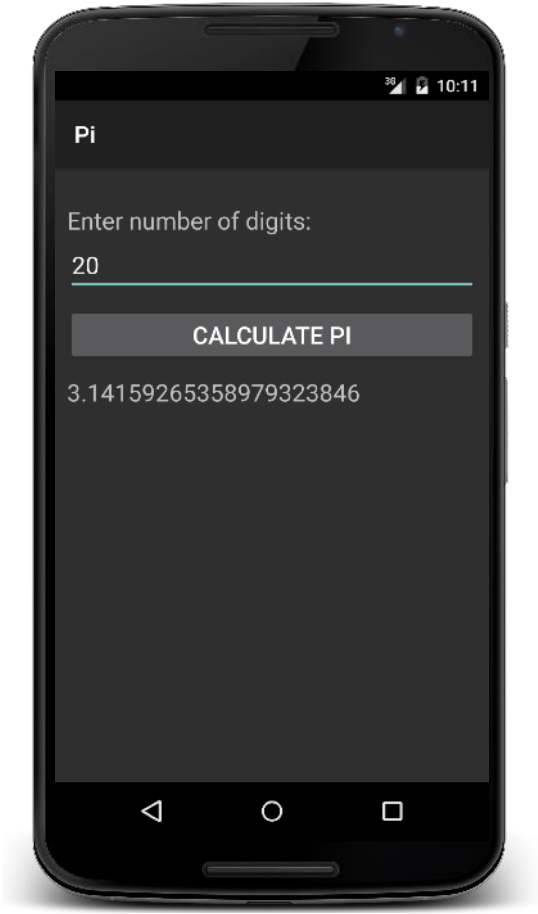
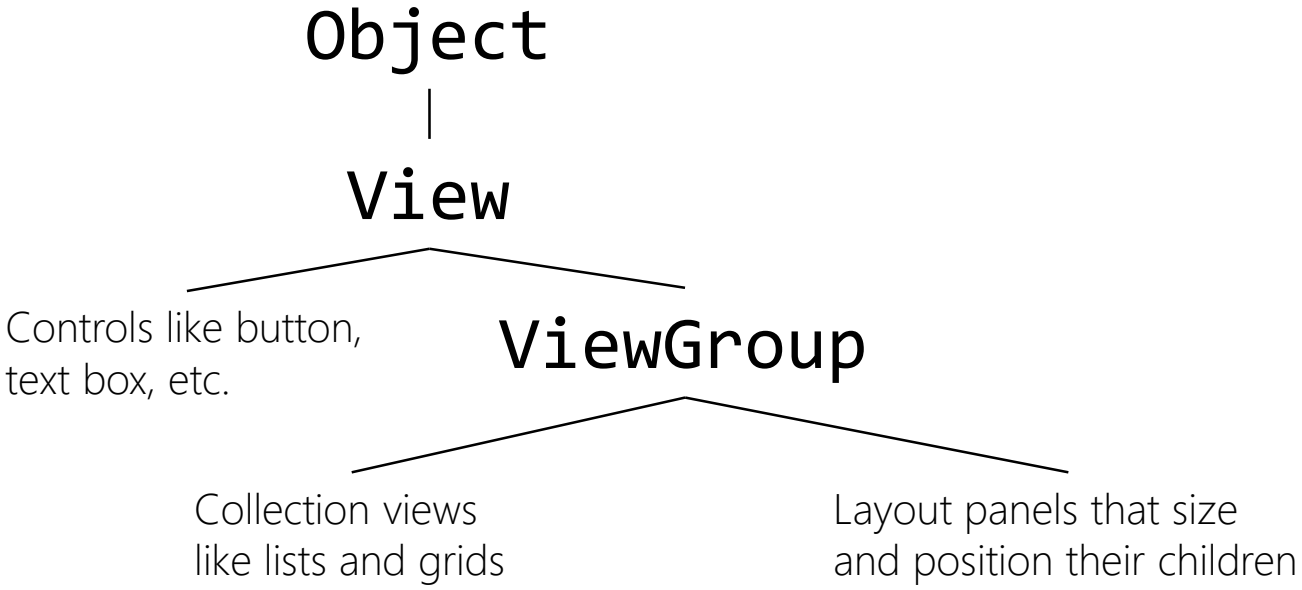
Tasks

1. Add Views to a Layout in XML
2. Use the Designer tool



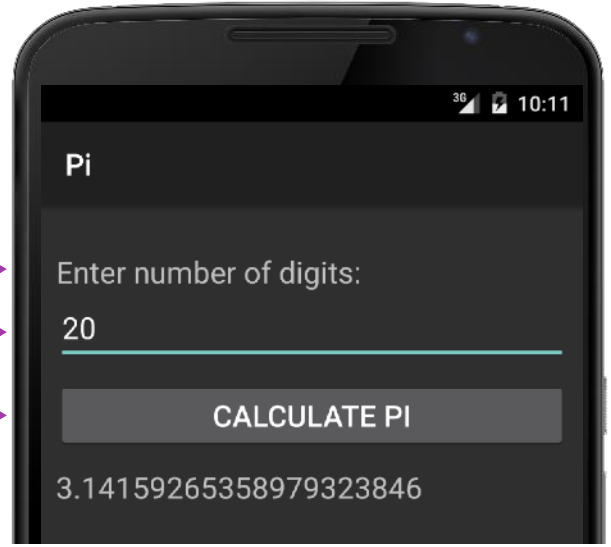
UI elements

- An Android UI is composed of **`Views`** and **`ViewGroups`**



What is a View?

- A *View* is a user-interface component with on-screen visuals and (typically) behavior such as events



`TextView` for text display

`EditText` for text entry

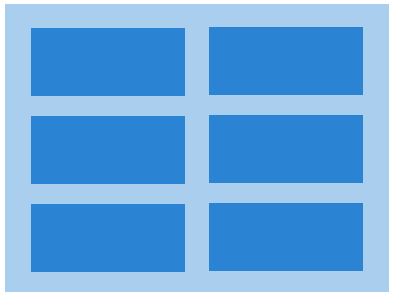
`Button`

Views are also called widgets. Many are defined in the Android.Widget namespace.

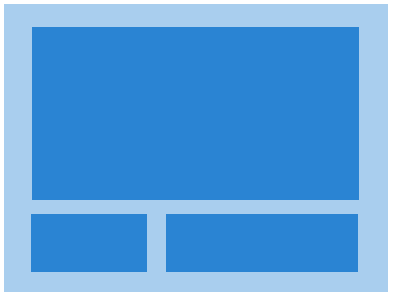
What is a layout?

- A *layout* is a container that manages a collection of child views and calculates their size/position on screen

`LinearLayout`
Single row or column



`GridLayout`
Rows and columns



`RelativeLayout`
You specify how each is positioned relative to neighbors

We will use only LinearLayout in this course.

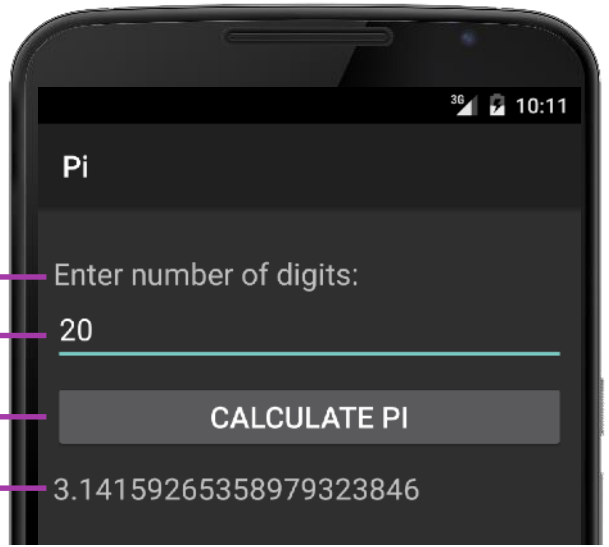
What is a layout file

- UI Views are typically created in an XML *layout file* (`.axml`)

Child views are nested inside a layout panel

Pi.axml

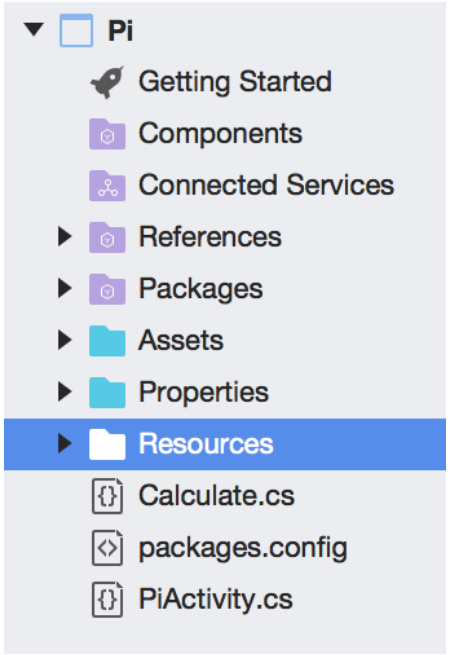
```
<LinearLayout ... >
  <TextView ... />
  <EditText ... />
  <Button   ... />
  <TextView ... />
</LinearLayout ... >
```



What are Resources?

- *Resources* are non-code files packaged with your app

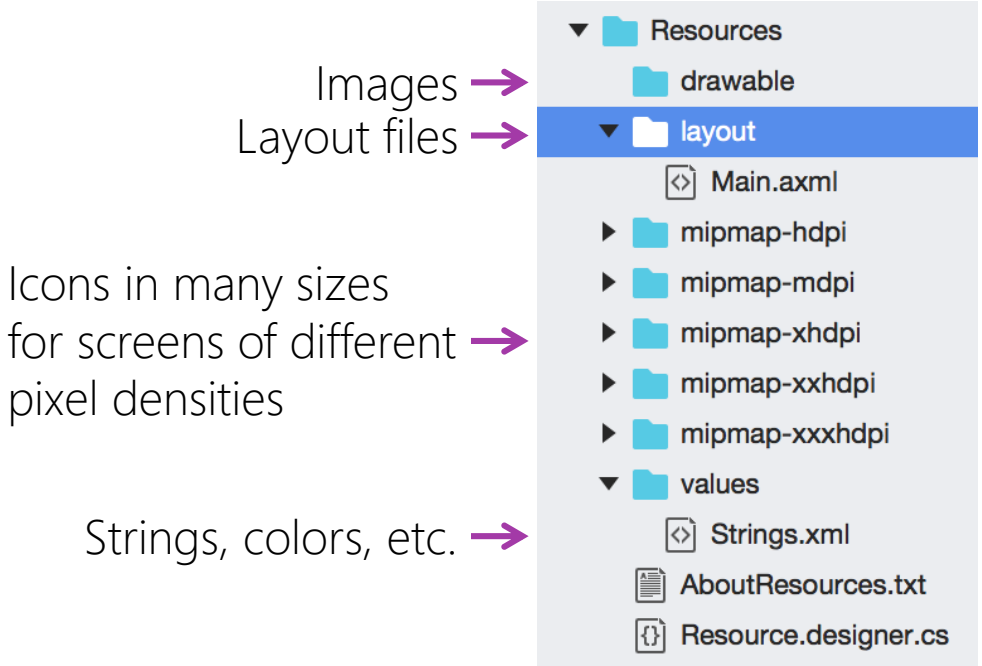
Placed in the app's Resources folder



Note: Visual Studio for Mac shown, Visual Studio on Windows is similar

Where to define your layout files

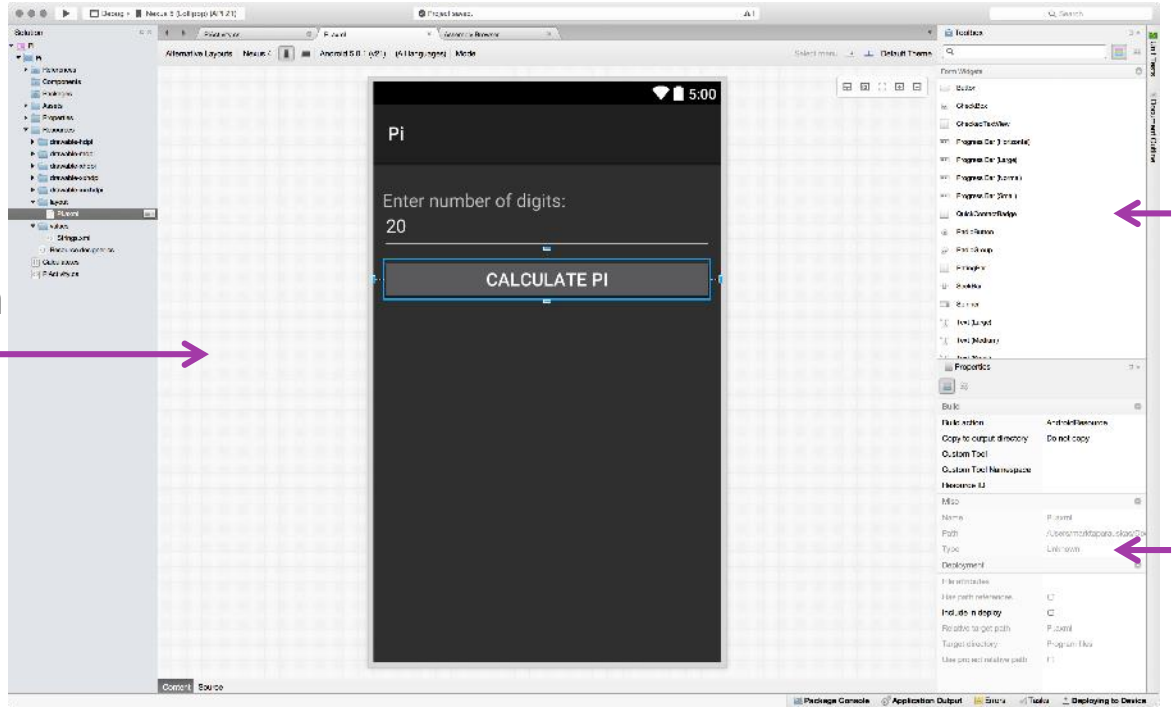
- Layout files are a Resource and must be placed in the **`layout`** folder



Note: Visual Studio for Mac shown, Visual Studio on Windows is similar

UI Designer

- Xamarin provides a UI design tool for creating and editing layout XML



Available for both Visual Studio platforms

Toolbox to add new Views with drag-drop

Property editor

View attributes

- XML **attributes** are used to set properties on the underlying objects

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android" android:orientation="vertical">
  <TextView android:text="Enter number of digits:" ... />
  ...
</LinearLayout>
```

`TextView`, **`EditText`**, and **`Button`** have a **`text`** attribute that sets their **`Text`** property

`LinearLayout` has an **`orientation`** that sets its **`Orientation`** property

Attributes names do not always match the underlying property names. See the Android documentation on each class (e.g. TextView) for a table of the XML attribute names.

Android namespace

- View attributes must be prefixed with the **Android namespace** when defined in XML

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android" android:orientation="vertical">
  <TextView android:text="Enter number of digits:" ... />
  ...
</LinearLayout>
```

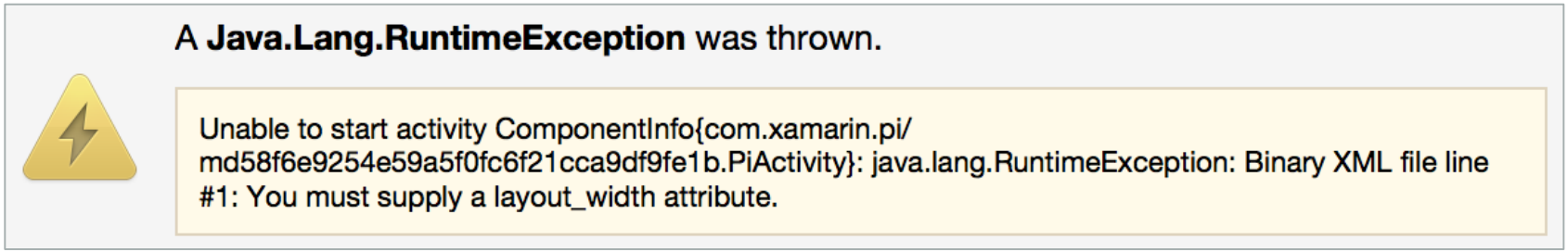
Prefix with namespace

Prefix with namespace

Android does not require the prefix on Elements so it is common practice to omit it.

View sizing [required]

- `LinearLayout` requires `layout_width` and `layout_height` on every view



Failure to set width and height yields a runtime exception

View sizing [automatic]

- There are **two special values** you can use to specify width and height

```
<LinearLayout ... >
  ...
  <TextView android:layout_width="match_parent" android:layout_height="wrap_content" ... />
  ...
</LinearLayout>
```

same size as the parent view

just large enough to fit around its content

`match_parent` is the replacement for the equivalent-but-deprecated `fill_parent`

Group Exercise

Add views to a layout file manually and with the Designer tool

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Pixel sizing

- You can use **px** (screen pixel) for sizing but they are not recommended since they do not adapt to different displays

```
<Button android:layout_width="100px" ... />
```

Always occupies 100 physical pixels,
it will be small on a high-density screen
and large on a low-density screen

What is a density-independent pixel?

- A *density-independent pixel* (**dp**) is an abstract unit of measure that maps to physical pixels at runtime based on screen density

```
<Button android:layout_width="100dp" ... />
```

The goal is for this to occupy about the same area on-screen regardless of the device's screen density. On a high-resolution screen, this would occupy more than 100 physical pixels.

Baseline density

- Android chose a baseline density of 160dpi, so **1dp=1px** on a 160dpi screen

```
<Button android:layout_width="100dp" ... />
```

On a 160dpi screen, this would occupy 100 physical pixels

The baseline density is derived from the screen of the G1, the first Android device.

Flash Quiz

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Flash Quiz

① How many physical pixels (**px**) would the **Button** shown below occupy on a 480dpi screen?

```
<Button android:layout_width="100dp" ... />
```

The conversion formula is: $px = dp * \frac{dpi}{160}$

Flash Quiz

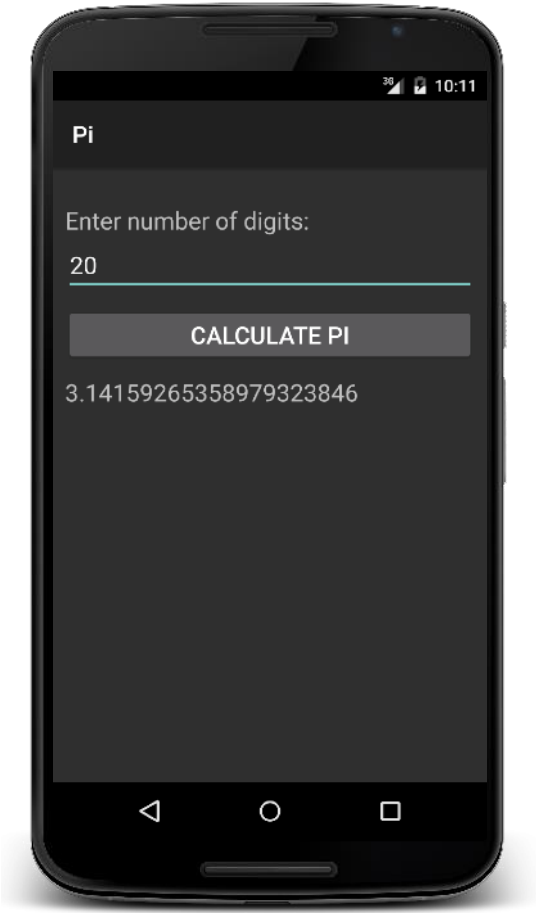
① How many physical pixels (**px**) would the **`Button`** shown below occupy on a 480dpi screen?

a) 300

$$300px = 100dp * \frac{480dpi}{160}$$

Summary

1. Add Views to a Layout in XML
2. Use the Designer tool



Write an Activity's behavior

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Tasks

1. Designate a Main Activity
2. Load an Activity's UI
3. Access Views from code

How to define an Activity

- An Activity has an XML layout file and a C# source file to drive the logic

Pi.axml

```
<LinearLayout ... >
  <TextView   ... >
  <EditText   ... >
  <Button     ... >
  <TextView   ... >
</LinearLayout>
```

UI layout file

PiActivity.cs

```
[Activity]
public class PiActivity : Activity
{
  ...
  ...
}
```

C# class must inherit from **`Activity`** and be decorated with the **`[Activity]`** attribute

Main Activity

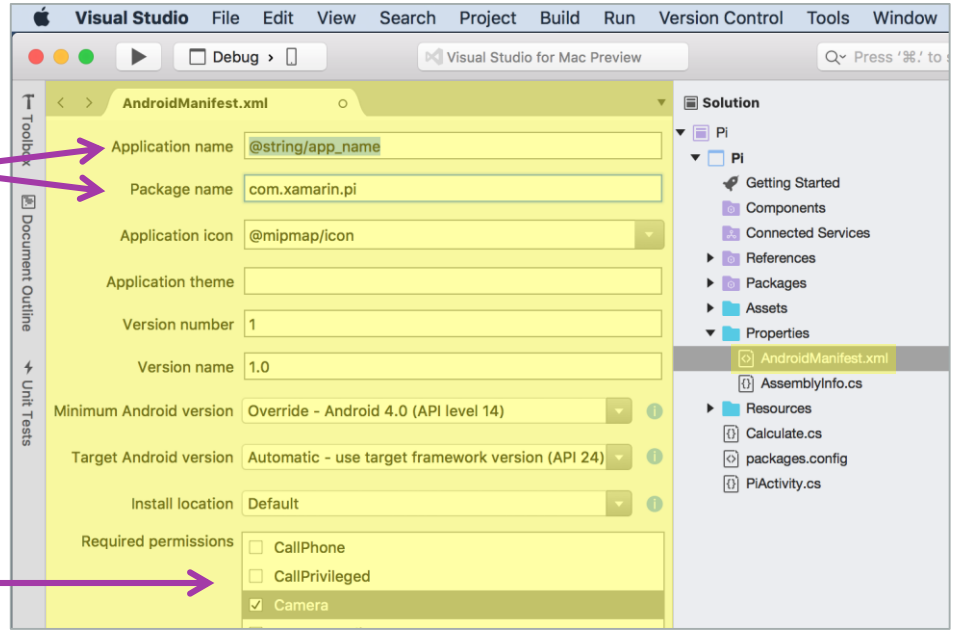
- An app uses the **[Activity]** attribute to designate an Activity as an entry point

Only one activity can be marked as the main entry point

```
[Activity(MainLauncher = true)]
public class PiActivity : Activity
{
   ...
}
```

What is the App Manifest?

- An app's manifest describes the app to the Android OS



Identity info

Needed services

Every app must have a manifest and it must be named AndroidManifest.xml

Main Activity and the Manifest

- The Manifest tells Android which is your app's main Activity

```
<manifest...>
  <application...>
    <activity...>
      <intent-filter>
        <action android:name="android.intent.action.MAIN" />
        <category android:name="android.intent.category.LAUNCHER" />
      </intent-filter>
    </activity>
  </application>
</manifest>
```

The **MainLauncher** property in the **[Activity]** attribute creates these values in the Manifest. Android uses these to determine the app entry point and to list this activity on the launcher screen.

Activity initialization

- Override **`Activity.OnCreate`** to do your initialization

Must call base or get an exception

```
[Activity(MainLauncher = true)]
public class PiActivity : Activity
{
  protected override void OnCreate(Bundle bundle)
  {
    base.OnCreate(bundle);
    ...
  }
  ...
}
```

How to identify a layout file

- The build process auto-generates a **`Resource.Layout`** class that contains an identifier for each of your layout files

Use **`Resource.Layout.Pi`** to refer to this layout in code

`Resource.designer.cs`

```
public partial class Resource
{
  public partial class Layout
  {
    public const int Pi = 2130903040;
    ...
  }
  ...
}
```

The generated field matches the filename

UI Creation

- The **`Activity.SetContentView`** method instantiates all the Views in a layout file and loads them as the Activity's UI

Call from **`OnCreate`**

```
[Activity(MainLauncher = true)]
public class PiActivity : Activity
{
  protected override void OnCreate(Bundle bundle)
  {
    base.OnCreate(bundle);

    SetContentView(Resource.Layout.Pi);
  }
  ...
}
```

Pass the resource identifier of the layout file

What is an Id?

- The **`View`** class defines an **`Id`** property that is used to uniquely identify an instance of a View

```
namespace Android.Views
{
  public class View
  {
    public virtual int Id { get; set; }
    ...
  }
}
```

Notice that the type is **`int`**, not **`string`**

How to set an Id

- Set the **`Id`** of a View in XML using the **`id`** attribute and the syntax **`@+id/`**

Set an id in the XML →

```
<EditText android:id="@+id/digitsInput" ... />
```

Build tool generates a integer field and loads the integer into the View's Id

```
public partial class Resource
{
  public partial class Id
  {
    public const int digitsInput = 2131034113;
    ...
  }
  ...
}
```

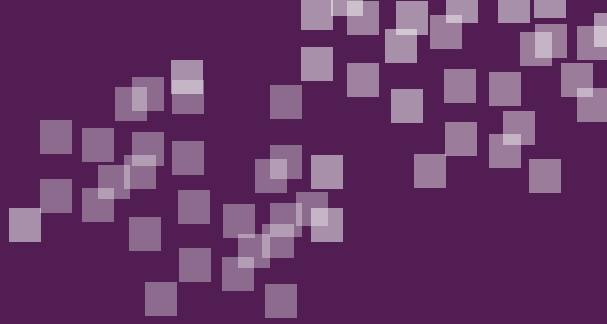
Resource.designer.cs

How to access views from code

- Use **`Activity.FindViewById`** to lookup a View in an Activity's UI

```
[Activity(MainLauncher = true)]
public class PiActivity : Activity
{
  protected override void OnCreate(Bundle bundle)
  {
    base.OnCreate(bundle);
    SetContentView(Resource.Layout.Pi);

    var et = FindViewById<EditText>(Resource.Id.digitsInput);
    ...
  }
  ...
}
```



Individual Exercise

Implement an Activity's behavior and run your app in an emulator

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Update your Android SDK

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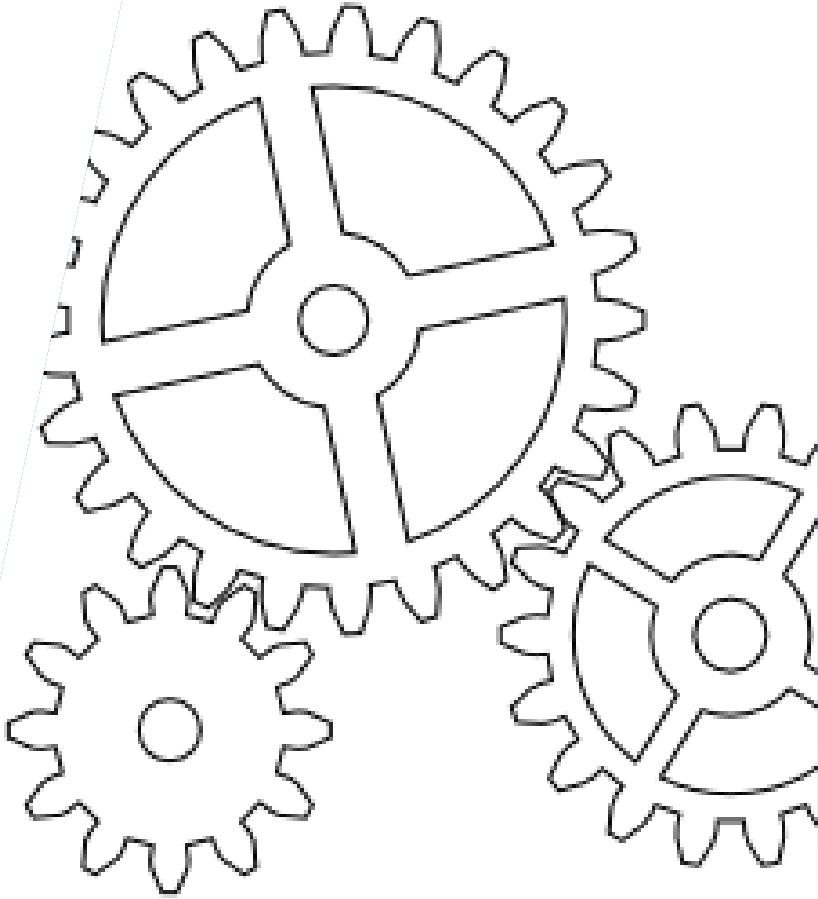
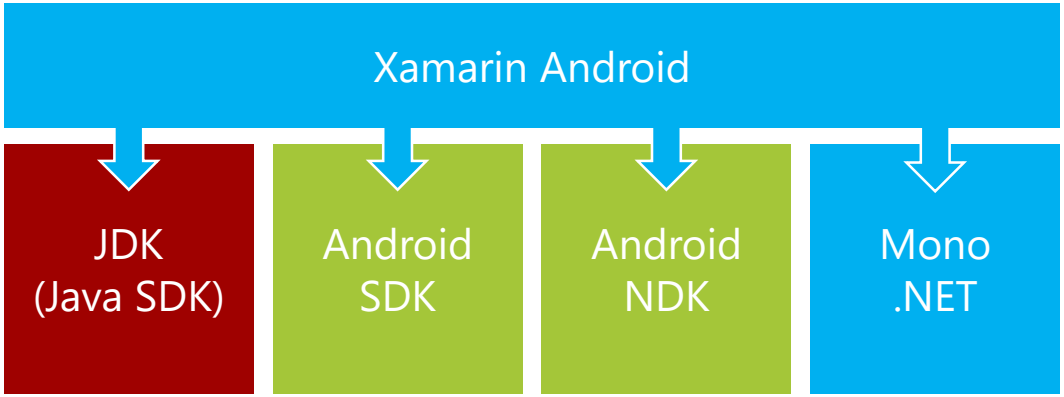
Tasks

1. Understand the Xamarin.Android development process
2. Update your Android Tools
3. Update your Android Platform SDK



Motivation

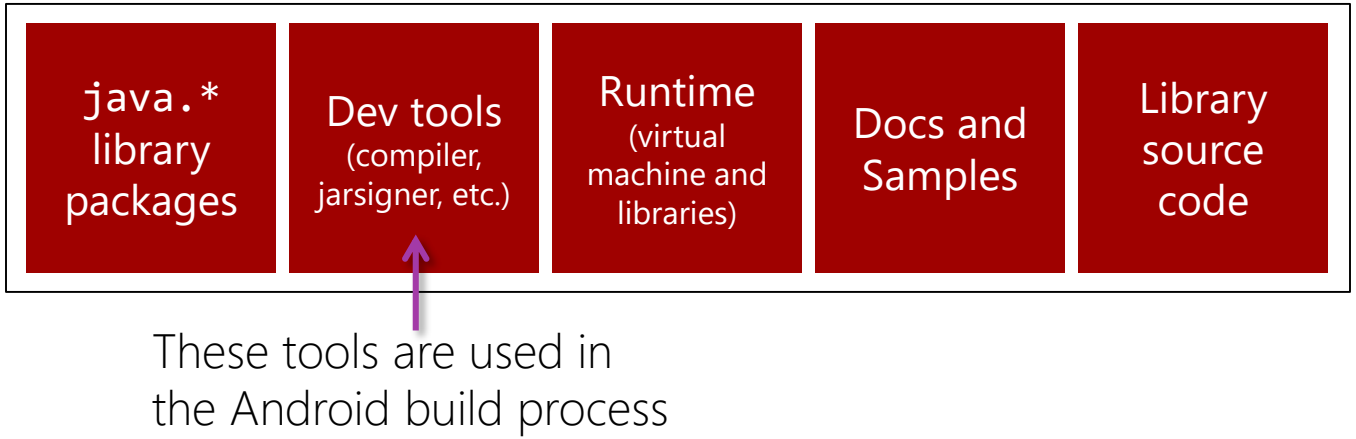
- Xamarin.Android uses native Android tools and libraries



You need to install updates to target new Android versions

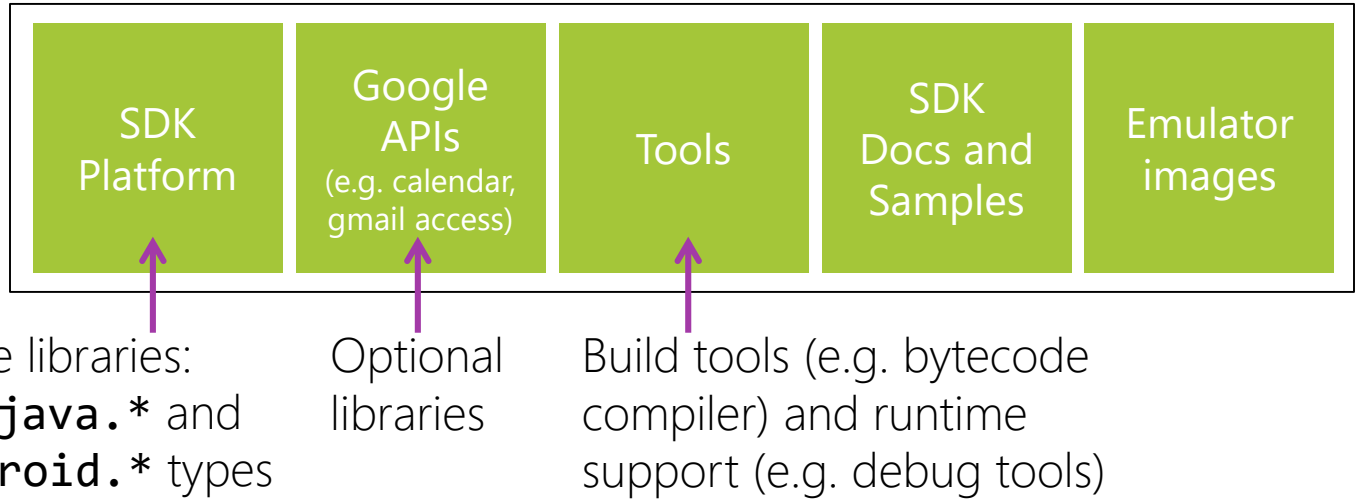
What is the JDK?

- The *Java SDK* (JDK) is the collection of libraries and tools needed to build and run Java applications



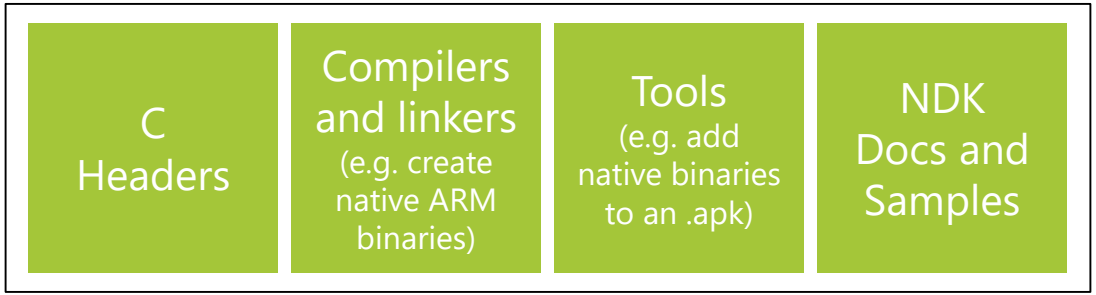
What is the Android SDK?

- The *Android SDK* contains the APIs and tools needed to create and run a native Android app



What is the Android NDK?

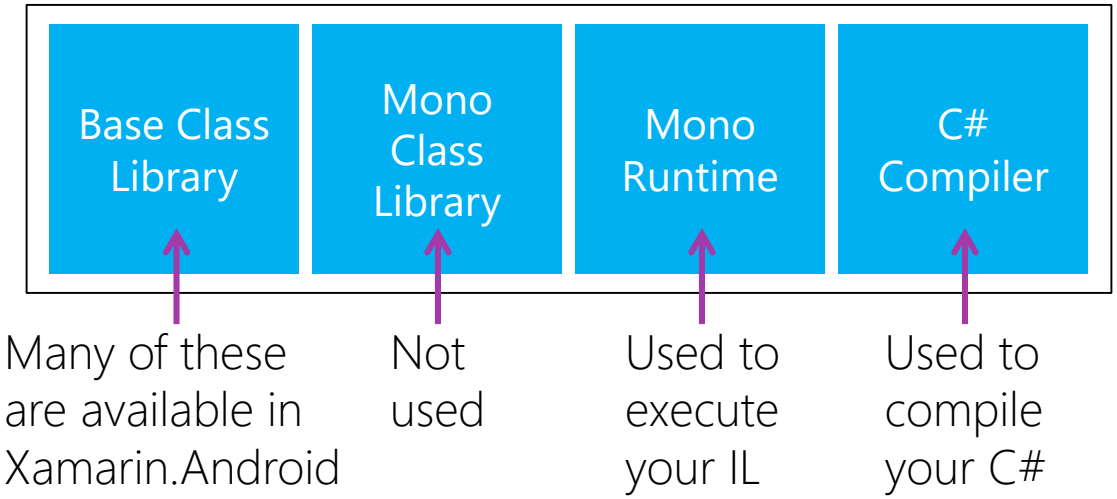
- The *Android NDK* is a collection of code and tools that let you write part of your native Android app in a language like C and C++



Writing part of your app in C/C++ is rare. It will increase complexity but may not increase performance. It can be useful in games or to reuse an existing C/C++ codebase.

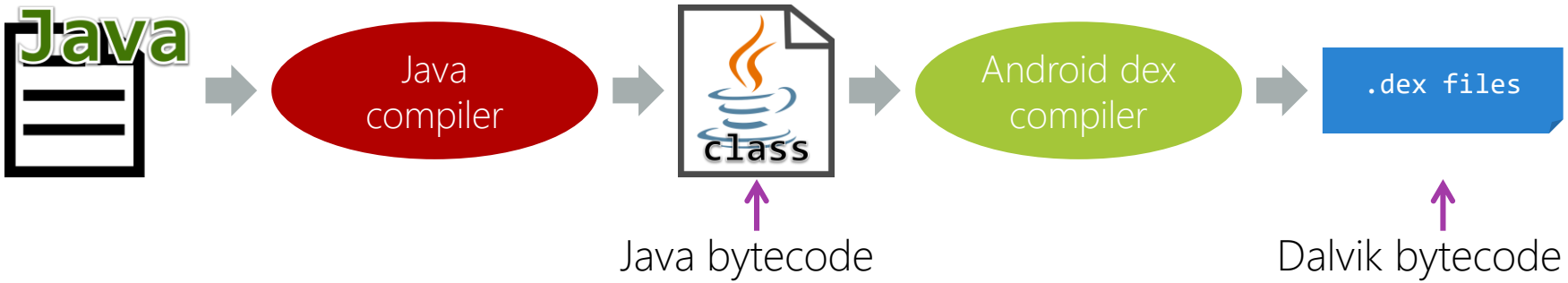
What is Mono?

- Mono is an open-source implementation of the .NET Framework; several parts are used in Xamarin.Android development



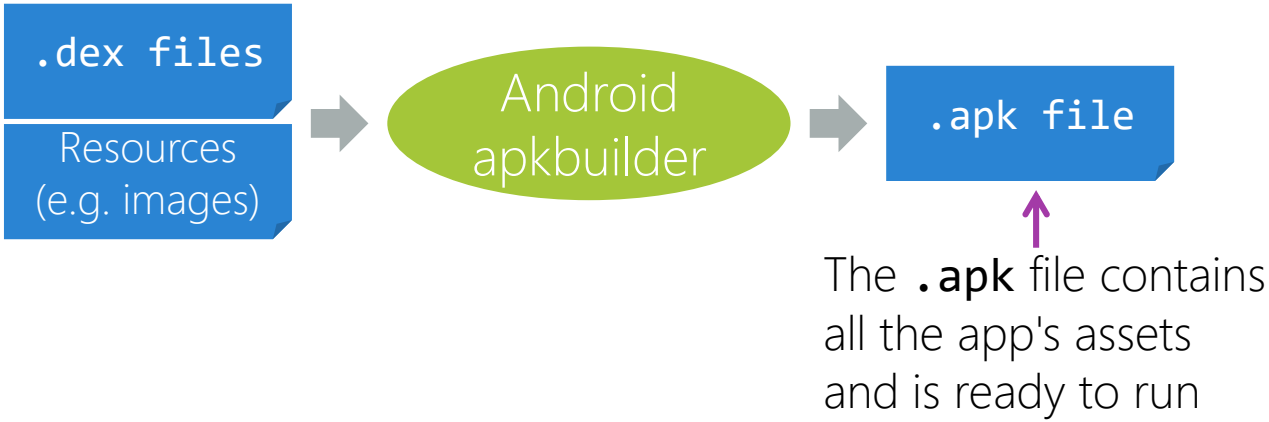
Native compilation

- Java source is compiled into *Dalvik bytecode* for deployment (bytecode are analogous to .NET Intermediate Language)



Native packaging

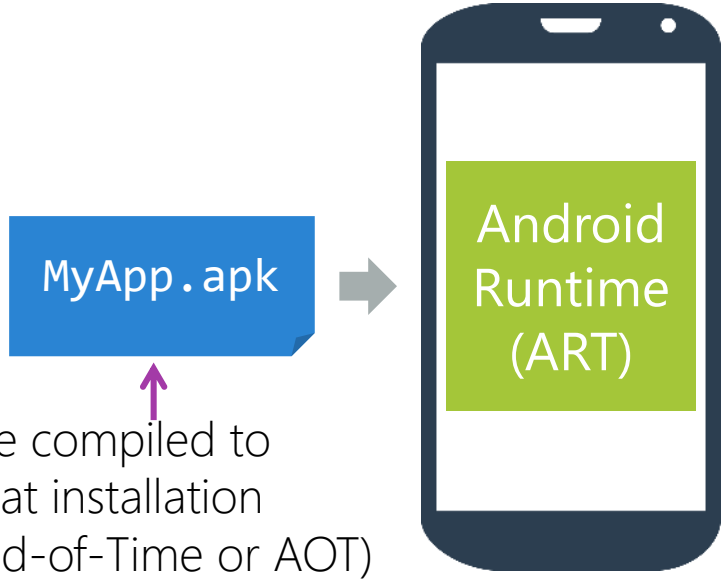
- An app's bytecode, images, data files, etc. are combined into an Application Package (**`.apk`** file) for deployment



For upload to the Play store, there are two more steps that are not shown: signing with jarsigner and optimizing the layout of the file with zipalign.

Native execution

- The Android Runtime (ART) is the execution engine for Android apps



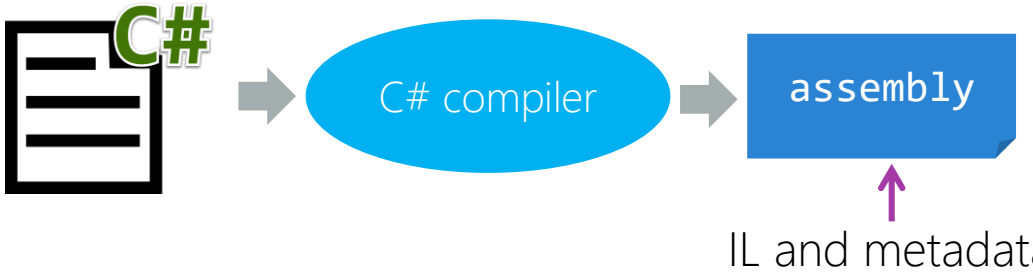
Apps run in their own process with their own copy of the ART Virtual Machine

bytecode are compiled to native code at installation (called Ahead-of-Time or AOT)

Android versions before 5.0 used the Dalvik VM which translated bytecode at runtime.

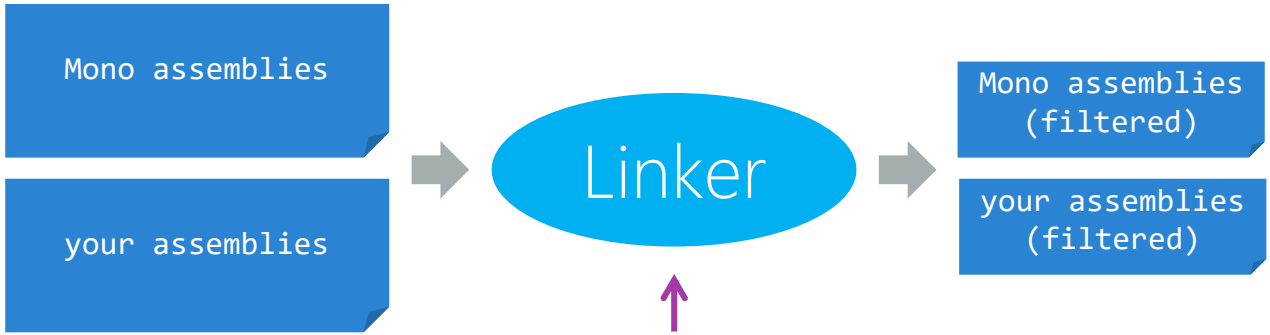
Xamarin.Android compilation

- C# code in Xamarin.Android apps is compiled to .NET Intermediate Language (IL)



Xamarin.Android linking

- The Xamarin.Android *linker* removes unused IL to reduce the size of your app for deployment



Determines which class members are used in your app and includes only those members in the output

Project settings and code Attributes let you control which assemblies are linked. Dynamic code should not use the linker (e.g. members accessed via reflection).

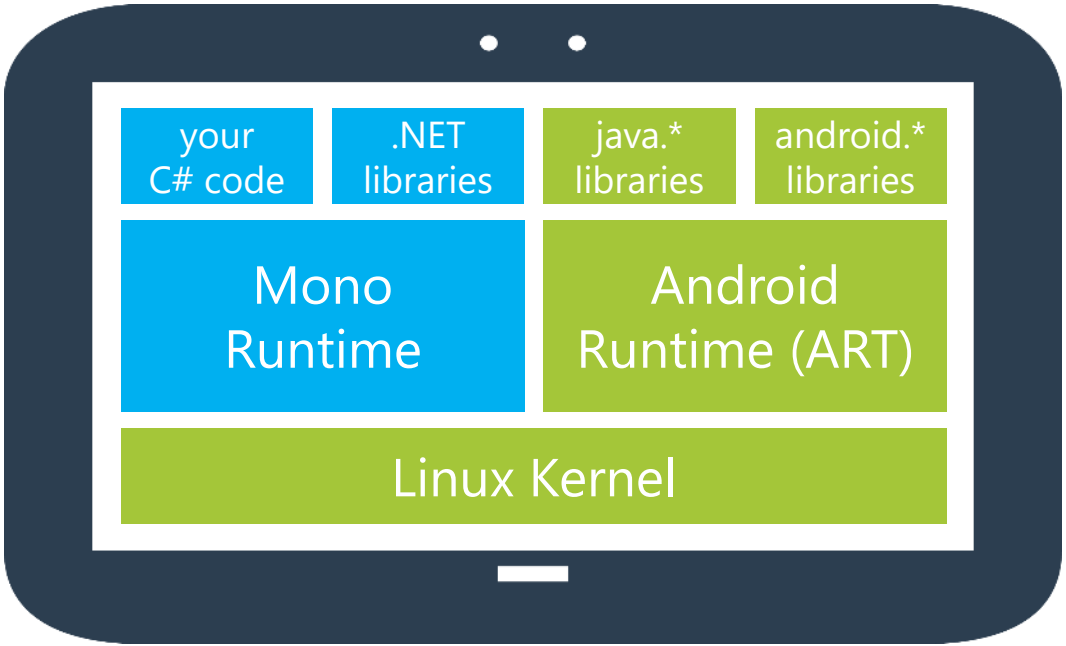
Xamarin.Android and the Mono VM

- Xamarin.Android apps have the Mono Runtime packaged in their .apk file because it is needed to execute IL

The Xamarin build tools add the Mono VM to your application package

Xamarin.Android execution

- Mono and ART VMs run side-by-side to execute a Xamarin.Android app



Flash Quiz

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Flash Quiz

① As a Xamarin.Android developer, why do you need to know how native Android development works?

a) You do not need to know, that is the point of Xamarin

b) Xamarin tools use native tools, you need the native tools installed

c) So you can run your app on other platforms

Flash Quiz

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Flash Quiz

② Which items do you need to have installed to develop Xamarin.Android apps?

a) JDK (Java SDK)
b) Android SDK
c) Mono.NET
d) All of the above

Flash Quiz

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a) JDK (Java SDK)

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Flash Quiz

③ Xamarin.Android compiles your C# to Java bytecode in order to execute it on the Android Runtime (ART)?

a) True

b) False

Flash Quiz

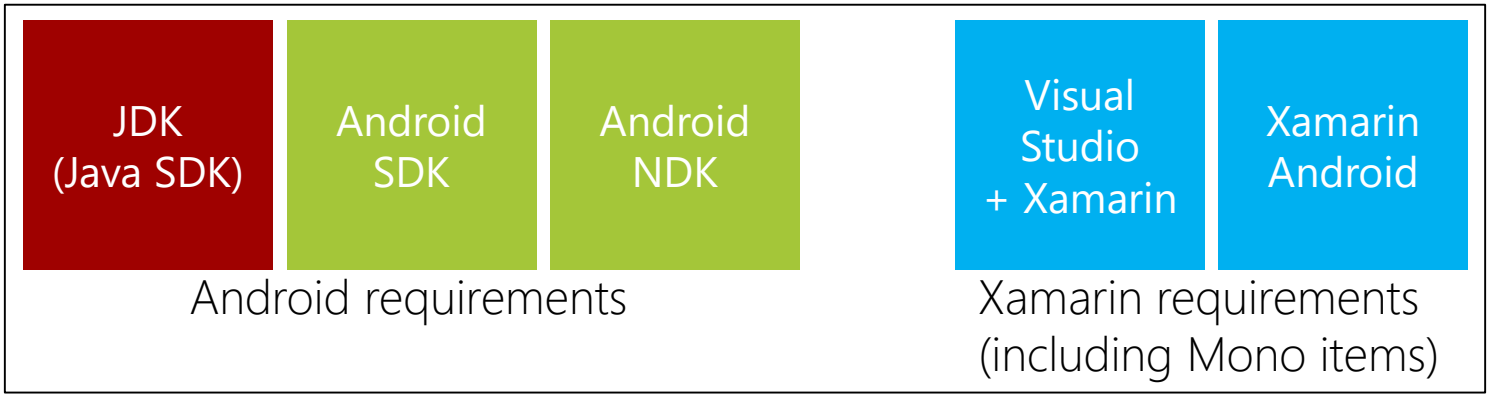
③ Xamarin.Android compiles your C# to Java bytecode in order to execute it on the Android Runtime (ART)?

a) True

b) False

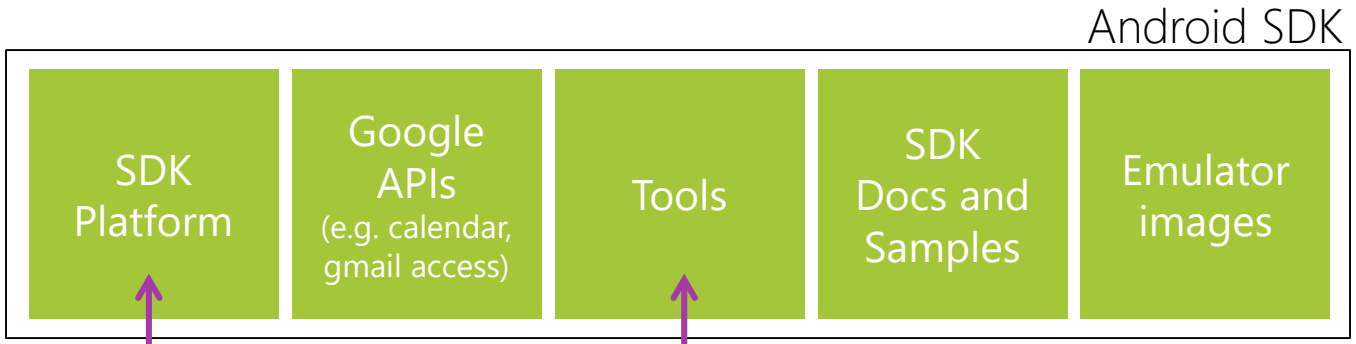
Xamarin.Android installation

- The *Xamarin unified installer* (http://xamarin.com/download) loads nearly everything you need to develop and run Xamarin.Android apps



Android SDK updates

- You need to manually update your Android SDK Platform and Tools so you can build against the latest versions of Android



Android versions

- Android versions are identified via a code name and two numbers

Code Name	Version	API Level
Nougat	7.0	24
Marshmallow	6.0	23
Lollipop	5.1	22
Lollipop	5.0	21
Kit Kat (watch)	4.4W	20
Kit Kat	4.4	19
Jelly Bean	4.3	18
…	…	…

Level identifies the combination of libraries, manifest elements, permissions, etc. that you code against as a developer

Determining version at runtime

- Apps can determine the version of Android running the app

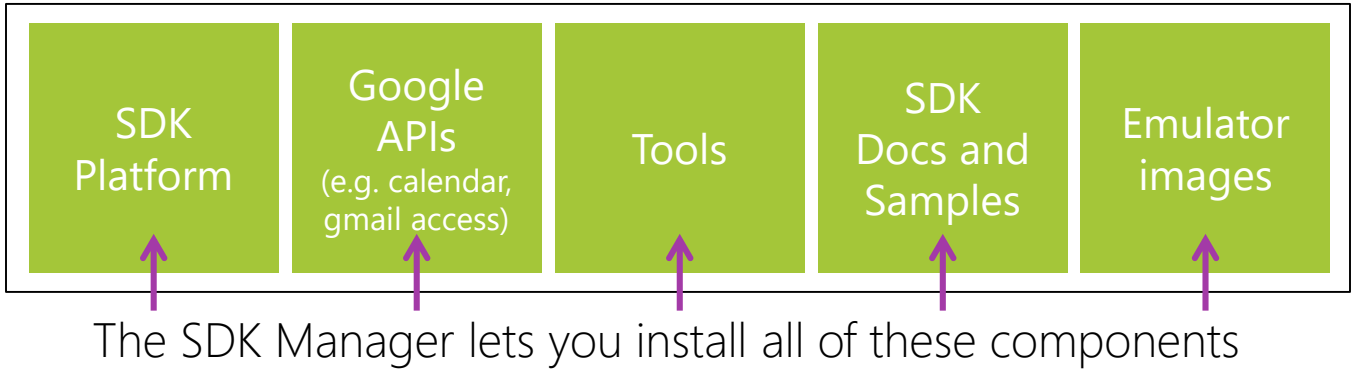
```
var version = Android.OS.Build.VERSION.SdkInt;

if (version >= Android.OS.BuildVersionCodes.Honeycomb)
{
  var va = Android.Animation.ValueAnimator.OfInt(1, 100);
  ...
}
```

ValueAnimator is available in API 11 and higher so you should test for availability before use

What is Android SDK Manager?

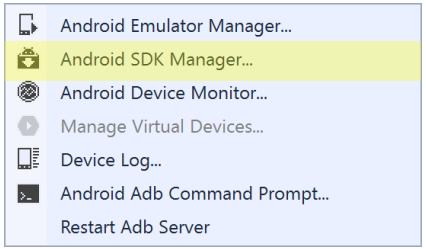
- The *Android SDK Manager* is a tool from Google that lets you install new (and old) versions of the Android SDK



How to launch Android SDK Manager

- Visual Studio menu entries launch the Android SDK Manager

Visual Studio for Mac Tools menu

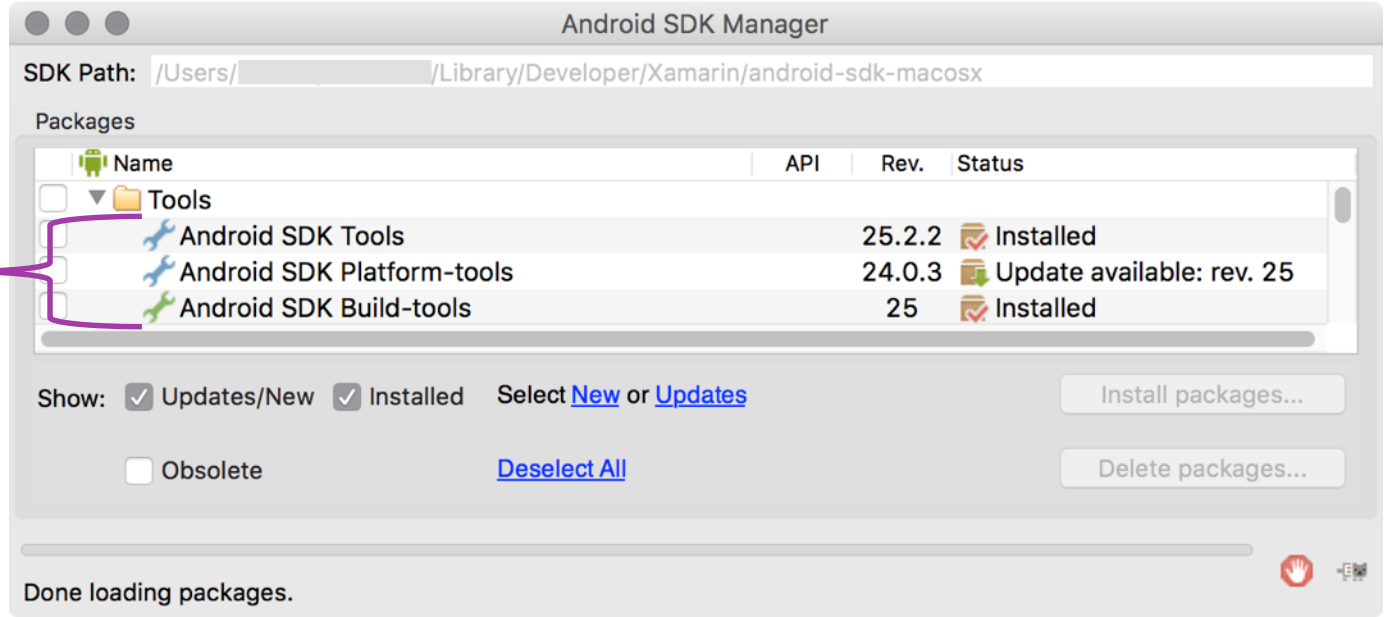


Visual Studio Tools > Android menu

Updating tools

- Android splits the SDK tools into three parts that can be updated separately; you should keep all three categories up-to-date

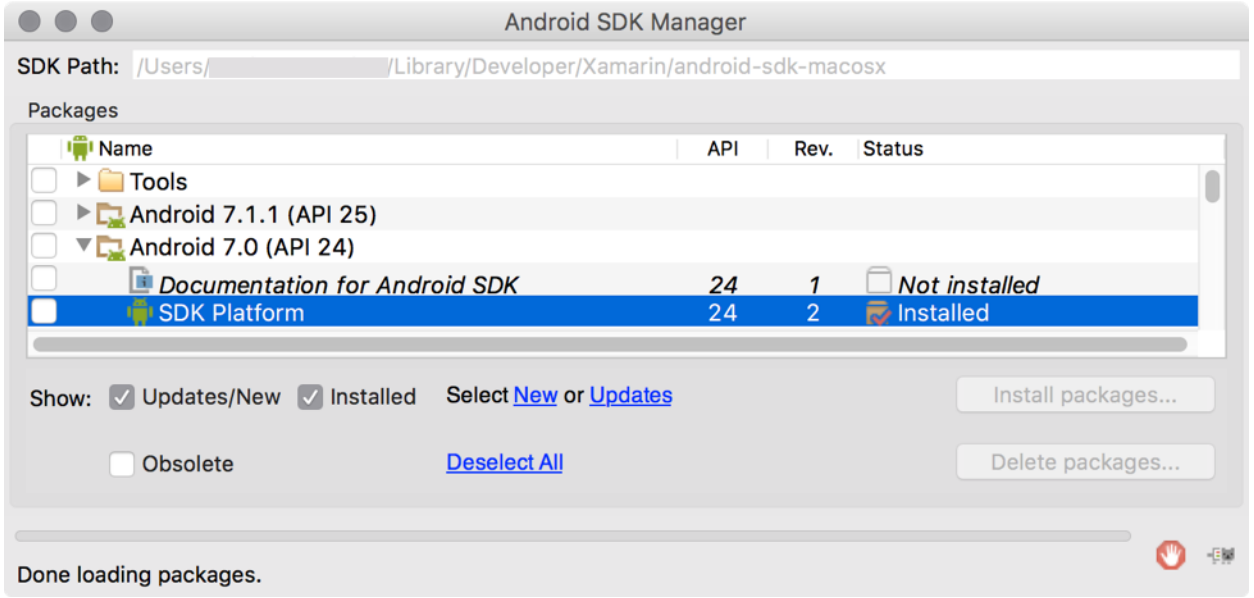
Update all of these. The SDK manager tells you when updates are ready.



Updating platform versions

- Use the SDK Manager to install the platform versions you would like to compile against

Install the SDK Platform for the versions you need →



Group Exercise

Update Tools and SDK Platform

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Next Steps

- This class has shown you how to build a Xamarin.Android app with one Activity
- In **AND102** we will look at how to create multiple Activities and get them to work together by passing arguments and retrieving results

Thank You!

Please complete the class survey in your profile:
university.xamarin.com/profile