
Developing Android Applications
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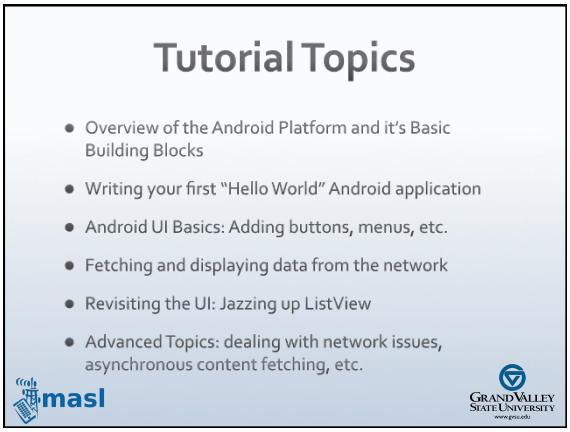
Tutorial Topics
Overview of the Android Platform and it's Basic Building Blocks
Writing your first "Hello World" Android application
Android UI Basics: Adding buttons, menus, etc.
Fetching and displaying data from the network
Revisiting the UI: Jazzing up ListView
Advanced Topics: dealing with network issues, asynchronous content fetching, etc.
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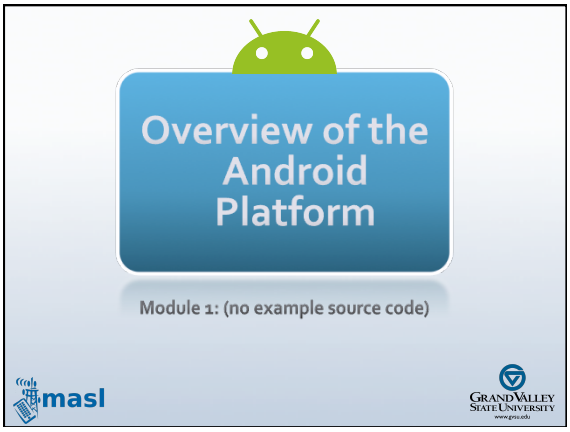
Overview of the Android Platform
Module 1: (no example source code)
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What is Android?

- Android is a software stack for mobile devices that includes an operating system, middleware and key applications.
- Developed and maintained by Google as an open source project.
- Adopted in the past couple of years by many leading mobile device manufacturers as an alternative to existing proprietary and/or commercial software stacks.

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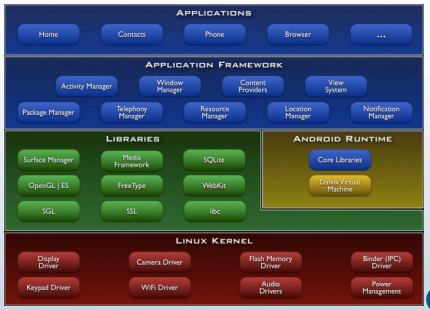
Android's Architecture



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Dalvik Virtual Machine

- Google implements its own VM specifically designed to:
  - Run on slow CPUs
  - Minimize memory footprint
  - Run on an OS with no swap space
  - Be as energy efficient as possible
  - As of Android 2.2 (aka Froyo), JIT compilation is supported, yielding 3x ~ 5x performance boost for compute intensive tasks.

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Dalvik Virtual Machine

- Dalvik is a register-based machine (vs. stack machine)
  - Minimizes instruction dispatch
  - Minimizes memory accesses
  - More efficient consumption of instruction stream (e.g. more semantic info per instruction

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Example #1: Source

```
public static long sumArray(int[] arr) {
    long sum = 0;
    for (int i : arr) {
        sum += i;
    }
    return sum;
}
```

Example taken from Dan Borenstein's 2008 GoogleIO presentation:
http://sites.google.com/site/io/dalvik-vm-internals

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Example #1: .class

```
0000: lconst_0
0001: lstore_1
0002: aload_0
0003: astore_3
0004: aload_3
0005: arraylength
0006: istore 04
0008: iconst_0
0009: istore_05
000b: iload 05          // rl ws
000d: iload 04          // rl ws
000f: if_icmpge 0024    // rs rs
0012: aload_3           // rl ws
0013: iload_05          // rl ws
0015: iaload            // rs rs ws
0016: istore_06         // rs wl
0018: lload_1           // rl rl ws ws
0019: iload_06          // rl ws
001b: i2l               // rs ws ws   (read stack)
001c: ladd              // rs rs rs rs ws ws
001d: lstore_1          // rs rs wl wl   (write stack)
001e: iinc 05, #+01     // rl wl
0021: goto 000b         (read local / write local)
0024: lload_1
0025: lreturn
```

- 25 bytes
- 14 dispatches
- 45 reads
- 16 writes

android

Example #1: .dex

- 18 bytes
- 6 dispatches
- 19 reads
- 6 writes

```
0000: const-wide/16 v0, #long 0
0002: array-length v2, v8
0003: const/4 v3, #int 0
0004: move v7, v3
0005: move-wide v3, v0
0006: move v0, v7
0007: if-ge v0, v2, 0010          // r r
0009: aget v1, v8, v0             // r r w
000b: int-to-long v5, v1          // r w w
000c: add-long/2addr v3, v5       // r r r r w w
000d: add-int/lit8 v0, v0, #int 1 // r w
000f: goto 0007
0010: return-wide v3
```

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Basic Building Blocks (1)

- Activity
  - A representation of a user doing something
  - Usually represents a single screen
  - Can contain one or more views. (A "View" is an Android GUI base class for drawing a rectangle on the screen and handling events within its context.)
  - Created by extending the Android Activity class.
  - Example: display a list of contacts and let the user choose one.

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Basic Building Blocks (2)

- Service
  - An app that doesn't have a user interface.
  - Runs in the background
  - Created by extending the Android Service class.
  - Example: a media player app might keep playing audio even when the app is not in the foreground.

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Basic Building Blocks (3)

- Broadcast Receiver
  - Receive and react to "broadcasts".
  - Don't have a user interface, but can invoke Activities that do.
  - Created by extending the Android BroadcastReceiver class.
  - Example: An application wants to be notified when a photo is taken on the device.

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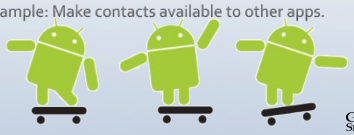
Basic Building Blocks (4)

- Content Provider
  - Make's an application's data available to other apps, and can also be used by the defining app itself.
  - Data is stored on device in a SQLite database, but Android also supports a files system, and preferences for local data storage.
  - Created by extending the Android ContentProvider class.
  - Example: Make contacts available to other apps.



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Android App Fundamentals

- The Android application framework makes it easy to seamlessly reuse functionality of one app in the context of another.
- Android runs each app as a separate Linux process, with its own app specific user id.
- From a user interface perspective, Android manages a stack of active Activities on behalf of the user.

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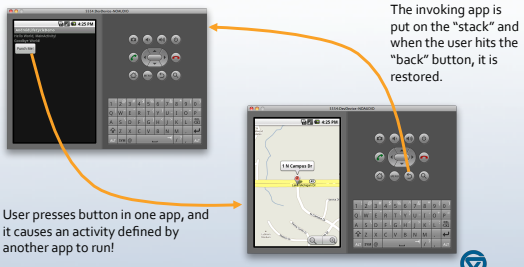
Android's Seamless App Integration (example)



The invoking app is put on the "stack" and when the user hits the "back" button, it is restored.

User presses button in one app, and it causes an activity defined by another app to run!

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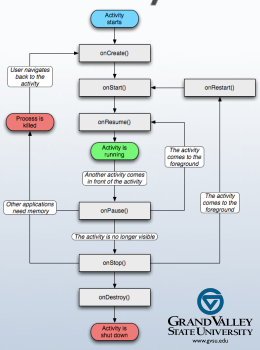
The Android "Activity"

- Apps with a UI consist of 1 or more Activities
- Activities are managed by Android in the "Activity Stack"
- Apps can invoke an Activity defined by another app that was installed separately on the device.



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Android "Intents"

- An "Intent" is an asynchronous message sent from one Activity to another.

Step 1: An activity signals an intent.

Step 2: Android determines which available activity is most appropriate for handling that intent.

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Summary

- In this module we have learned
  - Android background info
  - Basic Android concepts: Activities, Intents, etc.
- In the next module we will:
  - Establish our working Android Dev Environment
  - Write a simple "hello world" app
  - Get familiar with some basic Android Dev tools.

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Writing a "Hello World" App on Android

Module 2: (Refer to source code in the AndroidIntro1 project)

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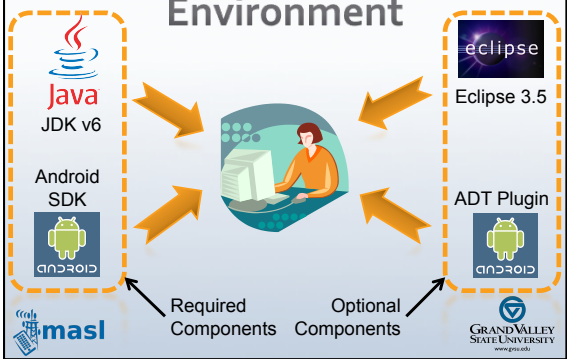
The Android Dev Environment



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Android SDK Quick Start Install Guide Overview

Prep: Make sure you have JDK version 6 and Eclipse 3.5 installed on your computer.

Step 1: Download and install the Android SDK starter package.

Step 2: Install the ADT Eclipse plugin.

Step 3: Add Android platforms and other components using the Android SDK and AVD Manager tool.

See http://developer.android.com/sdk/index.html for details.

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Step 1: Android SDK Starter Package

a) Download the appropriate package for your computer.

Platform	Package	Size	MD5 Checksum
Windows	android-sdk_r05-windows.zip	23449838 bytes	cc2c51a24e2f876e0fa652e182ef5840
Mac OS X (intel)	android-sdk_r05-mac_86.zip	19871714 bytes	6fcfeed0e1c36624c926551637eb3308
Linux (i386)	android-sdk_r05-linux_86.tgz	16208523 bytes	1d695d6a31310406f5d49092a1bd9850

b) Unpack archive contents on your hard disk.

c) Adjust your system's PATH variable (details on next slide)

See http://developer.android.com/sdk/index.html for details.

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Updating your PATH...

Details vary by platform:

- On Linux, edit your `~/.bash_profile` or `~/.bashrc` file. Look for a line that sets the PATH environment variable and add the full path to the `tools/` directory to it. If you don't see a line setting the path, you can add one:

```
export PATH=${PATH}:<your_sdk_dir>/tools
```

- On a Mac OS X, look in your home directory for `.bash_profile` and proceed as for Linux. You can create the `.bash_profile` if you haven't already set one up on your machine.
- On Windows, right-click on My Computer, and select Properties. Under the Advanced tab, hit the Environment Variables button, and in the dialog that comes up, double-click on Path (under System Variables). Add the full path to the `tools/` directory to the path.

See http://developer.android.com/sdk/index.html for details.

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Step 2: Install the ADT Plugin

Eclipse 3.4 (Ganymede)

1. Start Eclipse, then select **Help > Software Updates...**. In the dialog that appears, click the **Available Software** tab.
2. Click **Add Site...**
3. In the Add Site dialog that appears, enter this URL in the "Location" field:

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

   Note: If you have trouble acquiring the plugin, try using "http" in the Location URL, instead of "https" (https is preferred for security reasons).

   Click **OK**.
4. Back in the Available Software view, you should see the plugin listed by the URL, with "Developer Tools" nested within it. Select the checkbox next to Developer Tools and click **Install...**
5. On the subsequent Install window, "Android DDMS" and "Android Development Tools" should both be checked. Click **Next**.
6. Read and accept the license agreement, then click **Finish**.
7. Restart Eclipse.

Eclipse 3.5 (Galileo)

1. Start Eclipse, then select **Help > Install New Software**.
2. In the Available Software dialog, click **Add...**.
3. In the Add Site dialog that appears, enter a name for the remote site (for example, "Android Plugin") in the "Name" field.

   In the "Location" field, enter this URL:

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

   Note: If you have trouble acquiring the plugin, you can try using "http" in the URL, instead of "https" (https is preferred for security reasons).

   Click **OK**.
4. Back in the Available Software view, you should now see "Developer Tools" added to the list. Select the checkbox next to Developer Tools, which will automatically select the nested tools Android DDMS and Android Development Tools. Click **Next**.
5. In the resulting Install Details dialog, the Android DDMS and Android Development Tools features are listed. Click **Next** to read and accept the license agreement and install any dependencies, then click **Finish**.
6. Restart Eclipse.

See http://developer.android.com/sdk/index.html for details.

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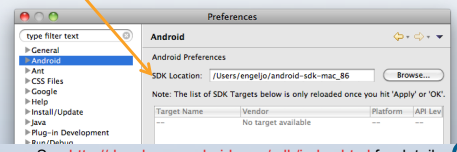
Inform Eclipse of Android SDK...

Once you've successfully downnloaded ADT as described above, the next step is to modify your ADT preferences in Eclipse to point to the Android SDK directory:

1. Select **Window > Preferences...** to open the Preferences panel (Mac OS X: **Eclipse > Preferences**).
2. Select **Android** from the left panel.
3. For the *SDK Location* in the main panel, click **Browse...** and locate your downloaded SDK directory.
4. Click **Apply**, then **OK**.



See http://developer.android.com/sdk/index.html for details.

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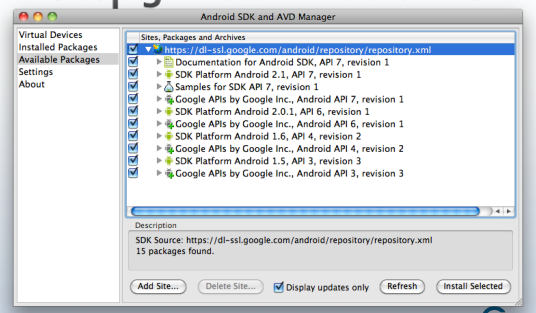
Step 3: Install Platforms



See http://developer.android.com/sdk/index.html for details.

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Creating and running an Android "Hello World" App!

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Summary

- In this module we have:
  - Established our Android Development Environment
  - Wrote our first "hello world" app.
  - Became familiar with the basic anatomy of an Android project.
  - Learned how to emulate and debug Android apps on our desktop computer.
- In the next module we will learn:
  - Android user interface basics.

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Android User Interface Basics

Module 3: (Refer to source code in the AndroidIntro2 project)

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Android Views

- **View**: a data structure whose properties store the layout parameters and content for a specific rectangular area of the screen. Views also serve as a point of interaction for the user and the receiver of the interaction events.
- **ViewGroup**: A specialized View that contains children Views. ViewGroup is a base class of a set of subclasses called *layouts* which call for different types of layout strategies of its children views.

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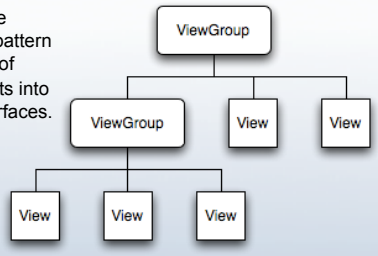
ViewGroup

ViewGroup uses the Composite design pattern to enable grouping of multiple View objects into non-trivial user interfaces.



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Rendering Views

```
public class IntroActivity extends Activity {
    /** Called when the activity is first created. */
    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);

        /* Use res/layout/main.xml as the view of
         * this Activity */
        setContentView(R.layout.main);
    }
}
```

In order to render a "view tree" on the device's screen an Activity must call the setContentView() method.

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Android Layouts

The normal way to create user interfaces in Android apps is to declaratively describe the UI in an XML layout file, though UI's can also be created programmatically in code.

main.xml

```
<?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="@string/hello"
    />
</LinearLayout>
```

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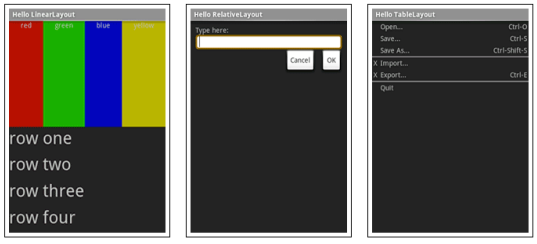
Android Layout Examples

Linear Layout | Relative Layout | Table Layout



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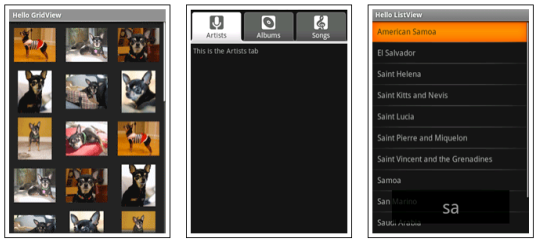
Android Layout Examples

Grid View | Tab Layout | List View



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Android Widgets

- A Widget is a View that serves as an interaction interface to the user. The Android platform defines a number of commonly used widgets, but you can also create your own.
  - Buttons
  - Checkboxes
  - Radio buttons
  - Date picker
  - Text entry fields

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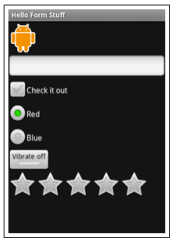
Android Widget Examples

Date Picker

Time Picker

Form Stuff



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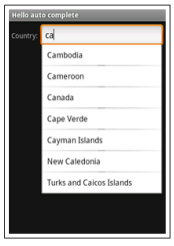
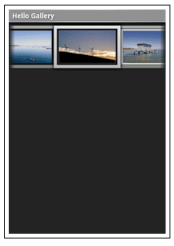
Android Widget Examples

Spinner

Auto Complete



Gallery



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Additional View Examples…

Google Map View

Web View

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Adding an interactive UI

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Summary

- In this module we have learned
  - About basic Android user interface concepts, including views, viewgroups/layouts, widgets.
  - Android UI's are typically specified declaratively in XML files.
  - How to make our demo application more interactive.
- In the next module we will learn:
  - How to fetch and display data in the network using web services.

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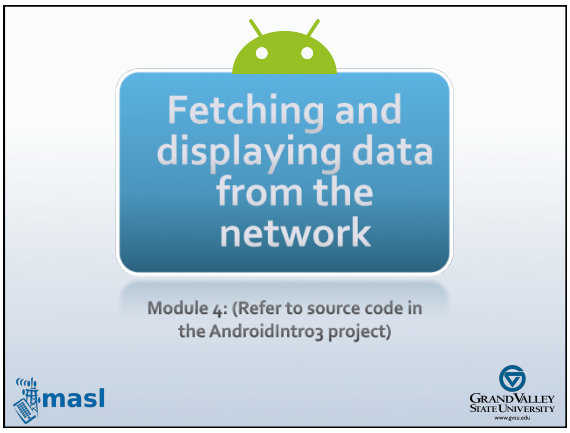

Networked Mobile Apps

- Many of the more interesting mobile apps utilize network connectivity to access data stored in the "cloud". For example:
  - Integrate with online social media.
  - Access metadata relevant to user's current location or to report user's current location for tracking purposes (Yikes!)
  - Sync with game server for multiplayer game experience.

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Challenges

- Accessing data in the network from a mobile device poses a number of challenges:
  - Bandwidth/latency limitations
  - Intermittent service
  - Battery drain
  - Security/Privacy
  - Unanticipated charges for the user?

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Some Guidelines

- Dealing with latency:
  - Make sure UI remains responsive during network access (async fetching)
  - On Android this requires special handling when fetch completes (only UI thread can update the view tree).
- Dealing with intermittent service
  - Make sure the app handles lack of service in a user friendly way.
  - Cache data so some functionality is still offered when there is no service.
- Dealing with battery drain:
  - Limit network access frequency/duration
  - Cache when possible to avoid extraneous access.

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Fetching Tweets from the Network

- Get the Search Key (in the UI thread)
- Get the tweets from the net (in a background thread)
  - TwitterTask + TwitterHelper
- Store the tweets in an internal data structure (JSON Array)
- Populate the ListView from the data structure (in the UI thread)
  - JSONAdapter

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Fetching Tweets!

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Summary

- In this module we have learned
  - About challenges in accessing data in the network from a mobile app.
  - How to fetch tweets via web services in our demo app.
- In the next module we will:
  - Revisit and improve our demo app's user interface.

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Revisiting the UI: Jazzing up ListView

Module 5: (Refer to source code in the AndroidIntro04 project)

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Additional Features

- Specify number of tweets per page
  - http://dev.twitter.com/doc/get/search
- Allow special characters in search key
- Use an XML layout to render ListView items
  - User name + tweet message
  - **Time of creation**
  - Introduce LayoutInflater

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Number of Tweets & Search Key

- Number of tweets
  - IntroActivity.java @ line 91
  - URL to Twitter API **q**=*searchstring*&**rpp**=*50*
- URL encoded Search Key
  - IntroActivity.java @ line 92
  - Uri.encode(*userinputstring*)
  - Uri.encode("**tea party?**") returns "tea%20party%3f"

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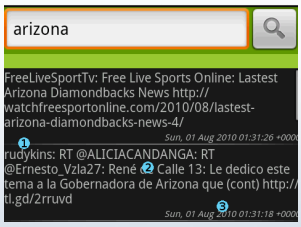
ListView Item



- Username & tweet message [left justified]
- *Creation time [right justified]*

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List Item Layout (XML)

- RelativeLayout
  - Powerful
  - Avoid a hierarchical nesting of LinearLayouts
  - Romain Guy, "Turbo-Charge Your UI", Google I/O 2009
- Attributes to control **relative** placement of views
  - layout_above, layout_below, layout_toLeftOf, layout_toRightOf
  - layout_align{Left, Right, Top, Bottom}
  - layout_ alignParent{Left,Right,Top,Bottom}

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Item.xml

item.xml

```
1  <?xml version="1.0" encoding="utf-8"?>
2  <RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
3      android:layout_width="wrap_content" android:layout_height="wrap_content">
4      <TextView android:layout_height="wrap_content"
5          android:layout_width="wrap_content"
6          android:id="@+id/text" android:text="text" />
7      <TextView android:layout_height="wrap_content" android:id="@+id/created_at"
8          android:text="now" android:textSize="10sp" android:layout_below="@id/text"
9          android:layout_alignParentRight="true" android:textStyle="italic"
10         android:layout_width="wrap_content" />
11 </RelativeLayout>
```

Pay attention to the following attributes:

- android:layout_below="@id/text"
- android:layout_alignParentRight="true"

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item.xml

```
1  <?xml version="1.0" encoding="utf-8"?>
2  <RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
3      android:layout_width="wrap_content" android:layout_height="wrap_content">
4      <TextView android:layout_height="wrap_content"
5          android:layout_width="wrap_content"
6          android:id="@+id/text" android:text="text" />
7      <TextView android:layout_height="wrap_content" android:id="@+id/created_at"
8          android:text="now" android:textSize="10sp" android:layout_below="@id/text"
9          android:layout_alignParentRight="true" android:textStyle="italic"
10         android:layout_width="wrap_content" />
11 </RelativeLayout>
```

FreeLiveSportTv: Free Live Sports Online: Lastest Arizona Diamondbacks News http://watchfreesportonline.com/2010/08/lastest-arizona-diamondbacks-news-4/
Sun, 01 Aug 2010 01:31:26 +0000

rudykins: RT @ALICIACANDANGA: RT @Ernesto_Vzla27: René Calle 13: Le dedico este tema a la Gobernadora de Arizona que (cont) http://tl.gd/2rruvd
Sun, 01 Aug 2010 01:31:18 +0000

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LayoutInflater

- Instantiate a View from its XML definition
  - Invoked automatically by the Android View System when an Activity invokes: setContentView(____)
  - Can be invoked by a user program
    - But, it is a **costly** operation
    - Avoid calling this method, **recycle** the view (when possible)
- IntroActivity.java @ line 170

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Our jazzed up UI!

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Summary

- In this module we have learned
  - How to customize the search results of Twitter queries
  - How to customize each item of a ListView by defining its layout in an XML file
  - Learned how to programmatically inflate views from XML files.
- In the next module we will
  - Handle network errors
  - Force the app to run only in Portrait mode
  - Parse the tweet message for hyperlinks
  - Load user images in background

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Android Advanced Topics

Module 6: (Refer to source code in the AndroidIntro5 project)

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New Features

- Timeout after 5 seconds & cancel the background task
- Parse hyperlinks in a tweet message body
  - TweetAuthor
  - @mentions
  - #hashtags
  - URLs
- Download Tweet user images (in background)

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Adding Timeout Logic

```
OnClickListener ok_handler = new OnClickListener() {
    @Override
    public void onClick(View v) {
        /* hide the soft keyboard */
        im_ctrl.hideSoftInputFromWindow(m_search_key.getWindowToken(), 0);
        TwitterTask twit_task = new TwitterTask();
        try {
            /* get 50 most recent tweets */
            twit_task.execute("?rpp=50&q="
                    + Uri.encode(m_search_key.getText().toString()));
            twit_task.get(5000, TimeUnit.MILLISECONDS);
        }
        catch (Exception e)
        {
            twit_task.cancel(true);
            Toast.makeText(getApplicationContext(), "Unable to connect",
                Toast.LENGTH_LONG).show();
        }
    }
);
```

IntroActivity.java 117-135 (commit c27e6)

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Parsing Twitter Hyperlinks

- Convert plain text to Twitter hyperlinks
- Example given for @mentions. [*Similar technique applies to other hyperlinks*]
  - Input: Hello @bhambhoo. What's up?
  - Output: Hello http://twitter.com/bhambhoo. What's up?
- Java classes & methods
  - Pattern ("regex"s) to match the input string
  - Linkify.TransformFilter an interface that defines the abstract method "transformUrl()"
  - Linkify.addLinks: insert hyperlinks into a TextView

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How do they work?

- Define a regular expression for Twitter @mentions
  - IntroActivity.java : **line 58**
- Define replacement (output) string
  - IntroActivity.java: **line 67 [line 70]**
- Define a TransformFilter that removes the "@"
  - IntroActivity.java: **lines 174-182 [lines 179-185]**
- Transform the plain input text and insert the transformed text to the current textview
  - IntroActivity.java **line 234 [line 251]**

[commit fa7e]
[commit c27e]

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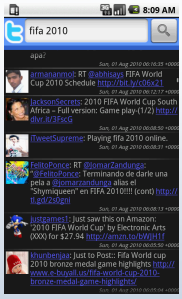
Displaying User Images



- Load all textual data in one HTTP request
- Load the images on demand (and do it in background)
  - JSONAdapter::getView()
- Use an internal cache
  - make an HTTP request only when the requested image is not found in the cache

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How to do it fast?

- Add an ImageView into item.xml
- Introduce ImageWorker.java
  - ASyncTask for downloading images
  - notifyDataSetChanged()
- Improve JSONAdapter with ViewHolder for caching list item views.
- Detail in IntroActivity.java
  - lines **199-202**, lines **232-236**, lines **256-258**

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Summary

- In this module we have learned
  - How to use a timer to cancel an AsyncTask
  - How to use the Linkify class to parse and convert Twitter hyperlinks
  - How to use an AsyncTask to download images in background and use this technique in conjunction with an internal image cache and ListView item tags

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Our final "polished" app!

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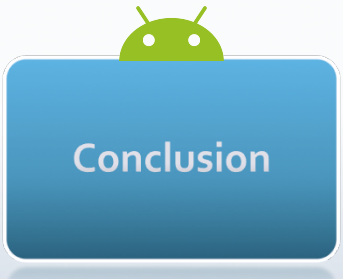

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- GVSU Mobile Apps & Services Lab
  - http://masl.cis.gvsu.edu

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Android Resources

- http://www.android.com - the official Android site where you can get the SDK, documentation, sample code, official source code, etc.
- http://code.google.com/events/io/2010/ - archives from the recent Google IO conference. Lot's of useful up-to-date material in the Android tracks.
- http://masl.cis.gvsu.edu - the Mobile Applications & Services Lab in GVSU's School of Computing. Our tutorial viewgraphs and sample source will be available here for download.

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