

Mobile Application Development

Produced
by

David Drohan (ddrohan@wit.ie)

Department of Computing & Mathematics
Waterford Institute of Technology

<http://www.wit.ie>



Waterford Institute of Technology
INSTITIÚID TEICNEOLAÍOCHTA PHORT LÁIRGE





Android Multithreading & Networking





Agenda & Goals

- Be aware of the different approaches to Multithreading and Networking in Android Development
- Be able to work with **AsyncTasks** and **Volley** to execute background tasks and make API calls



Data Storage Solutions *

❑ Shared Preferences

- Store private primitive data in key-value pairs.

❑ Internal Storage

- Store private data on the device memory.

❑ External Storage

- Store public data on the shared external storage.

❑ SQLite/Realm Databases

- Store data in a private database.

❑ Network Connection

- Store data on the web with your own network server.



CoffeeMate.6a.0

Multithreading, AsyncTasks & Volley



Background Processes in General

- ❑ One of the key features of Android (and iPhone) is the ability to run things in the background
 - Threads
 - ◆ Run something in the background while user interacts with UI
 - Services
 - ◆ Regularly or continuously perform actions that don't require a UI



Threads

- ❑ Recall that Android ensures responsive apps by enforcing a 5 second limit on Activities
- ❑ Sometimes we need to do things that take longer than 5 seconds, or that can be done while the user does something else
- ❑ Activities, Services, and Broadcast Receivers run on the *main application thread*
- ❑ But we can start background/child threads to do other things for us



Android Thread Constraints

- ❑ Child threads *cannot* access UI elements (views); these elements must (and can only) be accessed through the main thread
- ❑ So what do you do?
 - You pass results to the main thread and let it use the results

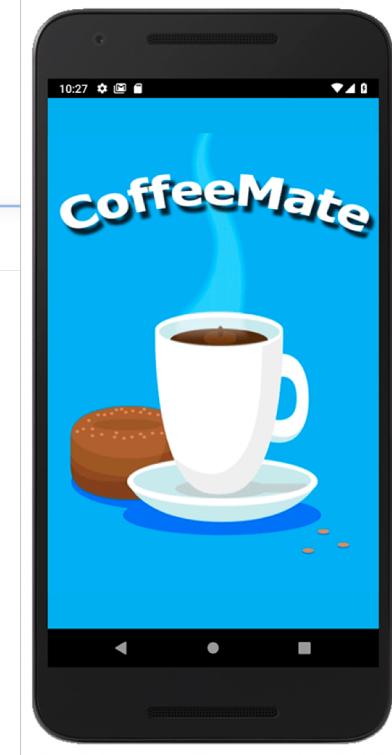


Multithreading – Our Splash Screen

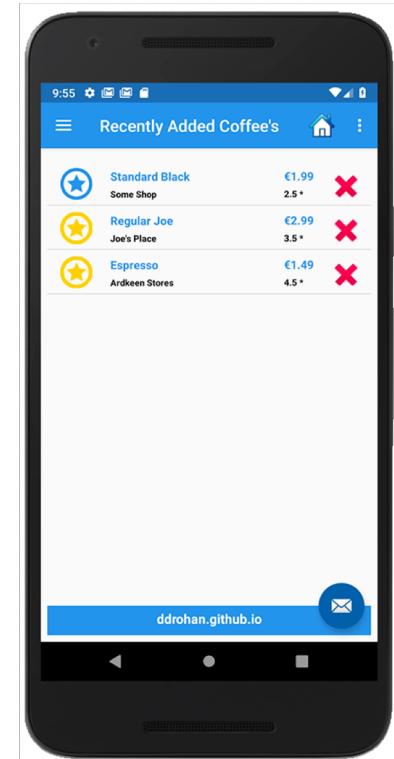
```
Handler handler = new Handler();
// run a thread after 3 seconds to start the home screen
handler.postDelayed(new Runnable() {

    @Override
    public void run() {
        // make sure we close the splash screen so the user
        // won't come back to it if back key pressed
        finish();

        if (!mIsBackPressed) {
            // start the home screen if the back button wasn't pressed already
            Intent intent = new Intent(Splash.this, Home.class);
            Splash.this.startActivity(intent);
        }
    }
}, SPLASH_DURATION); // time in milliseconds to delay call to run()
```



3 secs later





Using the `AsyncTask` class

<http://developer.android.com/reference/android/os/AsyncTask.html>

- ❑ The `AsyncTask` class allows to perform background operations and publish results on the UI thread without having to manipulate threads and/or handlers.
- ❑ An asynchronous task is defined by a computation that runs on a background thread and whose result is published on the UI thread.
- ❑ An asynchronous task is defined by

3 Generic Types	4 Main States	1 Auxiliary Method
Params, Progress, Result	onPreExecute, doInBackground, onProgressUpdate onPostExecute.	publishProgress



Using the `AsyncTask` class

`AsyncTask <Params, Progress, Result>`

AsyncTask's generic types

Params: the type of the input parameters sent to the task at execution.

Progress: the type of the progress units published during the background computation.

Result: the type of the result of the background computation.

❑ Not all types are always used by an asynchronous task. To mark a type as unused, simply use the type **Void**

Note:

Syntax “`String ...`” indicates (Varargs) array of String values, similar to “`String[]`”



Using the `AsyncTask` class

- ❑ `onPreExecute`
 - is invoked before the execution.
- ❑ `onPostExecute`
 - is invoked after the execution.
- ❑ `doInBackground`
 - the main operation. Write your heavy operation here.
- ❑ `onProgressUpdate`
 - Indication to the user on the current progress. It is invoked every time `publishProgress()` is called.

Using the AsyncTask class *



```
private class MyAsyncTask extends AsyncTask<String, Void, Bitmap> {  
    protected void onPreExecute() {  
        // Runs on the UI thread before doInBackground  
        // Good for toggling visibility of a progress indicator  
        progressBar.setVisibility(ProgressBar.VISIBLE);  
    }  
  
    protected Bitmap doInBackground(String... strings) {  
        // Some long-running task like downloading an image.  
        Bitmap = downloadImageFromUrl(strings[0]);  
        return someBitmap;  
    }  
  
    protected void onProgressUpdate(Progress... values) {  
        // Executes whenever publishProgress is called from doInBackground  
        // Used to update the progress indicator  
        progressBar.setProgress(values[0]);  
    }  
  
    protected void onPostExecute(Bitmap result) {  
        // This method is executed in the UIThread  
        // with access to the result of the long running task  
        imageView.setImageBitmap(result);  
        // Hide the progress bar  
        progressBar.setVisibility(ProgressBar.INVISIBLE);  
    }  
}
```

1

2

3

4



Using the `AsyncTask` class

AsyncTask's methods

`onPreExecute()`, invoked on the UI thread immediately after the task is executed. This step is normally used to setup the task, for instance by showing a progress bar in the user interface.

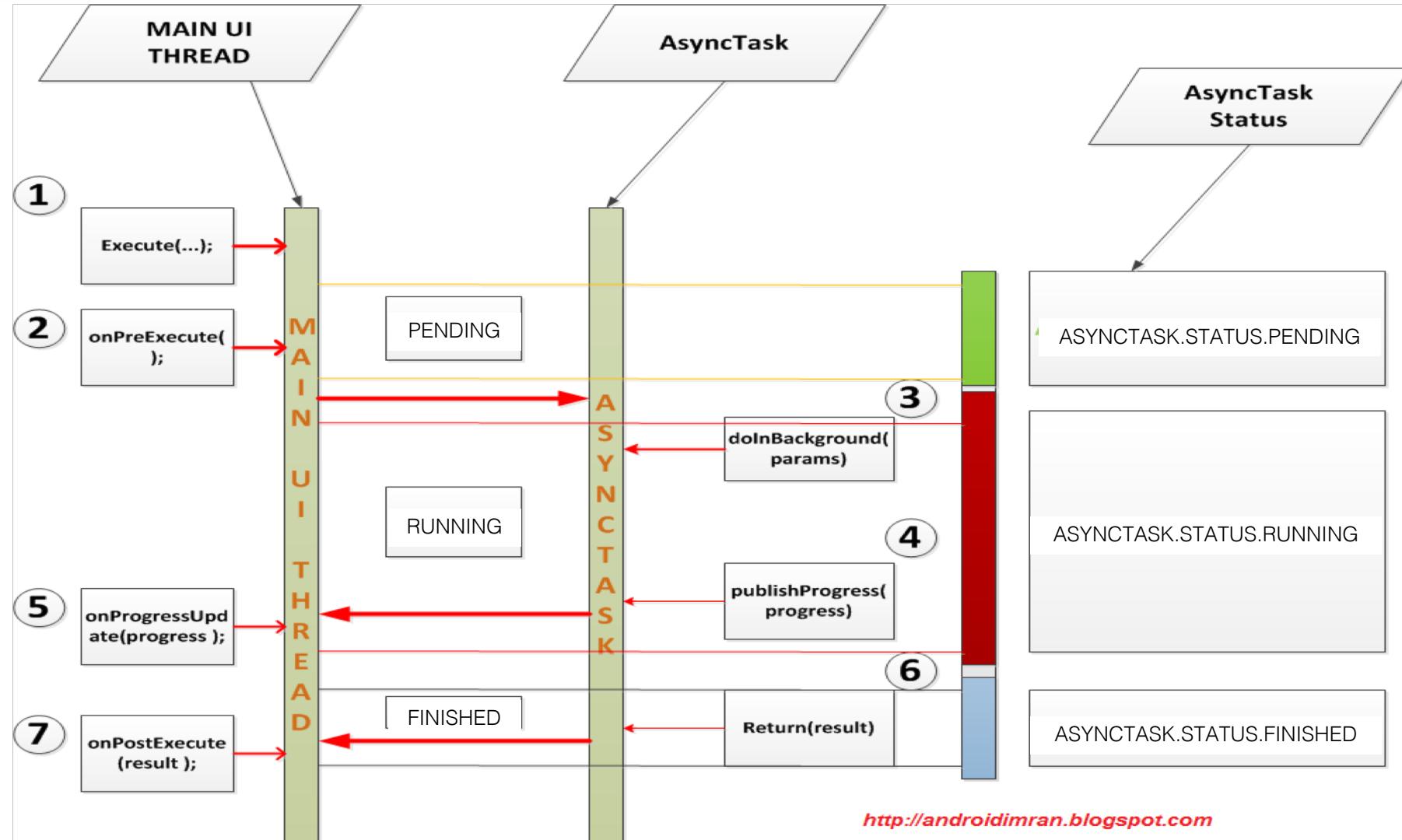
`doInBackground(Params...)`, invoked on the background thread immediately after `onPreExecute()` finishes executing. This step is used to perform background computation that can take a long time. The parameters of the asynchronous task are passed to this step. The result of the computation must be returned by this step and will be passed back to the last step. This step can also use `publishProgress(Progress...)` to publish one or more units of progress. These values are published on the UI thread, in the `onProgressUpdate(Progress...)` step.

`onProgressUpdate(Progress...)`, invoked on the UI thread after a call to `publishProgress(Progress...)`. The timing of the execution is undefined. This method is used to display any form of progress in the user interface while the background computation is still executing. For instance, it can be used to animate a progress bar or show logs in a text field.

`onPostExecute(Result)`, invoked on the UI thread after the background computation finishes. The result of the background computation is passed to this step as a parameter.



AsyncTask Lifecycle





A Little bit about CoffeeMate & Googles Gson



Google's Gson

<https://sites.google.com/site/gson/gson-user-guide>

Gson is a Java library that can be used to convert Java Objects into their JSON representation. It can also be used to convert a JSON string to an equivalent Java object. Gson is an open-source project hosted at <http://code.google.com/p/google-gson>.

Gson can work with arbitrary Java objects including pre-existing objects that you do not have source-code of.



CoffeeMate & Google's Gson

- To create a POJO **from** a JSON String we can do something like this (**.fromJson()**)

```
// Result handling
Coffee result = null;
Type objType = new TypeToken<Coffee>(){}.getType();
result = new Gson().fromJson(response, objType);
```

- To convert a POJO **to** a JSON String we can do something like this (**.toJson()**)

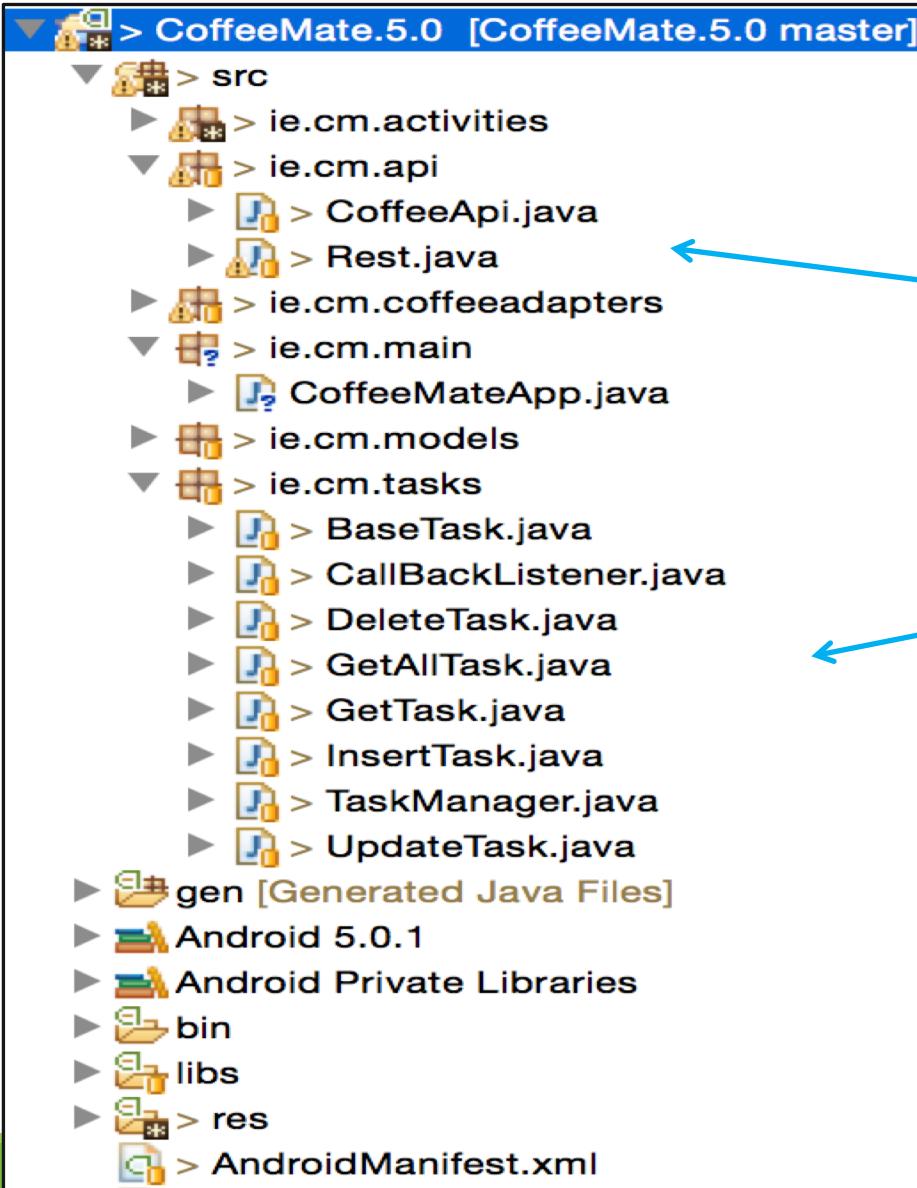
```
Type objType = new TypeToken<Coffee>(){}.getType();
String json = new Gson().toJson(aCoffee, objType);
```



CoffeeMate Example (Using AsyncTasks)



CoffeeMate using AsyncTasks (and more)



- api classes for calling REST service
- AsyncTasks for CRUD
(and callback mechanism to update UI)

See Appendix for
CoffeeMate Version using
AsyncTasks



Android Networking (Using Volley)



Volley is an HTTP library developed by Google that makes networking for Android apps easier and most importantly, faster. Volley is available through the open [AOSP repository](#).

Introduced during Google I/O 2013, it was developed because of the absence, in the Android SDK, of a networking class capable of working without interfering with the user experience.



Volley

☐ Volley offers the following benefits:

- Automatic scheduling of network requests.
- Multiple concurrent network connections.
- Transparent disk and memory response caching with standard HTTP [cache coherence](#).
- Support for request prioritization.
- Cancellation request API. You can cancel a single request, or you can set blocks or scopes of requests to cancel.
- Ease of customization, for example, for retry and backoff.
- Strong ordering that makes it easy to correctly populate your UI with data fetched asynchronously from the network.
- Debugging and tracing tools.



Why Volley?

❑ Avoid `HttpURLConnection` and `HttpClient`

- On lower API levels (mostly on Gingerbread and Froyo), `HttpURLConnection` and `HttpClient` are far from being perfect. There are some [known issues](#) and [bugs](#) that were never fixed.
- Moreover, `HttpClient` was [deprecated](#) in the last API update (API 22), which means that it will no longer be maintained and may be removed in a future release.
- These are sufficient reasons for deciding to switch to a more reliable way of handling your network requests.



Why Volley?

❑ Avoid **AsyncTask**

- Since the introduction of Honeycomb (API 11), it's been mandatory to perform network operations on a separate thread, different from the main thread. This substantial change led the way to massive use of the **AsyncTask<Params, Progress, Result>** specification.
- The class is pretty straightforward, way easier than the implementation of a **service**, and comes with a ton of examples and documentation.
- The main problem (next slide), however, is the serialization of the calls. Using the **AsyncTask** class, you can't decide which request goes first and which one has to wait. Everything happens FIFO, first in, first out.



Problem Solved...

- ❑ The problems arise, for example, when you have to load a list of items that have attached a thumbnail. When the user scrolls down and expects new results, you can't tell your activity to first load the JSON of the next page and only then the images of the previous one. This can become a serious user experience problem in applications such as Facebook or Twitter, where the list of new items is more important than the thumbnail associated with it.
- ❑ Volley aims to solve this problem by including a powerful cancellation API. You no longer need to check in **onPostExecute** whether the activity was destroyed while performing the call. This helps avoiding an unwanted **NullPointerException**.



Why Volley?

❑ It's Much Faster

- Some time ago, the Google+ team did a series of performance tests on each of the different methods you can use to make network requests on Android. Volley got a score up to ten times better than the other alternatives when used in RESTful applications.

❑ Small Metadata Operations

- Volley is perfect for small calls, such as JSON objects, portions of lists, details of a selected item, and so on. It has been devised for RESTful applications and in this particular case it gives its very best.



Why Volley?

□ It Caches Everything

- Volley automatically caches requests and this is something truly life-saving. Let's return for a moment to the example given earlier. You have a list of items—a JSON array let's say—and each item has a description and a thumbnail associated with it. Now think about what happens if the user rotates the screen: the activity is destroyed, the list is downloaded again, and so are the images. Long story short, a significant waste of resources and a poor user experience.
- Volley proves to be extremely useful for overcoming this issue. It **remembers** the previous calls it did and handles the activity destruction and reconstruction. It caches everything without you having to worry about it.



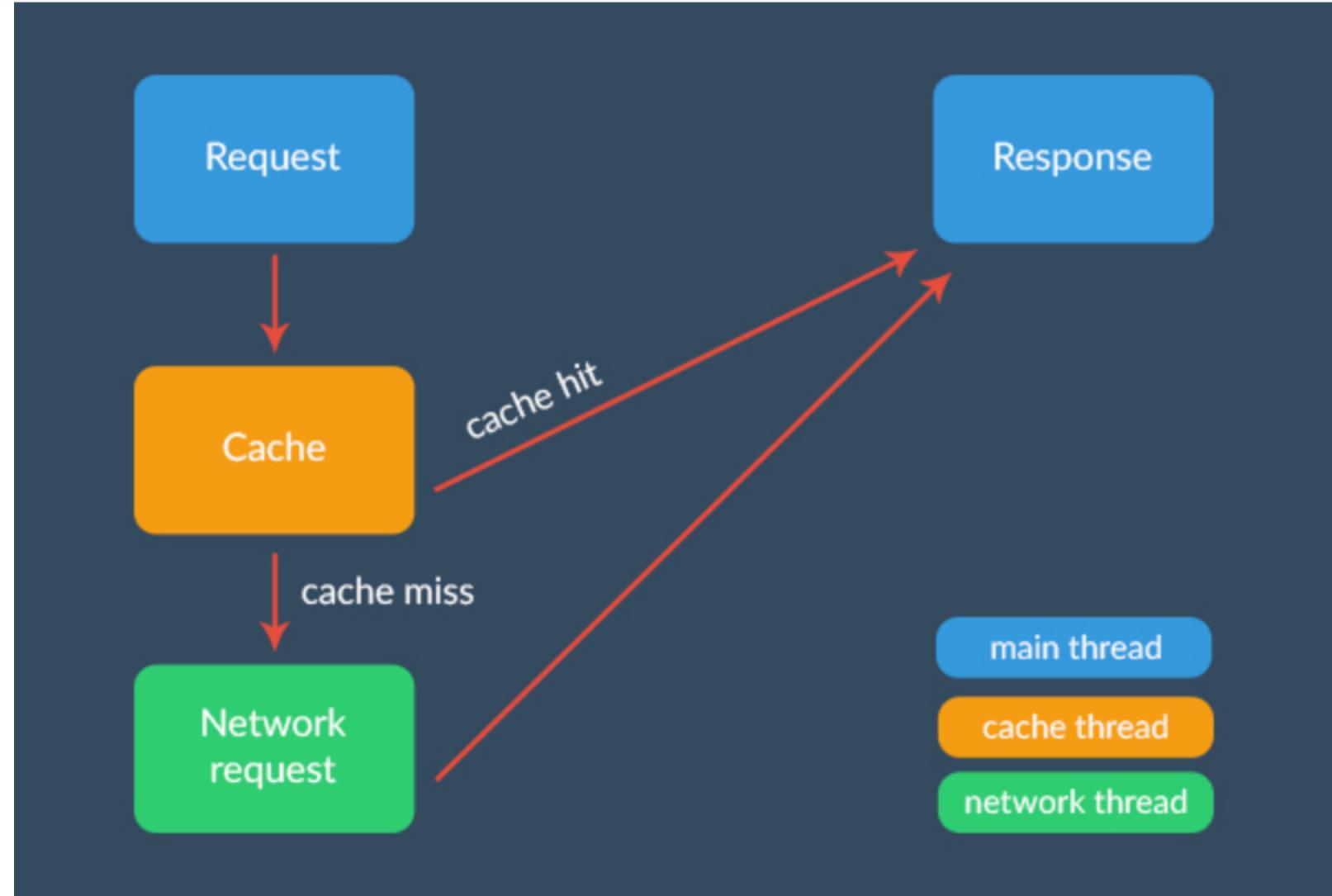
Why Not Volley?

- ❑ It is not so good, however, when employed for streaming operations and large downloads. Contrary to common belief, Volley's name doesn't come from the sport dictionary. It's rather intended as repeated bursts of calls, grouped together. It's somehow intuitive why this library doesn't come in handy when, instead of a volley of arrows, you want to fire a cannon ball.



Under the Hood

- ❑ Volley works on three different levels with each level operating on its own thread.





Under the Hood

❑ Main Thread

- On the main thread, consistently with what you already do in the **AsyncTask** specification, you are only allowed to fire the request and handle its response. Nothing more, nothing less.
- The main consequence is that you can actually ignore everything that was going on in the **doInBackground** method. Volley automatically manages the HTTP transactions and the catching network errors that you needed to care about before.



Under the Hood

❑ Cache and Network Threads

- When you add a request to the queue, several things happens under the hood. First, Volley checks if the request can be serviced from cache. If it can, the cached response is read, parsed, and delivered. Otherwise it is passed to the network thread.
- On the network thread, a round-robin with a series of threads is constantly working. The first available network thread dequeues the request, makes the HTTP request, parses the response, and writes it to cache. To finish, it dispatches the parsed response back to the main thread where your listeners are waiting to handle the result.



Getting Started With Volley

❑ Add dependency

- `implementation 'com.android.volley:volley:1.1.1'`

OR

❑ Download the Volley Source

- `git clone https://github.com/google/volley`

❑ Import Source as **Module**

- File -> New Module, choose Import Existing Project
- Add dependency `compile project(':volley')`



Using Volley

- ❑ Volley mostly works with just two classes, **RequestQueue** and **Request**. You first create a **RequestQueue**, which manages worker threads and delivers the parsed results back to the main thread. You then pass it one or more **Request** objects.

- ❑ The **Request** constructor always takes as parameters the method type (GET, POST, etc.), the **URL of the resource**, and **event listeners**. Then, depending on the type of request, it may ask for some more variables.



Using Volley *

- Here we create a **RequestQueue** object by invoking one of Volley's convenience methods, **Volley.newRequestQueue**. This sets up a **RequestQueue** object, using default values defined by Volley.
- As you can see, it's incredibly straightforward. You create the request and add it to the request queue. And you're done.
- If you have to fire multiple requests in several activities, you should avoid using this approach - better to instantiate one shared request queue and use it across your project (**CoffeeMate 5.0**)

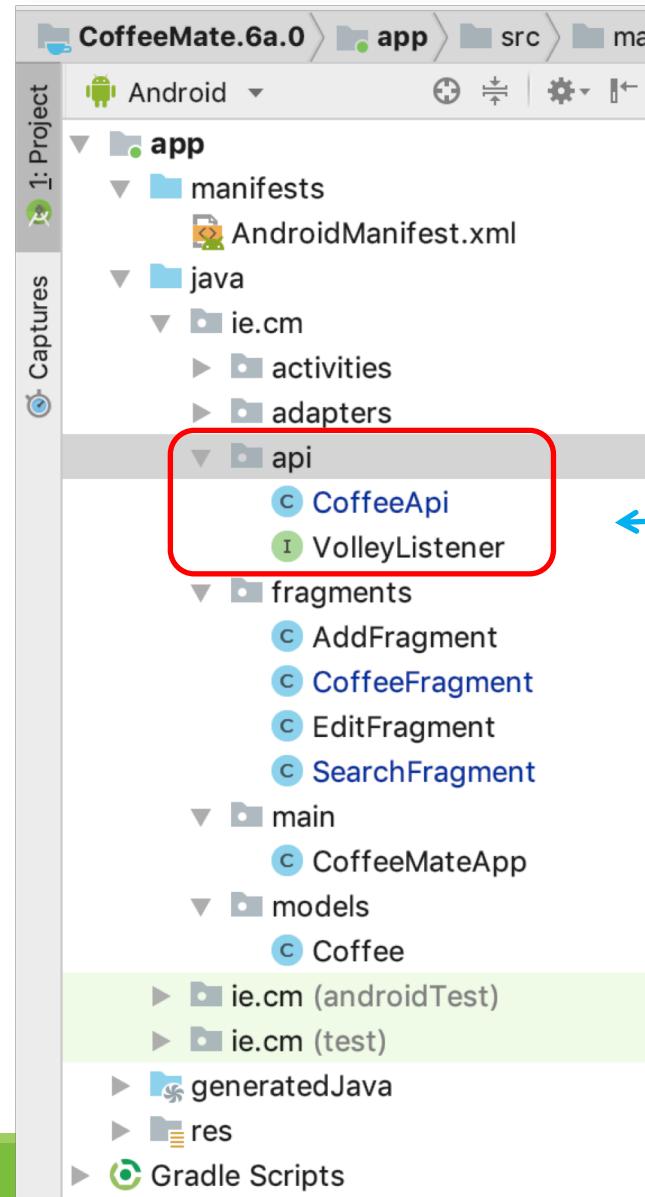
```
String url = "http://httpbin.org/html";  
  
// Request a string response  
StringRequest stringRequest = new StringRequest(Request.Method.GET, url,  
        new Response.Listener<String>() {  
            @Override  
            public void onResponse(String response) {  
  
                // Result handling  
                System.out.println(response.substring(0,100));  
            }  
        }, new Response.ErrorListener() {  
            @Override  
            public void onErrorResponse(VolleyError error) {  
  
                // Error handling  
                System.out.println("Something went wrong!");  
                error.printStackTrace();  
            }  
    );  
  
// Add the request to the queue  
Volley.newRequestQueue(this).add(stringRequest);
```



CoffeeMate Example (Using Volley)



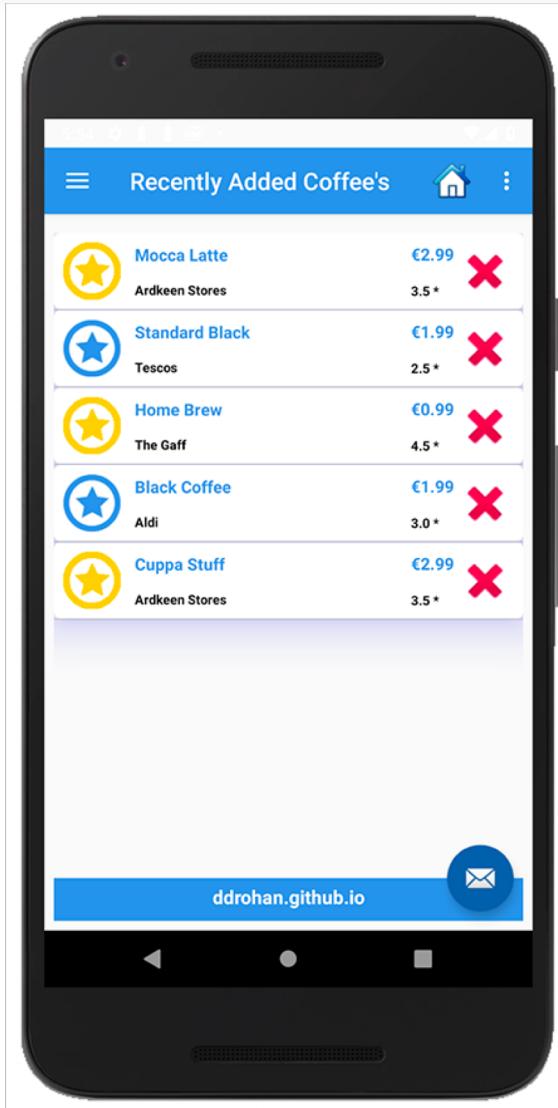
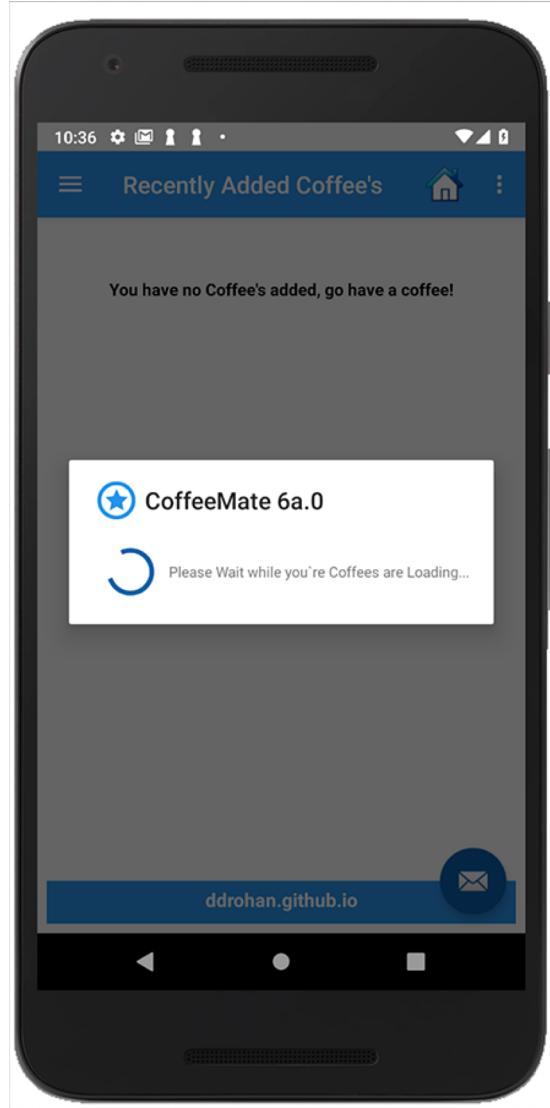
CoffeeMate 6a.0 API & Callback Interface



- api class for calling REST service
- callback mechanism to update UI



CoffeeMate 6a.0 & Volley



```
@Override  
public void onAttach(Context context)  
{  
    super.onAttach(context);  
    this.activity = (Base) context;  
    CoffeeApi.attachListener(this);  
    CoffeeApi.attachDialog(activity.loader);  
  
    public void onCreate(Bundle savedInstanceState)  
{  
    super.onCreate(savedInstanceState);  
    CoffeeApi.get("/coffees");  
}
```

- Here we ‘attach’ our **VolleyListener** to the Fragment (**CoffeeFragment**) and then **get()** all of the coffees.
- This **get()** method triggers a call to **setList()** via the callback interface, and then updates the UI via **updateUI()** ONLY when our API call completes.

```
@Override  
public void setList(List list) {  
    Base.app.coffeeList = list;  
}
```

- We use a similar approach for Updating, Deleting etc.

CoffeeApi – using Volley *



```
public class CoffeeApi {  
  
    private static final String hostURL = "http://coffeemate-nodeserver.herokuapp.com";  
    private static final String LocalhostURL = "http://192.168.0.13:3000";  
    private static VolleyListener vListener;  
    private static AlertDialog loader;  
  
    public static void attachListener(VolleyListener fragment) { vListener = fragment; }  
    public static void detachListener() { vListener = null; }  
    public static void attachDialog(AlertDialog aloader) { loader = aloader; }  
    public static int FLAG;  
  
    public static void get(String url) {  
        showLoader("Downloading Coffee Data...");  
        JsonObjectRequest gsonRequest = new JsonObjectRequest(Request.Method.GET, hostURL + url, null,  
            new Response.Listener<JSONObject>() {  
                @Override  
                public void onResponse(JSONObject response) {  
                    try { FLAG = response.getInt("status"); }  
                    catch (JSONException e) { e.printStackTrace(); }  
                    // Result handling  
                    List<Coffee> result = null;  
                    Type collectionType = new TypeToken<List<Coffee>>(){}.getType();  
                    try { result = new Gson().fromJson(response.getString("data"), collectionType); }  
                    catch (JSONException e) { e.printStackTrace(); }  
  
                    if(FLAG == 99)vListener.setList(result); //99 indicates a 'GetAll' on Server  
                    vListener.setCoffee(result.get(0));  
                    vListener.updateUI((Fragment)vListener);  
                    hideLoader();  
                }  
            }, new Response.ErrorListener() {  
                @Override  
                public void onErrorResponse(VolleyError error) {  
                    System.out.println("Something went wrong!");  
                    error.printStackTrace();  
                }  
        );  
  
        // Add the request to the queue  
        Base.app.add(gsonRequest);  
    }  
}
```

- Here we create a **JsonObjectRequest** **GET** request.
- On a successful **RESPONSE** we convert the result into a List of coffees and
- Trigger the callback to set the list in the 'attached' fragment

```
@Override  
public void setList(List list) {  
    Base.app.coffeeList = list;  
}
```



CoffeeFragment (Extracts) *

```
public class CoffeeFragment extends Fragment implements  
    AdapterView.OnItemClickListener, View.OnClickListener,  
    AbsListView.MultiChoiceModeListener, VolleyListener  
  
{@Override  
    public void onAttach(Context context)  
{  
    super.onAttach(context);  
    this.activity = (Base) context;  
    CoffeeApi.attachListener(this);  
    CoffeeApi.attachDialog(activity.loader);  
}  
  
{@Override  
    public void onCreate(Bundle savedInstanceState)  
{  
    super.onCreate(savedInstanceState);  
    CoffeeApi.get("/coffees");  
}
```

Overriding the necessary
methods from the
interface

```
public class CoffeeFragment extends Fragment implements  
    AdapterView.OnItemClickListener, View.OnClickListener,  
    AbsListView.MultiChoiceModeListener, VolleyListener
```

```
@Override  
    public void setList(List list) {  
        Base.app.coffeeList = list;  
    }  
  
    @Override  
    public void updateUI(Fragment fragment) {  
        fragment.onResume();  
        checkSwipeRefresh(v);  
    }  
}
```



EditFragment (Extracts) *

```
public class EditFragment extends Fragment implements VolleyListener {  
  
    @Override  
    public void onAttach(Context context) {  
        super.onAttach(context);  
        CoffeeApi.attachListener(this);  
        if (context instanceof OnFragmentInteractionListener) {  
            mListener = (OnFragmentInteractionListener) context;  
        } else {  
            throw new RuntimeException(context.toString()  
                + " must implement OnFragmentInteractionListener");  
        }  
    }  
  
    @Override  
    public void onCreate(Bundle savedInstanceState)  
    {  
        super.onCreate(savedInstanceState);  
        app = (CoffeeMateApp) getActivity().getApplication();  
  
        if(getArguments() != null)  
            CoffeeApi.get("/coffees/" + getArguments().getString("coffeeId"));  
    }  
  
    @Override  
    public void setList(List list) {  
        app.coffeeList = list;  
    }  
  
    @Override  
    public void setCoffee(Coffee coffee) {  
        aCoffee = coffee;  
    }  
}
```



CoffeeMate 6a.0 – Using AsyncTasks Vs Volley

❑ Using AsyncTasks

- CoffeeApi
- CallBackListener
- Rest
- TaskManager
- CRUD Tasks x 6

❑ Total = 10 Classes

❑ Using Volley

- CoffeeApi
- VolleyListener

❑ Total = 2 Classes

See Appendix for CoffeeMate Version using AsyncTasks



Summary

- ❑ We looked at data persistence and multithreading in Android Development and how to use an SQLite database
- ❑ We covered a brief overview of JSON & Googles Gson
- ❑ We covered in detail the use of **AsyncTasks** and **Volley** to execute background tasks and make API calls
- ❑ We Compared the two in our CoffeeMate Case Study



References

- ❑ Victor Matos Notes – Lesson 13 (Cleveland State University)
- ❑ Android Developers
<http://developer.android.com/index.html>
- ❑ <http://code.tutsplus.com/tutorials/an-introduction-to-volley--cms-23800>



Questions?





Appendix

- ❑ Multithreading Overview
- ❑ CoffeeMate Version using AsyncTasks
- ❑ Using a Splash & Login Screen
- ❑ Files
- ❑ Content Providers
- ❑ REST

- ❑ And a bit on Bundles...



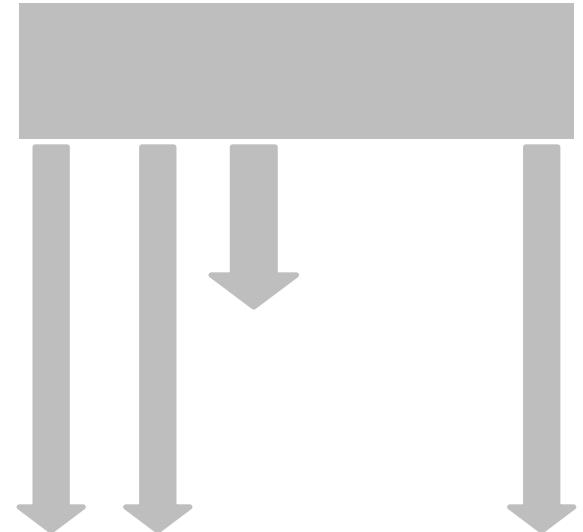
Multithreading Overview



Threads

<http://developer.android.com/reference/java/lang/Thread.html>

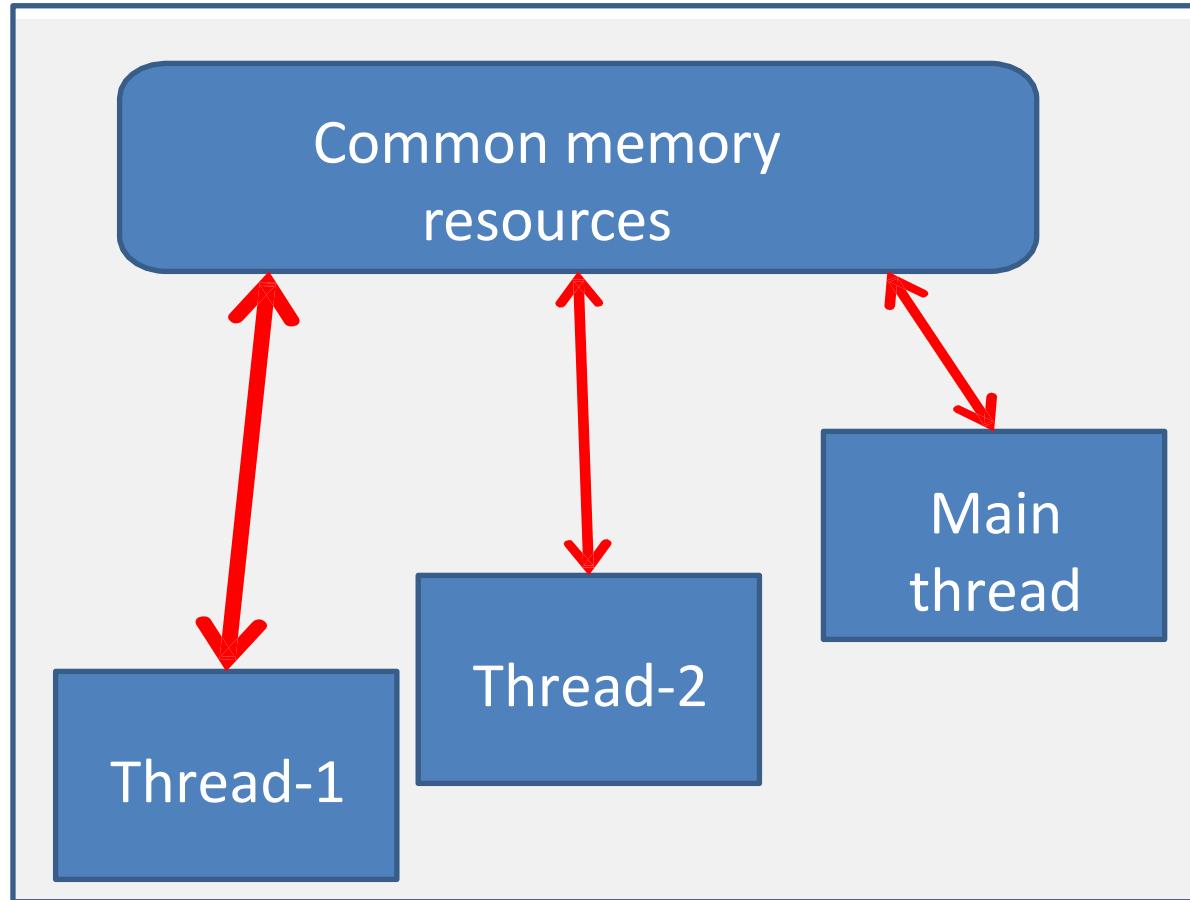
- ❑ A Thread is a concurrent unit of execution.
- ❑ Each thread has its own call stack. The call stack is used on method calling, parameter passing, and storage for the called method's local variables.
- ❑ Each virtual machine instance has at least one main thread.
- ❑ Threads in the same VM interact and synchronize by the use of shared objects and monitors associated with these objects.



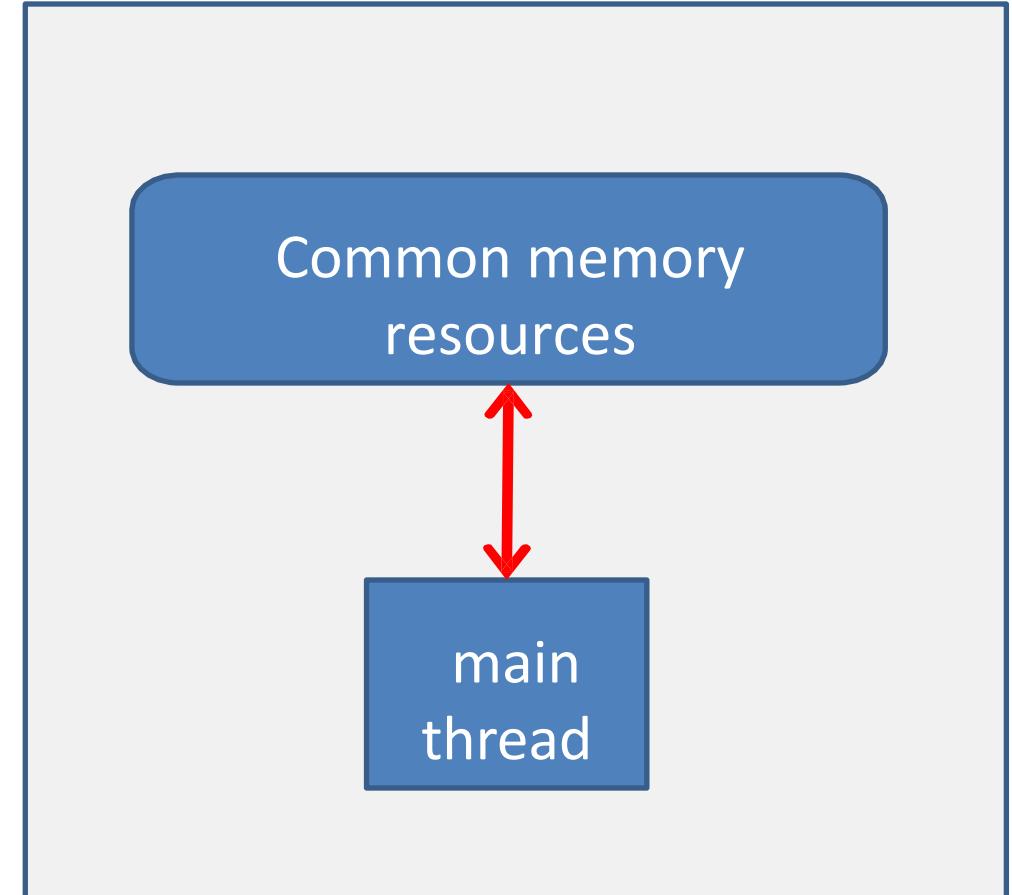


Threads

Process 1 (Virtual Machine 1)



Process 2 (Virtual Machine 2)





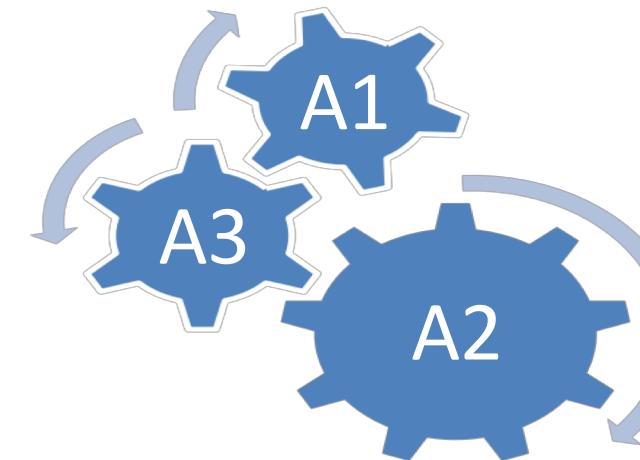
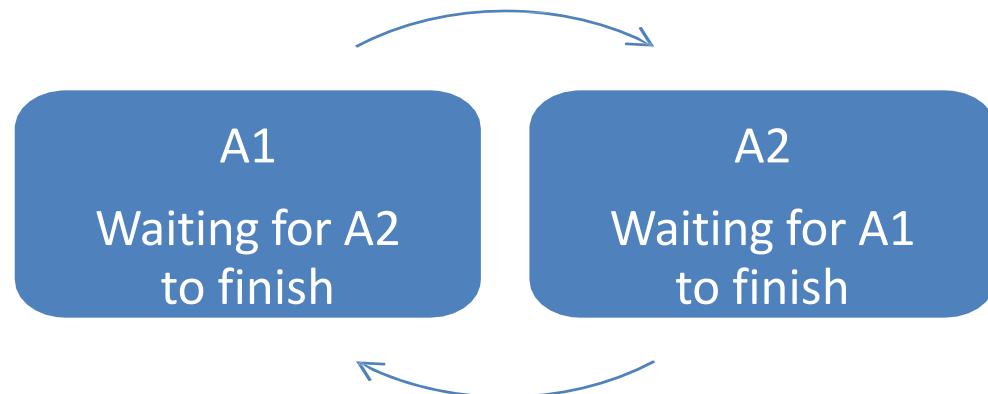
Advantages of Multithreading

- ❑ Threads share the process' resources but are able to execute independently.
- ❑ Applications responsibilities can be separated
 - main thread runs UI, and
 - slow tasks are sent to background threads.
- ❑ Threading provides an useful abstraction of *concurrent* execution.
- ❑ A multithreaded program operates *faster* on computer systems that have *multiple CPUs*.
(Java 8 supports multi-core multi-threading)



Disadvantages

- Code tends to be more complex
- Need to detect, avoid, resolve deadlocks





Android's Approach to Slow Activities

Problem: An application may involve a time-consuming operation.

Goal: We want the **UI** to be responsive to the user in spite of heavy load.

Solution: Android offers two ways for dealing with this scenario:

1. Do expensive operations in a background **service**, using *notifications* to inform users about next step

2. Do the slow work in a **background thread**.

Using Threads: Interaction ***between*** Android threads is accomplished using

- (a) a main thread **Handler** object and
- (b) posting **Runnable** objects to the main view.



Thread Execution – Example

There are basically two main ways of having a **Thread** execute application code.

- Create a new class that *extends Thread* and override its **run()** method.

```
MyThread t = new MyThread();
t.start();
```

- Create a new **Thread** instance passing to it a **Runnable** object.

```
Runnable myRunnable1 = new
MyRunnableClass(); Thread t1 = new
Thread(myRunnable1); t1.start();
```

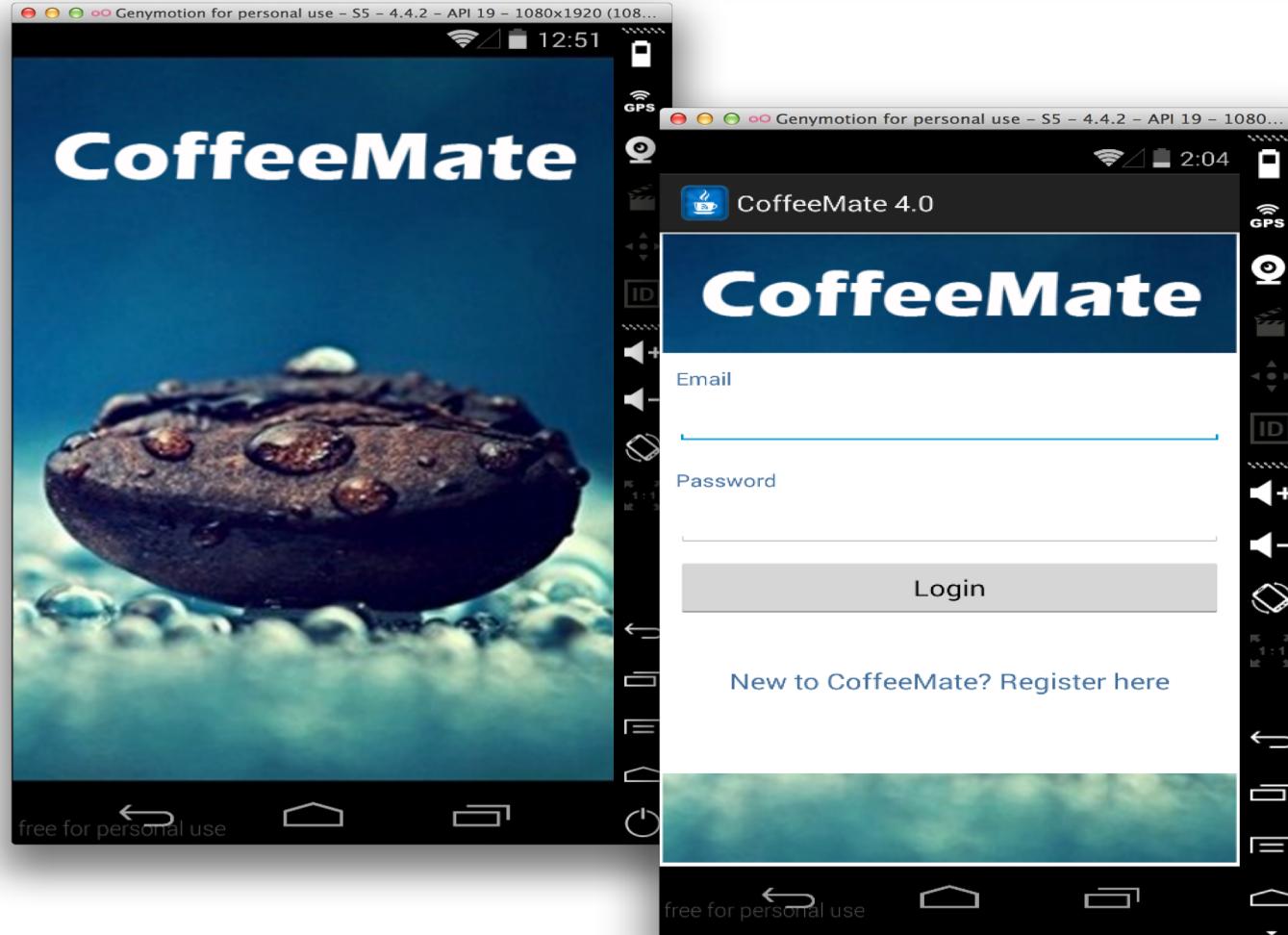
In both cases, the **start()** method must be called to actually execute the new Thread.



Using a Splash Screen & Login Screen



What do we want exactly?



- Display Splash Screen for a few seconds
- Display Login Screen
- Only show Home Screen once valid details entered



Splash

```
public class Splash extends Activity {  
    // used to know if the back button was pressed in the splash screen activity  
    // and avoid opening the next activity  
    private boolean mIsBackPressed;  
    private static final int SPLASH_DURATION = 2000; // 2 seconds  
  
    public void onCreate(Bundle savedInstanceState) {  
        super.onCreate(savedInstanceState);  
        setContentView(R.layout.splash);  
  
        Handler handler = new Handler();  
        // run a thread after 2 seconds to start the home screen  
        handler.postDelayed(new Runnable() {  
  
            @Override  
            public void run() {  
                // make sure we close the splash screen so the user  
                // won't come back when it presses back key  
                finish();  
  
                if (!mIsBackPressed) {  
                    // start the home screen if the back button wasn't pressed already  
                    Intent intent = new Intent(Splash.this, Login.class);  
                    Splash.this.startActivity(intent);  
                }  
            }  
        }, SPLASH_DURATION); // time in milliseconds to delay call to run()  
    }  
  
    @Override  
    public void onBackPressed() {  
        // set the flag to true so the next activity won't start up  
        mIsBackPressed = true;  
        super.onBackPressed();  
    }  
}
```

Handler object associated with single thread

Start Login Screen via Intent



Update Manifest File

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="ie.cm"
    android:versionCode="1"
    android:versionName="1.0" >

    <uses-sdk android:minSdkVersion="14" android:targetSdkVersion="21" />
<application
    android:allowBackup="true"
    android:icon="@drawable/ic_launcher1"
    android:theme="@style/appTheme"
    android:label="@string/appName"
    android:name="ie.cm.main.CoffeeMateApp">

        <activity
            android:name="ie.cm.activities.Splash"
            android:configChanges="orientation|keyboardHidden"
            android:screenOrientation="portrait"
            android:theme="@android:style/Theme.NoTitleBar" >
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />

                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>

        <activity android:name="ie.cm.activities.Home"></activity>
        <activity android:name="ie.cm.activities.Login"></activity>
        <activity android:name="ie.cm.activities.Help"></activity>
        <activity android:name="ie.cm.activities.Add"></activity>
        <activity android:name="ie.cm.activities.Edit"></activity>
        <activity android:name="ie.cm.activities.Search"></activity>
        <activity android:name="ie.cm.activities.Favourites"></activity>
    </application>
</manifest>
```

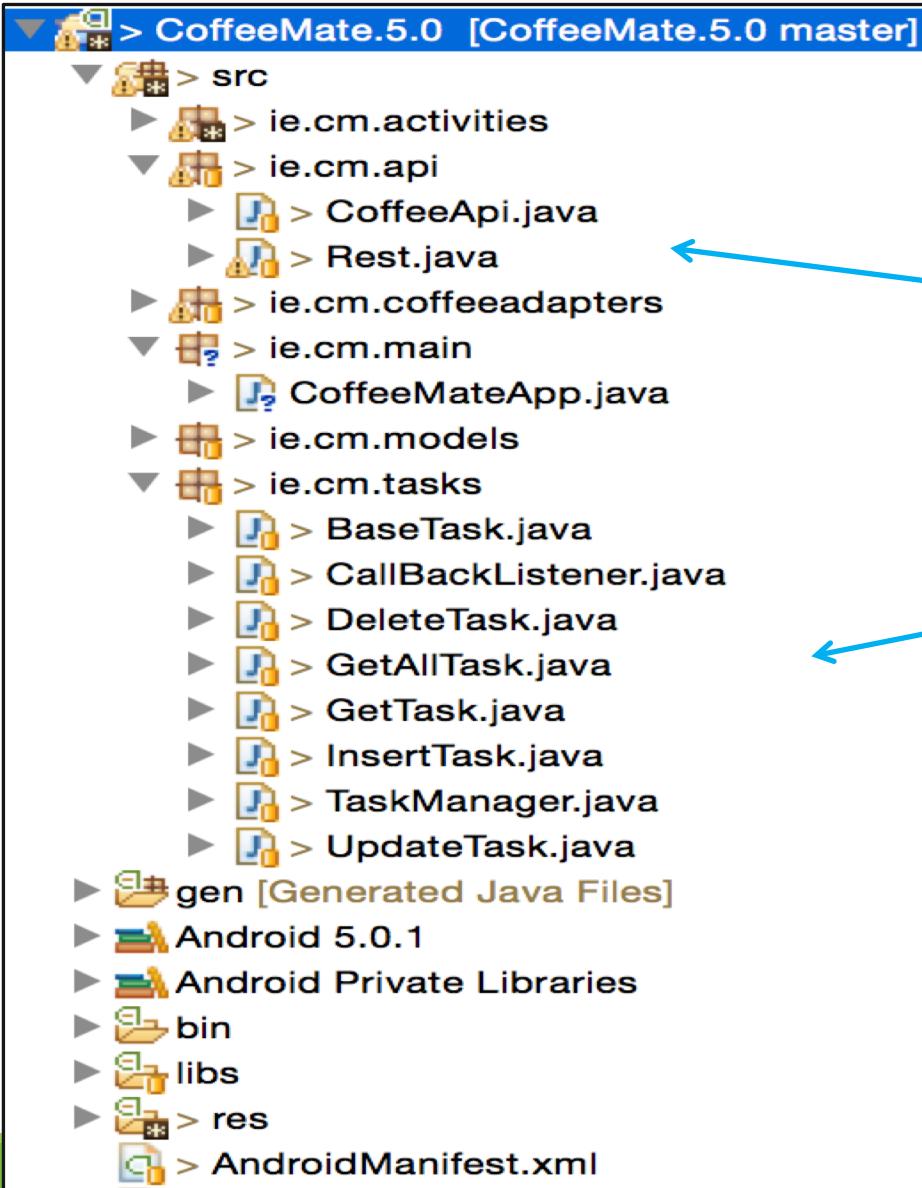
Activity to Launch



CoffeeMate Example (Using AsyncTasks)



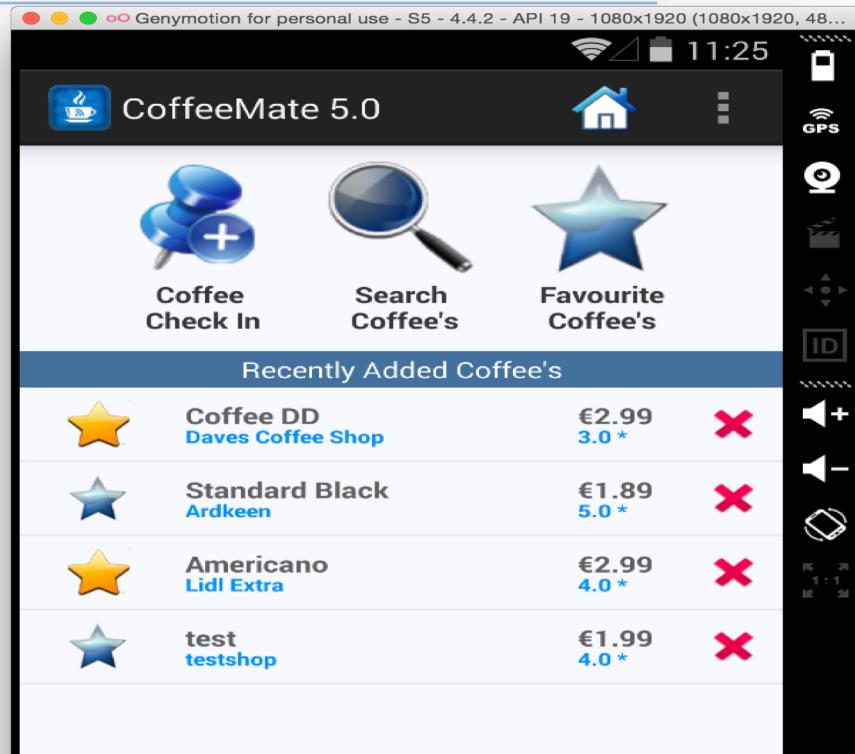
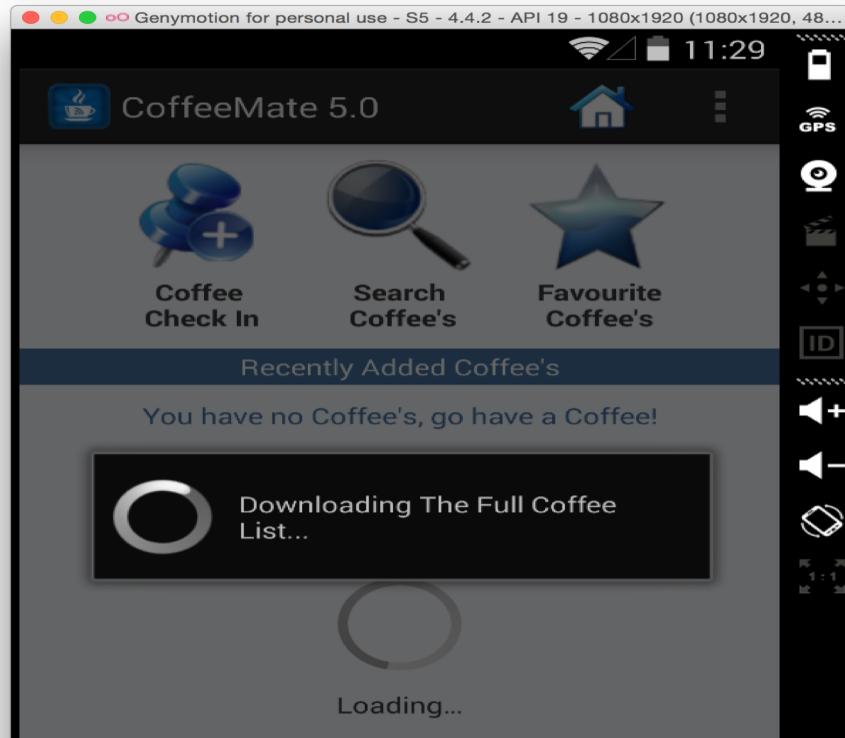
CoffeeMate 5.0 AsyncTasks (and more)



- api classes for calling REST service
- AsyncTasks for CRUD
(and callback mechanism to update UI)



CoffeeMate 5.0 AsyncTasks



```
public class TaskManager {  
    public static void getall(Activity activity, CoffeeFragment fragment) {  
        new GetAllTask(activity, fragment, "Downloading The Full Coffee List...")  
            .execute("/getall"); // "/getall" on JumpyJosh "/coffees" on cloudbees  
    }  
}
```

free for personal use



free for personal use



CoffeeApi

Used for
passing/retrieving JSON
coffee
data

```
public class CoffeeApi {  
    ///////////////////////////////  
    public static List<Coffee> getAll(String call) {  
        String json = Rest.get(call);  
        Type collectionType = new TypeToken<List<Coffee>>() {}.getType();  
  
        return new Gson().fromJson(json, collectionType);  
    }  
    ///////////////////////////////  
    public static Coffee get(String call) {  
        String json = Rest.get(call);  
        Type objType = new TypeToken<Coffee>(){}.getType();  
  
        return new Gson().fromJson(json, objType);  
    }  
    ///////////////////////////////  
    public static String delete(String call) {  
        return Rest.delete(call);  
    }  
    ///////////////////////////////  
    public static String insert(String call,Coffee coffee) {  
        Type objType = new TypeToken<Coffee>(){}.getType();  
        String jsonCoffee = new Gson().toJson(coffee, objType);  
  
        return Rest.post(call,jsonCoffee);  
    }  
    ///////////////////////////////  
    public static String update(String call,Coffee coffee) {  
        Type objType = new TypeToken<Coffee>(){}.getType();  
        String jsonCoffee = new Gson().toJson(coffee, objType);  
  
        return Rest.put(call,jsonCoffee);  
    }  
}
```



Rest.java (extract)

```
public class Rest {  
  
    private static String server;  
    private static HttpParams httpParameters;  
    private static DefaultHttpClient httpClient;  
  
    private static final String URL = "http://www.jumpjosh.com/cms/rest/api";  
    private static final String EURL = "http://coffeemate.edel020.cloudbees.net/api";  
  
    public static void setup() {  
        Rest.server = URL;  
        httpParameters = new BasicHttpParams();  
        HttpConnectionParams.setConnectionTimeout(httpParameters,  
            10000);  
        HttpConnectionParams.setSoTimeout(httpParameters, 20000);  
        httpClient = new DefaultHttpClient(httpParameters);  
    }  
  
    private static String getBase() {  
        return server;  
    }  
  
    ///////////////////////////////  
    public static String get(String url) {  
        String result = "";  
        try {  
            HttpGet getRequest = new HttpGet(getBase() + url);  
            getRequest.setHeader("accept", "application/json");  
            //getRequest.setHeader("accept", "text/plain");  
            HttpResponse response = httpClient.execute(getRequest);  
            result = getResult(response).toString();  
        } catch (Exception e) {  
            System.out.println(e.getMessage());  
        }  
        return result;  
    }  
}
```

Used for making the web service calls



AsyncTask -TaskManager

```
public class TaskManager {  
    public static void getall(Activity activity,CoffeeFragment fragment) {  
        new GetAllTask(activity, fragment, "Downloading The Full Coffee List...")  
            .execute("/getall"); // "/getall" on JumpyJosh "/coffees" on cloudbees  
    }  
  
    public static void get(Activity activity, int id) {  
        new GetTask(activity, "Downloading Individual Coffee Data...")  
            .execute("/get/" + id);  
    }  
    public static void delete(Activity activity,CoffeeFragment fragment,int id) {  
        new DeleteTask(activity, fragment, "Deleting A Single Coffee...")  
            .execute("/delete/" + id);  
    }  
  
    public static void insert(Activity activity,Coffee c) {  
        new InsertTask(activity, "Adding a Single Coffee...")  
            .execute("/insert",c,"dave");  
    }  
  
    public static void update(Activity activity,Coffee c) {  
        new UpdateTask(activity,"Updating A Single Coffee...")  
            .execute("/update",c);  
    }  
}
```

In our CoffeeFragment

```
@Override  
public void onResume() {  
    super.onResume();  
    TaskManager.getall(getActivity(),this);  
}
```

Calling our
AsyncTasks



AsyncTask -BaseTask

```
public class BaseTask<T> extends AsyncTask<Object, Void, Object> {  
  
    protected CallBackListener<T> callback;  
    protected ProgressDialog dialog;  
    protected Context context;  
    protected String message;  
  
    @SuppressWarnings("unchecked")  
    public BaseTask(Context context, CoffeeFragment fragment, String message)  
    {  
        this.callback = (CallBackListener<T>) fragment;  
        this.context = context;  
        this.message = message;  
    }  
  
    @SuppressWarnings("unchecked")  
    public BaseTask(Context context, String message)  
    {  
        if(context instanceof CallBackListener)  
            this.callback = (CallBackListener<T>) context;  
        this.context = context;  
        this.message = message;  
    }  
  
    @Override  
    protected void onPreExecute()  
    {  
        super.onPreExecute();  
        this.dialog = new ProgressDialog(context, 1);  
        this.dialog.setMessage(message);  
        this.dialog.show();  
    }  
  
    @Override  
    protected Object doInBackground(Object... params) {  
        return null;  
    }  
}
```

CallBack
Reference

```
public interface CallBackListener<T> {  
    public void setList(List<T> aList);  
    public void setObject(T object);  
    public void updateUI();  
}
```



Callback Interface

- ❑ Necessary, due to AsyncTasks in separate classes

```
public interface CallBackListener<T> {  
    public void setList(List<T> aList);  
    public void setObject(T object);  
    public void updateUI();  
}
```

- ❑ Reference maintained in BaseTask

```
protected CallBackListener<T> callback;
```

- ❑ Set in subclass Task, via TaskManager, e.g.

```
public static void get(Activity activity, int id) {  
    new GetTask(activity, "Downloading Individual Coffee Data...")  
        .execute("/get/" + id);  
}
```

```
public class GetTask extends BaseTask<Coffee> {  
  
    public GetTask(Context context, String message) {  
        super(context, message);  
    }  
}
```



Callback Interface

- ❑ Invoked in relevant methods

```
@Override  
public void onCreate(Bundle savedInstanceState) {  
    super.onCreate(savedInstanceState);  
  
    activityInfo = getIntent().getExtras();  
    TaskManager.get(this, activityInfo.getInt("coffeeID"));  
    setContentView(R.layout.edit);  
}
```

In our Edit Activity

```
@Override  
protected void onPostExecute(Object result) {  
    super.onPostExecute(result);  
  
    callback.setObject((Coffee) result);  
    callback.updateUI();  
  
    if (dialog.isShowing())  
        dialog.dismiss();  
}
```

In our GetTask



Callback Interface

- ❑ Overridden in class that implements the interface

```
@Override  
public void setObject(Coffee object) {  
    this.aCoffee = object;  
}  
  
@Override  
public void updateUI() {  
    setTextString(R.id.coffeeNameTextView, aCoffee.name);  
    setTextString(R.id.coffeeShopTextView, aCoffee.shop);  
  
    setEditString(R.id.nameEditText, aCoffee.name);  
    setEditString(R.id.shopEditText, aCoffee.shop);  
    setEditDouble(R.id.priceEditText, aCoffee.price);  
    setRatingBarValue(R.id.coffeeRatingBar, (float)aCoffee.rating);  
  
    favouriteImage = (ImageView) findViewById(R.id.favouriteImageView);  
  
    if (aCoffee.favourite == 1) {  
        favouriteImage.setImageResource(R.drawable.ic_favourite_on);  
        isFavourite = true;  
    } else {  
        favouriteImage.setImageResource(R.drawable.ic_favourite_off);  
        isFavourite = false;  
    }  
}
```

In our Edit Activity



AsyncTask -*GetAllTask*

```
public class GetAllTask extends BaseTask<Coffee> {

    public GetAllTask(Context context, CoffeeFragment fragment, String message) {
        super(context, fragment, message);
    }

    @Override
    protected List<Coffee> doInBackground(Object... params) {

        try {
            return CoffeeApi.getAll((String) params[0]);
        }

        catch (Exception e) {
            Log.v("ASYNC", "ERROR : " + e);
            e.printStackTrace();
        }
        return null;
    }

    @SuppressWarnings("unchecked")
    @Override
    protected void onPostExecute(Object result) {
        super.onPostExecute(result);

        callback.setList((List<Coffee>) result);
        callback.updateUI();

        if (dialog.isShowing())
            dialog.dismiss();
    }
}
```

Remaining Tasks
implemented in a similar
fashion



CoffeeFragment (Extracts)

```
public class CoffeeFragment extends ListFragment implements OnClickListener,  
    CallBackListener<Coffee> {  
  
    protected static CoffeeListAdapter listAdapter;  
    protected CoffeeFilter coffeeFilter;  
    protected List <Coffee> coffeeList = new ArrayList<Coffee>();
```

```
@Override  
public void setList(List<Coffee> aList) {  
    if(aList != null) // App Restart....  
        coffeeList = (ArrayList<Coffee>) aList;  
  
}  
  
@Override  
public void setObject(Coffee object) {}  
  
@Override  
public void updateUI() {  
    listAdapter = new CoffeeListAdapter(getActivity(), this, coffeeList);  
    coffeeFilter = new CoffeeFilter(coffeeList, "all", listAdapter);  
  
    if (getActivity() instanceof Favourites) {  
        coffeeFilter.setFilter("favourites");  
        coffeeFilter.filter(null);  
        listAdapter.notifyDataSetChanged();  
    }  
    this.setListAdapter(listAdapter);  
}
```

Overriding the necessary methods from the interface



Using SharedPreferences



SharedPreferences (1)

- Two forms:
 - Share across all components in an application
 - `getSharedPreferences("SomeString",Activity.MODE_PRIVATE);`
 - Store only data needed by this Activity
 - `getPreferences(Activity.MODE_PRIVATE);`
 - Store only data needed by this Activity when Activity becomes inactive
(but not when finished)
 - Eg. Orientation change from portrait to landscape
 - use Bundle in `onSaveInstanceState / onRestoreInstanceState / onCreate`



SharedPreferences (2)

- ❑ Create your SharedPreferences instance

```
    SharedPreferences settings  
    = this.getSharedPreferences("Demo",  
                             MODE_PRIVATE);
```

- ❑ Add data in the form : <String Key, String Value>

```
SharedPreferences.Editor editor = settings.edit();  
editor.putString("name", "value");  
editor.commit();
```

- ❑ Use 'Key' to get 'Value'

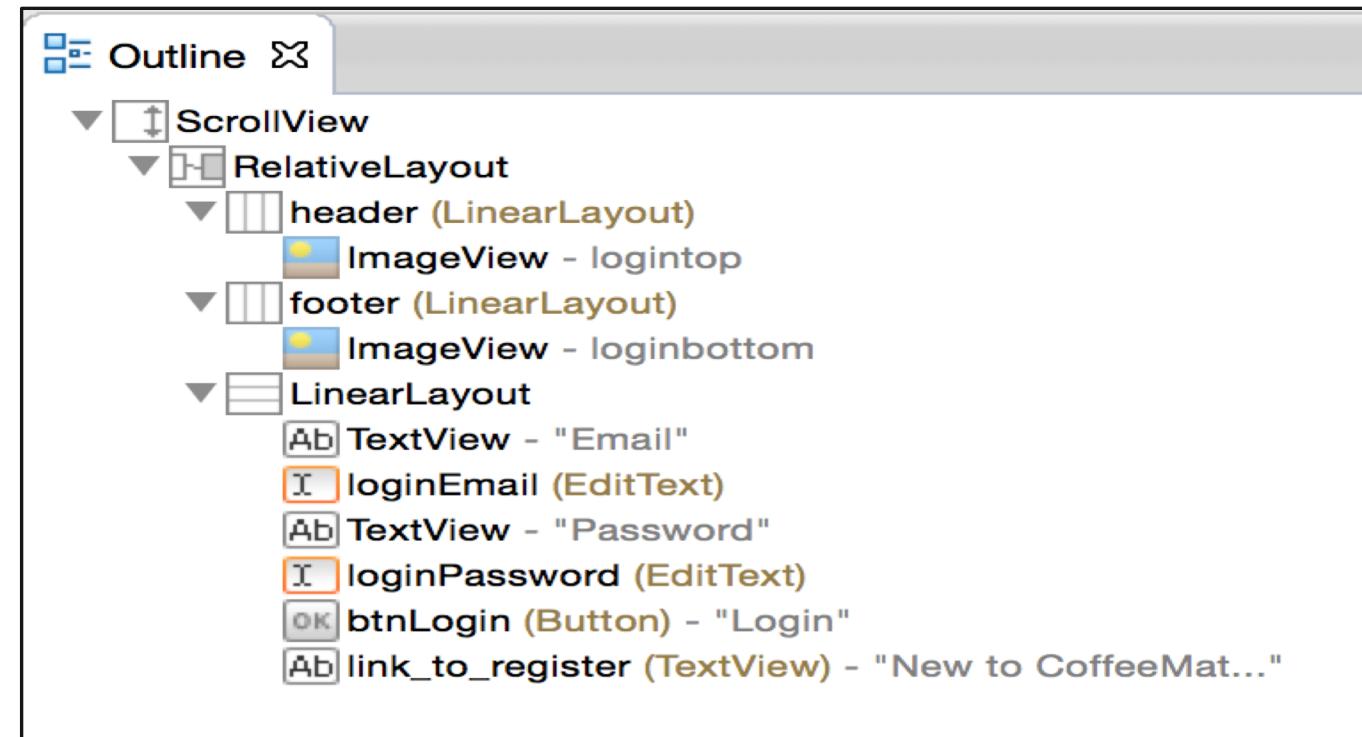
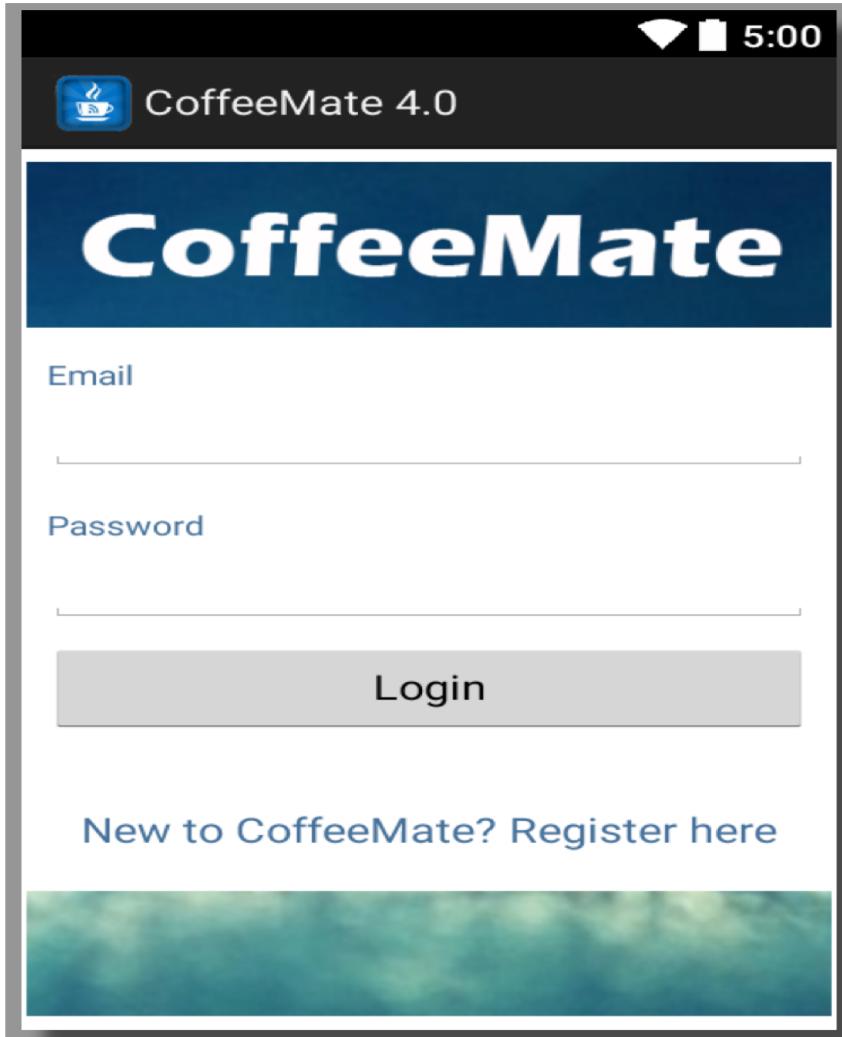
```
String str = settings.getString("name",
```

- ❑ Reset the preferences (clear)

```
"defaultValue");  
editor.clear().commit();
```



login.xml





Login (1)

```
public class Login extends Activity implements OnClickListener {  
  
    // used to know if the back button was pressed in the splash screen  
    // and avoid opening the next activity  
    private boolean mIsBackPressed;  
    private SharedPreferences settings;  
  
    public void onCreate(Bundle savedInstanceState) {  
        super.onCreate(savedInstanceState);  
  
        settings = getSharedPreferences("loginPrefs", 0);  
        if (settings.getBoolean("loggedin", false))  
            /* The user has already logged in, so start the Home Screen */  
            startHomeScreen();  
  
        setContentView(R.layout.login);  
        Button login = (Button) findViewById(R.id.btnLogin);  
        login.setOnClickListener(this);  
    }  
  
    @Override  
    public void onBackPressed() {  
        // set the flag to true so the next activity won't start unless  
        mIsBackPressed = true;  
        super.onBackPressed();  
    }  
}
```

Load your Preferences

Default value



Login (2)

```
@Override  
public void onClick(View arg0) {  
  
    CharSequence email = ((TextView) findViewById(R.id.loginEmail))  
        .getText();  
    CharSequence password = ((TextView) findViewById(R.id.loginPassword))  
        .getText();  
  
    if (email.length() <= 0 || password.length() <= 0)  
        Toast.makeText(this, "You must enter an email & password",  
            Toast.LENGTH_SHORT).show();  
    else if (!email.toString().matches("d")  
        || !password.toString().matches("d"))  
        Toast.makeText(this, "Unable to validate your email & password",  
            Toast.LENGTH_SHORT).show();  
    else if (!mIsBackPressed) {  
        // Validate User with Server Here  
  
        // Update logged in preferences  
        SharedPreferences.Editor editor = settings.edit();  
        editor.putBoolean("loggedin", true);  
        editor.commit();  
        // start the home screen if the back button wasn't pressed already  
        startHomeScreen();  
        this.finish(); // destroy the Login Activity  
    }  
  
    private void startHomeScreen() {..}
```

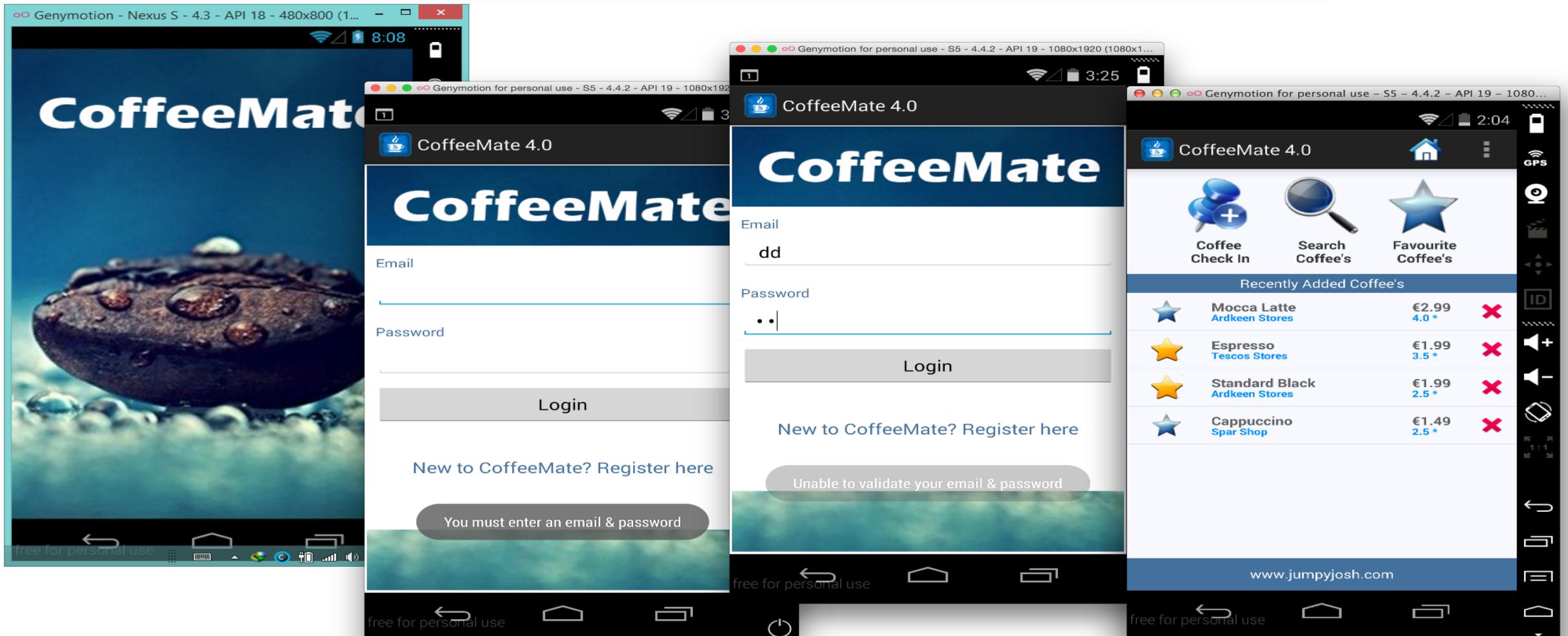
“Very Secure”
email & password
credentials!

Possibly via a
Web Service??
(Not now obviously)

Update Preferences
with data



End Result





Using Files



File Access (Internal & External)

- Store data to file
- Use `java.io.*` to read/write file
- Only local file can be visited
 - Advantages: can store large amounts of data
 - Disadvantages: file format changes and/or updates may result in significant programming/refactoring
- Very similar to file handling in java desktop applications
- Generally though, not recommended



Read from a file

□ Open a File for input

- Context.openFileInput(String name)
- If failure then throw a FileNotFoundException

```
public Map<String, String> readFromFile(Context context) {  
    Map<String, String> temp = null;  
  
    try{  
        inByteStream = context.openFileInput(FILENAME);  
        OIStream = new ObjectInputStream(inByteStream);  
  
        temp = (Map<String, String>) OIStream.readObject();  
  
        inByteStream.close();  
        OIStream.close();  
    }  
    catch(Exception e){...}  
  
    return temp;  
}
```



Write to file

□ Open a File for output

- Context.openFileOutput(String name,int mode)
- If failure then a new File is created
- Append mode: to add data to file

```
public void writeToFile(Map<String, String> times, Context context){  
  
    try{  
        outByteStream = context.openFileOutput(FILENAME, Context.MODE_PRIVATE);  
        OOSstream = new ObjectOutputStream(outByteStream);  
        OOSstream.writeObject(times);  
        outByteStream.close();  
        OOSstream.close();  
    }  
    catch(Exception e){...}  
}
```



Write file to SDCard

- ❑ To get permission for SDCard r/w in
AndroidManifest.xml:

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



SDCard read/write

- ❑ Need a SD Card, (obviously ☺)

```
if(Environment.getExternalStorageState() .equals(Environment.MEDIA_MOUNTED))  
{  
    File sdCardDir = Environment.getExternalStorageDirectory();  
    File saveFile = new File(sdCardDir, "stuff.txt");  
    FileOutputStream outStream = new FileOutputStream(saveFile);  
  
    // Same approach as before, once you have a FileOutputStream and/or  
    // FileInputStream reference...  
    ...  
  
    outStream.close();  
}
```



Using ContentProviders



Content Provider

- ❑ a content provider is a specialized type of datastore that exposes standardized ways to retrieve and manipulate the stored data.
- ❑ Apps can expose their data layer through a Content Provider, identified by a URI.
- ❑ Some native apps provide Content Providers
- ❑ Your apps can provide Content Providers



Using ContentProvider to share data

- Content Providers are the Android platforms way of sharing information between multiple applications through its ContentResolver interface.
- Each application has access to the SQLite database to maintain their information and this cannot be shared with another application.

```
public class PersonContentProvider extends ContentProvider{  
    public boolean onCreate()  
    public Uri insert(Uri uri, ContentValues values)  
    public int delete(Uri uri, String selection, String[]  
        selectionArgs)  
    public int update(Uri uri, ContentValues values, String  
        selection, String[] selectionArgs)  
    public Cursor query(Uri uri, String[] projection, String  
        selection, String[] selectionArgs, String  
        sortOrder)  
    public String getType(Uri uri) }
```



Addition to the AndroidManifest.xml

- Add the following user permission tag

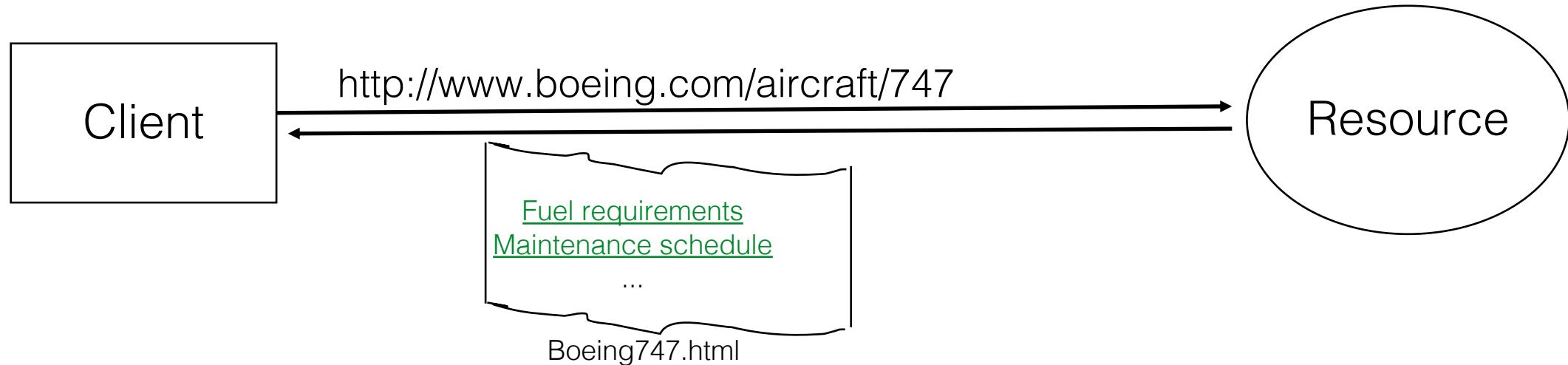
```
<uses-permission android:name="android.permission.READ_CONTACTS" />
```

- To give your application access to the contacts information.

```
<manifest .... >
    <application android:icon="@drawable/icon"
        android:label="@string/app_name">
        <provider android:name=".PersonContentProvider"
            android:authorities="ie.wit.provider.personprovider"/>
    </application>
</manifest>
```



Why is it called "Representational State Transfer"?



- The Client references a Web resource using a URL.
- A **representation** of the resource is returned (in this case as an HTML document).
- The representation (*e.g.*, Boeing747.html) places the client in a new **state**.
- When the client selects a hyperlink in Boeing747.html, it accesses another resource.
- The new representation places the client application into yet another state.
- Thus, the client application **transfers** state with each resource representation.



REST Characteristics

- ❑ REST is not a standard (unlike SOAP)
 - You will not see the W3C putting out a REST specification.
 - You will not see IBM or Microsoft or Sun selling a REST developer's toolkit.
- ❑ REST is just a **design pattern**
 - You can't bottle up a pattern.
 - You can only understand it and design your Web services to it.
- ❑ REST does prescribe the **use** of standards:
 - HTTP
 - URL
 - XML/HTML/GIF/JPEG/etc. (**Resource Representations**)
 - text/xml, text/html, image/gif, image/jpeg, etc. (**Resource Types, MIME Types**)



REST Principles

- ❑ Everything is a resource
 - ❑ Every resource is identified by a unique identifier
 - ❑ Use simple and uniform interfaces
 - ❑ Communication is done by representation
 - ❑ Be Stateless
-
- ❑ *We'll look at these, and more, next year ☺.*



Using Bundles



The Bundle Class (Saving)

Override onSaveInstanceState

- And pass the Bundle to the superclass method

```
protected void onSaveInstanceState(Bundle outState) {  
    super.onSaveInstanceState(outState);  
    outState.putBlah(someData);  
}
```

Called

- When user rotates screen
- When user changes language
- When app is hidden and Android needs the memory

Not called

- When user hits Back button

Note

- Superclass method automatically stores state of GUI widgets (EditText data, CheckBox state, etc.)



Bundle : Restoring Data

- ❑ Override onRestoreInstanceState
 - Pass Bundle to superclass method
 - Look for data by name, check for null, use the data

```
protected void onRestoreInstanceState(Bundle savedInstanceState) {  
    super.onRestoreInstanceState(savedInstanceState);  
    SomeType data = savedInstanceState.getBlah(key);  
    if (data != null) { doSomethingWith(data); }  
}
```
- ❑ Called
 - Any time app is restarted after onSaveInstanceState
- ❑ Note
 - The same Bundle is passed to onCreate.
 - Superclass method automatically restores widget state



The Bundle Class: Details

- ❑ Putting data in a Bundle
 - putBoolean, putBooleanArray, putDouble, putDoubleArray, putString, putStringArray, etc.
 - ◆ These all take keys and values as arguments.
The keys must be Strings. The values must be of the standard types (int, double, etc.) or array of them.
 - putSerializable, putParcelable
 - ◆ Lets you store custom objects. Note that ArrayList and most other builtin Java types are already Serializable
- ❑ Retrieving data from a Bundle
 - getBoolean, getBooleanArray, getDouble, getDoubleArray, getString, getStringArray, etc.
 - ◆ No typecast required on retrieval. Numbers are 0 if no match.
 - getSerializable, getParcelable
 - ◆ Typecast required on retrieval. Values are null if no match.



Bundle Summary

- ❑ Save data in `onSaveInstanceState`
 - Can put individual pieces of data in the Bundle, or can add a composite data structure.
 - Custom classes must implement `Serializable` or `Parcelable`
- ❑ Load data in `onRestoreInstanceState` or in `onCreate`
 - Look in Bundle for property of given name
 - For Object types, check for null
 - For number types, check for 0 (zero)



Note: Preventing Screen Rotations

❑ Issue

- Screen rotations usually require a new layout
- They also cause the app to be shutdown and restarted
 - ◆ Handling this is the topic of this lecture

❑ Problem

- What if you do not have landscape layout?
- Or have not yet handled shutdown and restart?

❑ Solution

- Put an entry in AndroidManifest.xml saying that app runs only in portrait mode (or only in landscape mode).

```
<activity android:name=".YourActivity"  
        android:label="@string/app_name"  
        android:screenOrientation="portrait">
```



More Reading

❑ JavaDoc: Activity

- <http://developer.android.com/reference/android/app/Activity.html>
 - ◆ Introductory parts give lots of details

❑ Chapters

- Handling Activity Lifecycle Events and
- Handling Rotation
 - ◆ From *The Busy Coder's Guide to Android Development* by Mark Murphy.
- <http://commonsware.com/Android/>



Sources

- ❑ <http://en.wikipedia.org/wiki/JSON>
- ❑ <http://www.w3schools.com/json/>
- ❑ <http://www.json.org/>
- ❑ <http://json-schema.org>
- ❑ <http://www.nczonline.net/blog/2008/01/09/is-json-better-than-xml/>
- ❑ [http://en.wikipedia.org/wiki/SOAP_\(protocol\)](http://en.wikipedia.org/wiki/SOAP_(protocol))
- ❑ <http://en.wikipedia.org/wiki/REST>
- ❑ <http://stackoverflow.com/questions/16626021/json-rest-soap-wsdl-and-soa-how-do-they-all-link-together>