

Anatomy of an Android App and the App Lifecycle

*content adapted from <http://www.cs.utexas.edu/~scottm/cs378/schedule.htm>

Outline

- Setup review
- 4 kinds of Android processes
(will explore 1 today)
- Android Project file structure
- Activity lifecycle within the Android OS
- LogCat

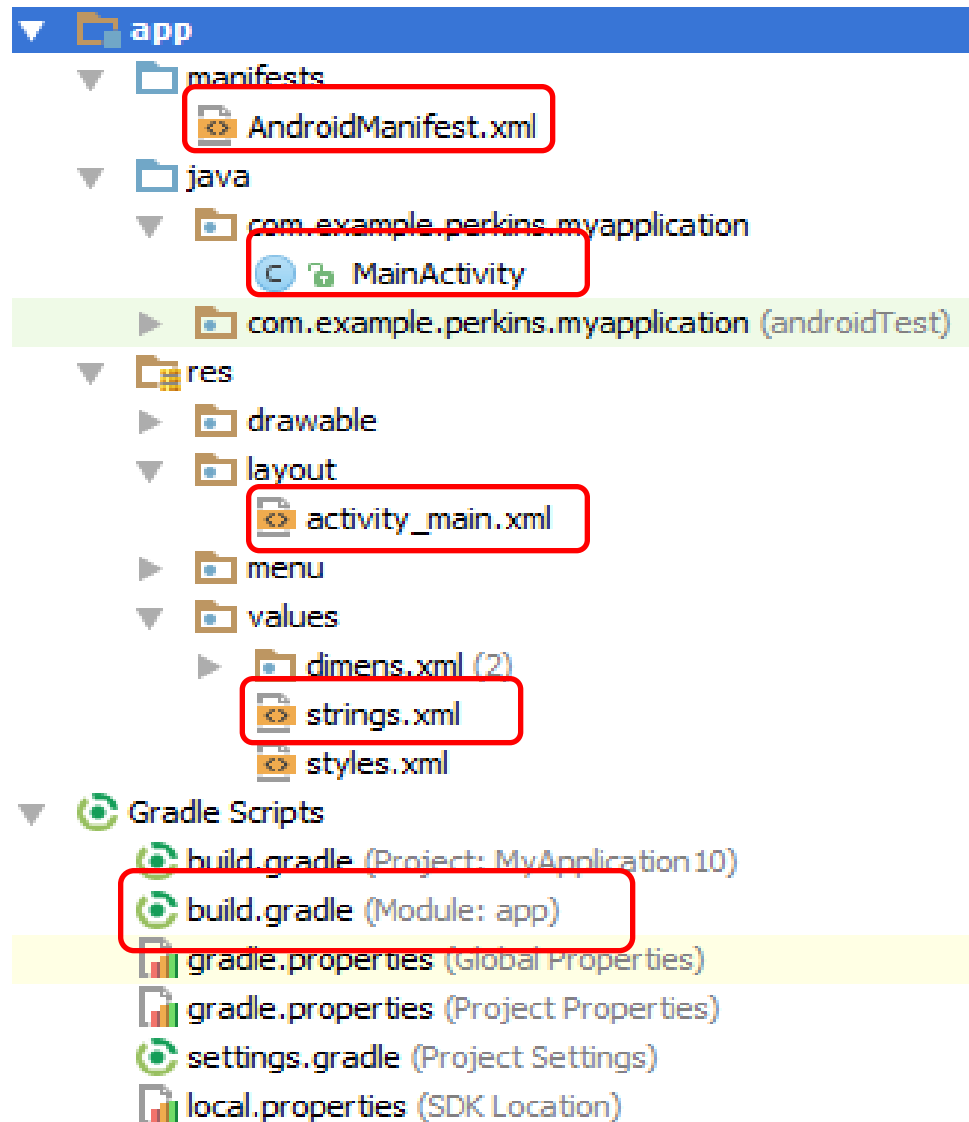
Setup(review)

- Setup
 - Android Studio
- Test
 - Virtual – Android AVD Manager
 - Alternate: GenyMotion
 - Physical – Install drivers for ADB
- Test Multiple Devices and APIs
 - Google Firebase Test Lab
 - Others (Grad student project)

Application Components

- four primary components (different purposes and different lifecycles)
 - Service
 - Content Provider
 - Broadcast receiver
 - Activity - single screen with a user interface, app may have several activities, each is a subclass of Activity. Most of early examples will be activities

Hello Android Tutorial



XML

- See Readings for tutorial!
- Human Readable
- Much like html
- Describes data (and is self descriptive)
- Doesn't do anything
- Define your own tags

```
<note>  
  <to>Keith</to>  
  <from>UPS</from>  
  <heading>Delivery Notice</heading>  
  <body>Your new 800 fill down slippers were delivered</body>  
</note>
```

XML more complex

```
<bookstore>
  <book category="COOKING">
    <title lang="en">Everyday Italian</title>
    <author>Giada De Laurentiis</author>
    <year>2005</year>
    <price>30.00</price>
  </book>
  <book category="CHILDREN">
    <title lang="en">Harry Potter</title>
    <author>J K. Rowling</author>
    <year>2005</year>
    <price>29.99</price>
  </book>
  <book category="WEB">
    <title lang="en">Learning XML</title>
    <author>Erik T. Ray</author>
    <year>2003</year>
    <price>39.95</price>
  </book>
</bookstore>
```

res/values/strings.xml

- String constants used by app

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <string name="hello">Android</string>
    <string name="app_name">Hello Android</string>
</resources>
```

- Used in java:

```
myString = getString(R.string.hello);
```

- Used in xml

```
android:text="@string/hello"
```

- Used for supporting Localization
 - res/values-es/values/strings.xml to support Spanish
 - res/values-fr/values/strings.xml to support French

Important Build files

- Build.gradle
 - 1 for the whole project (don't usually edit)
 - 1 per module
- AndroidManifest.xml
- Mostly work with manifest

AndroidManifest.xml

All Activities that are part of application must be registered in Manifest

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.cpsc475.project1_Paws" >

    <application
        android:allowBackup="true"
        android:icon="@drawable/ic_launcher"
        android:label="@string/app_name"
        android:theme="@style/AppTheme" >

        <activity
            android:name=".PAWS"
            android:label="@string/app_name" >
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />

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

</manifest>
```

Visible App Name ←

Specify Activity to start with ↗

Build.gradle

```
apply plugin: 'com.android.application' ←

android {
    compileSdkVersion 21 ←
    buildToolsVersion "21.1.2"

    defaultConfig {
        applicationId "com.cpsc475.project1_Paws"
        minSdkVersion 14 ←
        targetSdkVersion 21 ←
        versionCode 1
        versionName "1.0"
    }
    buildTypes {
        release {
            minifyEnabled false ←
            proguardFiles getDefaultProguardFile('proguard-android.txt'), 'proguard-rules.pro'
        }
    }
}

dependencies {
    compile fileTree(dir: 'libs', include: ['*.jar']) ←
    compile 'com.android.support:appcompat-v7:21.0.3'
}
```

Activities

- Most Typical
 - User Interface - defined by xml
 - Logic - defined by java
- Although you can do it all in Java if you want

Appearance

res/layout/activity_main.xml

- Defines complete UI in XML

LinearLayout is easiest
Lots of other layouts, relative, table
We will visit them later

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

ViewGroup

```
    <TextView
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="New Text"
        android:id="@+id/textView2" />
```

```
    <Button
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="New Button"
        android:id="@+id/button2" />
```

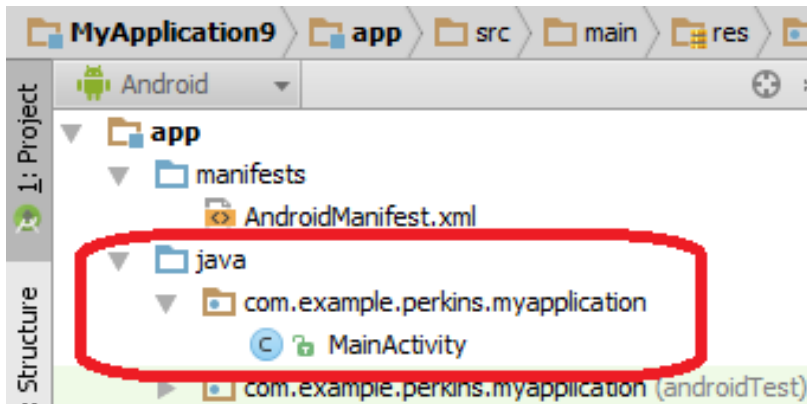
View

```
</LinearLayout>
```

match_parent means take up all available space
wrap_content means use just enough to display
@+id/name means add name to R.java for easy retrieval elsewhere
@string/hello gets defined hello text from string.xml file

Logic

- Java that corresponds to xml Layout



Marries Java
code to XML
layout

```
package com.example.perkins.myapplication;

import ...

public class MainActivity extends ActionBarActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }

    @Override
    public boolean onCreateOptionsMenu(Menu menu) {...}

    @Override
    public boolean onOptionsItemSelected(MenuItem item) {...}
}
```

Activities -Connecting XML to java

- Typically use event handlers (define what happens when user interacts with UI)
- Other ways? (anonymous listeners, interfaces)

The screenshot displays two files in an IDE: `MainActivity.java` and `activity_main.xml`.

MainActivity.java:

```
package com.example.perkins.myapplication;

import ...

public class MainActivity extends ActionBarActivity {

    private TextView myView;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);

        myView = (TextView) findViewById(R.id.textView2);

        public void doButton(View view) {
            myView.setText("70 degrees and sunny");
        }
    }
}
```

Annotations for MainActivity.java:

- `private TextView myView;` is circled in red with the text "create member var" next to it.
- `myView = (TextView) findViewById(R.id.textView2);` is circled in red with the text "get ref to XML widget" next to it.
- `public void doButton(View view) { ... }` is circled in red with the text "Respond to clicks" next to it.

activity_main.xml:

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

    <TextView
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="Whddays want"
        android:id="@+id/textView2"
        android:background="@color/material_deep_teal_200"
        android:textSize="34sp" />

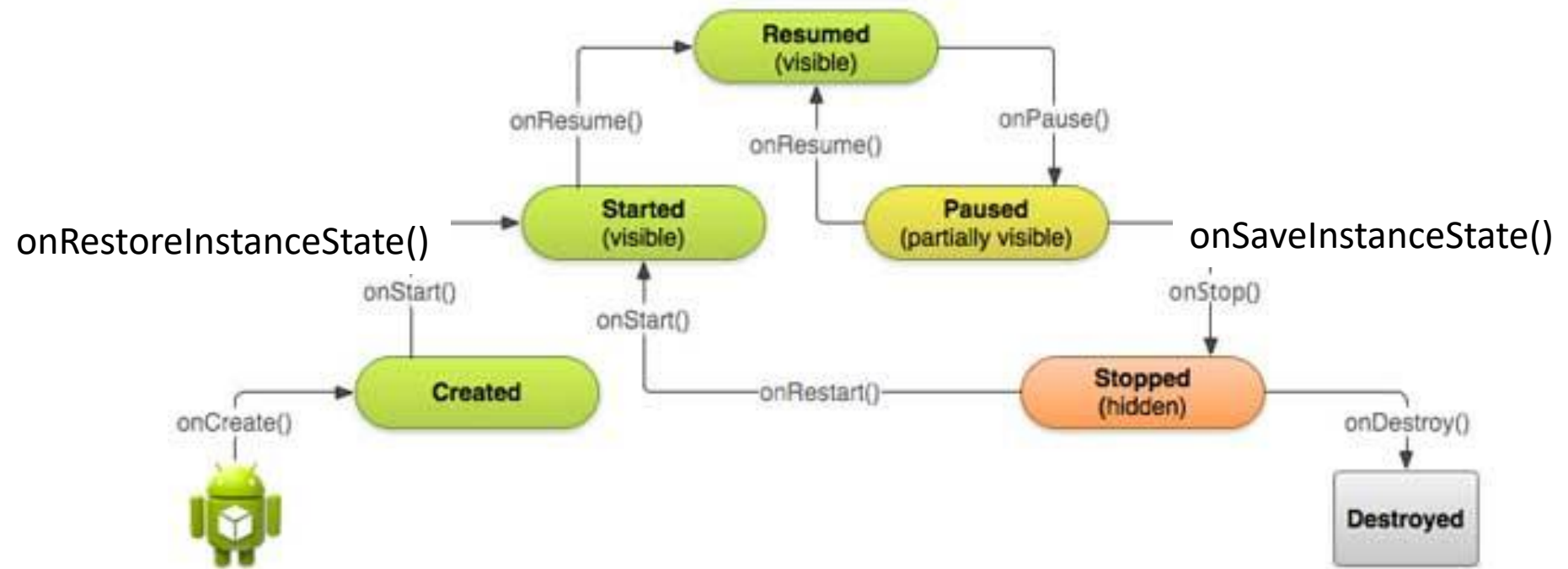
    <Button
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="New Button"
        android:id="@+id/button2"
        android:onClick="doButton"/>
</LinearLayout>
```

Annotations for activity_main.xml:

- `android:onClick="doButton"/>` is circled in red, corresponding to the `doButton` method in the Java file.

This seems random
How do I know When
Functions are called?

Activity Lifecycle



Android applications start with a series of callback methods. Each corresponds to specific stage of the Activity / application lifecycle

Callback methods also used to tear down Activity / application

Not all callbacks shown

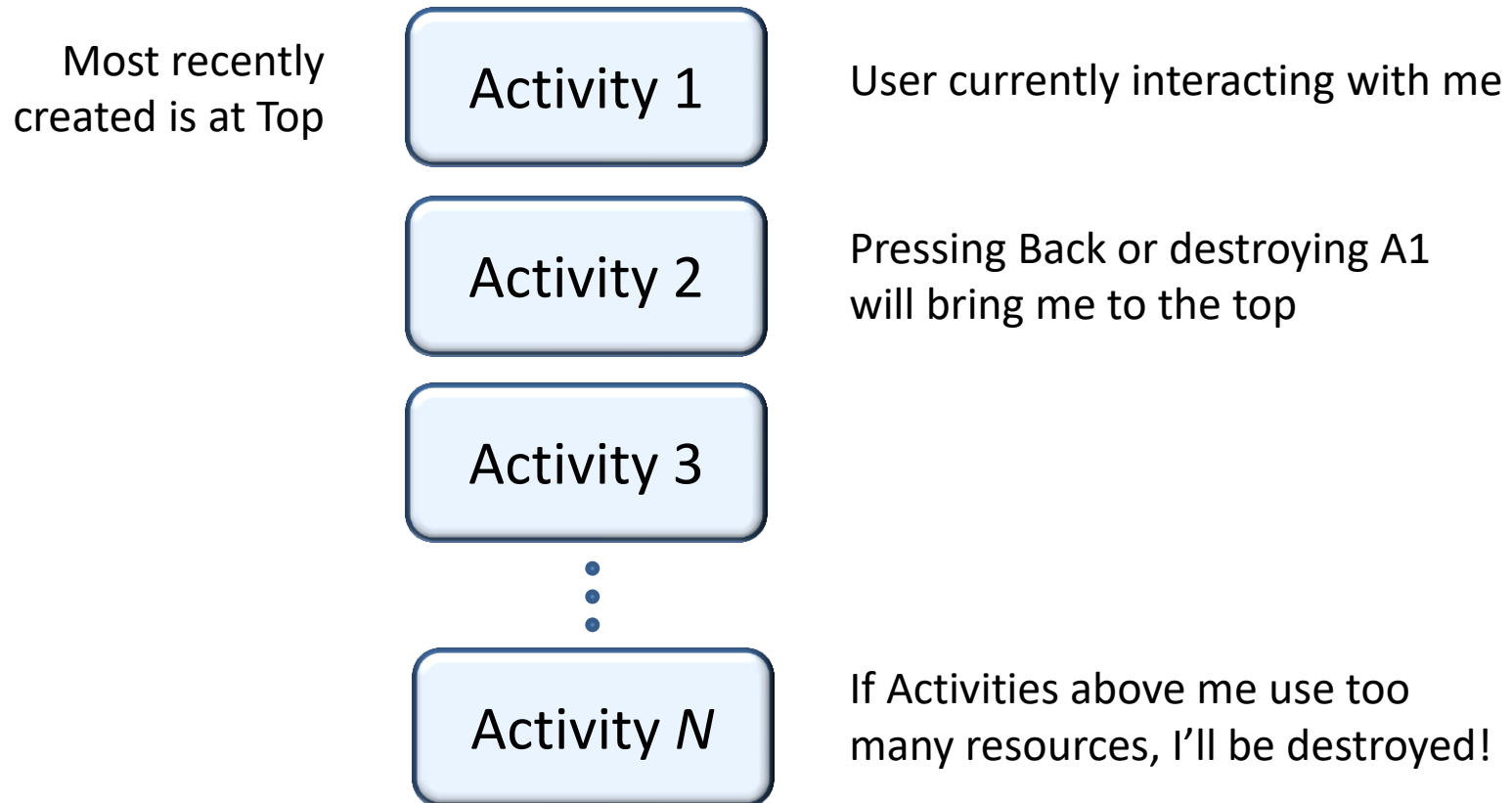
Understanding the Lifecycle

- App should not crash if the user receives a phone call or switches to another app while using your app So release resources when not using.
- App should not lose the user's progress if they leave your app and return to it at a later time or when the screen rotates between landscape and portrait orientation.

What is used for what?

- Callback **overload** for app behavior
- **Entire lifetime**: onCreate / onDestroy
 - Load UI
 - Could start and stop threads that should always be running
- **Visible lifetime**: onStart / onStop
 - Access or release resources that influence UI
- **Foreground lifetime**: onResume / onPause
 - Start and stop audio, video, animations, GPS
- **Saving Temp State** onRestoreInstanceState / onSaveInstanceState
 - Holds temp activity data (rotation, open another activity, incoming call...)

What happens when my app loses focus? Activity Stack



Activity Destruction and saving state (lets say you rotate your screen)

- Save your state data for later !
- Android saves state of UI widgets if you have given them an id
- system calls the onSaveInstanceState (Bundle outState) method
- Data Serialized for later app recreation (not Permanent though)
- Bundle is a data structure like a Map
 - String keys
 - put methods for primitives, arrays, Strings, Serializables (Java), and Parcels (android)
- Bundle given to android to manage until your activity is recreated

Activity recreation and restoring instance state

- Android gives your app any **Bundle** its managing
- You can access this bundle in **onCreate()** or **onRestoreInstanceState()**
- Grab the values you need from it to restore state

Bundles example

```
public class Lifecycle extends ActionBarActivity {
    private static final String TAG = "Lifecycle";
    private static final int DEFAULT_VALUE = 0;

    private int valueThatMustSurviveDestruction = DEFAULT_VALUE;
    private static final String VTMSD_NAME = "valueThatMustSurviveDestruction";

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_lifecycle);
        Log.d(TAG, "in onCreate, i=" + Integer.toString(valueThatMustSurviveDestruction));

        // Check whether we're recreating a previously destroyed instance
        if (savedInstanceState != null) {
            // Restore value of members from saved state
            valueThatMustSurviveDestruction = savedInstanceState.getInt(VTMSD_NAME);
        }
        Log.d(TAG, "in onCreate, i=" + Integer.toString(valueThatMustSurviveDestruction));

        //increment default value
        valueThatMustSurviveDestruction++;
    }

    protected void onSaveInstanceState(Bundle outState) {
        Log.d(TAG, "onSaveInstanceState, i=" + Integer.toString(valueThatMustSurviveDestruction));

        outState.putInt(VTMSD_NAME, valueThatMustSurviveDestruction);

        super.onSaveInstanceState(outState);
    }
}
```

Keep in mind a bundle is ephemeral

Bundles are not permanent!

- temp parking (rotations, dropping in the app stack etc)
- Want permanent storage? Use preferences or serialization (**Later**)

How can I track when these methods are called?

Breakpoints and Debug

LogCat

much like println()

has own window

Android Device Monitor

Android DDMS

LogCat

5. v, d, i, w, e

VERBOSE, DEBUG, INFO, WARN, ERROR

```
public class HelloAndroid extends Activity {  
  
    //used by logcat, useful for filtering in LogCat view  
    private static final String TAG = "HelloAndroidActivity";
```

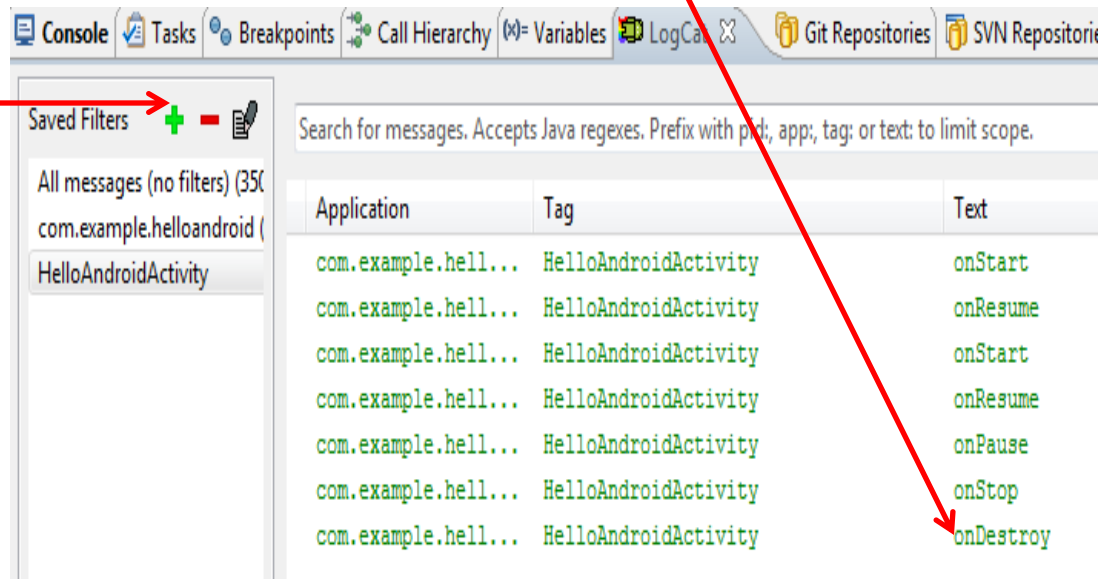
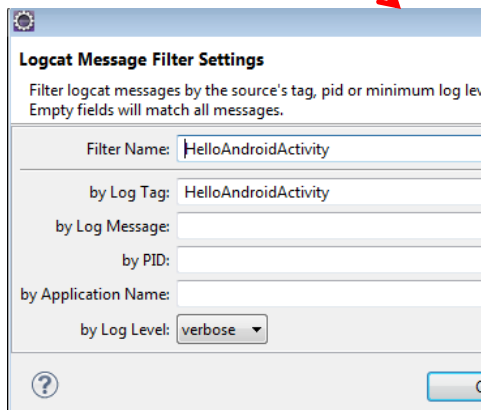
```
    protected void onDestroy() {  
        super.onDestroy();  
  
        //log the fact that we entered onDestroy  
        Log.i(TAG, "onDestroy");
```

1. Define Tag for filtering

4. Debug app to View Log.
Found in DDMS Or Added via
Window->Show View->LogCat

2. Log Message

3. Create filter



LifeCycleTest and LogCat Demo

- overload these methods from Activity:
 - onCreate(), onStart(), onResume(), onPause(), onStop(), onRestart, onDestroy(), onSaveInstanceState(), onRestoreInstanceState()
 - Use LogCat to log activity

LifeCycleTest

- Run the app and open the Logcat view.
- DDMS

```
protected void onStart() {  
    super.onStart();  
    Log.d(TAG, "in onStart Method");  
}  
  
protected void onRestart() {  
    super.onRestart();  
    Log.d(TAG, "in onRestart Method");  
}  
  
protected void onResume() {  
    super.onResume();  
    Log.d(TAG, "in onResume Method");  
}  
  
protected void onPause() {  
    super.onPause();  
    Log.d(TAG, "in onPause Method");  
}  
  
protected void onStop() {  
    super.onStart();  
    Log.d(TAG, "in onStop Method");  
}  
  
protected void onDestroy() {  
    super.onDestroy();  
    Log.d(TAG, "in onDestroy Method");  
}
```

A Last Bit

How to stop an Activity yourself?

- **Don't!** Android handles it according to lifecycle.
- methods: `finish()`, `finishActivity()`

So far

- Created Simple Apps
- Running Apps on emulator and Phone
- App innards (high level, Activity only)
- App lifecycle
- callbacks
- Saving Temp State (Bundle)
- LogCat