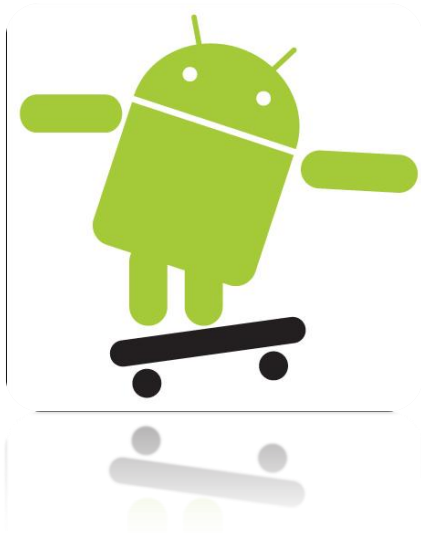


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## Android Programming

with Tutorials from the anddev.org-Community.

written by Nicolas Gramlich

*Check for the latest version on*

<http://andbook.anddev.org>



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## Foreword / How to read this doc

This document was written for developers who have worked with Java™ before and want to start developing for the Android Platform. I tried to make this as much “hands on” as possible, placing example codes everywhere it fit. Also I tried to insert as many picture as possible, because they liven up the learning process and relax the reader’s eyes.

But unfortunately 😊 coding is not everything; one has to learn about some basic facts of the Android Platform to fully understand. That is what is described on the first ~XXX pages. It is not necessary to read all those describing pages, but it is preferable. You could decide to treat it as a kind of reference. What you would read there is also explained when it occurs during the “hands on”-process. So you could directly start at [Hello World – The Android Way](#).

All codes you see in this document (the whole workspace) will be available on:

<http://andbook.anddev.org/sources/>

Have fun reading... 😊





## Introduction

The Open Handset Alliance (1) released the Google Android SDK on November 12<sup>th</sup>, 2007, having announced it about a week before. The impact was unbelievable, almost every IT/programming-related news-page dumped a news-post about the SDK release – the Google Groups (2) was overwhelmed with over 2000 Messages within the first two Days.

The idea of the Android Platform was and still is amazing and is of course attracting more and more programmers every day. Especially the open architecture based on Intents and the possibility to replace even the Home-application grant a really large amount of flexibility to the whole platform.

*“Android – Imagination is the limit”<sup>1</sup>*

---

<sup>1</sup> Nicolas Gramlich – anddev.org Site-Admin



## What is Android – a GPhone?

The weeks and months before Google released the Android SDK there had been a lot of rumors about a so called GPhone. It was said to be a mobile device manufactured by Google providing free communication by showing context-sensitive advertisements to the user on the device itself.



Picture 1 Render of a potential GPhone

But on November 5<sup>th</sup> 2007 Andy Rubin<sup>2</sup> announced:

“[The] Android [Platform] – is more significant and ambitious than a single phone.”

Google within the Open Handset Alliance (OHA) delivers a complete set of software for mobile devices: an operating system, middleware and key mobile applications. What was released a week later was not a final product, but a “*First Look SDK*” what many did not realize. Major news sites grabbed the discomforts of some developers who said that Android is full of bugs and heavily lacks of documentation. But the majority says that Android is not buggier than any other software at this stage.

---

<sup>2</sup> Andy Rubin – Google Director of Mobile Platforms



## Android from above

Let's take a look at what the OHA emphasizes on its Android Platform:

### Openness

*"Android was built from the ground-up to enable developers to create compelling mobile applications that take full advantage of all a handset has to offer. It is built to be truly open. For example, an application could call upon any of the phone's core functionality such as making calls, sending text messages, or using the camera, allowing developers to create richer and more cohesive experiences for users."*

This is true, as a developer you can do everything, from sending short messages with just 2 lines of code, up to replacing even the HOME-Screen of your device. One could easily create a fully customized operating system within weeks, providing no more of Google's default application to the user.

*"Android is built on the open Linux Kernel. Furthermore, it utilizes a custom virtual machine that has been designed to optimize memory and hardware resources in a mobile environment. Android will be open source; it can be liberally extended to incorporate new cutting edge technologies as they emerge. The platform will continue to evolve as the developer community works together to build innovative mobile applications."*

Here Google is talking of the so called Dalvik virtual machine (DalvikVM), which is a register based virtual machine, designed and written by *Dan Bornstein* and some other Google engineers, to be an important part of the Android platform. In the words "register based" we find the first difference to *normal* Java virtual machines (JVM) which are stack based. See the "[\*Dalvik.equals\(Java\) == false\*](#)"-chapter for more details on that issue.





## All applications are created equal

*“Android does not differentiate between the phone's core applications and third-party applications. They can all be built to have equal access to a phone's capabilities providing users with a broad spectrum of applications and services. With devices built on the Android Platform, users will be able to fully tailor the phone to their interests. They can swap out the phone's home screen, the style of the dialer, or any of the applications. They can even instruct their phones to use their favorite photo viewing application to handle the viewing of all photos.”*

Once again this is all true. Developers can 100% customize their Android-Device. The Android System Communication is based on so called Intents, which are more or less just a String (with some data attached) which defines an action that needs to be handled. An example for this is:

```
"android.provider.Telephony.SMS_RECEIVED"
```

One can simply listen on that Intent by writing about 5 lines of definitions. The system would then recognize that there is more than one application that wants to handle that Intent and ask the user to choose which one he or she would like to handle the Intent.

## Breaking down application boundaries

*“Android breaks down the barriers to building new and innovative applications. For example, a developer can combine information from the web with data on an individual's mobile phone - such as the user's contacts, calendar, or geographic location - to provide a more relevant user experience. With Android, a developer could build an application that enables users to view the location of their friends and be alerted when they are in the vicinity giving them a chance to connect.”*

## Fast & easy application development

*“Android provides access to a wide range of useful libraries and tools that can be used to build rich applications. For example, Android*



*enables developers to obtain the location of the device, and allows devices to communicate with one another enabling rich peer-to-peer social applications. In addition, Android includes a full set of tools that have been built from the ground up alongside the platform providing developers with high productivity and deep insight into their applications.”*

Since the Web 2.0 revolution, making content rich applications within minutes is no more illusion. Android has brought developing to unknown speeds. Let me provide an example:

Someday I stumbled over the Buzzword ‘DrivingDirections’ within the Android-Documentation.

Thought – done.



**Picture 2 Google DrivingDirections implementation in Android**

The development process of the application in the picture above took about 1½ hours! (Including the simple user interface and all images you see). Could one create such a sophisticated application on any other mobile-platform? – No.



Additionally this application could be enriched with the current GPS-position of the device within a handful of code-lines.

Google emphasizes Androids power of providing location-based-services. Google Maps are so neat within Android as if it was just developed for Android. One can integrate a fully zoom and drag enabled map by adding just 3(!) characters in the Java-Code of the Android-Default-Application and 3 lines of XML-Code.

Other nice features that are easy to use with Android are Animations and media-playback. Since version m5, the Android SDK contains functions for straight and reverse GeoCoding and in addition to mp3, playback of: ogg-Vorbis, MIDI and a bunch of other formats.



## The first weeks

Unfortunately the developers had to deal with a not fully implemented preview-SDK (initially released build: 'm3-rc20'), where even some key-parts of the SDK were poorly documented. The lack of documentation led to an explosion of the Android-Developer-Group within the Google-Groups. Sooner or later one had to respect the statement from Google:

*"If it is not documented it is not meant to work yet."*

Many developers did not realize that fact that the first SDK released were first-looks or developer-previews, where changes in the API had to be awaited.

Another annoying bug was the choppy emulator-sound, which was said fixed with the release of build 'm3-rc37a' about 4 weeks later, but still happened on some setups up to m5.



## Dalvik.equals(Java) == false

Why “Dalvik”? – The Dalvik virtual machine was named by *Bornstein* after the fishing village of [Dalvík in Eyjafjörður](#) (Iceland), where some of his ancestors lived.

As you may have heard of, Dalvik is the name of Android's virtual machine. It is an interpreter-only virtual machine that executes files in the Dalvik Executable (\*.dex) format, a format that is optimized for efficient storage and memory-mappable execution. The virtual machine is register-based, and it can run classes compiled by a Java language compiler that have been transformed into its native format using the included "dx" tool. The VM runs on top of a Linux 2.6 kernel, which it relies on for underlying functionality (such as threading and low level memory management). The DalvikVM was also optimized to be running in multiple instances with a very low memory-footprint. Several VMs protect ones application from being dragged down by another crashed Application.

## Differences to a normal JavaVM

JavaVM's one can find on almost any desktop computer nowadays are Stack-based Virtual Machines (VM).The DalvikVM on the other hand is register based, because on mobile-processors are optimized for register-based execution. Also of register-based VMs allow faster execution times at the expense of programs which are larger after compilation.



## The Android Code Challenge

The Android Code Challenge (ADC) is an idea of Google to encourage the community to build cool applications for the Android Platform by rewarding the 50 most promising applications submitted.



Picture 3 Android Developer Challenge Logo

Of course the Android Developers Challenge, with its overall 10 Million Dollars of prize money, was attracting even more software-developers to create a bunch of really useful applications. On the other side many voices said, that this was no good choice from Google, because it would lead to less code-sharing, as many would fear sharing their ideas with a community, during the first important months after the SDK release.

There were two Challenges planned:

- Android Developer Challenge I: Submissions up to April 14, 2008
- Android Developer Challenge II: This part will launch after the first handsets built on the platform become available in the second half of 2008.

In the Android Developer Challenge I, the 50 most promising entries submitted by April 14 will each receive a \$25,000 award to fund further development. Those selected will then be eligible for even greater recognition via ten \$275,000 awards and ten \$100,000 awards.

Applications submitted to the Challenge were supposed to be innovative and demonstrate all the capabilities of the Android platform, like location based services, media consumption, gaming and social networking, to enrich mobile experience.



## Creating Android Applications

In this chapter we will concentrate on the specialties in creating any Android-Application.

### Anatomy of an Android Application

There are four building blocks to an Android application:

- Activity
- Intent Receiver
- Service
- Content Provider

Not every application needs to have all four, but your application will be written with some combination of these.

Once you have decided what components you need for your application, you should list them in a file called [AndroidManifest.xml](#). This is an XML file where you declare the components of your application and what their capabilities and requirements are. We will discuss soon, what the `AndroidManifest.xml` is responsible for.

### Activity

Activities are the most common of the four Android building blocks. An activity is usually a single screen in your application. Each activity is implemented as a single class that extends the Activity base class. Your class will display a user interface composed of Views and respond to events. Most applications consist of multiple screens. For example, a text messaging application might have one screen that shows a list of contacts to send messages to, a second screen to write the message to the chosen contact, and other screens to review old messages or change settings. Each of these screens would be implemented as an activity. Moving to another screen is accomplished by a starting a new activity. In some cases an Activity may return a value to the previous activity - for



example an activity that lets the user pick a photo would return the chosen photo to the caller.

When a new screen opens, the previous screen is paused and put onto a history stack. The user can navigate backward through previously opened screens in the history. Screens can also choose to be removed from the history stack when it would be inappropriate for them to remain. Android retains history stacks for each application launched from the home screen.

### *Intent and Intent Filters*

Android uses a special class called `Intent` to move from screen to screen. Intent describe what an application wants done. The two most important parts of the intent data structure are the action and the data to act upon. Typical values for action are `MAIN` (the front door of the application), `VIEW`, `PICK`, `EDIT`, etc. The data is expressed as a Uniform Resource Indicator (URI). For example, to view a website in the browser, you would create an Intent with the `VIEW` action and the data set to a Website-URI.

```
new Intent(android.content.Intent.VIEW_ACTION,  
           ContentURI.create("http://anddev.org"));
```

There is a related class called an `IntentFilter`. While an intent is effectively a request to do something, an intent filter is a description of what intents an activity (or intent receiver, see below) is capable of handling. An activity that is able to display contact information for a person would publish an `IntentFilter` that said that it knows how to handle the action `VIEW` when applied to data representing a person. Activities publish their `IntentFilters` in the `AndroidManifest.xml` file.

Navigating from screen to screen is accomplished by resolving intents. To navigate forward, an activity calls `startActivity(myIntent)`. The system then looks at the intent filters for all installed applications and





picks the activity whose intent filters best matches `myIntent`. The new activity is informed of the intent, which causes it to be launched. The process of resolving intents happens at run time when `startActivity` is called, which offers two key benefits:

- Activities can reuse functionality from other components simply by making a request in the form of an Intent
- Activities can be replaced at any time by a new Activity with an equivalent `IntentFilter`

## Intent Receiver

You can use an `IntentReceiver` when you want code in your application to execute in reaction to an external event, for example, when the phone rings, or when the data network is available, or when it's midnight. Intent receivers do not display a UI, although they may display `Notifications` to alert the user if something interesting has happened. Intent receivers are also registered in `AndroidManifest.xml`, but you can also register them from code using `Context.registerReceiver()`. Your application does not have to be running for its intent receivers to be called; the system will start your application, if necessary, when an intent receiver is triggered. Applications can also send their own intent broadcasts to others with `Context.broadcastIntent()`.

## Service

A `Service` is code that is long-lived and runs without a UI. A good example of this is a media player playing songs from a play list. In a media player application, there would probably be one or more activities that allow the user to choose songs and start playing them. However, the music playback itself should not be handled by an activity because the user will expect the music to keep playing even after navigating to a new screen. In this case, the media player activity could start a service using `Context.startService()` to run in the background to keep the music going. The system will then keep the music playback service



running until it has finished. (You can learn more about the priority given to services in the system by reading *Life Cycle of an Android Application*.) Note that you can connect to a service (and start it if it's not already running) with the `Context.bindService()` method. When connected to a service, you can communicate with it through an interface exposed by the service. For the music service, this might allow you to pause, rewind, etc.

## **Content Provider**

Applications can store their data in files, a SQLite database, preferences or any other mechanism that makes sense. A content provider, however, is useful if you want your application's data to be shared with other applications. A content provider is a class that implements a standard set of methods to let other applications store and retrieve the type of data that is handled by that content provider.



## Android User Interfaces

User Interfaces (UI) in Android can be built within two ways, by defining XML-Code or by writing Java-Code. Defining the GUI structure in XML is highly preferable, because as one knows from the Model-Viewer-Control principle that the UI should always be separated from the program-logic. Additionally adapting a program from one screen-resolution to another is a lot easier.

Defining a UI in XML is very similar to creating a common HTML-document, where you have i.e. such a simple file:

```
<html>
  <head>
    <title>Page Title</title>
  </head>
  <body>
    The content of the body element.
  </body>
</html>
```

Just the same as in Android's XML-Layouts. Everything is well structured and can be expressed by tree-structures:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent">
  <TextView
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:text="Hello World"/>
</LinearLayout>
```

## Hierarchy of Screen Elements

The basic functional unit of an Android application is the activity-an object of the class `android.app.Activity`. An activity can do many things, but by itself it does not have a presence on the screen. To give your activity a screen presence and design its UI, you work with views



and viewgroups - basic units of user interface expression on the Android platform.

## *Views*

A view is an object extending the base class `android.view.View`. It's a data structure whose properties store the layout and content for a specific rectangular area of the screen. A View object handles measuring, its layout, drawing, focus changes, scrolling, and key/gestures for the screen area it represents.

The View class serves as a base class for all widgets - a set of fully implemented subclasses that draw interactive screen elements. Widgets handle their own measuring and drawing, so you can use them to build your UI more quickly. The list of widgets available includes i.e. TextView, EditText, Button, RadioButton, Checkbox, ScrollView, ...

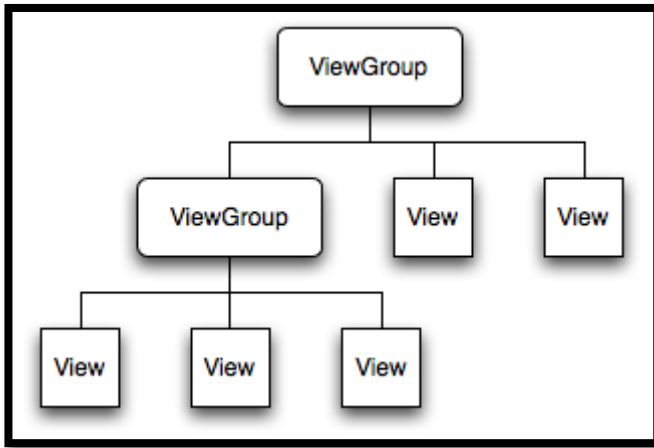
## *Viewgroups*

A viewgroup is an object of class `android.view.ViewGroup`. As its name indicates, a viewgroup is a special type of view object whose function is to contain and manage a subordinate set of views and other viewgroups, Viewgroups let you add structure to your UI and build up complex screen elements that can be addressed as a single entity.

The ViewGroup class serves as a base class for layouts - a set of fully implemented subclasses that provide common types of screen layout. The layouts give you a way to build a structure for a set of views.

## *A Tree-Structured UI*

On the Android platform, you define an Activity's UI using a tree of view and viewgroup nodes, as shown in the diagram below. The tree can be as simple or complex as you need to make it, and you can build it up using Android's set of predefined widgets and layouts or custom view types that you create yourself.



Picture 4 Android UI - Tree structure

To attach the tree to the screen for rendering, your Activity calls its `setContentView()` method and passes a reference to the root node object. Once the Android system has the reference to the root node object, it can work directly with the node to invalidate, measure, and draw the tree. When your Activity becomes active and receives focus, the system notifies your activity and requests the root node to measure and draw the tree. The root node then requests that its child nodes draw themselves - in turn, each viewgroup node in the tree is responsible for drawing its direct children.

As mentioned previously, each view group has the responsibility of measuring its available space, laying out its children, and calling `draw()` on each child to let it render itself. The children may request a size and location in the parent, but the parent object has the final decision on where how big each child can be.



## Comparing Android UI Elements to Swing UI Elements

As some developers who are reading this have probably coded UIs with Swing before here are some similarities between Android and Swing.

- **Activities** in Android refers *almost* to a **(J)Frame** in Swing.
- **Views** in Android refers to **(J)Components** in Swing.
- **TextViews** in Android refers to a **(J)Labels** in Swing.
- **EditTexts** in Android refers to a **(J)TextFields** in Swing.
- **Buttons** in Android refers to a **(J)Buttons** in Swing.

Setting listeners to a View is nearly the same in Android than in Swing.

```
// Android
myView.setOnClickListener(new OnClickListener() { ...

// Swing
myButton.addActionListener(new ActionListener() {...
```



## The AndroidManifest.xml

The `AndroidManifest.xml` is a required file for every Android application. It is located in the root folder of the application, and describes global values for your package, including the application components (activities, services, etc) that the package exposes to the 'outer world', what kind of data each of our Activities and co. can handle, and how they can be launched.

An important thing to mention of this file are its so called [IntentFilters](#). These filters describe where and when that activity can be started. When an activity (or the operating system) wants to perform an action such as open a Web page or open a contact picker screen, it creates an [Intent](#) object. This Intent-object can hold several information describing what you want to do, what data is needed to accomplish it and other bits of information. Android compares the information in an Intent object with the intent filter exposed by every application and finds the activity most appropriate to handle the data or action specified by the caller. If there it more than one application capable of handling that Intent, the user gets asked, which app he would prefer handling it.

Besides declaring your application's Activities, Content Providers, Services, and Intent Receivers, you can also specify permissions in `AndroidManifest.xml`.

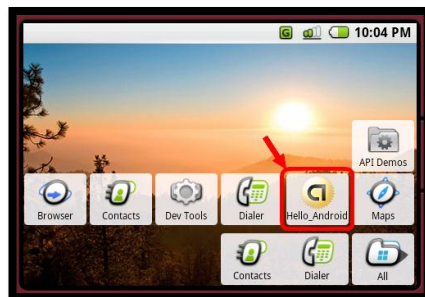


## General

A very simple AndroidManifest.xml looks like this:

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="org.anddev.android.hello_android">
    <application android:icon="@drawable/icon">
        <activity android:name=".Hello_Android"
            android:label="@string/app_name">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
    </application>
</manifest>
```

- Almost every `AndroidManifest.xml` (as well as many other Android XML files) will include the namespace declaration (`xmlns:android=http://schemas.android.com/apk/res/android`) in its first element. This makes a variety of standard Android attributes available in the file, which will be used to supply most of the data for elements in that file.
- Almost every manifest includes a single `<application>` tag, which itself contains several tags describing Applications, IntentReceivers, etc... that are available in this application.
- If you want to make an Activity launchable directly through the user, you will need to make it support the `MAIN` action and `LAUNCHER` category, what result as shown here:



Picture 5 Directly launchable Activity





What follows is a detailed list of the structure of an `AndroidManifest` file, describing all available `<tags>`, with an Example for each:

### **`<manifest>`**

This is the root node of each `AndroidManifest.xml`. It contains the package-attribute, which points to any package in out Activity. Other Activities-path will base relative to its value.

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
          package="org.anddev.android.smstretcher">
```

### **`<uses-permission>`**

Describes a security permission, which your package must be granted in order for it to operate correctly (i.e. when you want to send SMS or use the Phone-Contacts). The permissions get granted by the user during installation of your application. Quantity: 0<sup>+</sup>

```
<uses-permission android:name=" android.permission.RECEIVE_SMS"/>
```

### **`<permission>`**

Declares a security permission that can be used to restrict which applications can access components or features in your (or another) package. Quantity: 0<sup>+</sup>

### **`<instrumentation>`**

Declares the code of an instrumentation component that is available to test the functionality of this or another package. See Instrumentation for more details. Quantity: 0<sup>+</sup>

### **`<application>`**

Root element containing declarations of the application-level components contained in the package. This element can also include global and/or default attributes for the application, such as a label, icon, theme, required permission, etc. Quantity: 0 or 1.

```
<application android:icon="@drawable/icon">
```



You can place 0<sup>+</sup> of each of the following children:

### **<activity>**

An Activity is the primary thing for an application to interact with the user. The initial screen the user sees when launching an application is an activity, and most other screens they use will be implemented as separate activities declared with additional activity tags.

```
<activity android:name=".Welcome" android:label="@string/app_name">
```



**Note:** Every Activity must have an <activity> tag in the manifest whether it is exposed to the world or intended for use only within its own package. If an Activity has no matching tag in the manifest, you won't be able to launch it.

Optionally, to support late runtime lookup, you can include 1<sup>+</sup> <intent-filter> elements to describe the actions the activity supports.

### **<intent-filter>**

Declares what kind of Intents a component supports. In addition to the various kinds of values that can be specified under this element, attributes can be given here to supply a unique label, icon, and other information for the action being described.

```
<intent-filter>
```

### **<action>**

An action-type that the component supports. Example:

```
<action android:name="android.intent.action.MAIN" />
```



### <category>

A category-type that the component supports. Example:

```
<category android:name="android.intent.category.LAUNCHER" />
```

### <data>

An MIME type, URI scheme, URI authority, or URI path that the component supports.

You can also associate 1<sup>+</sup> pieces of meta-data with your activity:

### <meta-data>

Adds a new piece of meta data to the activity, which clients can retrieve through `ComponentInfo.metaData`.

### <receiver>

An `IntentReceiver` allows an application to be told about changes to data or actions that happen, even if it is not currently running. As with the activity tag, you can optionally include 1<sup>+</sup> `<intent-filter>` elements that the receiver supports or `<meta-data>` values, just all the same as with `<activity>`.

```
<receiver android:name=".SMSReceiver">
```

### <service>

A Service is a component that can run in the background for an arbitrary amount of time. As with the activity tag, you can optionally include one or more `<intent-filter>` elements that the service supports or `<meta-data>` values; see the activity's `<intent-filter>` and `<meta-data>` descriptions for more information.



### **<provider>**

A `ContentProvider` is a component that manages persistent data and publishes it for access by other applications. You can also optionally attach one or more `<meta-data>` values, as described in the activity's `<meta-data>` description.

Of course all `<tags>` have to be `</closed>` or closed `<directly/>`.



## Resources and the magic R.java

The resources of a project and the R.java are very close related.

### Resources

Resources are external files (non-code files) that are used by your code and compiled into your application at build time. Android supports a number of different kinds of resource files, including XML, PNG, and JPEG files. The XML files have very different formats depending on what they describe.

Resources are externalized from source code, and XML files are compiled into a binary, fast loading format for efficiency reasons. Strings are compressed into a more efficient storage form.

### List of resources

Resource-types and where to place them:

- layout-files → `"/res/layout/"`
- images → `"/res/drawable/"`
- animations → `"/res/anim/"`
- styles, strings and arrays → `"/res/values/"`
  - *Names do not have to be exactly like:*
  - `'arrays.xml'` to define arrays
  - `'colors.xml'` to define colors
    - `#RGB`, `#ARGB`, `#RRGGBB`, `#AARRGGBB`
  - `'dimens.xml'` to define dimensions
  - `'strings.xml'` to define strings
  - `'styles.xml'` to define style objects
- raw files like mp3s or videos → `"/res/raw/"`



## Using resources in code

Using resources in code is just a matter of knowing the full resource ID and what type of object your resource has been compiled into. Here is the syntax for referring to a resource:

```
R.resource_type.resource_name
```

or

```
android.R.resource_type.resource_name
```

Where `resource_type` is the R subclass that holds a specific type of `resource.resource_name` is the name attribute for resources defined in XML files, or the file name (without the extension) for resources defined by other file types. Each type of resource will be added to a specific R subclass, depending on the type of resource it is.

Resources compiled by your own application can be referred to without a package name (simply as `R.resource_type.resource_name`). Android contains a number of standard resources, such as screen styles and button backgrounds. To refer to these in code, you must qualify them with `android`, as for example in: `android.R.drawable.button_background`.



## Referencing Resources

A value supplied in an attribute (or resource) can also be a reference to another resource. This is often used in layout files to supply strings (so they can be localized) and images (which exist in another file), though a reference can be any resource type including colors and integers.

For example, if we have color resources, we can write a layout file that sets the text color size to be the value contained in one of those resources:

```
<EditText
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:textColor="@color/opaque_red"
    android:text="Hello, World!" />
```

Note here the use of the '@' prefix to introduce a resource reference -- the text following that is the name of a resource in the form of @[package:]type/name. In this case we didn't need to specify the package because we are referencing a resource in our own package. To reference a system resource, you would need to write:

```
<EditText
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:textColor="@android:color/opaque_red"
    android:text="Hello, World!" />
```

As another example, you should always use resource references when supplying strings in a layout file so that they can be localized:

```
<EditText
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:textColor="@android:color/opaque_red"
    android:text="@string/hello_world" />
```



## Alternate Resources & Localization

Alternate Resources and Localization is a very useful issue you will love Android for. Expect you would have to design a GUI that fits landscape and portrait screen-orientation well at the same time – that is almost impossible.

You can supply different resources for your application according to the UI language or hardware configuration of the device. Note that eventhough you can include different string, layout, and all other resources, the SDK does not expose methods to let you specify which alternate resource set to be used. Android detects the proper set for the hardware and location, and loads them as appropriate. Only the user can select alternate language settings using the settings panel on the device.

To include alternate resources, create parallel resource folders with dash-separated qualifiers appended to the folder names, indicating the configuration it applies to (language, screen orientation, dpi, resolution, ...).

For example, here is a project differs between differs between English and German value-resources (here only strings):

```
MyApp/  
  res/  
    values-en/  
      strings.xml  
    values-de/  
      strings.xml
```

Android supports several types of qualifiers, with various values for each. Append these to the end of the resource folder name, separated by dashes. You can add multiple qualifiers to each folder name, but they must appear in the order they are listed here. For example, a folder containing drawable resources for a fully specified configuration would look like:





```
MyApp/  
  res/  
    drawable-en-rUS-port-92dpi-finger-keyshidden-12key-dpad-480x320/
```

More typically, you will only specify a few specific configuration options that a resource is defined for. You may drop any of the values from the complete list, as long as the remaining values are still in the same order:

```
MyApp/  
  res/  
    drawable-en-rUS-finger/  
    drawable-port/  
    drawable-port-160dpi/  
    drawable-qwerty/
```

Android will pick which of the various underlying resource files fits best during runtime, depending on the current device-configuration.

## The magic R.java

A project's R.java is an auto-generated file indexing all the resources of your project. You use this class in your source code as a sort of shorthand way to refer to resources you've included in your project. This is particularly powerful with the code-completion features of IDEs like Eclipse because it lets you quickly and interactively locate the specific reference you're looking for.

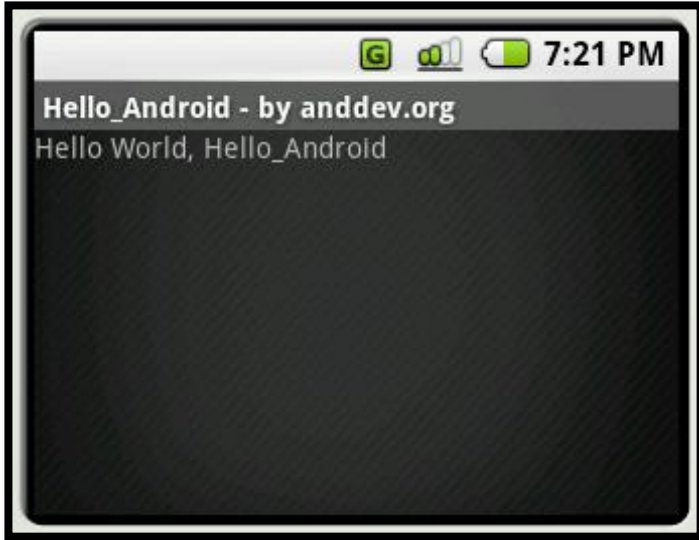
Additionally you gain compile-time safety that the resource you want to use really exists.



## Hello World – The Android way.

In this very first tutorial one will learn how to create an Android Application using a XML layout. Keep in mind that, using XML-Layouts is highly preferable!

What it will finally look like:



Picture 6 First Android Application - Final look (sdk-version: m5)

But before all that one needs to download and install the Android SDK...



## Installing the Android SDK

The latest Android SDK for Windows, Mac and Linux can always be obtained from the following URI:

<http://code.google.com/android/download.html>

It only needs to be downloaded and unzipped to your preferred hdd-location.

## The Android Development Tools (ADT)

Android provides an Eclipse plugin called 'ADT' to make programming and debugging easier.

The ADT provides easy access to the LogCat, the Android-Manifest/Resource-Editor, File, Thread, and Heap Control, incoming call/sms simulation, etc... – since SDK-version m5 all for multiple emulator instances at the same time.

## Installing the Eclipse Plugin (ADT)

To download and install the ADT plugin, follow the steps Google provides to developers:

1. Start Eclipse, then select **Help > Software Updates > Find and Install...**
2. In the dialog that appears, select **Search for new features to install** and press **Next**.
3. Press **New Remote Site**.
4. In the resulting dialog box, enter a name for the remote site (e.g. Android Plugin) and enter this as its URL:

`https://dl-ssl.google.com/android/eclipse/`

Press **OK**.

5. You should now see the new site added to the search list (and checked). Press **Finish**.



6. In the subsequent Search Results dialog box, select the checkbox for **Android Plugin > Developer Tools**. This will check both features: "Android Developer Tools", and "Android Editors". The Android Editors feature is optional, but recommended. If you choose to install it, you need the WST plugin mentioned earlier in this page.

Now press **Next**.

7. Read the license agreement and then select **Accept terms of the license agreement**, if appropriate. Press **Next**.
8. Press **Finish**.
9. The ADT plugin is not signed; you can accept the installation anyway by pressing **Install All**.
10. Restart Eclipse.
11. After restart, **update your Eclipse preferences** to point to the SDK directory:
  - a. Select **Window > Preferences...** to open the Preferences panel. (Mac OS X: **Eclipse > Preferences**)
  - b. Select **Android** from the left panel.
  - c. For the SDK Location in the main panel, press **Browse...** and locate the SDK directory.
  - d. Press **Apply**, then **OK**.

### *Updating the ADT Plugin*

Updating the ADT Plugin follows the standard procedure of upgrading a common Eclipse plugin:

1. Select **Help > Software Updates > Find and Install...**
2. Select **Search for updates of the currently installed features** and press **Finish**.
3. If any update for ADT is available, select and install.



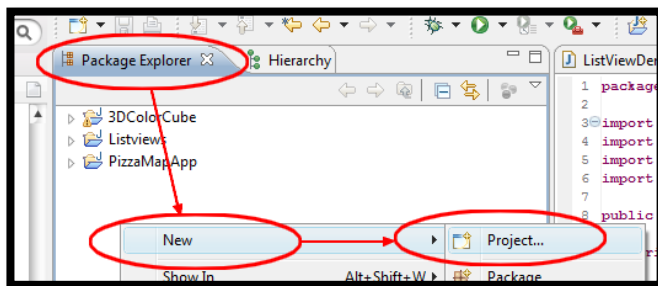
## Installation done, let's do some code

Before we can start coding we obviously have to create a new Android Project.

### Creating a new Android Project

1. The first thing that needs to be for every Android Application is to create a new Android Project. To do that, simply open the Package Explorer in Eclipse right-click on some blank space and choose:

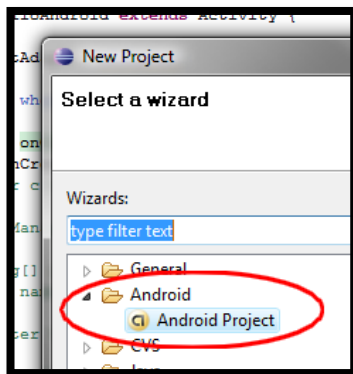
**New > Project...**



Picture 7 First Android Application - Step 1

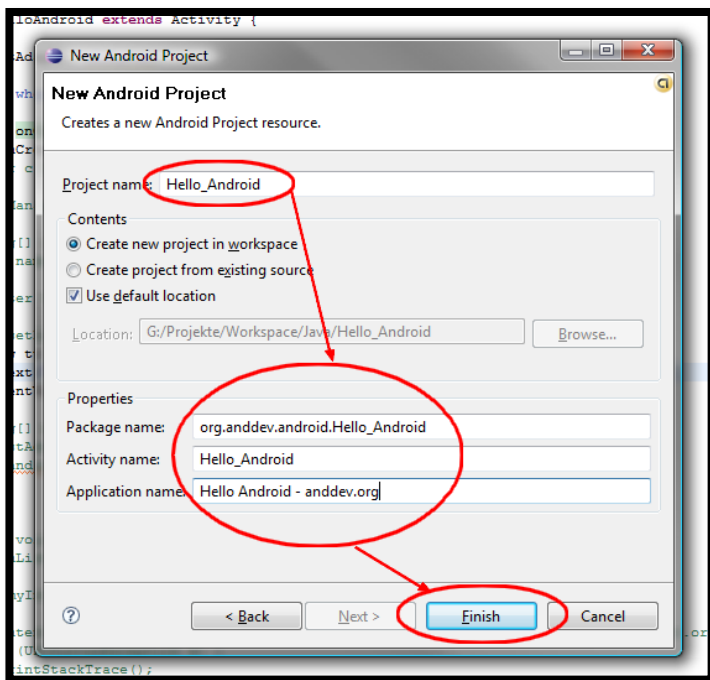
2. Select:

**Android > Android Project**



Picture 8 First Android Application - Step 2

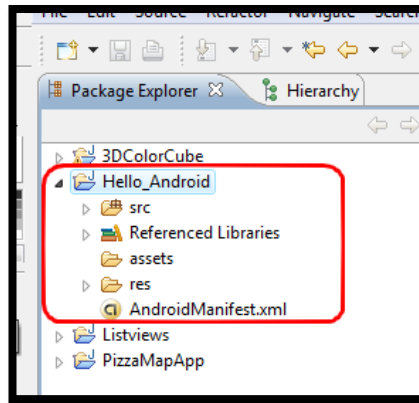
3. Fill out the form with values fitting your applications purpose...



Picture 9 First Android Application - Step 3



4. This are all the files for your first Android-Application (don't panic, mostly all of them are resource-files)



Picture 10 First Android Application - Step 4

### *Huh, what are all that files supposed to do ?*

As you now have created your first Android Project you will see a bunch of files appear in that new project.

### *The Main Activity*

You'll see some default code like the following, when you now navigate to:


`"/src/your_package_Structure/Hello_Android.java"`

```
package org.anddev.android.Hello_Android;

import android.app.Activity;
import android.os.Bundle;

public class Hello_Android extends Activity {
    /** Called when the activity is first created. */
    @Override
    public void onCreate(Bundle icle) {
        super.onCreate(icle);
        /* Make this application use
         * the main.xml-layout-file. */
        this setContentView(R.layout.main);
    }
}
```



We could now immediately  our Application but let me explain of the other files too.

### *The XML-Layout (main.xml)*

The ADT created this very basic Activity for you. As we know Activities are somehow like JFrames in Swing. In Android we extend from Activity and need to overwrite a single function, called `onCreate (...)`. Within this function we have to call `i.e. setContentView(R.layout.main)` which makes our Activity use the `main.xml` which was also created by the ADT:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent">
    <TextView
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:text="Hello World, Hello_Android"/>
</LinearLayout>
```

We have a ‘fullscreen’ vertical `LinearLayout`, that contains a single `TextView` showing a pre-defined String.

### *The AndroidManifest.xml*

So let's face the `AndroidManifest.xml`:

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="org.anddev.android.hello_android">
    <application android:icon="@drawable/icon">
        <activity android:name=".Hello_Android"
            android:label="@string/app_name">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category
                    android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
    </application>
</manifest>
```





Let's split that up...

Every xml-file starts with the following line, it defines the xml-version and encoding-type of the xml-text. Just copy-paste it to every new file.

```
<?xml version="1.0" encoding="utf-8"?>
```

As we know the outermost tag in every xml-file should contain this attribute:

```
xmlns:android="http://schemas.android.com/apk/res/android"
```

Because it makes a variety of general Android attributes available in the file.

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="org.anddev.android.hello_android">
    ....
</manifest>
```

The `<application>` tag is the root element containing declarations of all application-level components contained in the package. This element can also include global and/or default attributes for the application, such as a label, icon, theme, required permission, etc...

Here we define just the icon, by making a '@-refer' to a image placed under `"/res/drawable/"`.

```
<application android:icon="@drawable/icon">
    ....
</application>
```

Inside of the `<application>` tag we need to define all Activities/IntentReceivers that need to be started via Intents. In this case we have only one simple Activity.


```
<activity android:name=".Hello_Android"
    android:label="@string/app_name">
    ....
</activity>
```



You probably have recognizes that the `package`-attribute from the `<manifest>` tag together with the `android:name` attribute from the `<activity>` tag always result in the complete *package-path* to the Activity described.

The innermost tag is the `<intent-filter>` tag which defines on which Intents we want to listen. Here we want the *Hello\_Android* Activity launchable from within the emulator by clicking the icon (that was defined in the `<application>` tag).

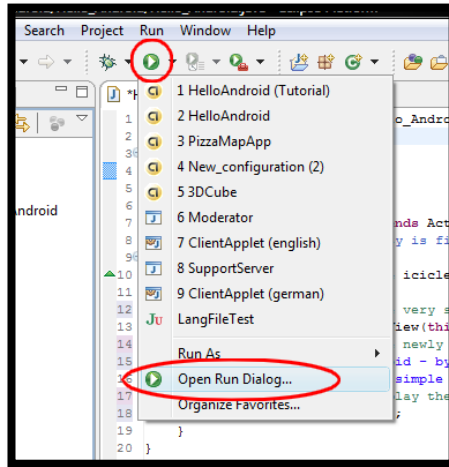
```
<intent-filter>
  <action android:name="android.intent.action.MAIN" />
  <category
    android:name="android.intent.category.LAUNCHER" />
</intent-filter>
```

 **Note:** The debugging-process with a Android Application is exactly the same than with a normal Java Application.

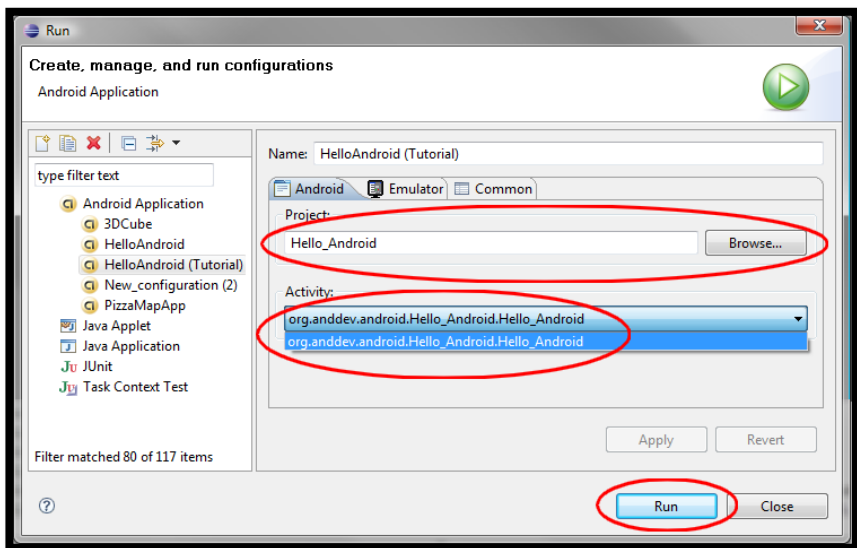


## Running your first application

Now we need to create a 'Run-Configuration'. Open the Run-DropDown in the Eclipses upper menu and Click "Open Run Dialog..."




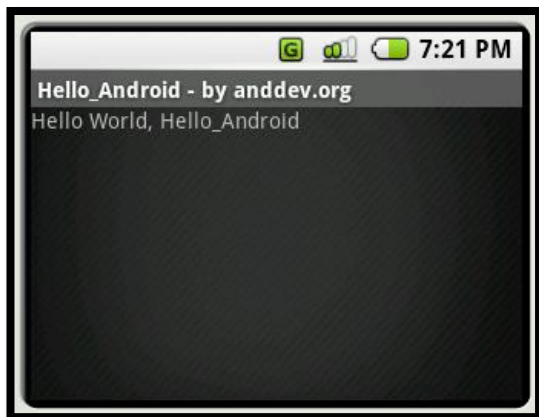
Picture 11 Opening the run-dialog



Picture 12 Creating a run-configuration



From now on you can run your application by clicking the  button. Having done that you'll see this:



**Picture 13 First Android Application - The result (sdk-version m5)**

After the first deploy you can also see your application being listed in the quick-menu, displayed with the default icon:



**Picture 14 First Android Application - Added to QuickMenu (sdk-version m5)**



## UIs the Java way

The same thing as we have just done with XML-Code can be achieved by hacking some lines of Java-Code.

Remember how we set our main.xml as the ContentView in the xml-example. We accomplished that by doing the following:

```
/* Make this application use
 * the main.xml-layout-file. */
this.setContentView(R.layout.main);
```

Activity.setContentView(...) also accepts a View as the parameter. We will use that to set a simple TextView as our ContentView.

```
package org.anddev.android.Hello_Android;

import android.app.Activity;
import android.os.Bundle;
import android.widget.TextView;

public class Hello_Android extends Activity {
    /** Called when the activity is first created. */
    @Override
    public void onCreate(Bundle icle) {
        super.onCreate(icle);
        /* We want to view some very simple text,
         * so we need a TextView associated with this Activity. */
        TextView tv = new TextView(this);
        /* Put some text to the newly created TextView */
        tv.setText("Hello Android - by: anddev.org \n" +
            "This is soooo simple =D ");
        /* Tell our Activity to display that TextView */
        this.setContentView(tv);
    }
}
```



## System.out.println(...) ?

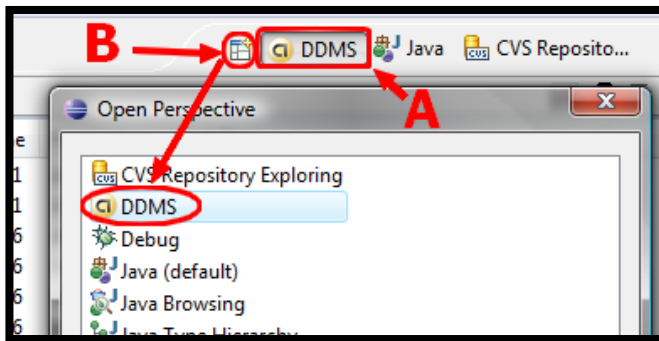
Debugging in Android cannot be done using `System.out.println(...)` because as we know Android is not running on a normal VM but inside of emulated hardware on the DalvikVM. ( To be honest, it can be done but it should definitely be not your choice)

But don't worry, Android provides a much more powerful debugging feature – The LogCat.

## The LogCat

The LogCat is a part of the DDMS (Dalvik Debug Monitor service) that provides a mechanism for collecting and viewing system debug output. Logs from various applications and portions of the system are collected in the LogCat, which then can be viewed and filtered.

*If you cannot see A, do it the B way.*



Picture 15 Opening the DDMS View

## Using the LogCat

Every Android log message has a tag and a priority associated with it.





When some critical things happened you can pass the Throwable/Exception to `Log.e(...)`, to get the StackTrace printed to the LogCat:

```
try{
    throw new Exception();
} catch (Exception e){
    Log.e("DEBUGTAG", "Error occurred", e);
}
```

Note:





## Using Intents

As we know things needed to be done are expressed by Intents. Intents can i.e. be used to start other Activities.

## Starting (Sub)Activities

An essential thing in the lifetime of an application, that is more sophisticated than a HelloWorld Application, is to start other Activities, especially SubActivities. Let's assume the following scenario:

We want to have something like an InputDialog where the user can write a keyword he wants to search on Google for.

So we will create a new Android Project as we already did it before. The first thing we will do is to add a second Activity we will name "MySecondActivity".

In the beginning the code shall look like this:

```
package org.anddev.andbook.startingsubactivities;

import android.app.Activity;
import android.os.Bundle;

public class MySecondActivity extends Activity {
    /** Called when the activity is first created. */
    @Override
    public void onCreate(Bundle icle) {
        super.onCreate(icle);
        setContentView(R.layout.main);
    }
}
```

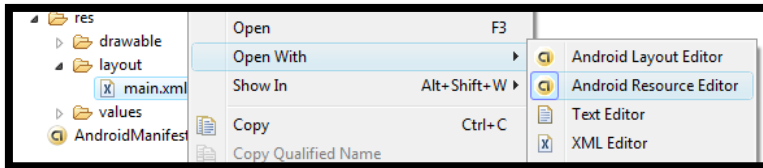


We now will add a Button to the first Activity. We do that by altering the main.xml, of course, and not by switching to a Java UI.

Browse to “/res/layout/main.xml” and you will see code similar to this:

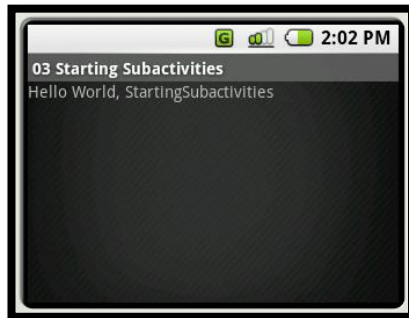
```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent" >
    <TextView
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:text="Hello World, StartingSubactivities" />
</LinearLayout>
```

**Note:** maybe Eclipse opened the main.xml with its default xml-Editor which is not of any use for us. Since SDK-version m5 the ADT plugin provides a Resource-Editor with Syntax-Highlighting.



Picture 17 Opening the Resource Editor

If we would start the Application right now it would look like this:



Picture 18 Layout default (sdk-version m5)



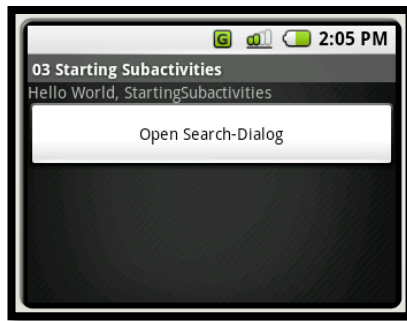
As we want to have a Button in our application, we will have to come up with some xml-code:

```
<Button
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:text="Open Search-Dialog" />
```

As one can imagine, “fill\_parent” makes a View us all space the parent View provides and “wrap\_content” uses just as much layout space as it needs to display its content correctly.

So our button will fill the whole screen in width and wrap around the “Open Search-Dialog” we typed for the `android:text` attribute.

Our application now looks like this:



Picture 19 Layout with Button (sdk-version m5)

When we now click the button – nothing happens, of course. We will have to apply a Listener to be specific an `OnClickListener` to Handle clicks to this Buttons.

But wait... how can we refer to that Button in Java Code ?



## Finding XML-defined Views in Java-Code

To find a View that was defined in XML we first have to add one single line to the XML-definition of that View, an `android:id` attribute. In this case we will give it the id `"btn_open_search"`:

```
<Button
    android:id="@+id/btn_open_search"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:text="Open Search-Dialog" />
```

Finding that View in Java Code is same easy. Within an Activity you can use the `findViewById(int resourceID)` method, to get a reference to a View using the `android:id` that has been defined in XML.

The same can be done with any other class that extends View, i.e. `EditText`, `TextView`, `MapView`, etc...



**But** `findViewById(...)` can only be used with Views that are placed within the Layout that was loaded to that Activity using `setContentView(...)`!

Coming back to our example, we add the following in Code to `onCreate(...)`, right after the `setContentView(...)`:

```
/* Find the Button from our XML-layout. */
Button b = (Button) this.findViewById(R.id.btn_open_search);
```

If Eclipse cannot find i.e. the `Button`-Class, just hit 'CTRL+SHIFT+O' what will organize the imports and automatically add (in this case):

```
import android.widget.Button;
```



## Handling Clicks to Views

We now remember that we once 😊 wanted to make our button clickable. Therefore we simply set an anonymous `OnClickListener` to our `Button`:

```
b.setOnClickListener(new OnClickListener() {  
    public void onClick(View arg0) {  
        // Place code to handle Button-Click here.  
    }  
});
```

**Note:** Eclipse might not recognize the following import by itself:

```
import android.view.View.OnClickListener;
```

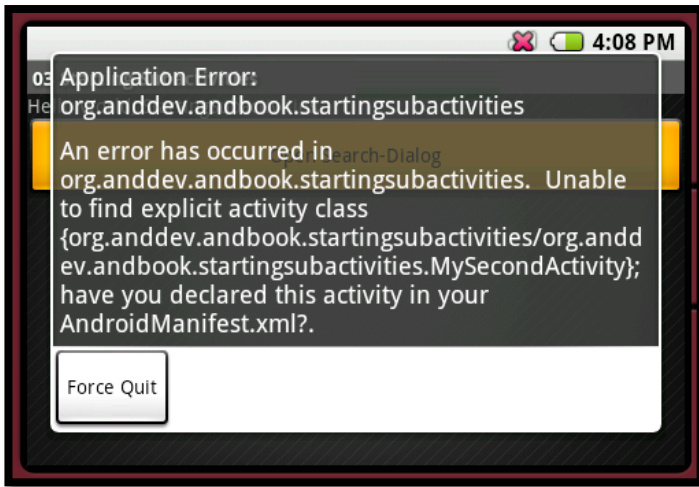
Now we will add an `Intent` to the `onClick`-Event that will start our `SubActivity`:

```
/* Create an Intent to start  
 * MySecondActivity. */  
Intent i = new Intent(  
    StartingSubactivities.this,  
    MySecondActivity.class);  
/* Send intent to the OS to make  
 * it aware that we want to start  
 * MySecondActivity as a SubActivity. */  
startSubActivity(i, 0x1337);
```


The second parameter of `startSubActivity` can be any unique Integer. It will get useful later on (then we will be placing it declared as `final` to our `Activity`), when we want to retrieve a result from the `SubActivity`.



If we would now run our code and click our button we would receive the following error-message:



Picture 20 Activity not defined in AndroidManifest.xml

 **Note:** Some of the messages shown are really helpful, read them.

So we need to define our “MySecondActivity” in the `AndroidManifest.xml` too. Just after the first `</activity>` tag we write:

```
<activity android:name=".MySecondActivity"
          android:label="@string/app_name">
    <intent-filter>
        <action
            android:name="android.intent.action.VIEW" />
        <category
            android:name="android.intent.category.DEFAULT" />
    </intent-filter>
</activity>
```

This time we did not choose “...MAIN” for `<action>` and “...LAUNCHER” for `<category>` because there is no need to get “MySecondActivity” launched from outside of our Application.



“MySecondActivity” is now reachable through a click to the button, but it also refers to our `main.xml`:

```
setContentView(R.layout.main);
```

So we have to create an additional layout file for “MySecondActivity”. It will contain a so called `EditText` what in Swing jargon would be a `TextField` and another `Button` to return to our “Main”-Activity:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent" >
    <EditText
        android:id="@+id/et_keyword"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"/>
    <Button
        android:id="@+id/btn_return"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:text="Submit" />
</LinearLayout>
```

Of course both need an `android:id` that we can use the in our JavaCode. Now we can change the `setContentView` of “MySecondActivity” to:

```
/* Get the EditText from the XML-file. */
this.et_keyword = (EditText) this.findViewById(R.id.et_keyword);

/* Get the return-Button from the XML-file. */
Button b = (Button) this.findViewById(R.id.btn_return);
/* Make that Button handle clicks to itself. */
b.setOnClickListener(new OnClickListener() {
    public void onClick(View arg0) {
        /* Place code to handle Button-Click here. */
    }
});
```



## Returning values from SubActivities

Returning values from SubActivities to the caller is also very simple:

```
/* Retrieve the Text from the EditText. */
String keyword =
    MySecondActivity.this.et_keyword.getText().toString();
/* The parameters passed to this function
 * will be available to the caller. */
MySecondActivity.this.setResult(1, keyword);
/* Our Activity is done and shall be closed. */
MySecondActivity.this.finish();
```

One could additionally pass a so called `Bundle` back to the caller (*what is more or less a `HashMap`*), but I'll tell you more of that soon.

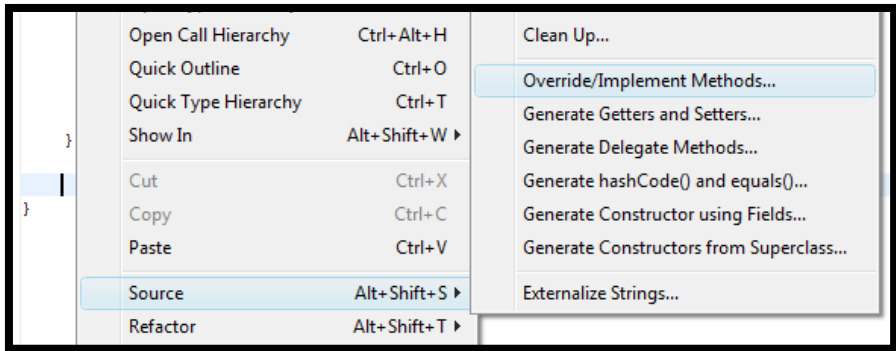
Obviously the caller has to react on the fact that the SubActivity decided to return. To accomplish that, we have to override a single method coming from the Activity class. It is called `onActivityResult(...)`:

```
@Override
protected void onActivityResult(int requestCode, int resultCode,
    String data, Bundle extras) {
    /* Place out code to react on Activity-Result here. */
    super.onActivityResult(requestCode, resultCode, data, extras);
}
```

You probably recognized that the first parameter is called `requestCode` – yes it is the same `requestCode` that we passed to `startSubActivity` earlier. So if we have more than one SubActivity, we can use `requestCode` to differentiate which SubActivity has just returned.

**Tip:** Eclipse provides a very useful function that you'll learn to love, especially if you are extending a base-class and search for methods to override:





Picture 21 Using Eclipse to find methods to override

So now we can simply switch on the `requestCode` and create another Intent to do the Google-search.

```
/* Check which SubActivity returned.
 * (Here we have only one.) */
switch(requestCode) {
    case MYSECONDACTIVITY_REQUESTCODE:
        /* Create a new Intent to
         * show the Google-Search Page
         * with the keyword returned. */
        Intent webIntent = new Intent(
            android.content.Intent.VIEW_ACTION,
            Uri.parse("http://www.google.com/search?q=" + data));
        startActivity(webIntent);
        break;
}
```

As you probably have recognized this time we are creating the Intent another way. Last time we said like: *“We want to start XYZ.class”*, but this time we describe what we want to get done. We want to VIEW a URI (Uniform Resource Indicator), which can be constructed by using i.e. `Uri.fromParts(...)`.

Our Application is now capable of starting a (Sub)Activity, grabbing its results and launching the Browser using an Intent.

But how to pass data to a (Sub)Activity?



## Passing Data to (Sub)Activities

Passing data to (Sub)Activities is, once again, not hard to manage. One can use so called Bundles, which are more or less ordinary HashMap's that can take only trivial data types, to carry information from one Activity to another. Just remember where we started our SubActivity in the last chapter:

```
/* Create an Intent to start
 * MySecondActivity. */
Intent i = new Intent(
    StartingSubactivities.this,
    MySecondActivity.class);
/* Send intent to the OS to make
 * it aware that we want to start
 * MySecondActivity as a SubActivity. */
startSubActivity(i, 0x1337);
```

Right between these two lines, we will put the following:

```
/* Create a bundle which will be
 * attached to the Intent, to carry
 * information to our SubActivity. */
Bundle b = new Bundle();
b.putString(MY_DEFAULTSTRING_ID, "anddev.org");
/* Attach Bundle to our Intent. */
i.putExtras(b);
```

Where MY\_DEFAULTSTRING\_ID can be any identifying String you can imagine. There is also a method Intent.putExtra(...,...) which takes only one information each call, which we could have used also.



Now we have to extract that information within our SubActivity. Every Activity can access the original Intent it was started with, by calling `getIntent()`. If there was a Bundle attached to the Intent we can grab that by using `getIntent().getExtras()`. In this case we, we will fill the `EditText`, where the user would type the keyword(s) with the `DefaultString` we passed over the Intent :

```
//...
setContentView(R.layout.second);

/* Get the Bundle from the Intent
 * this Activity was started with.*/
Bundle bundle = getIntent().getExtras();
/* Extract the default keyword
 * by using the public ID we
 * defined in the caller. */
String default_keyword = bundle.getString(
    StartingSubactivities.MY_DEFAULTSTRING_ID);

/* Get the EditText from the XML-file. */
this.et_keyword = (EditText) this.findViewById(R.id.et_keyword);

/* Set the default keyword to the EditText. */
this.et_keyword.setText(default_keyword);

/* Get the return-Button from the XML-file. */
//...
```

So let's resume what you have learned up to here:

- Create an simple Application using a XML Layout
- Do the same with a Java-based Layout
- Run Android Applications
- Using the LogCat for debugging purpose
- Use Intents to start (Sub)Activities
- Find Views defined in XML to use them in Java Code
- Handle Clicks to Views
- Return values from SubActivities
- Pass data to SubActivities using Bundles

Not bad for now 😊.



## Important Layouts and ViewGroups

Android provides many more Layouts than just the `LinearLayout` we used up to here. The most important Layouts, except `LinearLayout`, you will get to know closer here are:

- `RelativeLayout` (Views are placed relative to each other)
- `TableLayout` (Uses tables like in HTML)

Additionally to that I will introduce to you the following really often used ViewGroups:

- `GridView` (similar to `TableLayout`, supports 'Adapters')
- `ScrollView` (If your content exceeds the screen-size, you'll need to scroll)
- `TabHost` (Displays content in tabs)

## The RelativeLayout

According to its name, when using `RelativeLayouts` one defines the position of Views relative to other 'neighbors-Views'.



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## Lost chapters

### The communities

From the first day on, a couple of communities arose from the depth of the internet. The most important community-website to mention (*depending on Alexa-stats* (3)) is [anddev.org](http://anddev.org) (4) , which is the most viewed Tutorial/Community-Board for Google Android up to date. Also well known are the Community-Boards: [helloandroid.com](http://helloandroid.com) (5) and [androidcommunity.com](http://androidcommunity.com) (6). Last but definitely not least to mention is the [davanum.wordpress.com](http://davanum.wordpress.com)-Blog (7), which provided some very early sample code where many programmers found a good first source.

Some sites were more, some less promising, so sooner or later the viewers pointed their focus to the more-important sites listed above.