

Mobile Application Development

Produced
by

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Android Multithreading





Agenda & Goals

- ❑ Understand what multithreading is and the need for it in Android development
- ❑ Be aware of the different approaches available in Android multithreading
- ❑ Be aware how to implement some of these approaches (including *AsyncTasks*) in an Android app.
- ❑ Understand JSON & Googles Gson
- ❑ Revisit our Donation Case Study



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

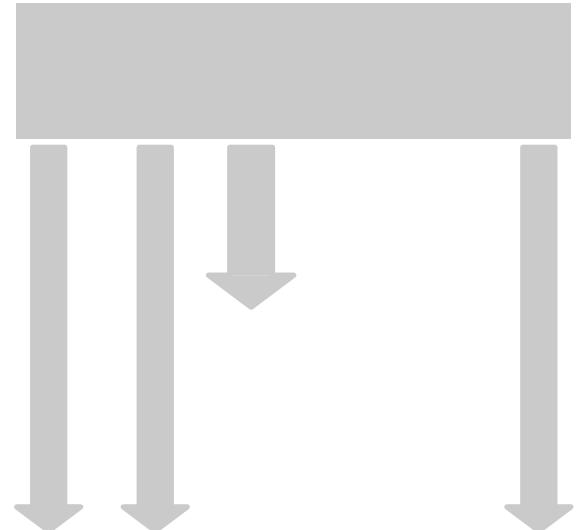
- ❑ Recall that Android ensures responsive apps by enforcing a 5 second limit on Activities
- ❑ Sometimes we need to do things that take longer than 5 seconds, or that can be done while the user does something else
- ❑ Activities, Services, and Broadcast Receivers run on the *main application thread*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



Threads

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

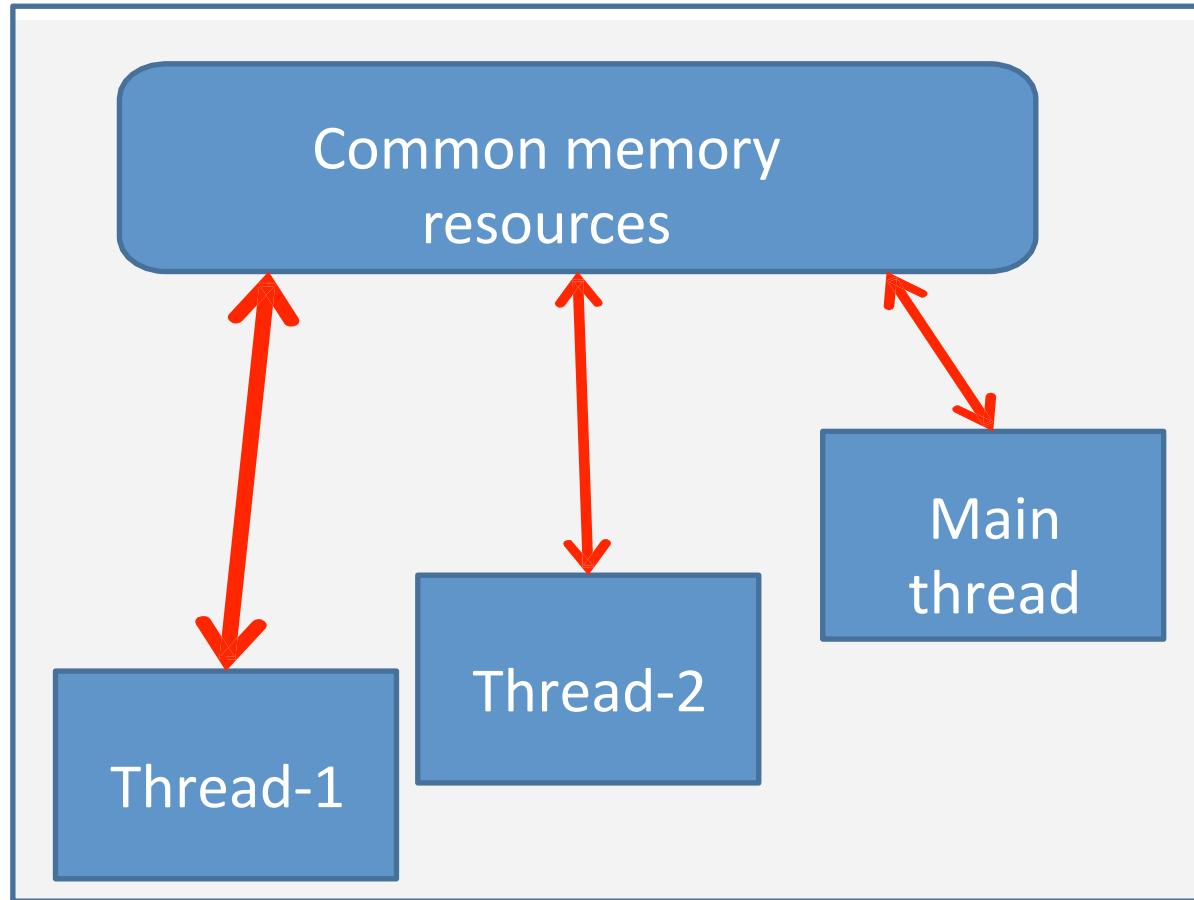
- ❑ A Thread is a concurrent unit of execution.
- ❑ Each thread has its own call stack. The call stack is used on method calling, parameter passing, and storage for the called method's local variables.
- ❑ Each virtual machine instance has at least one main thread.
- ❑ Threads in the same VM interact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



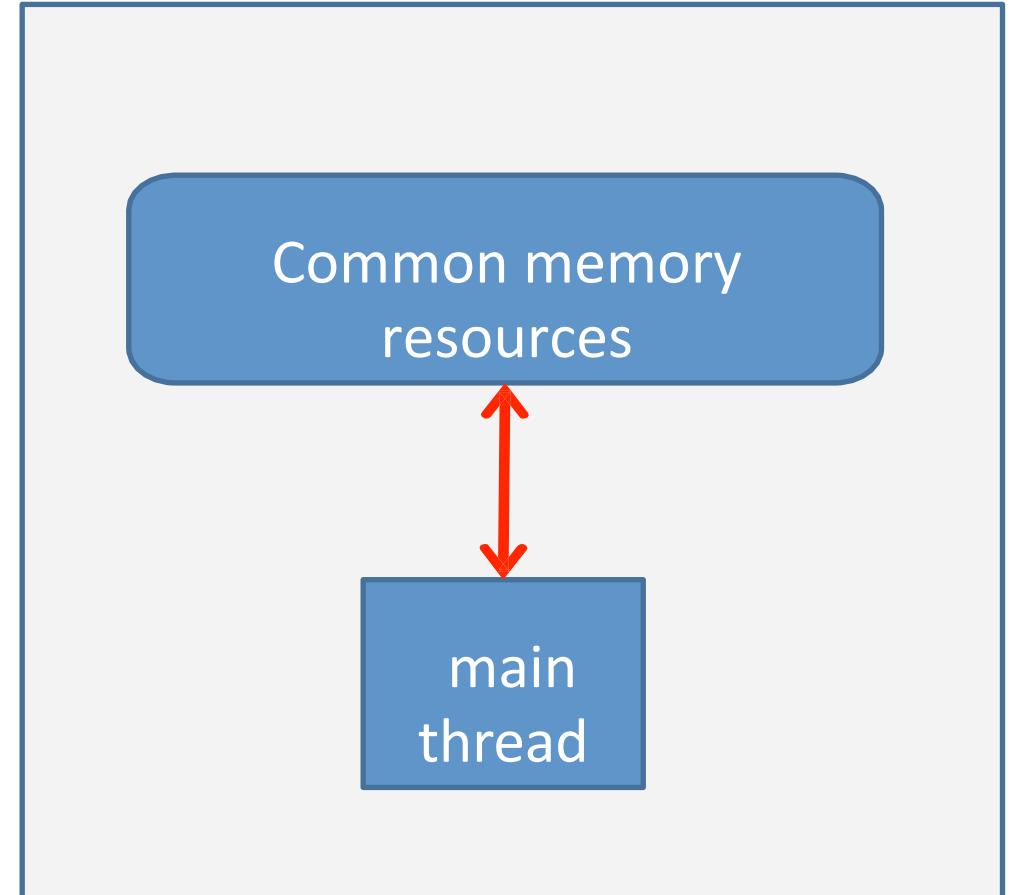


Threads

Process 1 (Virtual Machine 1)



Process 2 (Virtual Machine 2)





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 give results to the main thread and let it use the results



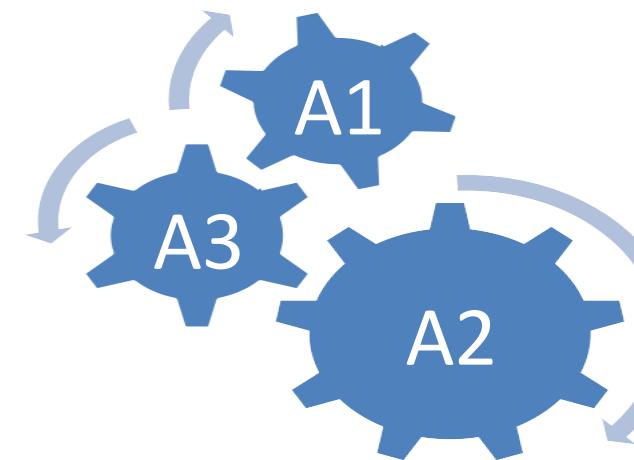
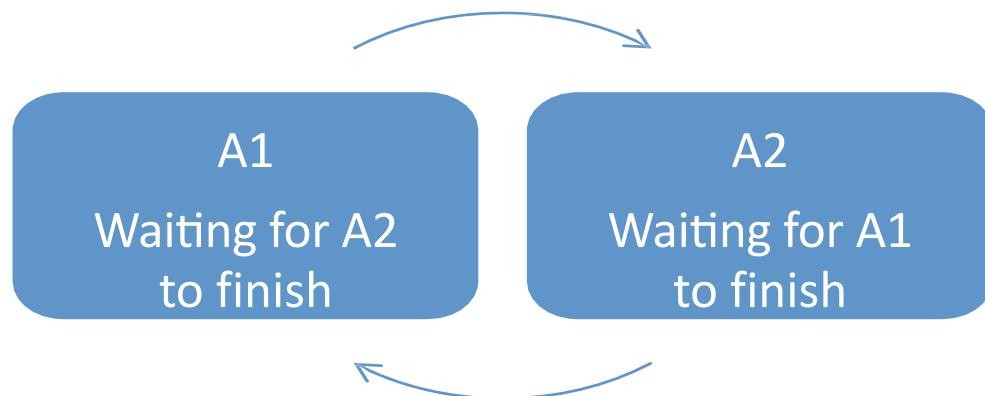
Advantages of Multithreading

- ❑ 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.

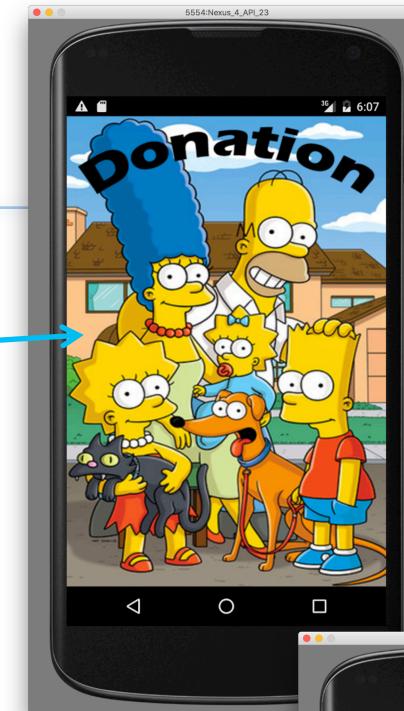
```
Runnable myRunnable1 = new
MyRunnableClass(); Thread t1 = new
Thread(myRunnable1); t1.start();
```

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

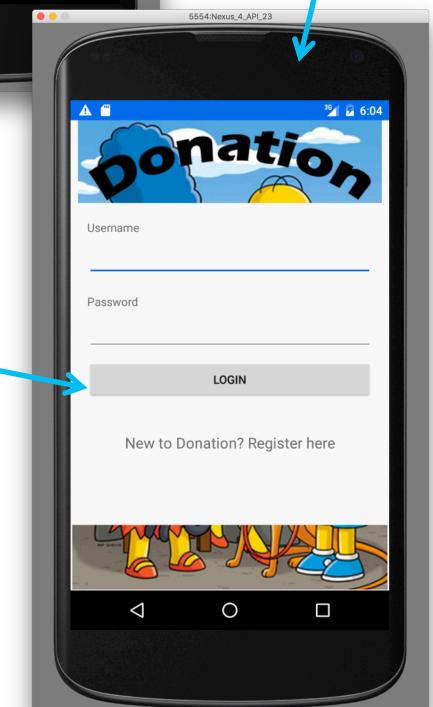


Multithreading – Our Splash Screen

```
public void onCreate(Bundle savedInstanceState) {  
    super.onCreate(savedInstanceState);  
    setContentView(R.layout.activity_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  
                Splash.this.startActivity(new Intent(Splash.this, Login.class));  
            }  
        }  
    }, SPLASH_DURATION); // time in milliseconds to delay call to run()  
}
```



2 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
<code>Params,</code> <code>Progress,</code> <code>Result</code>	<code>onPreExecute</code> , <code>doInBackground</code> , <code>onProgressUpdate</code> <code>onPostExecute</code> .	<code>publishProgress</code>



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 UI Thread  
        // 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.

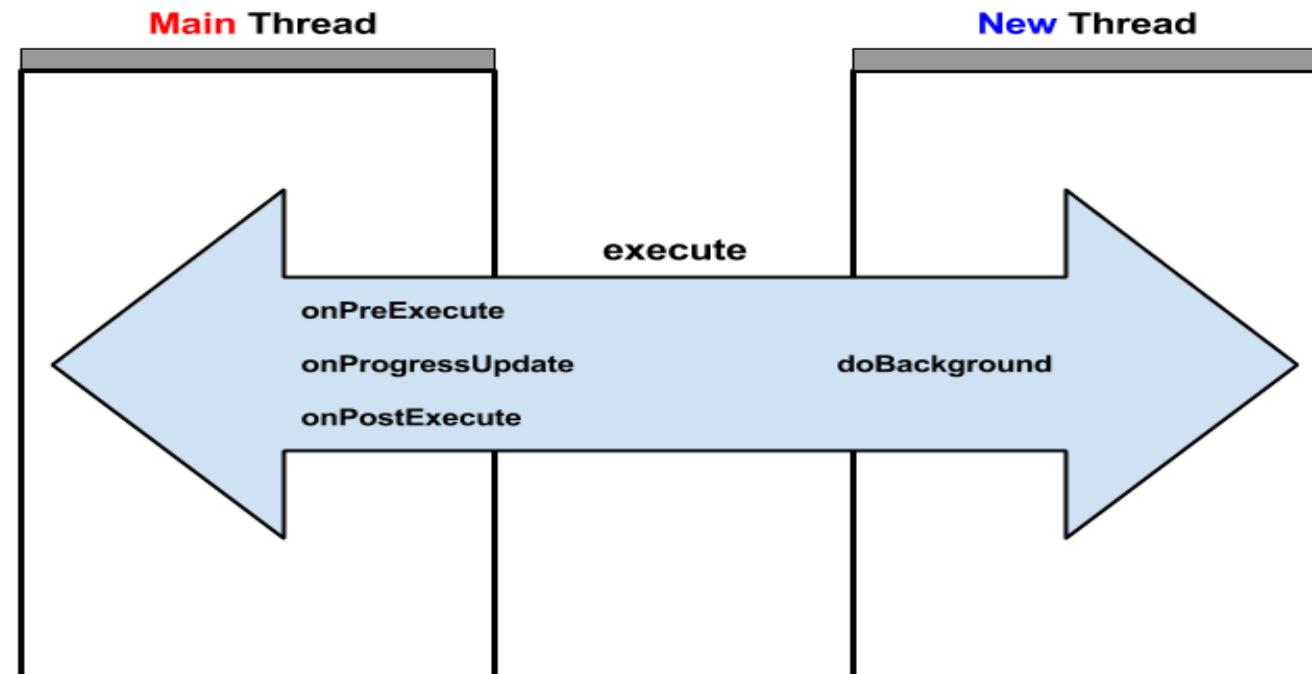
doInBackground(Params...), invoked on the background thread immediately after `onPreExecute()` finishes executing. This step is used to perform background computation that can take a long time. The parameters of the asynchronous task are passed to this step. The result of the computation must be returned 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.

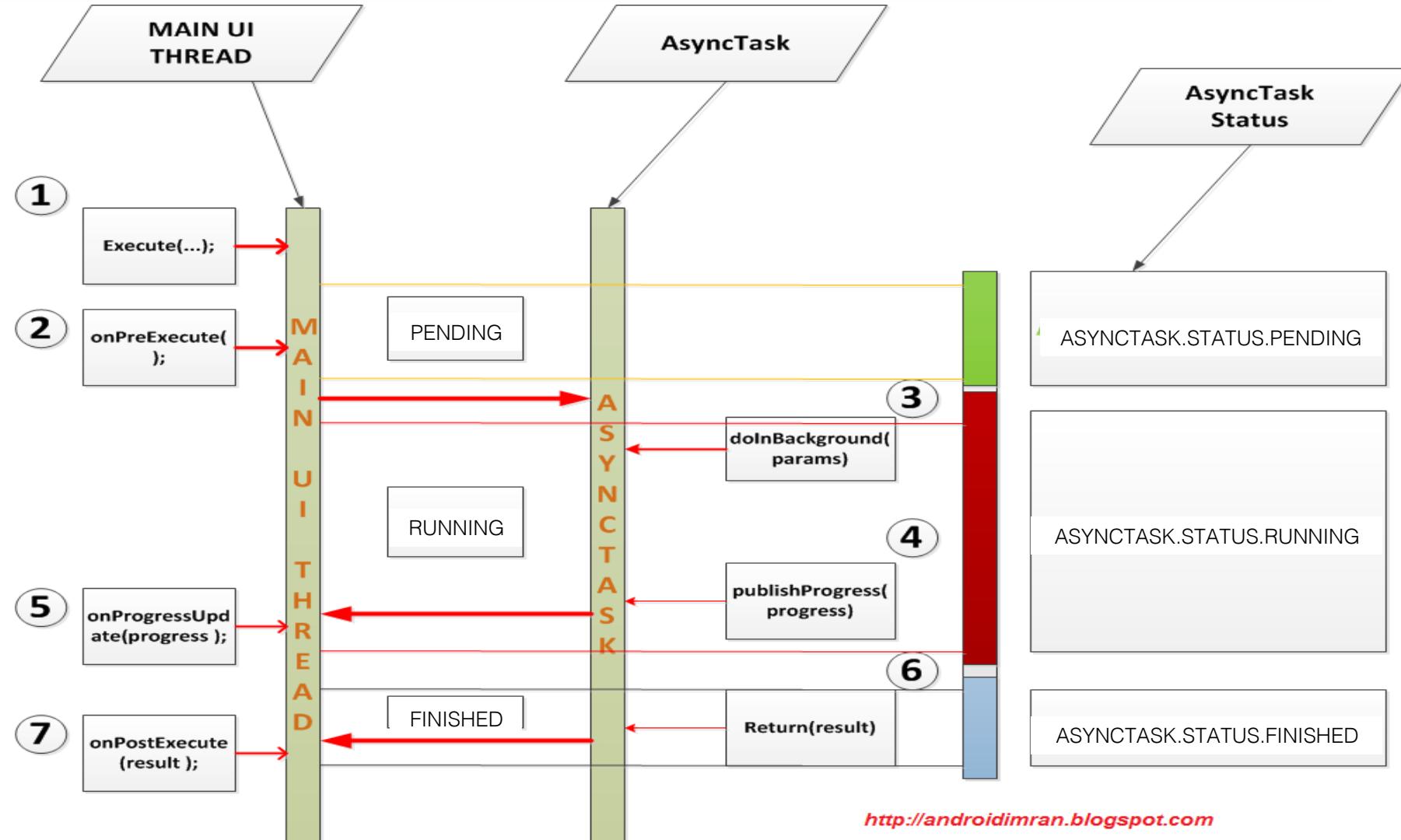


The Asynchronous Calls





AsyncTask Lifecycle





UPDATE Jan 2016 - Volley

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



Volley

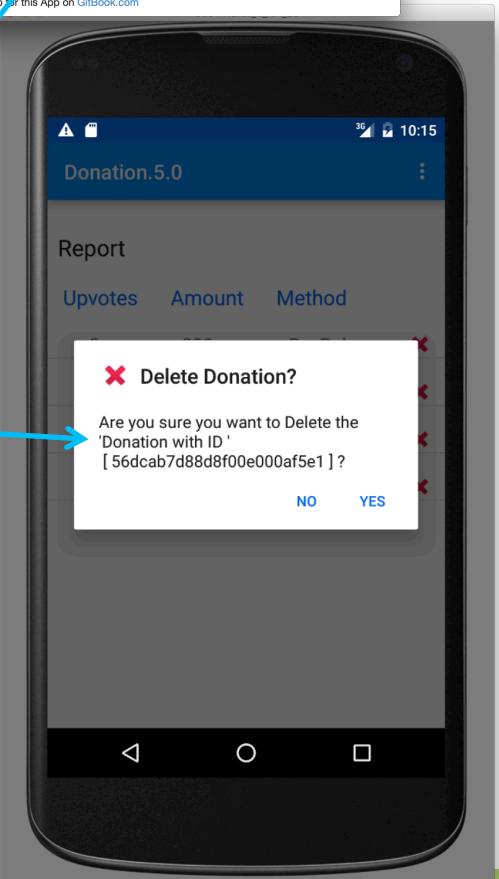
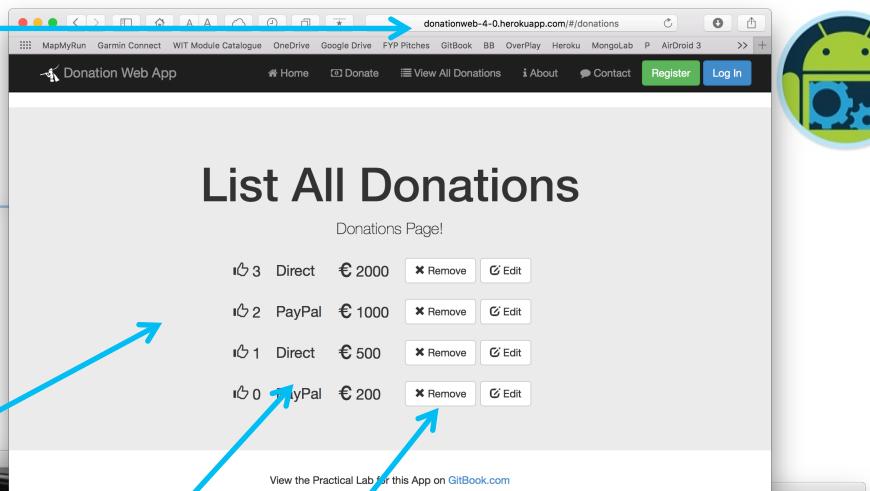
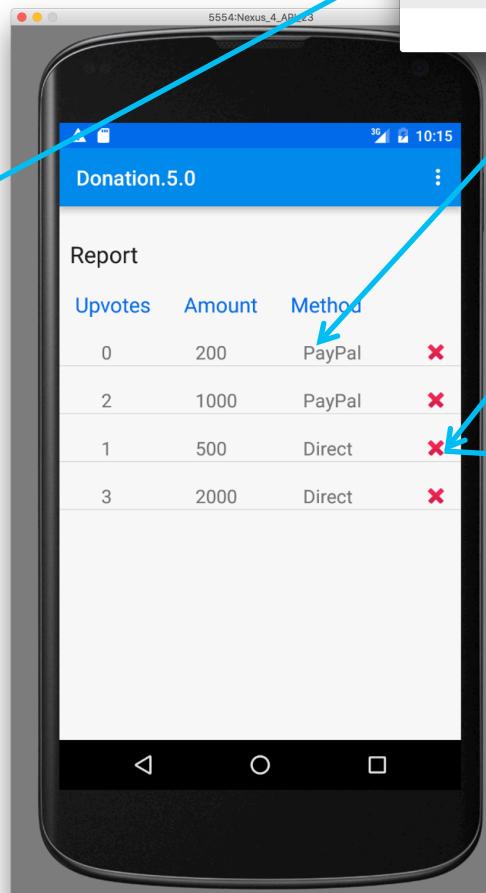
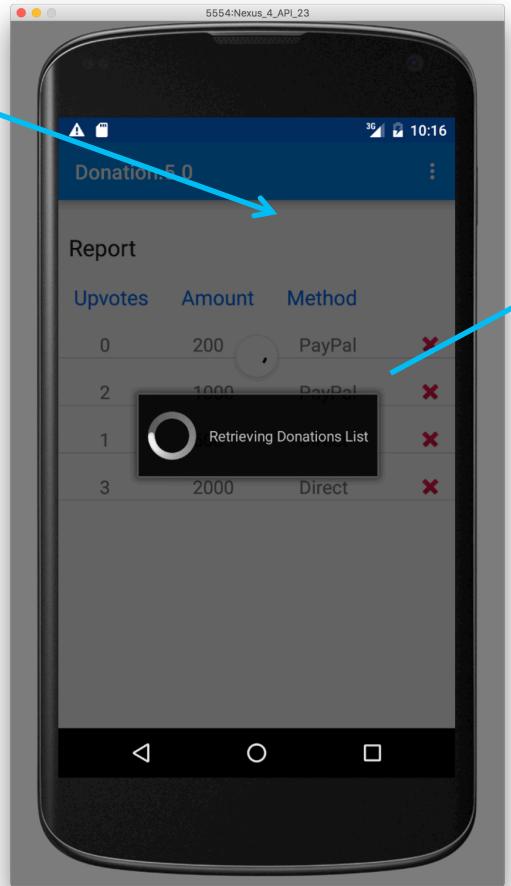
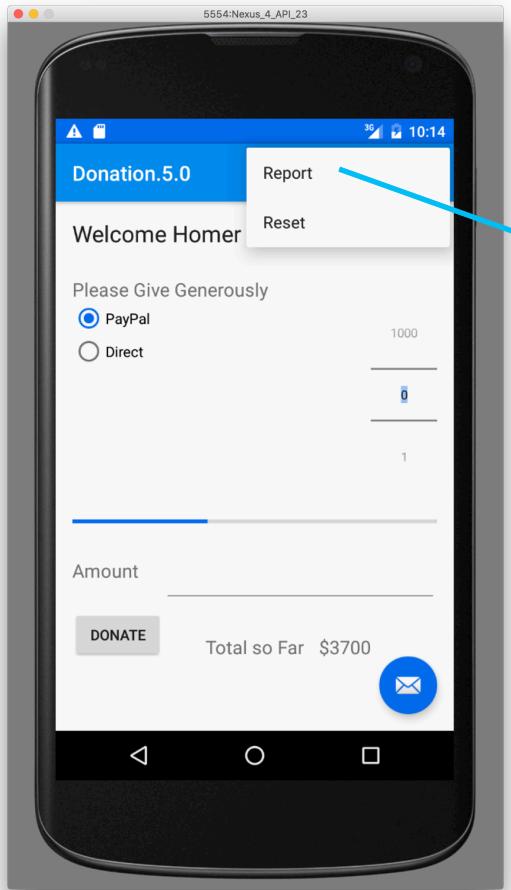
❑ Volley offers the following benefits:

- 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.



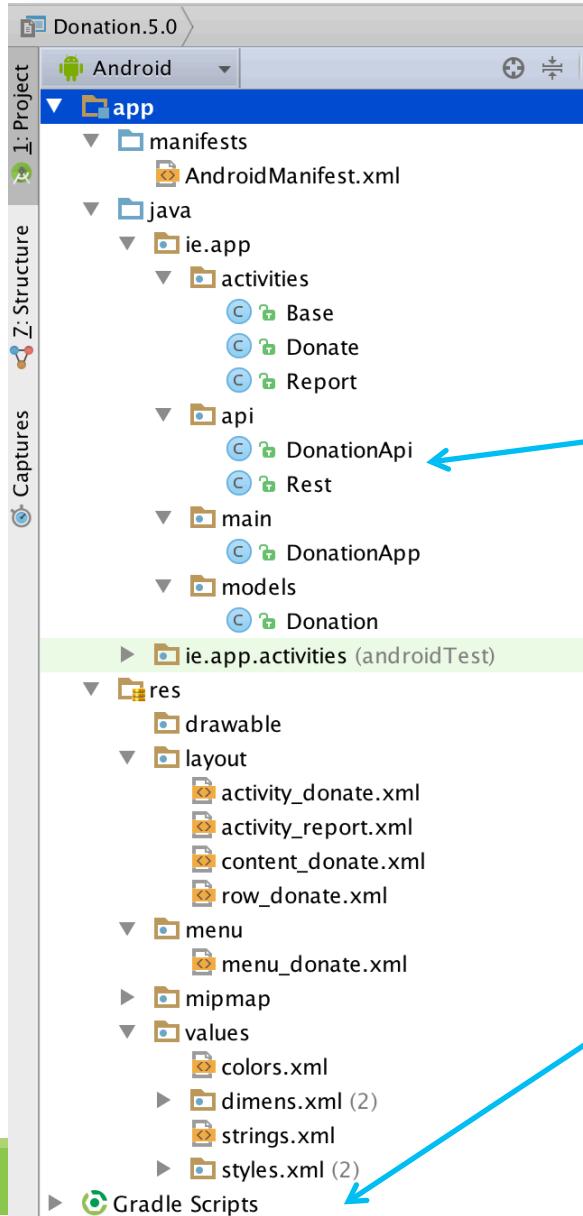
Let's look at our
Donation Example

What do we want?





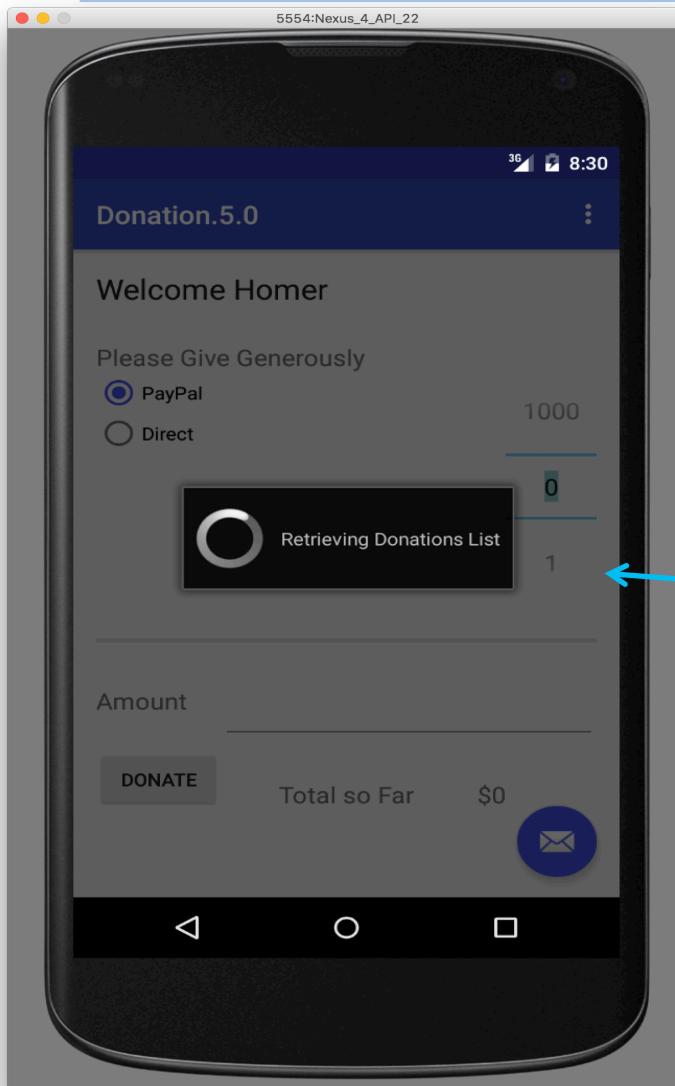
Donation 5.0 Project Structure



- api classes for calling REST service (we'll investigate these classes in our networking section)
- Googles gson for parsing JSON strings included in build



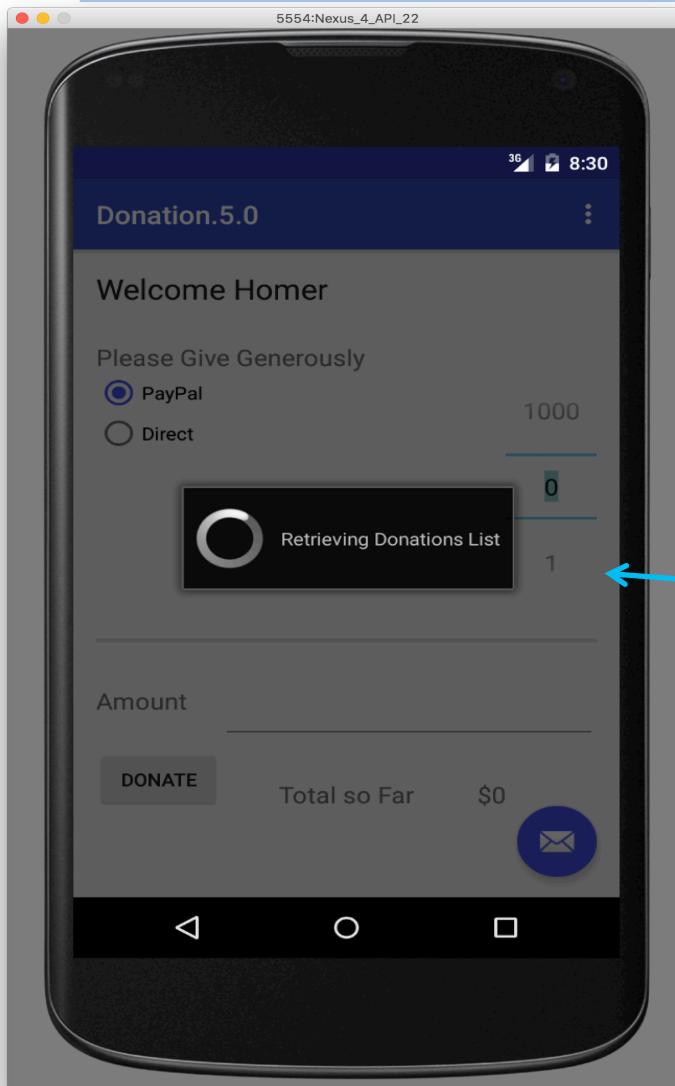
Donation 5.0 – Donate Activity



```
1 package ie.app.activities;
2
3 import ...
29
30 public class Donate extends Base {
31
32     private Button donateButton;
33     private RadioGroup paymentMethod;
34     private ProgressBar progressBar;
35     private NumberPicker amountPicker;
36     private EditText amountText;
37     private TextView amountTotal;
38
39
40     @Override
41     protected void onCreate(Bundle savedInstanceState) {...}
42
43
44     @Override
45     public void onResume() {
46         super.onResume();
47         new GetAllTask(this).execute("/donations");
48     }
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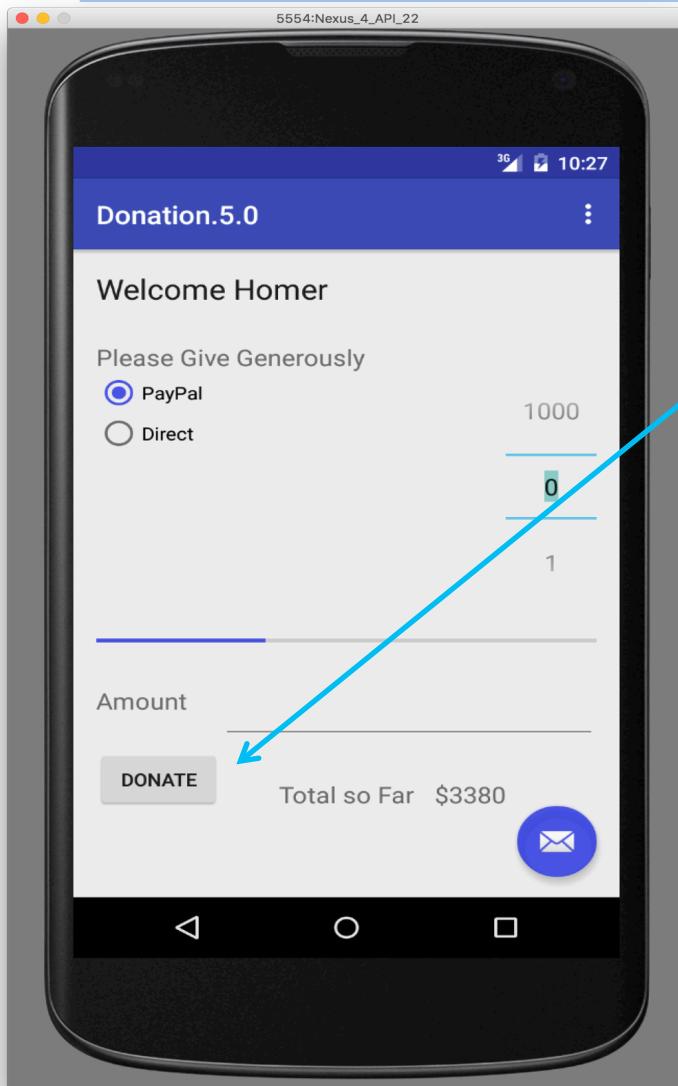
Donation 5.0 – Donate Activity



```
1 package ie.app.activities;
2
3 import ...
4
5 public class Donate extends Base {
6
7     private Button          donateButton;
8     private RadioGroup       paymentMethod;
9     private ProgressBar      progressBar;
10    private NumberPicker     amountPicker;
11    private EditText         amountText;
12    private TextView         amountTotal;
13
14
15    @Override
16    protected void onCreate(Bundle savedInstanceState) {...}
17
18    @Override
19    public void onResume() {
20        super.onResume();
21        new GetAllTask(this).execute("/donations");
22    }
23
24
25    @Override
26    public void reset(MenuItem item)
27    {
28        new ResetTask(this, app.donations).execute("/donations");
29        app.totalDonated = 0;
30        amountTotal.setText("$" + app.totalDonated);
31    }
32
33
34    public void donateButtonPressed (View view)
35    {...}
36
37    private boolean isTargetAchieved() {...}
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```



Donation 5.0 – Donate Activity

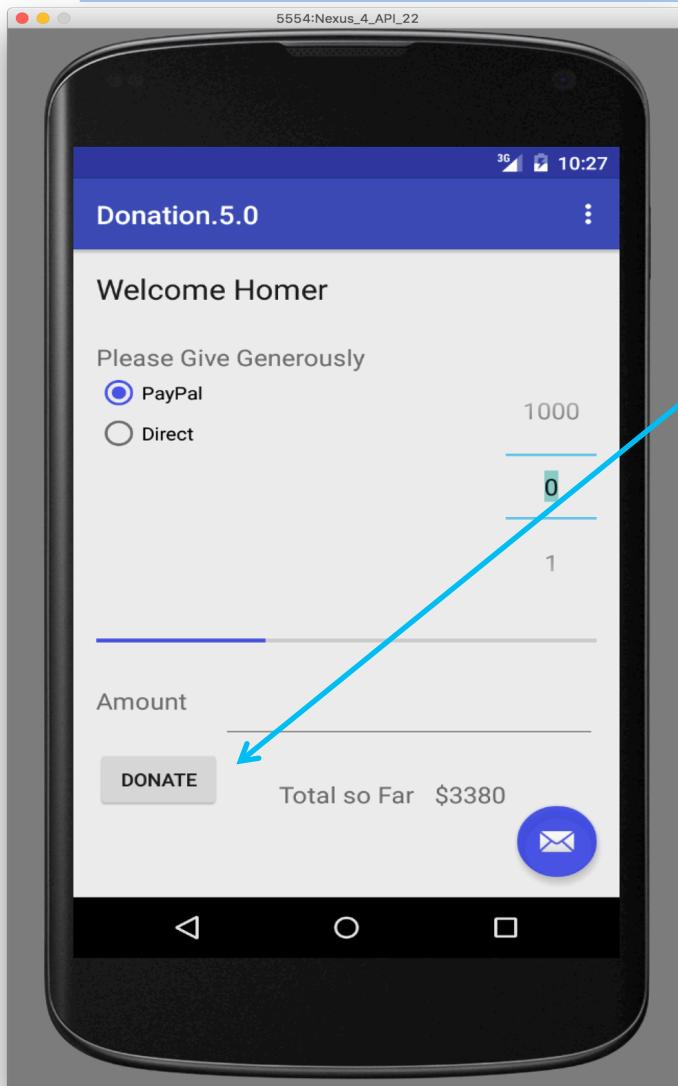


```
public void donateButtonPressed (View view)
{
    String method = paymentMethod.getCheckedRadioButtonId() == R.id.PayPal ? "PayPal" : "Direct";
    int donatedAmount = amountPicker.getValue();
    if (donatedAmount == 0)
    {
        String text = amountText.getText().toString();
        if (!text.equals(""))
            donatedAmount = Integer.parseInt(text);
    }
    if (donatedAmount > 0)
    {
        if (!isTargetAchieved())
        {
            new InsertTask(this).execute("/donations", new Donation(donatedAmount, method, 0));
            new GetAllTask(this).execute("/donations");

            progressBar.setProgress(app.totalDonated);
            String totalDonatedStr = "$" + app.totalDonated;
            amountTotal.setText(totalDonatedStr);
        }
        else
            Toast.makeText(this, "Target Exceeded!", Toast.LENGTH_SHORT).show();
    }
}
```



Donation 5.0 – Donate Activity

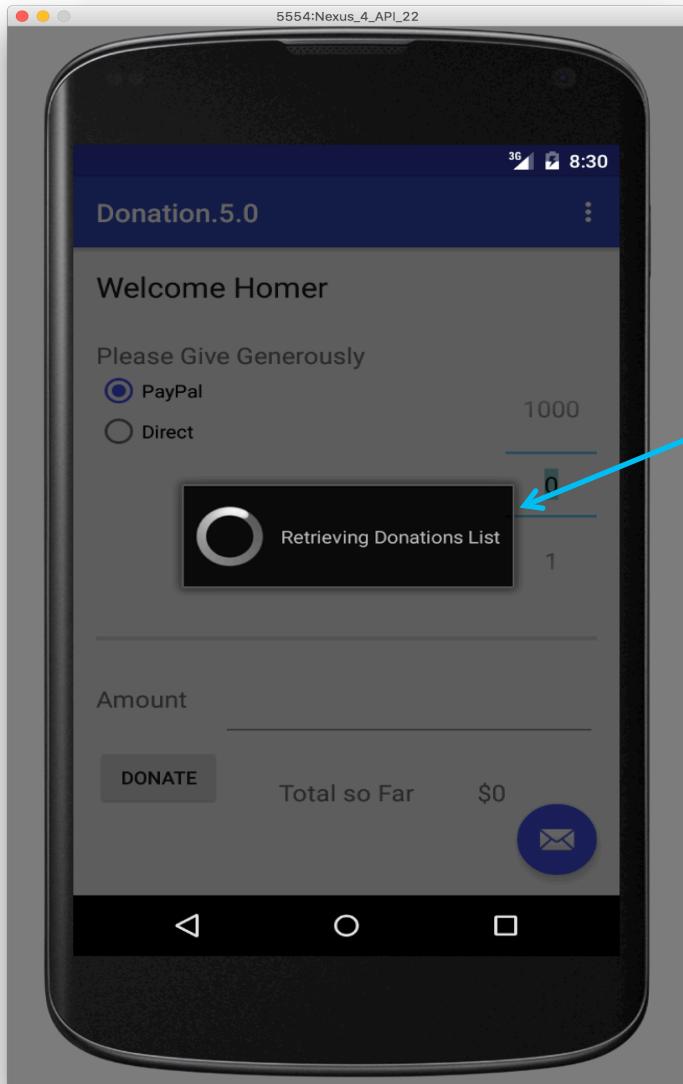


```
public void donateButtonPressed (View view)
{
    String method = paymentMethod.getCheckedRadioButtonId() == R.id.PayPal ? "PayPal" : "Direct";
    int donatedAmount = amountPicker.getValue();
    if (donatedAmount == 0)
    {
        String text = amountText.getText().toString();
        if (!text.equals(""))
            donatedAmount = Integer.parseInt(text);
    }
    if (donatedAmount > 0)
    {
        if(!listTargetAchieved()){
            new InsertTask(this).execute("/donations", new Donation(donatedAmount, method, 0));
            new GetAllTask(this).execute("/donations");

            progressBar.setProgress(app.totalDonated);
            String totalDonatedStr = "$" + app.totalDonated;
            amountTotal.setText(totalDonatedStr);
        }
        else
            Toast.makeText(this, "Target Exceeded!", Toast.LENGTH_SHORT).show();
    }
}
```



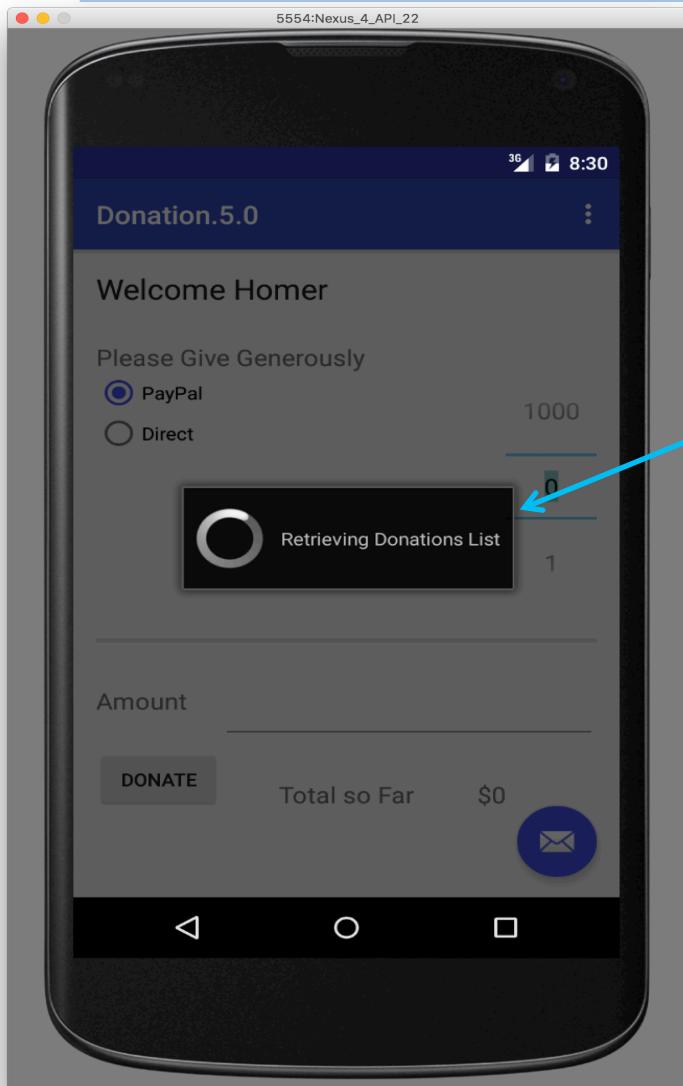
Donation 5.0 – AsyncTask : GetAllTask



```
private class GetAllTask extends AsyncTask<String, Void, List<Donation>> {  
  
    protected ProgressDialog dialog;  
    protected Context context;  
  
    public GetAllTask(Context context) { this.context = context; }  
  
    @Override  
    protected void onPreExecute() {  
        super.onPreExecute();  
        this.dialog = new ProgressDialog(context, 1);  
        this.dialog.setMessage("Retrieving Donations List");  
        this.dialog.show();  
    }  
  
    @Override  
    protected List<Donation> doInBackground(String... params) {  
        try {  
            Log.v("donate", "Donation App Getting All Donations");  
            return (List<Donation>) DonationApi.getAll((String) params[0]);  
        } catch (Exception e) {  
            Log.v("donate", "ERROR : " + e);  
            e.printStackTrace();  
        }  
        return null;  
    }  
  
    @Override  
    protected void onPostExecute(List<Donation> result) {  
        super.onPostExecute(result);  
        app.totalDonated = 0;  
        app.donations = result;  
        for (Donation d : app.donations)  
            app.totalDonated += d.amount;  
  
        progressBar.setProgress(app.totalDonated);  
        amountTotal.setText("$" + app.totalDonated);  
  
        if (dialog.isShowing())  
            dialog.dismiss();  
    }  
}
```



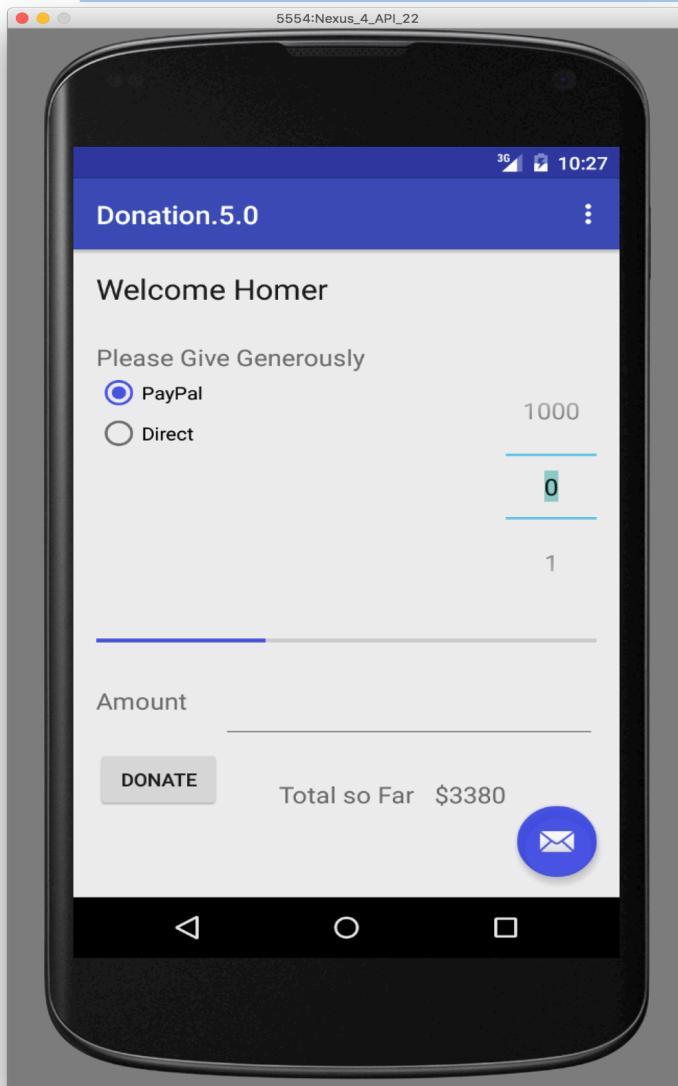
Donation 5.0 – AsyncTask : GetAllTask



```
private class GetAllTask extends AsyncTask<String, Void, List<Donation>> {  
  
    protected ProgressDialog dialog;  
    protected Context context;  
  
    public GetAllTask(Context context) { this.context = context; }  
  
    @Override  
    protected void onPreExecute() {  
        super.onPreExecute();  
        this.dialog = new ProgressDialog(context, 1);  
        this.dialog.setMessage("Retrieving Donations List");  
        this.dialog.show();  
    }  
  
    @Override  
    protected List<Donation> doInBackground(String... params) {  
        try {  
            Log.v("donate", "Donation App Getting All Donations");  
            return (List<Donation>) DonationApi.getAll((String) params[0]);  
        } catch (Exception e) {  
            Log.v("donate", "ERROR : " + e);  
            e.printStackTrace();  
        }  
        return null;  
    }  
  
    @Override  
    protected void onPostExecute(List<Donation> result) {  
        super.onPostExecute(result);  
        app.totalDonated = 0;  
        app.donations = result;  
        for (Donation d : app.donations)  
            app.totalDonated += d.amount;  
  
        progressBar.setProgress(app.totalDonated);  
        amountTotal.setText("$" + app.totalDonated);  
  
        if (dialog.isShowing())  
            dialog.dismiss();  
    }  
}
```



Donation 5.0 – AsyncTask : InsertTask



```
private class InsertTask extends AsyncTask<Object, Void, String> {

    protected ProgressDialog dialog;
    protected Context context;

    public InsertTask(Context context) { this.context = context; }

    @Override
    protected void onPreExecute() {
        super.onPreExecute();
        this.dialog = new ProgressDialog(context, 1);
        this.dialog.setMessage("Saving Donation....");
        this.dialog.show();
    }

    @Override
    protected String doInBackground(Object... params) {

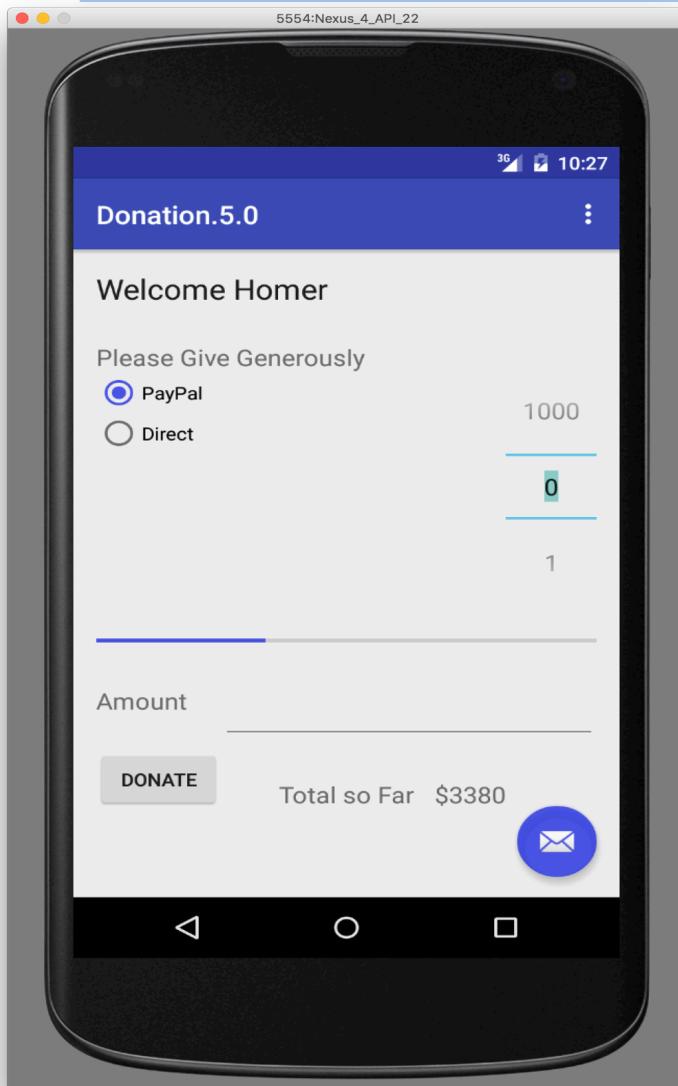
        String res = null;
        try {
            Log.v("donate", "Donation App Inserting");
            res = DonationApi.insert((String) params[0], (Donation) params[1]);
        } catch(Exception e) {
            Log.v("donate", "ERROR : " + e);
            e.printStackTrace();
        }
        return res;
    }

    @Override
    protected void onPostExecute(String result) {
        super.onPostExecute(result);

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



Donation 5.0 – AsyncTask : InsertTask



```
private class InsertTask extends AsyncTask<Object, Void, String> {

    protected ProgressDialog dialog;
    protected Context context;

    public InsertTask(Context context) { this.context = context; }

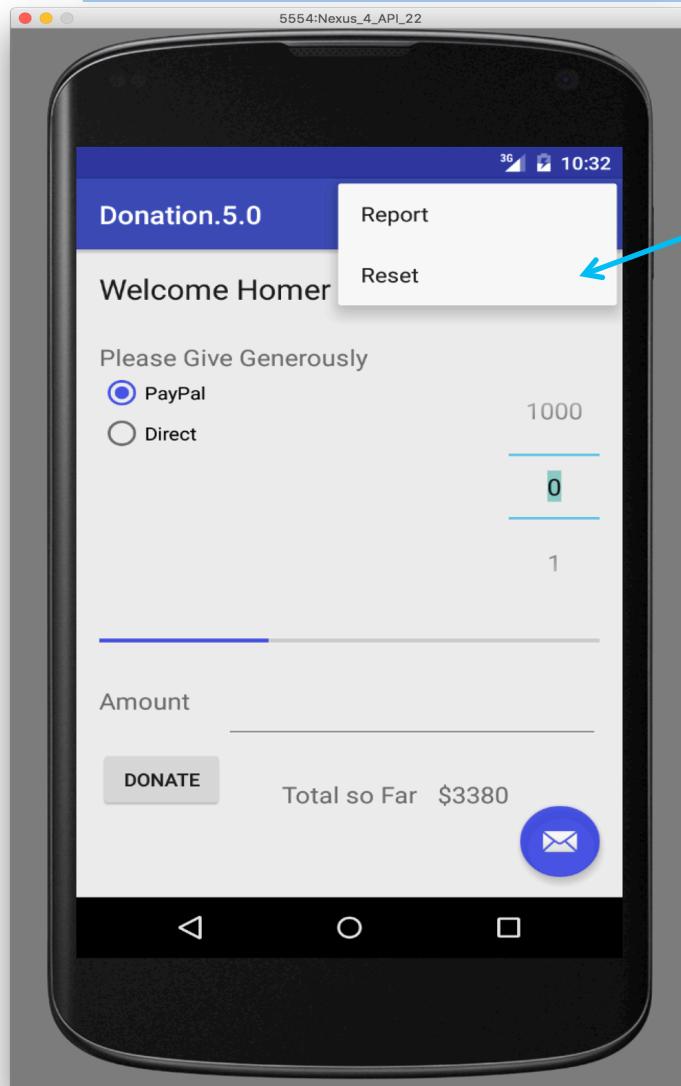
    @Override
    protected void onPreExecute() {
        super.onPreExecute();
        this.dialog = new ProgressDialog(context, 1);
        this.dialog.setMessage("Saving Donation....");
        this.dialog.show();
    }

    @Override
    protected String doInBackground(Object... params) {
        String res = null;
        try {
            Log.v("donate", "Donation App Inserting");
            res = DonationApi.insert((String) params[0], (Donation) params[1]);
        } catch (Exception e) {
            Log.v("donate", "ERROR : " + e);
            e.printStackTrace();
        }
        return res;
    }

    @Override
    protected void onPostExecute(String result) {
        super.onPostExecute(result);

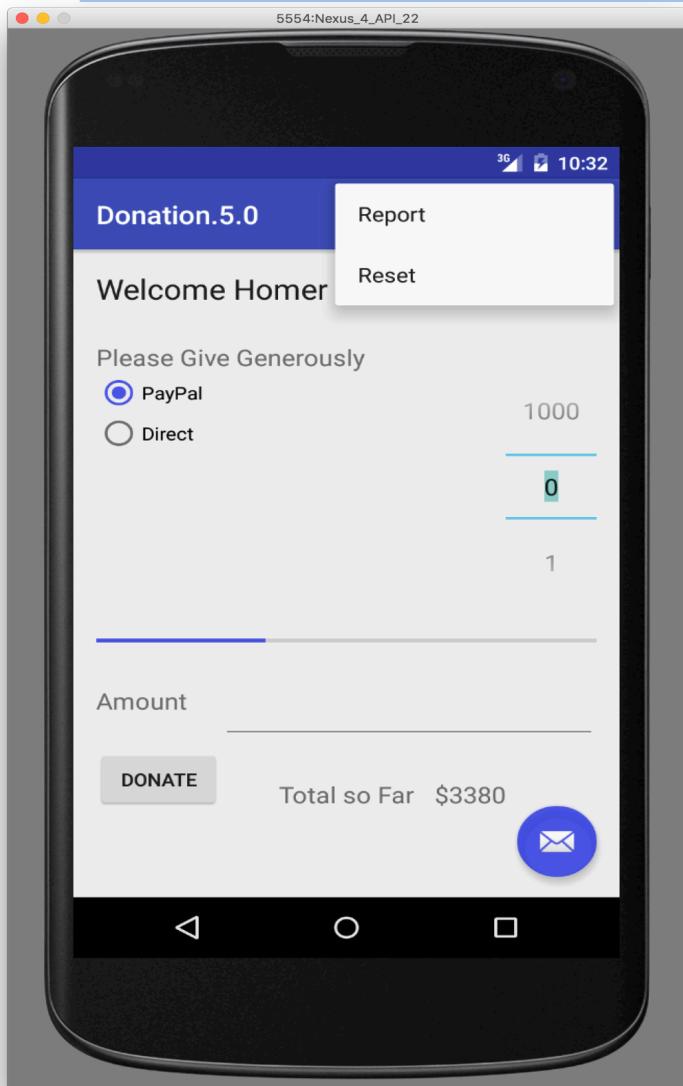
        if (dialog.isShowing())
            dialog.dismiss();
    }
}
```

Donation 5.0 – ResetTask



```
@Override  
public void reset(MenuItem item)  
{  
    new ResetTask(this, app.donations).execute("/donations");  
    app.totalDonated = 0;  
    amountTotal.setText("$" + app.totalDonated);  
}
```

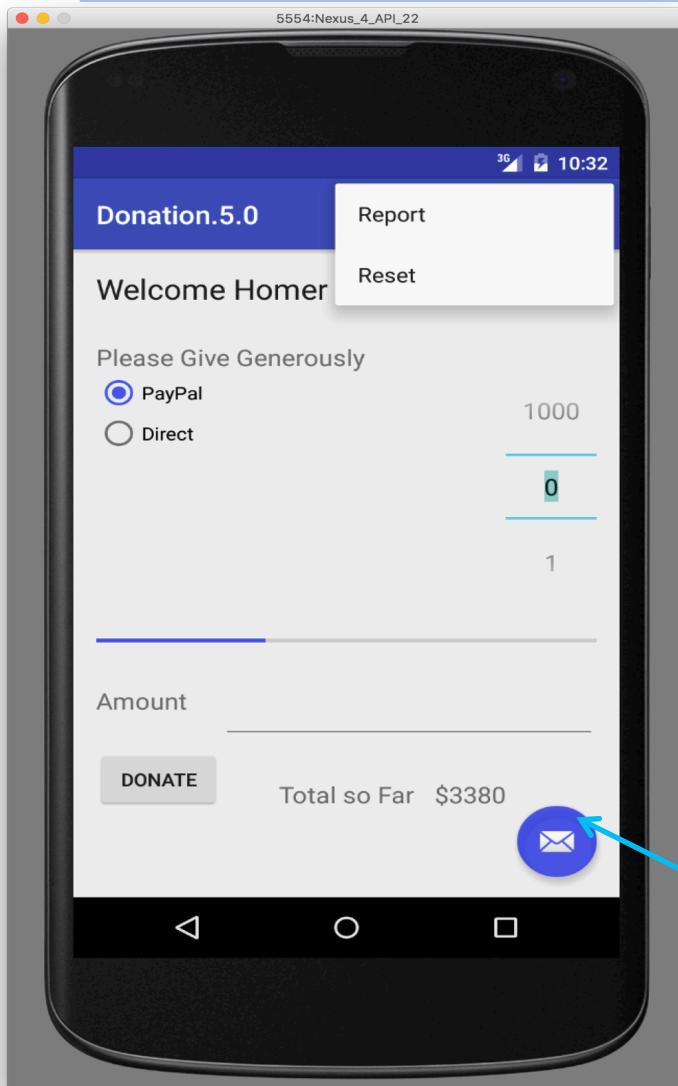
Donation 5.0 – ResetTask



```
private class ResetTask extends AsyncTask<Object, Void, String> {  
    protected ProgressDialog dialog;  
    protected Context context;  
    protected List<Donation> donations;  
  
    public ResetTask(Context context, List<Donation> donations)  
    {...}  
  
    @Override  
    protected void onPreExecute() {...}  
  
    @Override  
    protected String doInBackground(Object... params) {  
  
        String res = null;  
        try {  
            res = DonationApi.deleteAll((String)params[0]);  
        }  
  
        catch(Exception e)  
        {  
            Log.v("donate", " RESET ERROR : " + e);  
            e.printStackTrace();  
        }  
        return res;  
    }  
  
    @Override  
    protected void onPostExecute(String result) {  
        super.onPostExecute(result);  
  
        app.totalDonated = 0;  
        progressBar.setProgress(app.totalDonated);  
        amountTotal.setText("$" + app.totalDonated);  
  
        if (dialog.isShowing())  
            dialog.dismiss();  
    }  
}  
  
@Override  
public void reset(MenuItem item)  
{  
    new ResetTask(this,app.donations).execute("/donations");  
    app.totalDonated = 0;  
    amountTotal.setText("$" + app.totalDonated);  
}
```



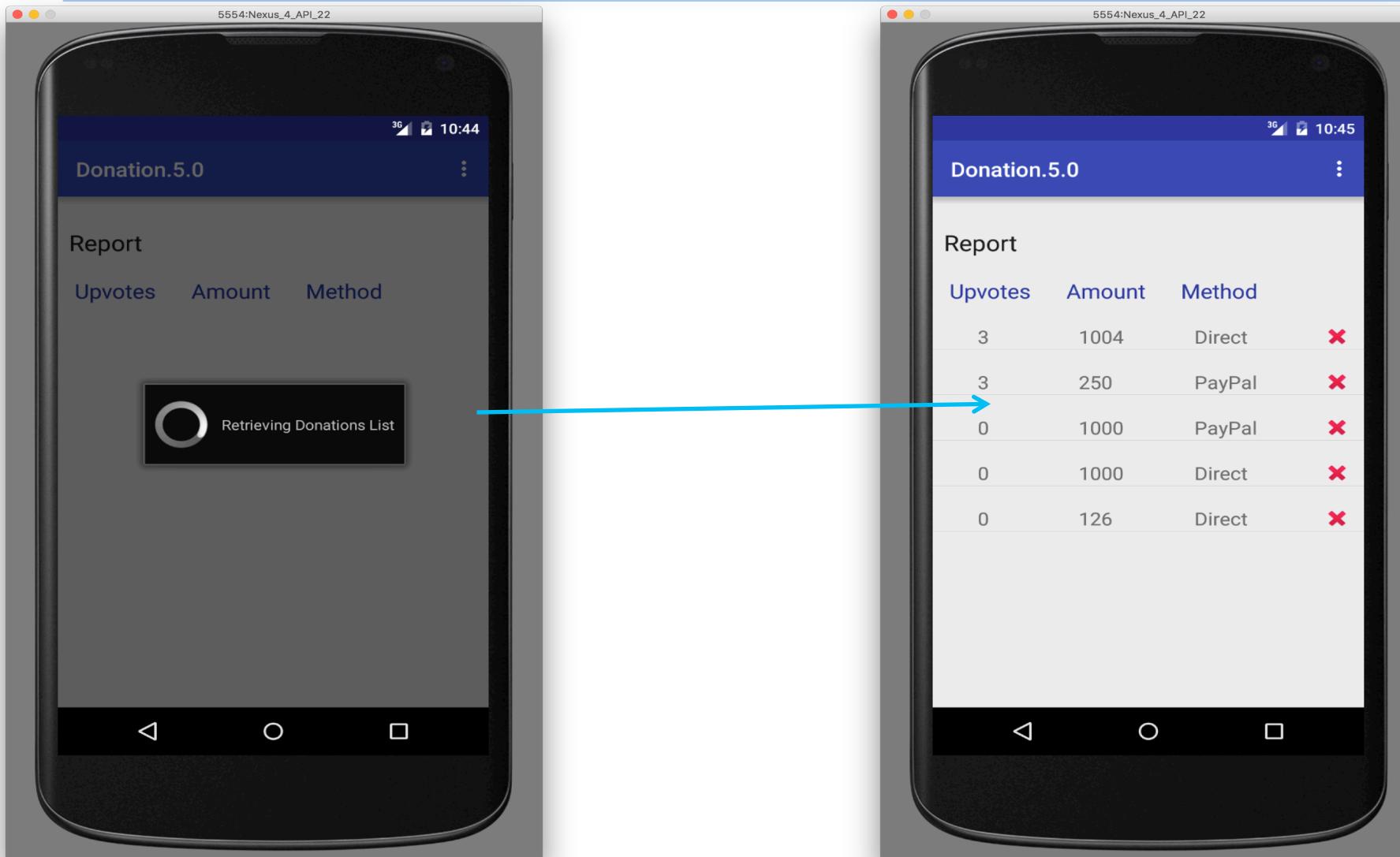
Donation 5.0 – ResetTask



```
private class ResetTask extends AsyncTask<Object, Void, String> {  
    protected ProgressDialog dialog;  
    protected Context context;  
    protected List<Donation> donations;  
  
    public ResetTask(Context context, List<Donation> donations)  
    {...}  
  
    @Override  
    protected void onPreExecute() {...}  
  
    @Override  
    protected String doInBackground(Object... params) {  
  
        String res = null;  
        try {  
            res = DonationApi.deleteAll((String)params[0]);  
        } catch(Exception e){  
            Log.v("donate", " RESET ERROR : " + e);  
            e.printStackTrace();  
        }  
        return res;  
    }  
  
    @Override  
    protected void onPostExecute(String result) {  
        super.onPostExecute(result);  
  
        app.totalDonated = 0;  
        progressBar.setProgress(app.totalDonated);  
        amountTotal.setText("$" + app.totalDonated);  
  
        if (dialog.isShowing())  
            dialog.dismiss();  
    }  
}
```

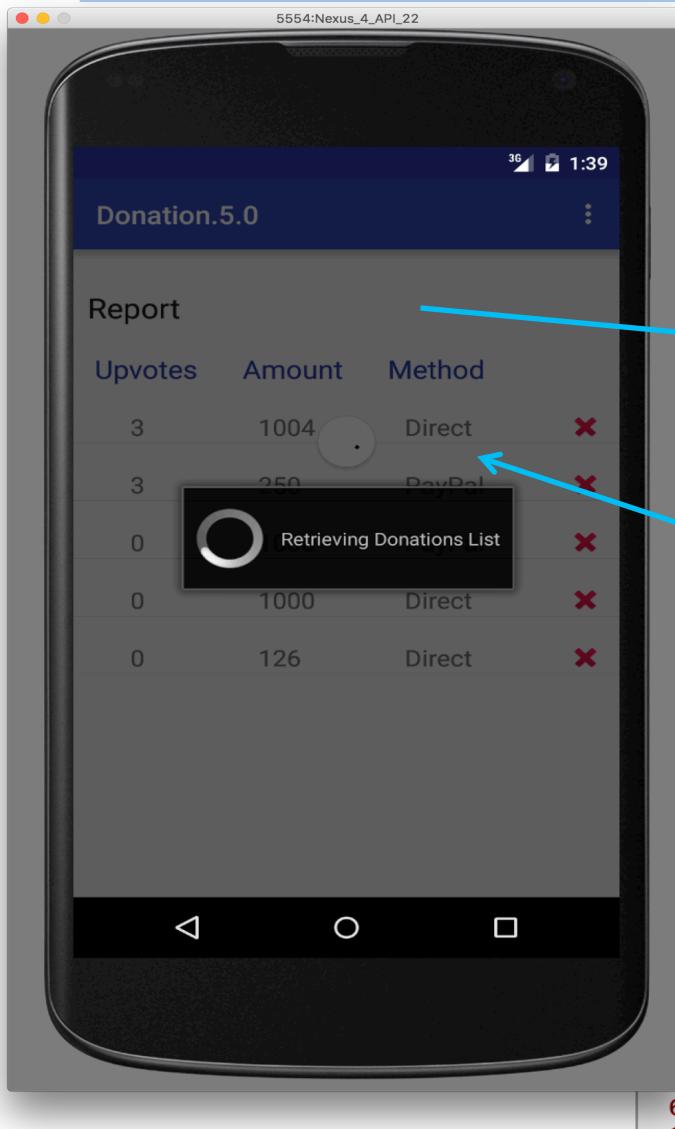


Donation 5.0 – Report Activity





Donation 5.0 – Report Activity



```
package ie.app.activities;

import ...

public class Report extends Base implements OnItemClickListener, OnClickListener {
    ListView listView;
    DonationAdapter adapter;
    SwipeRefreshLayout mSwipeRefreshLayout;

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_report);

        listView = (ListView) findViewById(R.id.reportList);
        mSwipeRefreshLayout = (SwipeRefreshLayout) findViewById(R.id.report_swipe_refresh_layout);

        new GetAllTask(this).execute("/donations");

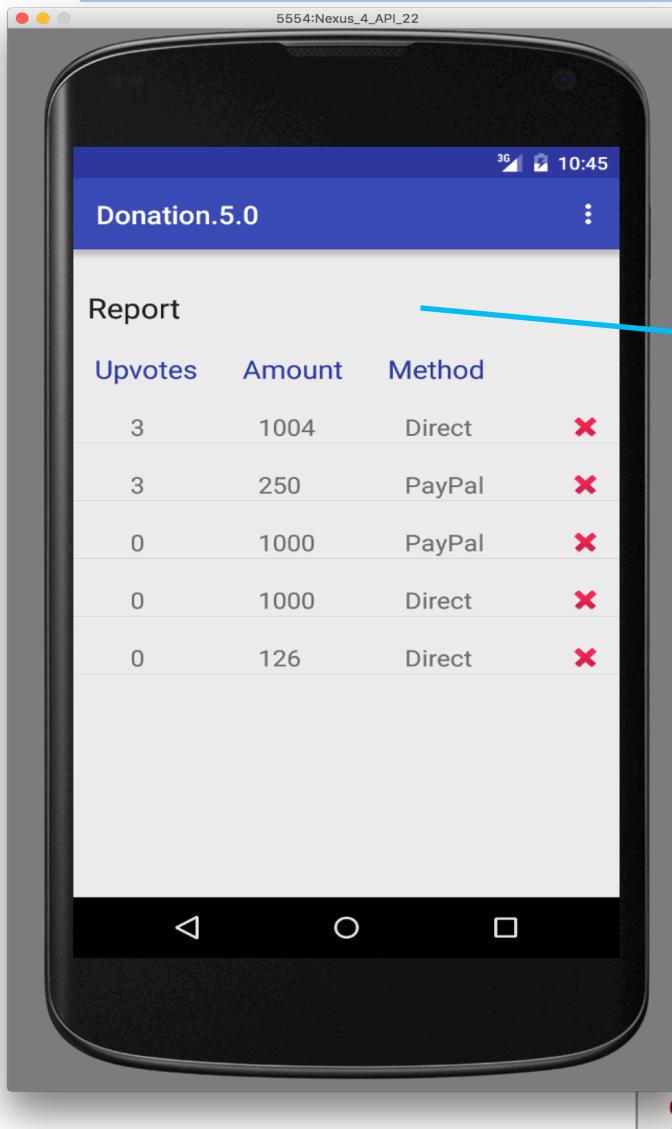
        mSwipeRefreshLayout.setOnRefreshListener(new SwipeRefreshLayout.OnRefreshListener() {
            @Override
            public void onRefresh() {
                new GetAllTask(Report.this).execute("/donations");
            }
        });
    }

    @Override
    public void onItemClick(AdapterView<?> arg0, View row, int pos, long id) {
        new GetTask(this).execute("/donations", row.getTag().toString());
    }

    @Override
    public void onClick(View view) {
        if (view.getTag() instanceof Donation) {
            onDonationDelete((Donation) view.getTag());
        }
    }
}
```



Donation 5.0 – Report Activity



```
package ie.app.activities;

import ...

public class Report extends Base implements OnItemClickListener, OnClickListener {
    ListView listView;
    DonationAdapter adapter;
    SwipeRefreshLayout mSwipeRefreshLayout;

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_report);

        listView = (ListView) findViewById(R.id.reportList);
        mSwipeRefreshLayout = (SwipeRefreshLayout) findViewById(R.id.report_swipe_refresh_layout);

        new GetAllTask(this).execute("/donations");
    }

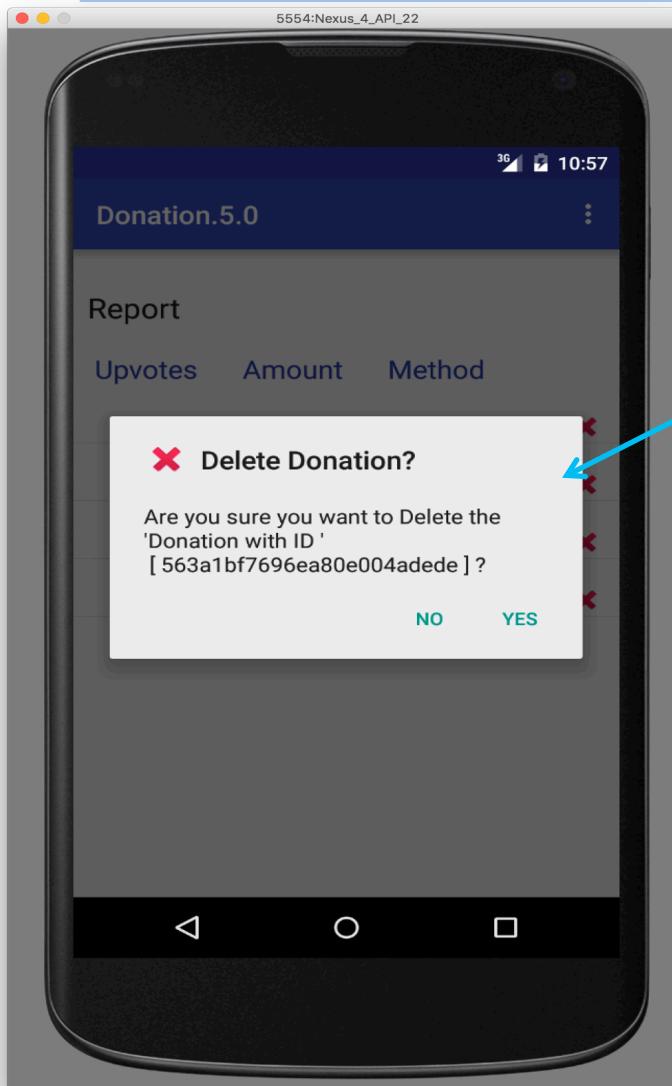
    mSwipeRefreshLayout.setOnRefreshListener(new SwipeRefreshLayout.OnRefreshListener() {
        @Override
        public void onRefresh() {
            new GetAllTask(Report.this).execute("/donations");
        }
    });

    @Override
    public void onItemClick(AdapterView<?> arg0, View row, int pos, long id) {
        new GetTask(this).execute("/donations", row.getTag().toString());
    }

    @Override
    public void onClick(View view) {
        if (view.getTag() instanceof Donation) {
            onDonationDelete((Donation) view.getTag());
        }
    }
}
```



Donation 5.0 – Report Activity



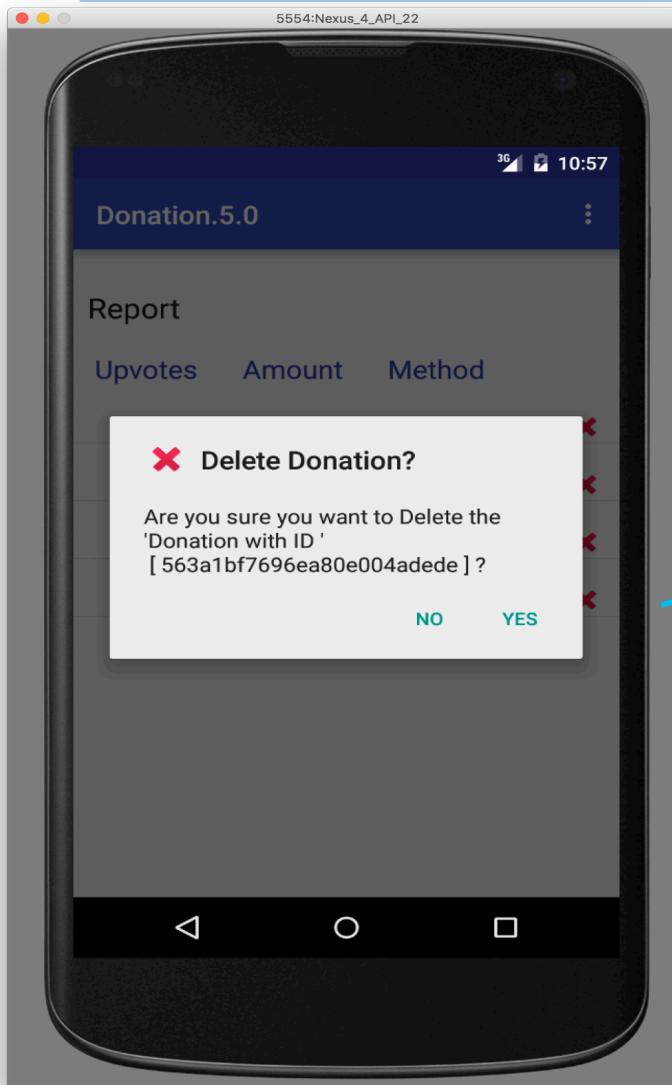
```
66
67
68
69
70 x
71
72
73
74
75 ↑
76
77
78
79
80
81
82
83
84
85
86
87
88
```

```
public void onDonationDelete(final Donation donation) {
    String stringId = donation._id;
    AlertDialog.Builder builder = new AlertDialog.Builder(this);
    builder.setTitle("Delete Donation?");
    builder.setIcon(android.R.drawable.ic_delete);
    builder.setMessage("Are you sure you want to Delete the \\'Donation with ID \' \n [ "
        + stringId + " ] ?");
    builder.setCancelable(false);

    builder.setPositiveButton("Yes", (dialog, id) -> {
        new DeleteTask(Report.this).execute("/donations", donation._id);
    }).setNegativeButton("No", (dialog, id) -> { dialog.cancel(); });
    AlertDialog alert = builder.create();
    alert.show();
}
```



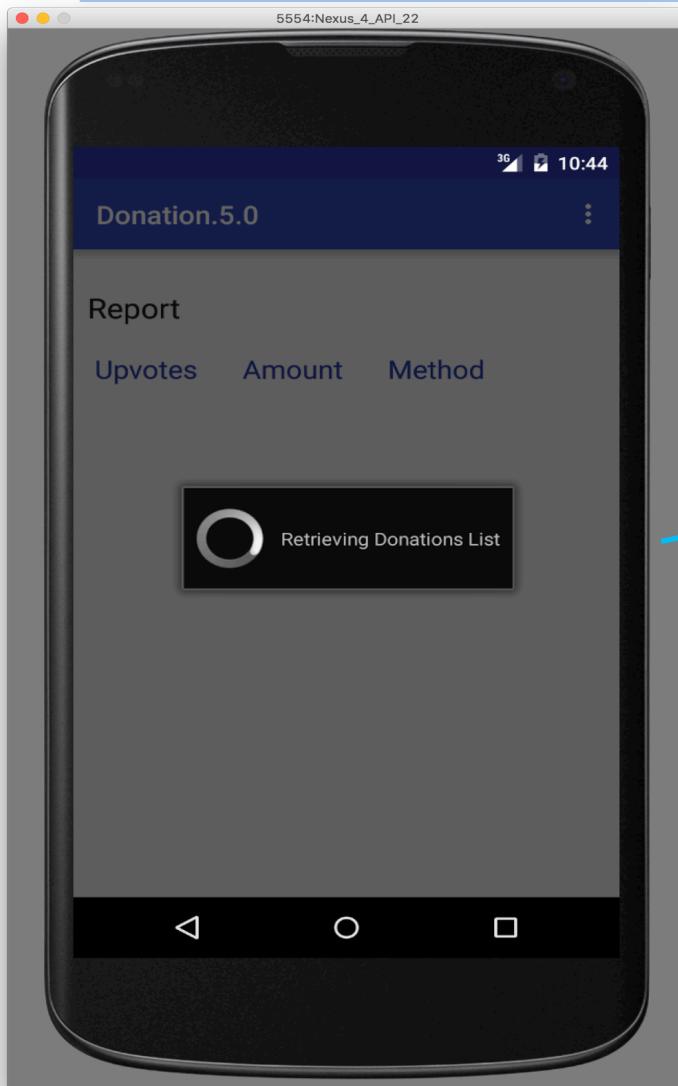
Donation 5.0 – Report Activity



```
66 public void onDonationDelete(final Donation donation) {  
67     String stringId = donation._id;  
68     AlertDialog.Builder builder = new AlertDialog.Builder(this);  
69     builder.setTitle("Delete Donation?");  
70     builder.setIcon(android.R.drawable.ic_delete);  
71     builder.setMessage("Are you sure you want to Delete the \n'Donation with ID ' \n[ " +  
72         stringId + " ] ?");  
73     builder.setCancelable(false);  
74  
75     builder.setPositiveButton("Yes", (dialog, id) -> {  
76         new DeleteTask(Report.this).execute("/donations", donation._id);  
77     }).setNegativeButton("No", (dialog, id) -> { dialog.cancel(); });  
78     AlertDialog alert = builder.create();  
79     alert.show();  
80 }  
81  
82 }  
83  
84 }  
85  
86 }  
87  
88 }  
89  
90 }
```



Donation 5.0 – Report : GetAllTask



```
private class GetAllTask extends AsyncTask<String, Void, List<Donation>> {

    protected ProgressDialog dialog;
    protected Context context;

    public GetAllTask(Context context) { this.context = context; }

    @Override
    protected void onPreExecute() {}

    @Override
    protected List<Donation> doInBackground(String... params) {

        try {
            return (List<Donation>) DonationApi.getAll((String) params[0]);
        } catch (Exception e) {
            Log.v("ASYNC", "ERROR : " + e);
            e.printStackTrace();
        }
        return null;
    }

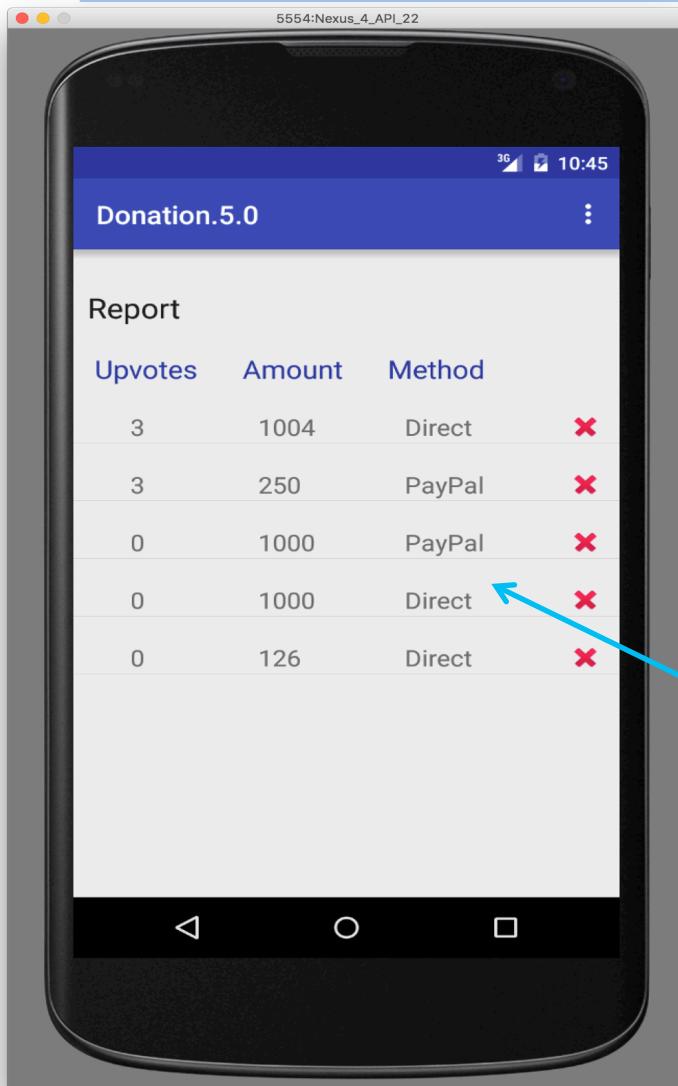
    @Override
    protected void onPostExecute(List<Donation> result) {
        super.onPostExecute(result);

        app.donations = result;
        adapter = new DonationAdapter(context, app.donations);
        listView.setAdapter(adapter);
        listView.setOnItemClickListener(Report.this);
        mSwipeRefreshLayout.setRefreshing(false);

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



Donation 5.0 – Report : GetAllTask



```
private class GetAllTask extends AsyncTask<String, Void, List<Donation>> {

    protected ProgressDialog dialog;
    protected Context context;

    public GetAllTask(Context context) { this.context = context; }

    @Override
    protected void onPreExecute() {}

    @Override
    protected List<Donation> doInBackground(String... params) {

        try {
            return (List<Donation>) DonationApi.getAll((String) params[0]);
        } catch (Exception e) {
            Log.v("ASYNC", "ERROR : " + e);
            e.printStackTrace();
        }
        return null;
    }

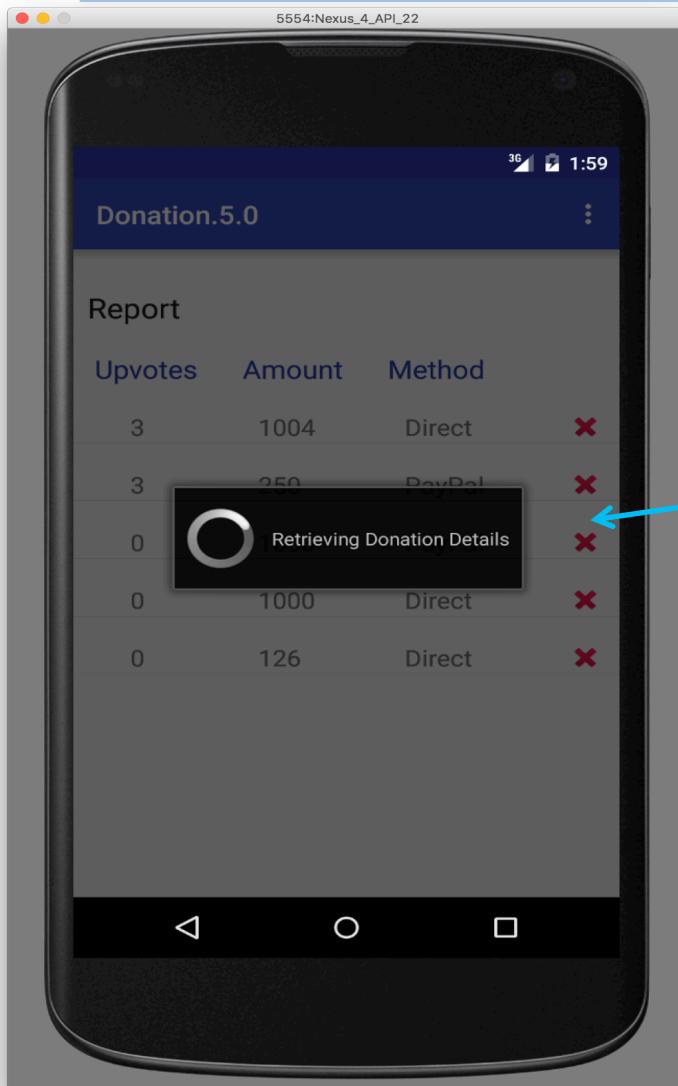
    @Override
    protected void onPostExecute(List<Donation> result) {
        super.onPostExecute(result);

        app.donations = result;
        adapter = new DonationAdapter(context, app.donations);
        listView.setAdapter(adapter);
        listView.setOnItemClickListener(Report.this);
        mSwipeRefreshLayout.setRefreshing(false);

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



Donation 5.0 – Report : GetTask



```
private class GetTask extends AsyncTask<String, Void, Donation> {

    protected ProgressDialog dialog;
    protected Context context;

    public GetTask(Context context) { this.context = context; }

    @Override
    protected void onPreExecute() {}

    @Override
    protected Donation doInBackground(String... params) {

        try {
            return (Donation) DonationApi.get((String) params[0], (String) params[1]);
        } catch (Exception e) {
            Log.v("donate", "ERROR : " + e);
            e.printStackTrace();
        }
        return null;
    }

    @Override
    protected void onPostExecute(Donation result) {
        super.onPostExecute(result);

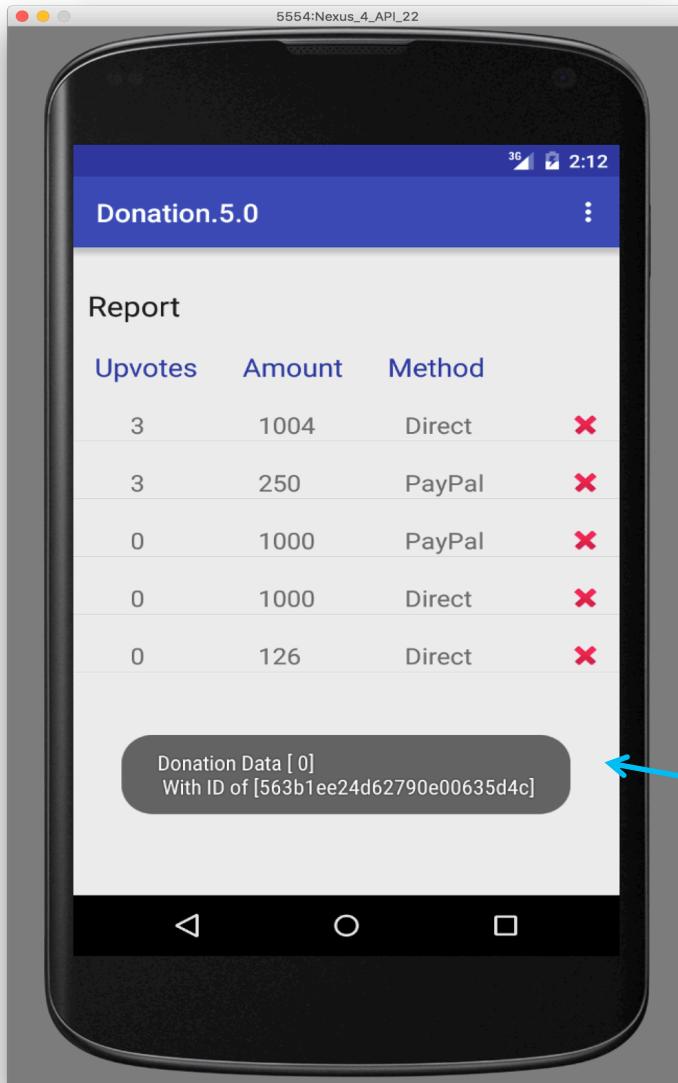
        Donation donation = result;

        Toast.makeText(Report.this, "Donation Data [ " + donation.upvotes + "\n " +
                "With ID of [ " + donation._id + "]", Toast.LENGTH_LONG).show();

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



Donation 5.0 – Report : GetTask



```
private class GetTask extends AsyncTask<String, Void, Donation> {

    protected ProgressDialog dialog;
    protected Context context;

    public GetTask(Context context) { this.context = context; }

    @Override
    protected void onPreExecute() {}

    @Override
    protected Donation doInBackground(String... params) {

        try {
            return (Donation) DonationApi.get((String) params[0], (String) params[1]);
        } catch (Exception e) {
            Log.v("donate", "ERROR : " + e);
            e.printStackTrace();
        }
        return null;
    }

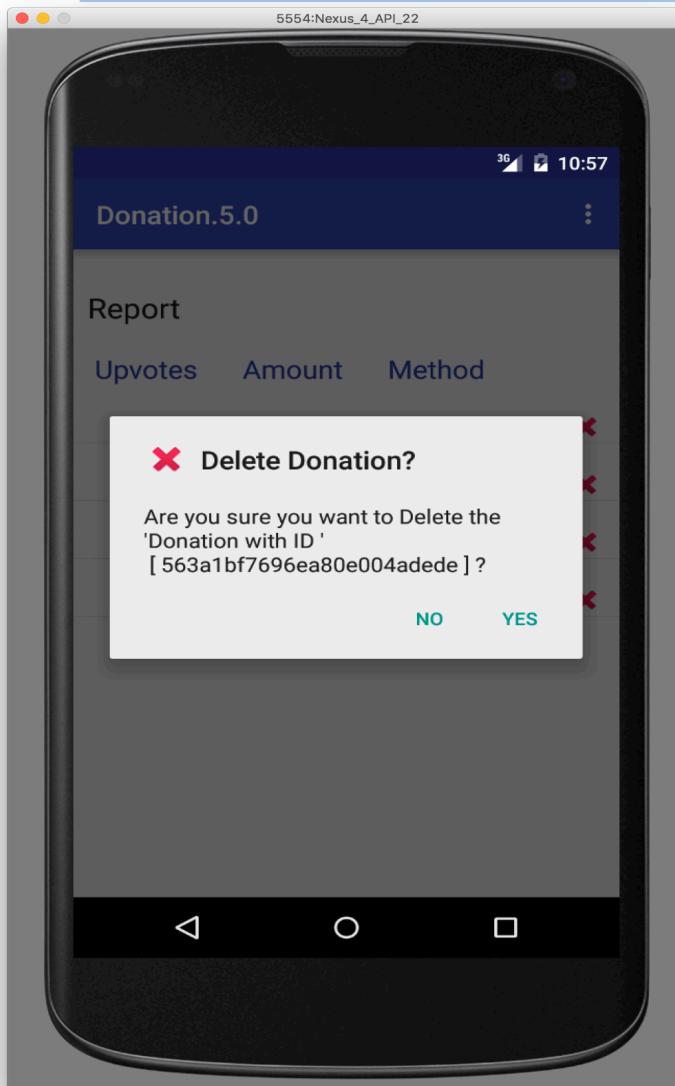
    @Override
    protected void onPostExecute(Donation result) {
        super.onPostExecute(result);

        Donation donation = result;
        Toast.makeText(Report.this, "Donation Data [ " + donation.upvotes + "]\n" +
                "With ID of [ " + donation._id + "]", Toast.LENGTH_LONG).show();

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



Donation 5.0 – Report : DeleteTask



```
private class DeleteTask extends AsyncTask<String, Void, String> {

    protected ProgressDialog dialog;
    protected Context context;

    public DeleteTask(Context context) { this.context = context; }

    @Override
    protected void onPreExecute() {}

    @Override
    protected String doInBackground(String... params) {

        try {
            return (String) DonationApi.delete((String) params[0], (String) params[1]);
        } catch (Exception e) {
            Log.v("donate", "ERROR : " + e);
            e.printStackTrace();
        }
        return null;
    }

    @Override
    protected void onPostExecute(String result) {
        super.onPostExecute(result);

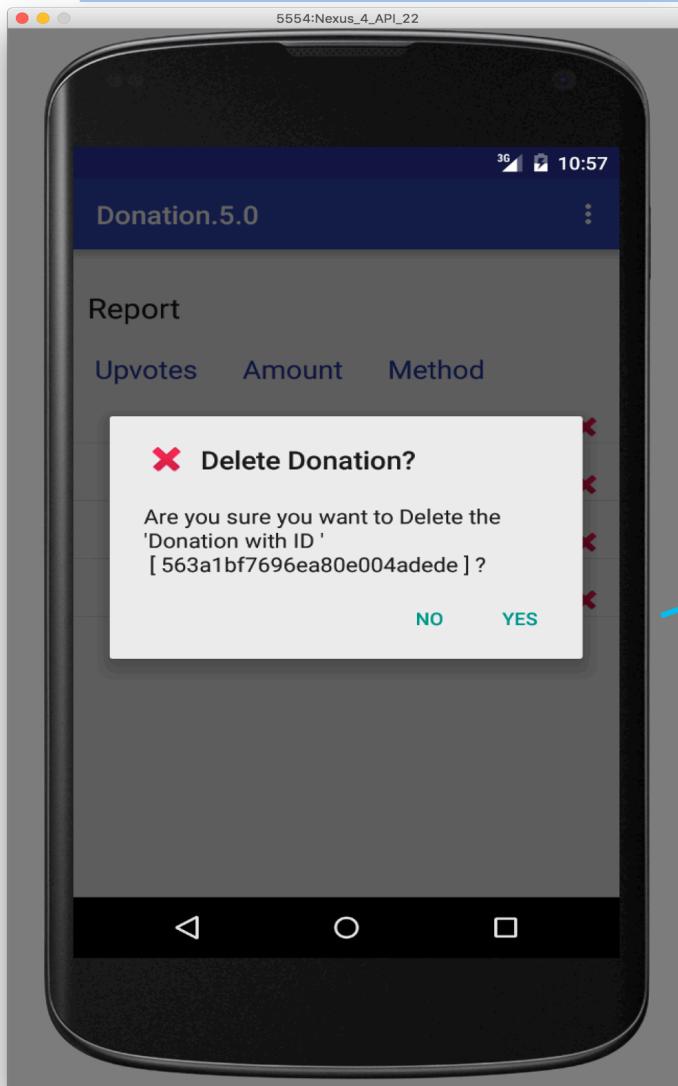
        String s = result;
        Log.v("donate", "DELETE REQUEST : " + s);

        new GetAllTask(Report.this).execute("/donations");

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



Donation 5.0 – Report : DeleteTask



```
private class DeleteTask extends AsyncTask<String, Void, String> {

    protected ProgressDialog dialog;
    protected Context context;

    public DeleteTask(Context context) { this.context = context; }

    @Override
    protected void onPreExecute() {}

    @Override
    protected String doInBackground(String... params) {

        try {
            return (String) DonationApi.delete((String) params[0], (String) params[1]);
        } catch (Exception e) {
            Log.v("donate", "ERROR : " + e);
            e.printStackTrace();
        }
        return null;
    }

    @Override
    protected void onPostExecute(String result) {
        super.onPostExecute(result);

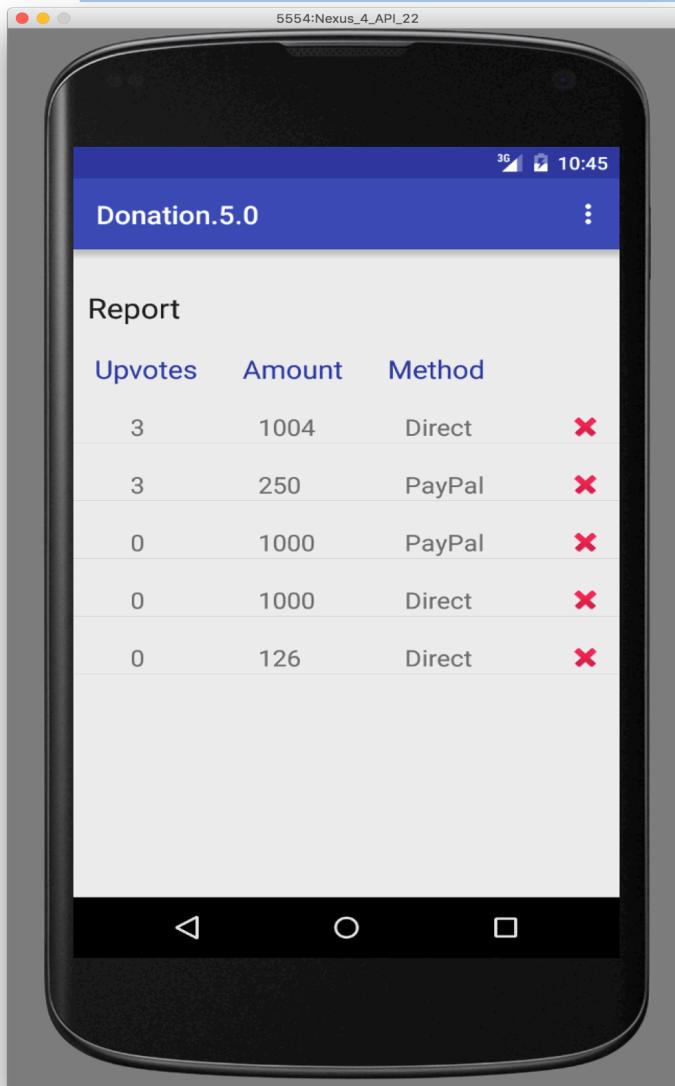
        String s = result;
        Log.v("donate", "DELETE REQUEST : " + s);

        new GetAllTask(Report.this).execute("/donations");

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



Donation 5.0 – Report : DonationAdapter



```
class DonationAdapter extends ArrayAdapter<Donation> {
    private Context context;
    public List<Donation> donations;

    public DonationAdapter(Context context, List<Donation> donations) {
        super(context, R.layout.row_donate, donations);
        this.context = context;
        this.donations = donations;
    }

    @Override
    public View getView(int position, View convertView, ViewGroup parent) {
        LayoutInflater inflater = (LayoutInflater) context
            .getSystemService(Context.LAYOUT_INFLATER_SERVICE);

        View view = inflater.inflate(R.layout.row_donate, parent, false);
        Donation donation = donations.get(position);

        ImageView imgDelete = (ImageView) view.findViewById(R.id.imgDelete);
        imgDelete.setTag(donation);
        imgDelete.setOnClickListener(Report.this);

        TextView amountView = (TextView) view.findViewById(R.id.row_amount);
        TextView methodView = (TextView) view.findViewById(R.id.row_method);
        TextView upvotesView = (TextView) view.findViewById(R.id.row_upvotes);

        amountView.setText("+" + donation.amount);
        methodView.setText(donation.paymenttype);
        upvotesView.setText("+" + donation.upvotes);

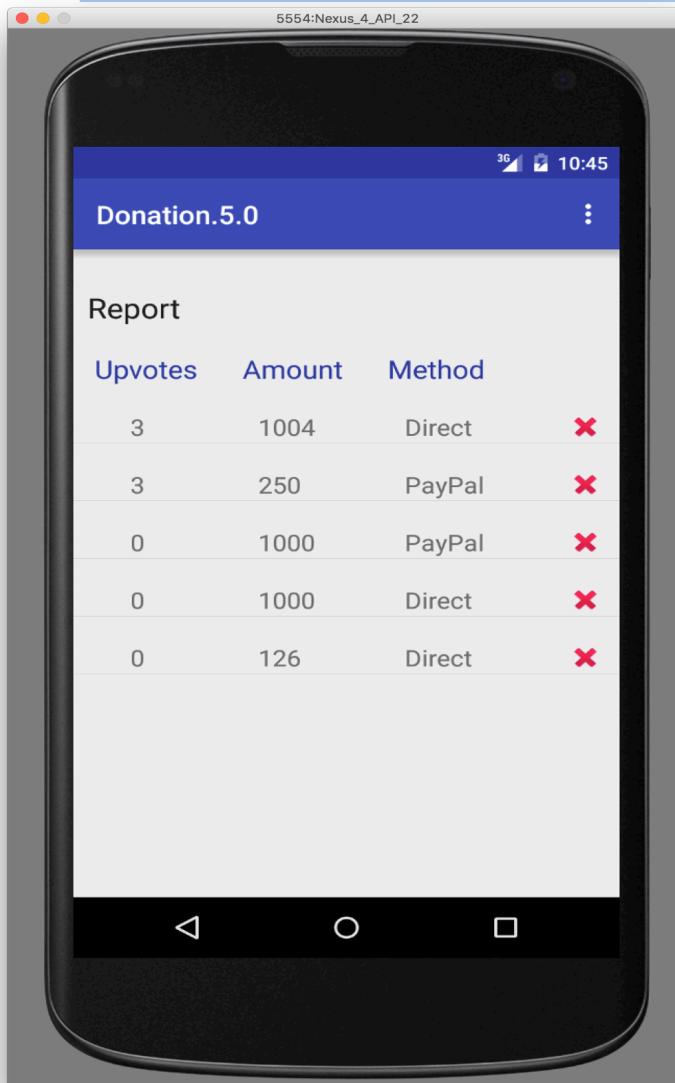
        view.setTag(donation._id); // setting the 'row' id to the id of the donation

        return view;
    }

    @Override
    public int getCount() { return donations.size(); }
}
```



Donation 5.0 – Report : DonationAdapter



```
class DonationAdapter extends ArrayAdapter<Donation> {
    private Context context;
    public List<Donation> donations;

    public DonationAdapter(Context context, List<Donation> donations) {
        super(context, R.layout.row_donate, donations);
        this.context = context;
        this.donations = donations;
    }

    @Override
    public View getView(int position, View convertView, ViewGroup parent) {
        LayoutInflater inflater = (LayoutInflater) context
            .getSystemService(Context.LAYOUT_INFLATER_SERVICE);

        View view = inflater.inflate(R.layout.row_donate, parent, false);
        Donation donation = donations.get(position);

        ImageView imgDelete = (ImageView) view.findViewById(R.id.imgDelete);
        imgDelete.setTag(donation);
        imgDelete.setOnClickListener(Report.this);

        TextView amountView = (TextView) view.findViewById(R.id.row_amount);
        TextView methodView = (TextView) view.findViewById(R.id.row_method);
        TextView upvotesView = (TextView) view.findViewById(R.id.row_upvotes);

        amountView.setText(" " + donation.amount);
        methodView.setText(donation.paymenttype);
        upvotesView.setText(" " + donation.upvotes);

        view.setTag(donation._id); // setting the 'row' id to the id of the donation

        return view;
    }

    @Override
    public int getCount() { return donations.size(); }
}
```



A bit about JSON & Googles Gson



Question?

- ❑ Given a particular set of data, how do you store it permanently?
 - What do you store on disk?
 - What format?
 - Can you easily transmit over the web?
 - Will it be readable by other languages?
 - Can humans read the data?
- ❑ Examples:
 - A Square
 - A Dictionary
 - A Donation...



Storage Using Plain Text

❑ Advantages

- Human readable (good for debugging / manual editing)
- Portable to different platforms
- Easy to transmit using web

❑ Disadvantages

- Takes more memory than necessary

❑ Alternative? - use a standardized system -- JSON

- Makes the information more portable



JavaScript Object Notation – What is it?

- ❑ Language Independent.
- ❑ Text-based.
- ❑ Light-weight.
- ❑ Easy to parse.



JavaScript Object Notation – What is it?

- JSON is lightweight text-data interchange format
- JSON is language independent*
 - *JSON uses JavaScript syntax for describing data objects
 - JSON parsers and JSON libraries exists for many different programming languages.
- JSON is "self-describing" and easy to understand
- **JSON - Evaluates to JavaScript Objects**
 - The JSON text format is syntactically identical to the code for creating JavaScript objects.
 - Because of this similarity, instead of using a parser, a JavaScript program can use the built-in `eval()`*** function and execute JSON data to produce native JavaScript objects.



When to use JSON?

- ❑ SOAP is a protocol specification for exchanging structured information in the implementation of Web Services.
- ❑ SOAP internally uses XML to send data back and forth.

- ❑ REST is a design concept.
- ❑ You are not limited to picking XML to represent data, you could pick anything really (JSON included).



JSON example

```
{  
    "firstName": "John",  
    "lastName": "Smith",  
    "age": 25,  
    "address": {  
        "streetAddress": "21 2nd Street",  
        "city": "New York",  
        "state": "NY",  
        "postalCode": 10021  
    },  
    "phoneNumbers": [  
        {  
            "type": "home",  
            "number": "212 555-1234"  
        },  
        {  
            "type": "fax",  
            "number": "646 555-4567"  
        }  
    ]  
}
```



JSON to XML

```
<?xml version="1.0" encoding="UTF-8"?>
<persons>
    <person>
        <firstName>John</firstName>
        <lastName>Smith</lastName>
        <age>25</age>
        <address>
            <streetAddress>21 2nd Street</streetAddress>
            <city>New York</city>
            <state>NY</state>
            <postalCode>10021</postalCode>
        </address>
        <phoneNumbers>
            <phoneNumber>
                <number>212 555-1234</number>
                <type>home</type>
            </phoneNumber>
            <phoneNumber>
                <number>646 555-4567</number>
                <type>fax</type>
            </phoneNumber>
        </phoneNumbers>
    </person>
</persons>
```



JSON vs XML size

- ❑ XML: 549 characters, 549 bytes
 - ❑ JSON: 326 characters, 326 bytes
 - ❑ XML ~68,4 % larger than JSON!
-
- ❑ But a large data set is going to be large regardless of the data format you use.
 - ❑ Most servers gzip or otherwise compress content before sending it out, the difference between gzipped JSON and gzipped XML isn't nearly as drastic as the difference between standard JSON and XML.



JSON vs XML

Favor XML over JSON when any of these is true:

- You need message validation
- You're using XSLT
- Your messages include a lot of marked-up text
- You need to interoperate with environments that don't support JSON

Favor JSON over XML when all of these are true:

- Messages don't need to be validated, or validating their deserialization is simple
- You're not transforming messages, or transforming their deserialization is simple
- Your messages are mostly data, not marked-up text
- The messaging endpoints have good JSON tools



Security problems***

- ❑ The eval() function can compile and execute any JavaScript.
This represents a potential security problem.
- ❑ It is safer to use a JSON parser (like Gson) to convert a JSON text to a JavaScript object. A JSON parser will recognize only JSON text and will not compile scripts.
- ❑ In browsers that provide native JSON support, JSON parsers are also faster.
- ❑ Native JSON support is included in newer browsers and in the newest ECMAScript (JavaScript) standard.



JSON Schema

- ❑ Describes your JSON data format
- ❑ <http://jsonschemaLint.com/>
- ❑ <http://json-schema.org/implementations>
- ❑ [http://en.wikipedia.org/wiki/
JSON#Schema_and_Metadata](http://en.wikipedia.org/wiki/JSON#Schema_and_Metadata)



JSON Values

JSON values can be:

- A number (integer or floating point)
- A string (in double quotes)
- A boolean (true or false)
- An *object* (in curly brackets)
- An *array* (in square brackets)
- null



JSON Values

❑ Object

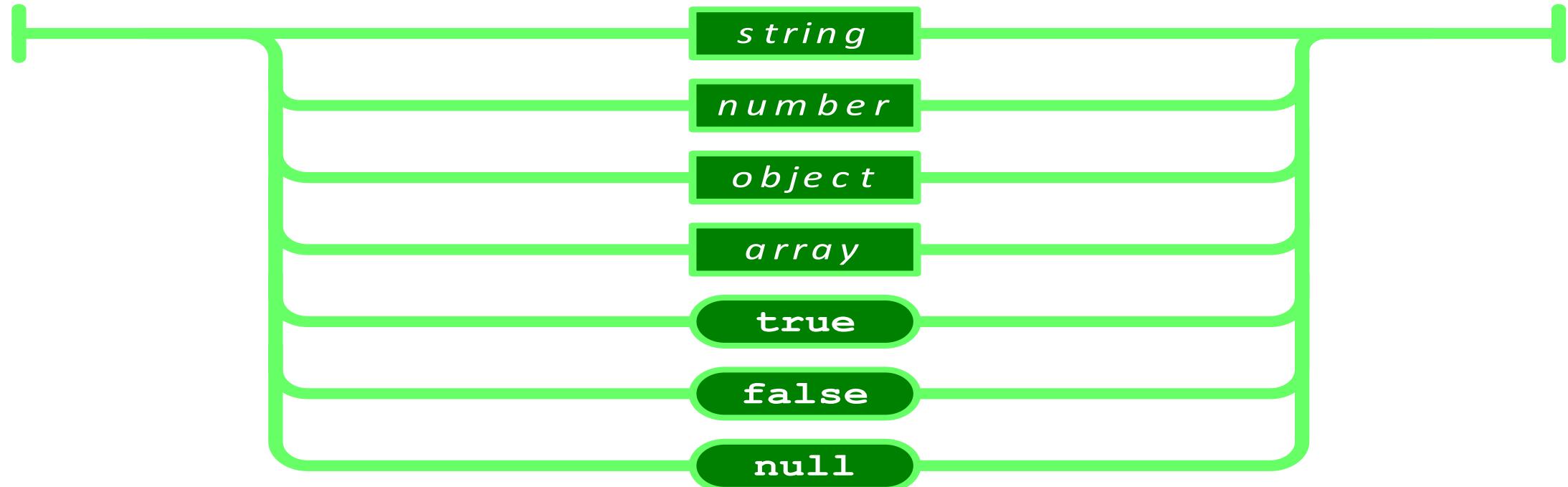
- Unordered set of name-value pairs
- names must be strings
- { name1 : value1, name2 : value2, ..., nameN : valueN }

❑ Array

- Ordered list of values
- [value1, value2, ... valueN]



Value



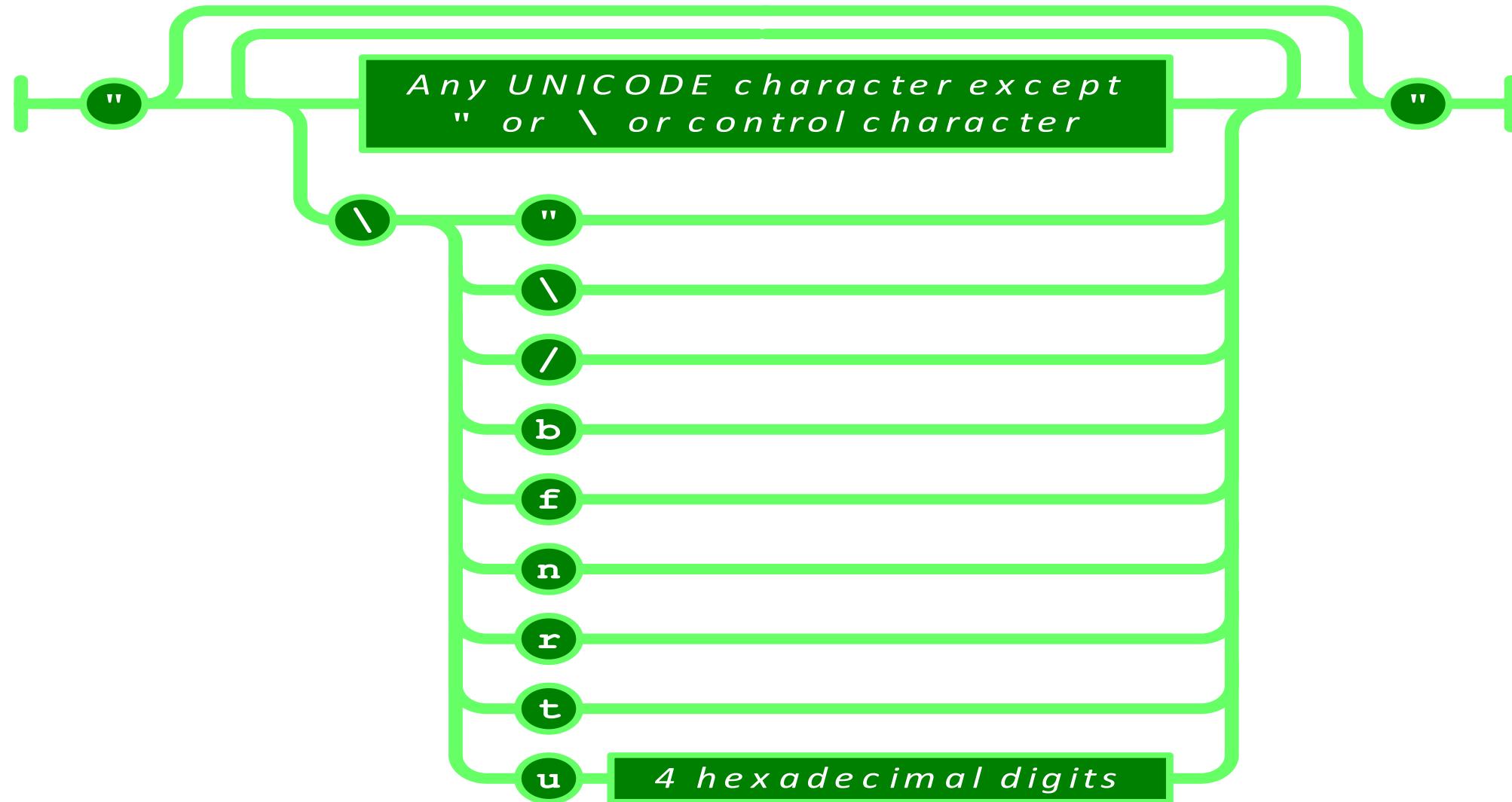


Strings

- ❑ Sequence of 0 or more Unicode characters
- ❑ No separate character type
 - A character is represented as a string with a length of 1
- ❑ Wrapped in "double quotes"
- ❑ Backslash escapement



String





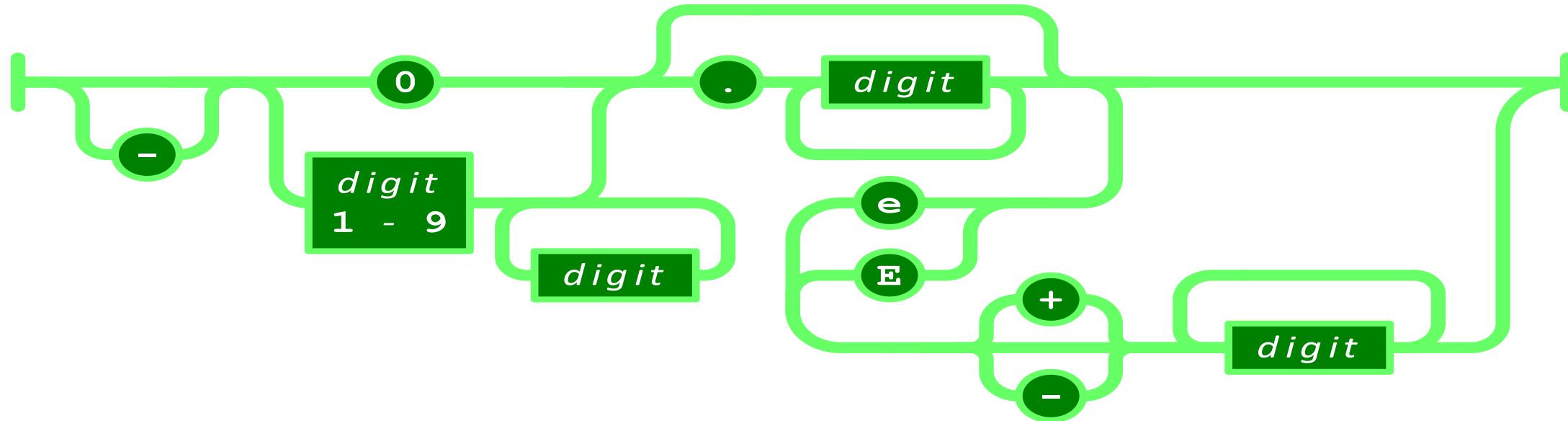
Numbers

- ❑ Integer
- ❑ Real
- ❑ Scientific

- ❑ No octal or hex
- ❑ No **NaN** or **Infinity**
 - Use **null** instead



Number





Booleans

- true**
- false**



null

- A value that isn't anything

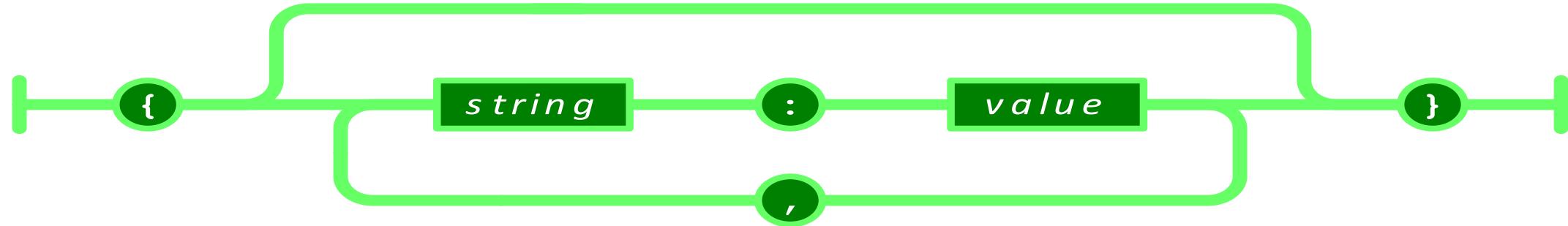


Object

- ❑ Objects are unordered containers of key/value pairs
 - ❑ Objects are wrapped in { }
 - ❑ , separates key/value pairs
 - ❑ : separates keys and values
 - ❑ Keys are strings
 - ❑ Values are JSON values
-
- struct, record, hashtable, object



Object



```
{  
    "_id": "560515770f76130300c69953",  
    "usertoken": "11343761234567808125",  
    "paymenttype": "PayPal",  
    "__v": 0,  
    "upvotes": 0,  
    "amount": 1999  
}
```

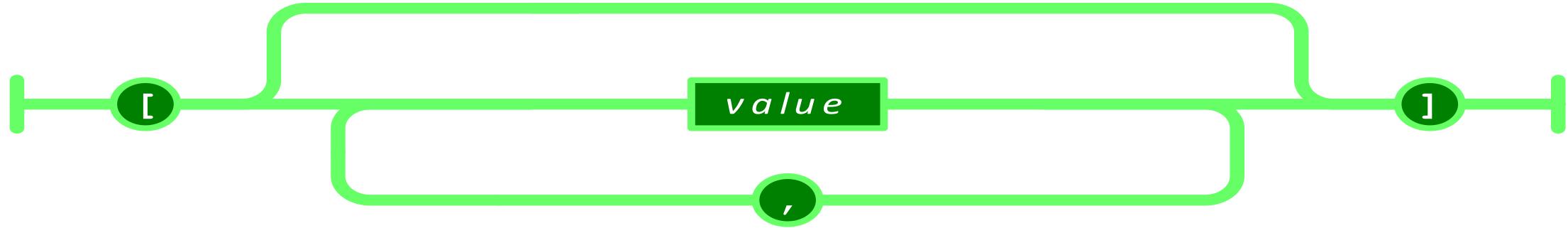


Array

- ❑ Arrays are ordered sequences of values
- ❑ Arrays are wrapped in []
- ❑ , separates values
- ❑ JSON does not talk about indexing.
 - An implementation can start array indexing at 0 or 1.



Array



```
[  
{"_id":"560515770f76130300c69953","usertoken":"11343761234567808125","  
paymenttype":"PayPal","__v":0,"upvotes":0,"amount":1999},  
  
{"_id":"56125240421892030048403d","usertoken":"11343761234567808125","  
paymenttype":"PayPal","__v":0,"upvotes":5,"amount":1234},  
  
{"_id":"5627620ac9e9e303005b113c","usertoken":"11343761234567808125","  
paymenttype":"Direct","__v":0,"upvotes":2,"amount":1001}  
]
```



MIME Media Type & Character Encoding

- application/json**

- Strictly UNICODE.

- Default: UTF-8.

- UTF-16 and UTF-32 are allowed.



Versionless

- ❑ JSON has no version number.
- ❑ No revisions to the JSON grammar are anticipated.
- ❑ JSON is very stable.



Rules

- ❑ A JSON decoder must accept all well-formed JSON text.
- ❑ A JSON decoder may also accept non-JSON text.
- ❑ A JSON encoder must only produce well-formed JSON text.
- ❑ *Be conservative in what you do, be liberal in what you accept from others.*



Donation 5.0, Googles Gson & REST



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.



Donation 5.0 & Google's Gson

```
public class DonationApi {  
    ////////////////////////////////////////////////  
    public static List<Donation> getAll(String call) {  
        String json = Rest.get(call);  
        //Log.v("donate", "JSON RESULT : " + json);  
        Type collectionType = new TypeToken<List<Donation>>(){}.getType();  
  
        return new Gson().fromJson(json, collectionType);  
    }  
    ////////////////////////////////////////////////  
    public static Donation get(String call, String id) {  
        String json = Rest.get(call + "/" + id);  
        Log.v("donate", "JSON RESULT : " + json);  
        Type objType = new TypeToken<Donation>(){}.getType();  
  
        return new Gson().fromJson(json, objType);  
    }  
    ////////////////////////////////////////////////  
    public static String deleteAll(String call) { return Rest.delete(call); }  
    ////////////////////////////////////////////////  
    public static String delete(String call, String id) { return Rest.delete(call + "/" + id); }  
    ////////////////////////////////////////////////  
    public static String insert(String call, Donation donation) {  
        Type objType = new TypeToken<Donation>(){}.getType();  
        String json = new Gson().toJson(donation, objType);  
  
        return Rest.post(call, json);  
    }  
}
```



Donation 5.0 & Google's Gson

```
public class DonationApi {  
    ///////////////////////////////////////////////  
    public static List<Donation> getAll(String call) {  
        String json = Rest.get(call);  
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    }  
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    public static String delete(String call, String id) { return Rest.delete(call + "/" + id); }  
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Donation 5.0 & Google's Gson

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    public static String deleteAll(String call) { return Rest.delete(call); }  
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    ///////////////////////////////////////////////////  
    public static String insert(String call, Donation donation) {  
        Type objType = new TypeToken<Donation>(){}.getType();  
        String json = new Gson().toJson(donation, objType);  
  
        return Rest.post(call, json);  
    }  
}
```



Summary

- ❑ JSON is a standard way to exchange data
 - Easily parsed by machines
 - Human readable form

- ❑ JSON uses dictionaries and lists
 - Dictionaries are unordered
 - Lists are ordered

- ❑ GSON is Googles JSON parser
 - Very simple to use



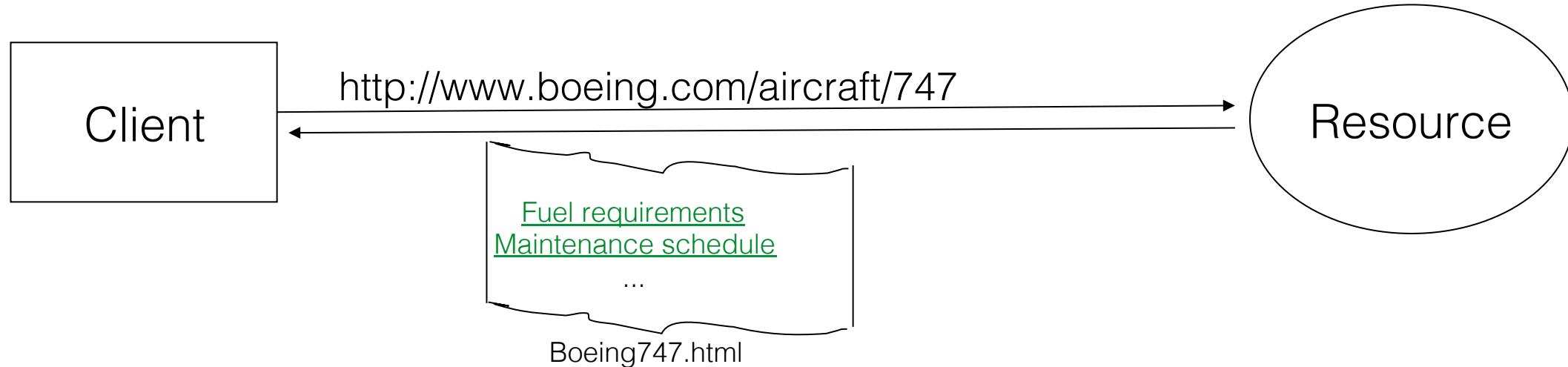
What is REST?

"*REST*" was coined by Roy Fielding in his Ph.D. dissertation [1] to describe a *design pattern* for implementing networked systems.

[1] <http://www.ics.uci.edu/~fielding/pubs/dissertation/top.htm>



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 ☺.*



Donation 5.0 & Rest.java

```
public class Rest {  
  
    private static HttpURLConnection httpCon = null;  
    private static URL url;  
  
    private static final String hostURL = "http://donationweb-4-0.herokuapp.com";  
    private static final String LocalhostURL = "http://192.168.0.13:3000";  
  
    public static void setup(String request) {  
        try {  
            url = new URL(hostURL + request);  
            httpCon = (HttpURLConnection) url.openConnection();  
            httpCon.setUseCaches(false);  
            httpCon.setReadTimeout(15 * 1000); // 15 seconds to timeout  
            httpCon.setRequestProperty("Content-Type", "application/json" );  
            httpCon.setRequestProperty("Accept", "application/json");  
        }  
        catch (Exception e)  
        {  
            Log.v("donate","REST SETUP ERROR" + e.getMessage());  
        }  
    }  
}
```



Donation 5.0 & Rest.java – GET Request

```
public static String get(String url) {  
  
    BufferedReader reader = null;  
    StringBuilder stringBuilder = null;  
  
    try {  
        setup(url);  
        httpCon.setRequestMethod("GET");  
        httpCon.setDoInput(true);  
        httpCon.connect();  
  
        Log.v("donate", "GET REQUEST is : " + httpCon.getRequestMethod() + " " + httpCon.getURL());  
  
        // read the output from the server  
        reader = new BufferedReader(new InputStreamReader(httpCon.getInputStream()));  
        stringBuilder = new StringBuilder();  
  
        String line = null;  
        while ((line = reader.readLine()) != null)  
            stringBuilder.append(line);  
  
        reader.close();  
        Log.v("donate", "JSON GET REQUEST : " + stringBuilder.toString());  
    }  
  
    catch (Exception e) {  
        Log.v("donate", "GET REQUEST ERROR" + e.getMessage());  
    }  
  
    return stringBuilder.toString();  
}
```



Donation 5.0 & Rest.java – POST Request

```
public static String post(String url, String json) {  
  
    OutputStreamWriter writer = null;  
    StringBuilder stringBuilder = null;  
  
    try {  
        setup(url);  
        httpCon.setRequestMethod("POST");  
        httpCon.setDoOutput(true);  
        httpCon.setDoInput(true);  
        httpCon.connect();  
  
        Log.v("donate", "POST REQUEST is : " + httpCon.getRequestMethod() + " " + httpCon.getURL());  
  
        // read the output from the server  
        writer = new OutputStreamWriter(httpCon.getOutputStream());  
        writer.write(json);  
        writer.close();  
  
        stringBuilder = new StringBuilder();  
        int HttpResult = httpCon.getResponseCode();  
        if(HttpResult == HttpURLConnection.HTTP_OK) {  
            BufferedReader br = new BufferedReader(new InputStreamReader(httpCon.getInputStream(), "utf-8"));  
            String line = null;  
            while ((line = br.readLine()) != null)  
                stringBuilder.append(line + "\n");  
  
            Log.v("donate", "JSON POST RESPONSE : " + stringBuilder.toString());  
        }  
  
    } catch (Exception e) {  
        Log.v("donate", "POST REQUEST ERROR" + e.getMessage());  
    }  
  
    return stringBuilder.toString();  
}
```



Donation 5.0 & Rest.java – DELETE Request

```
public static String delete(String url) {  
  
    String response = null;  
  
    try {  
        setup(url);  
        httpCon.setRequestMethod("DELETE");  
        httpCon.connect();  
  
        Log.v("donate", "DELETE REQUEST is : " + httpCon.getRequestMethod() + " " + httpCon.getURL());  
  
        response = httpCon.getResponseMessage();  
        Log.v("donate", "JSON DELETE RESPONSE : " + response);  
    }  
  
    catch (Exception e) {  
        Log.v("donate","DELETE REQUEST ERROR" + e.getMessage());  
    }  
  
    return response;  
}
```



References

- ❑ Victor Matos Notes – Lesson 13 (Cleveland State University)
- ❑ Android Developers
<http://developer.android.com/index.html>



Sources

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Questions?