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

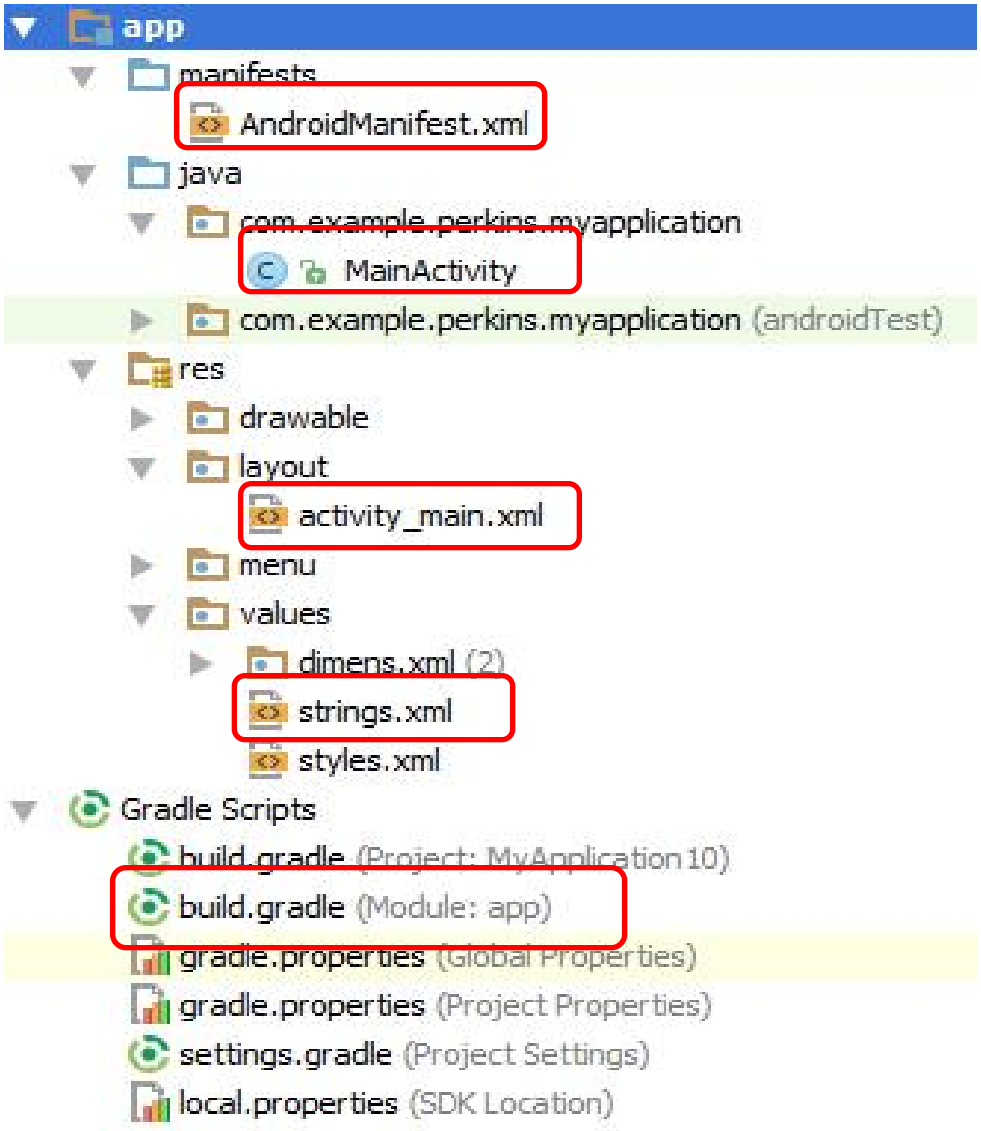
Setup(review)

- Setup
  - Android Studio
- Deploy
  - Virtual – Android AVD Manager
  - Physical – Install drivers for ADB
- Test Multiple Devices and APIs and manage crash analytics
  - Google Firebase and 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



Demo

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>
```

Tutorial

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 M

```
<?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 wi

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">

    <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" />
</LinearLayout>
```

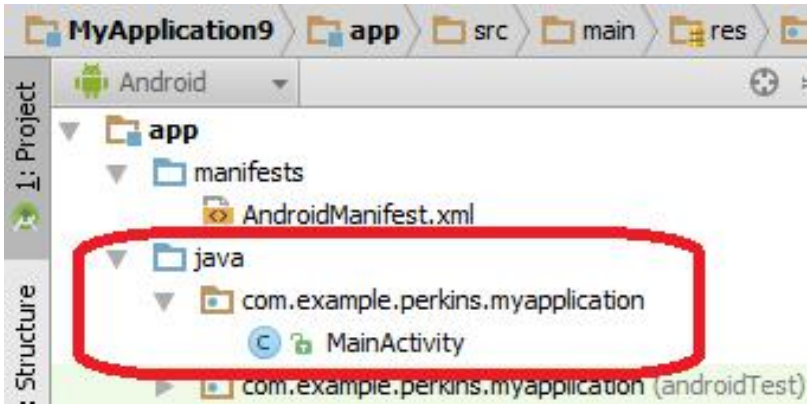
ViewGroup

View

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 elsewh
@string/hello gets defined hello text from string.xml file

Logic

- Java that corresponds 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) {...}
}
```

Marries Java code to XML layout

Demo
Wire xml to java

Activities -Connecting XML to java

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

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");
    }
```

create member var

get ref to XML widget

Respond to clicks

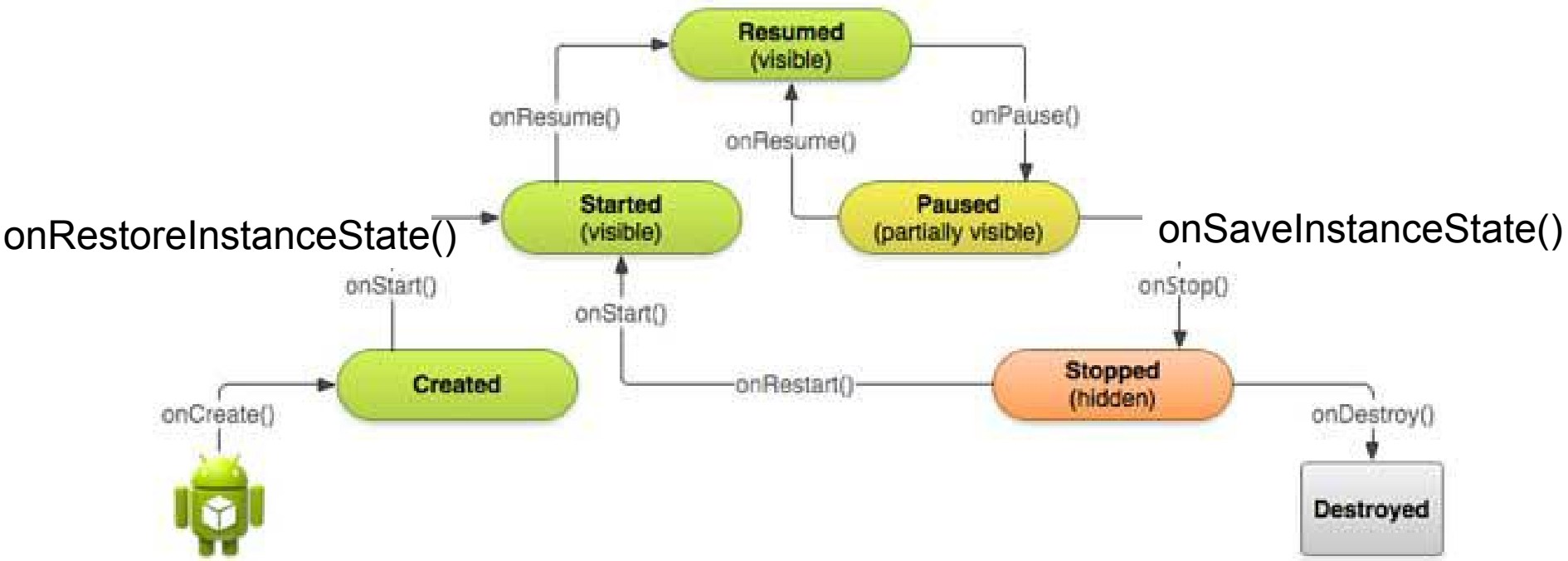
activity_main.xml

```
<?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="Whddaya 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"/>
```

Demo
Wire xml to java

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

Activity Lifecycle

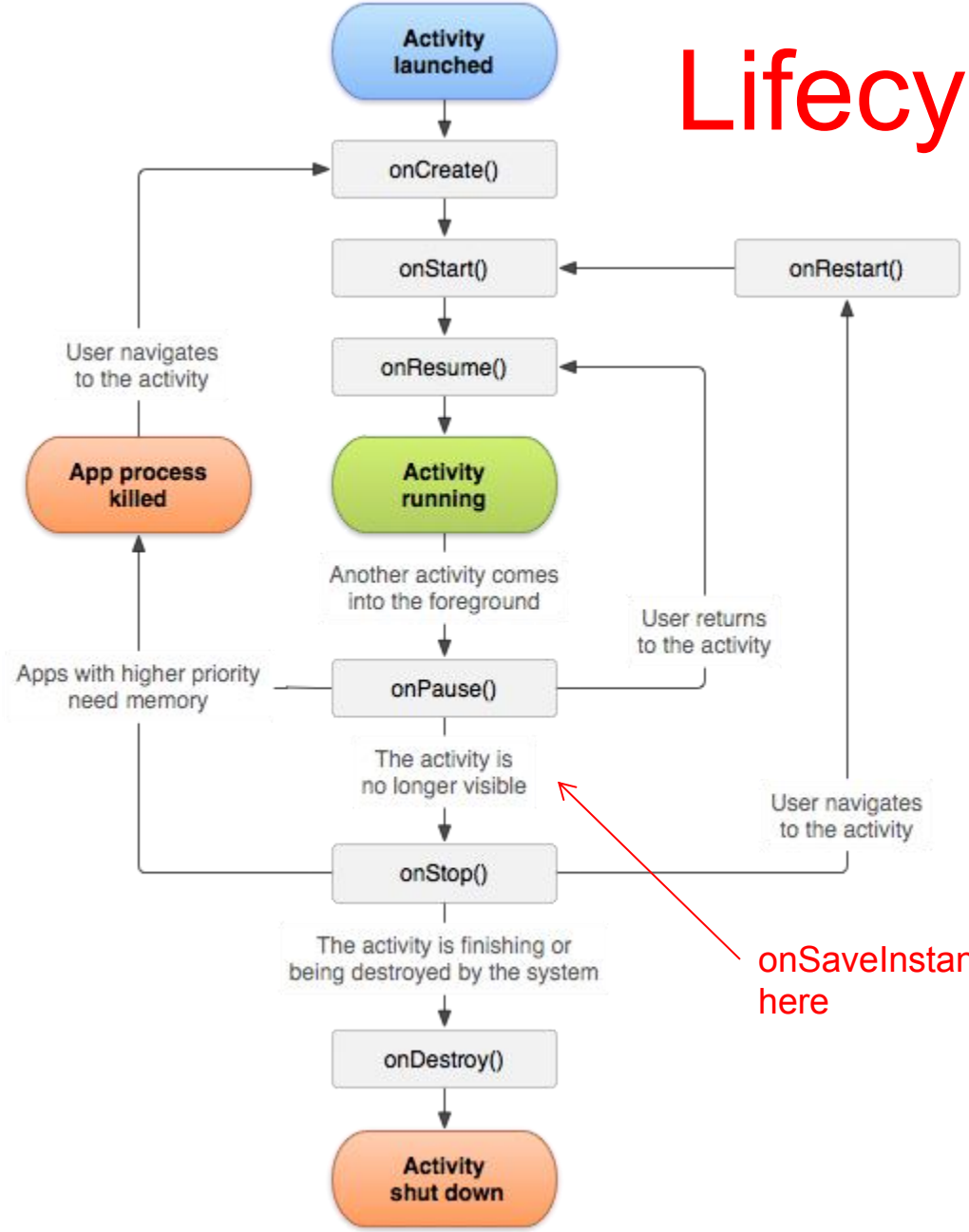


Android applications start with a series of callback methods. Each corresponds to specific stage of the Activity / application lifecycle

Callback methods also used to tear down Activity / application

Not all callbacks shown

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

onSaveInstanceState() here

Understanding the Lifecycle

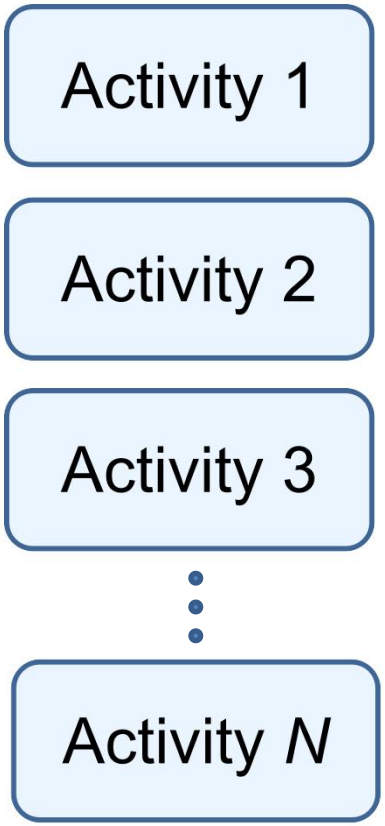
- App should not crash if the user receives a phone call or switches to another app while using your app So release resources when not using.
- App should not lose the user's progress if they leave your app and return to it at a later time or when the screen rotates between landscape and portrait orientation.

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

Most recently created is at Top



User currently interacting with me

Pressing Back or destroying A1 will bring me to the top

If Activities above me use too many resources, I'll be destroyed!

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 are not permanent!

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++;
    }
```

Keep in mind a bundle is ephemeral

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

        outState.putInt(VTMSD_NAME,valueThatMustSurviveDestruction);

        super.onSaveInstanceState(outState);
    }
```

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

LogCat

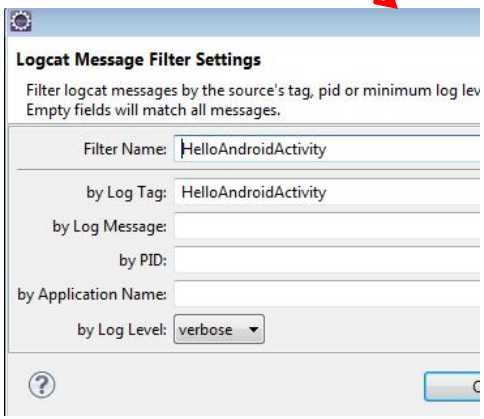
5. v, d, i, w, e
VERBOSE, DEBUG, INFO, WARN, ERROR

```
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");
```

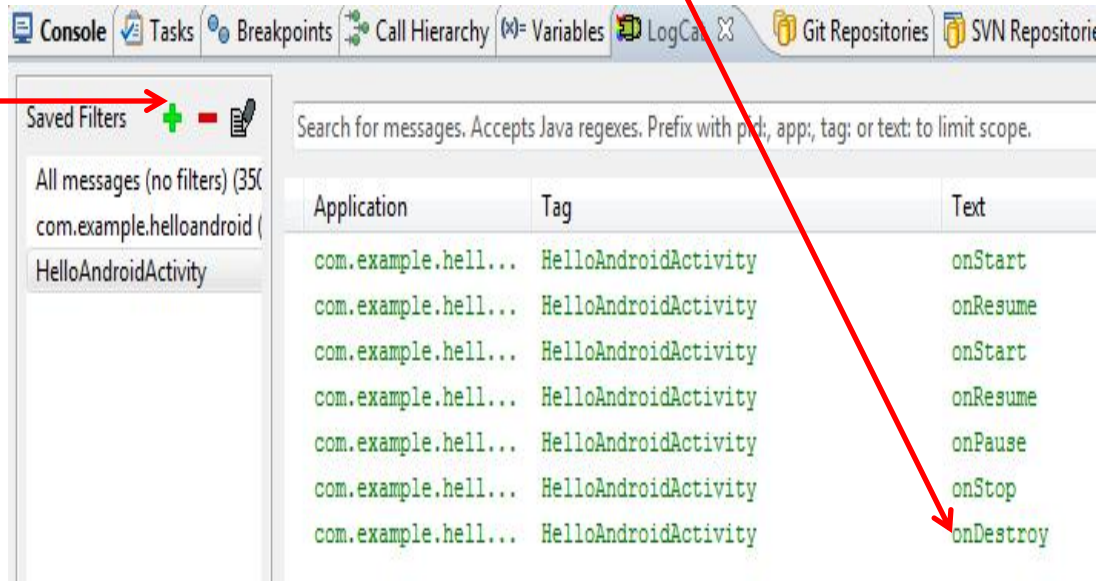
1. Define Tag for filtering

2. Log Message

3. Create filter



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



LifeCycleTest and LogCat Demo

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

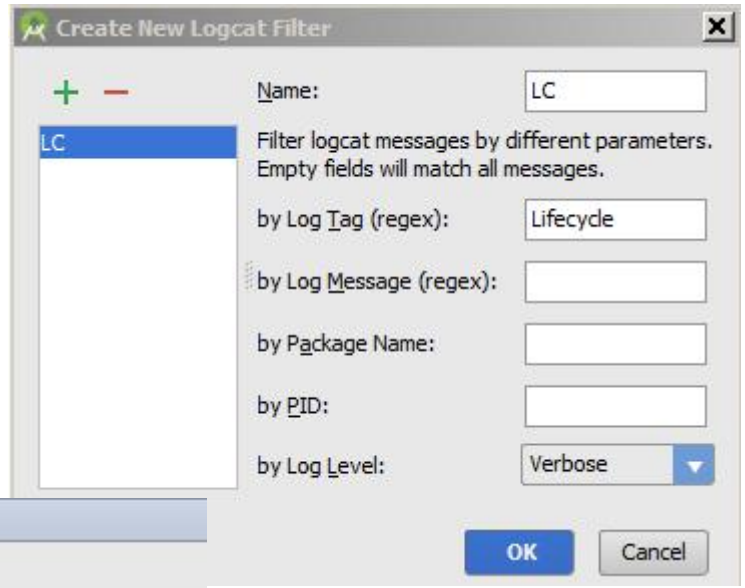
LifeCycleTest

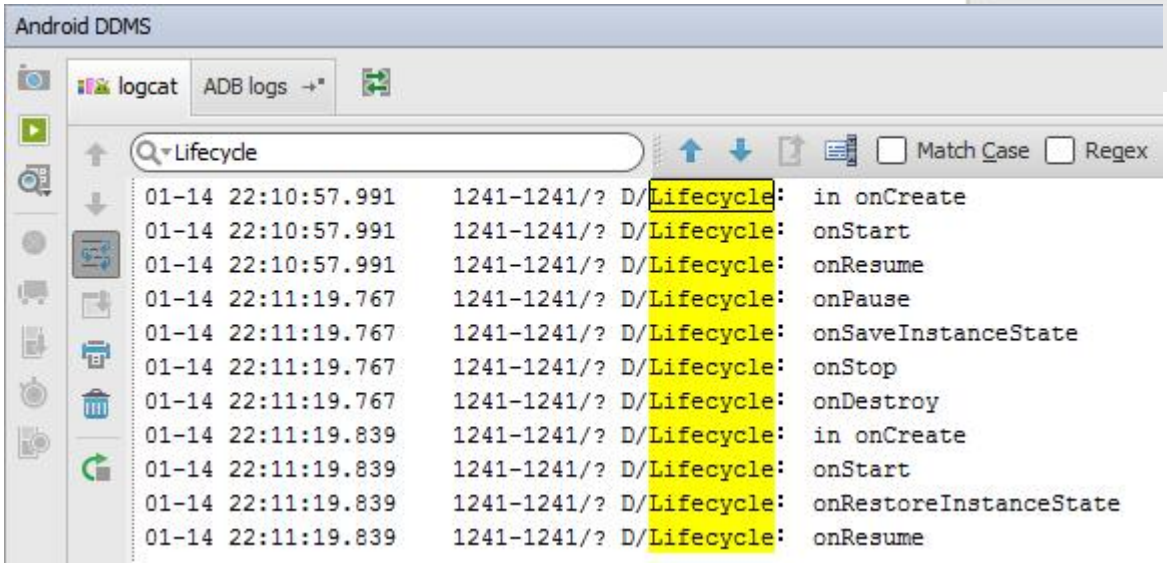
- Run the app and open the Logcat view.
- DDMS

```
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");
}
```

Logcat

- Rotate emulator with CTRL+F-11





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

Intro Wrap Up

- Created Simple Apps
- Running Apps on emulator and Phone
- App innards (high level, Activity only)
- App lifecycle
- Some of the callbacks
- Saving states

Important Files

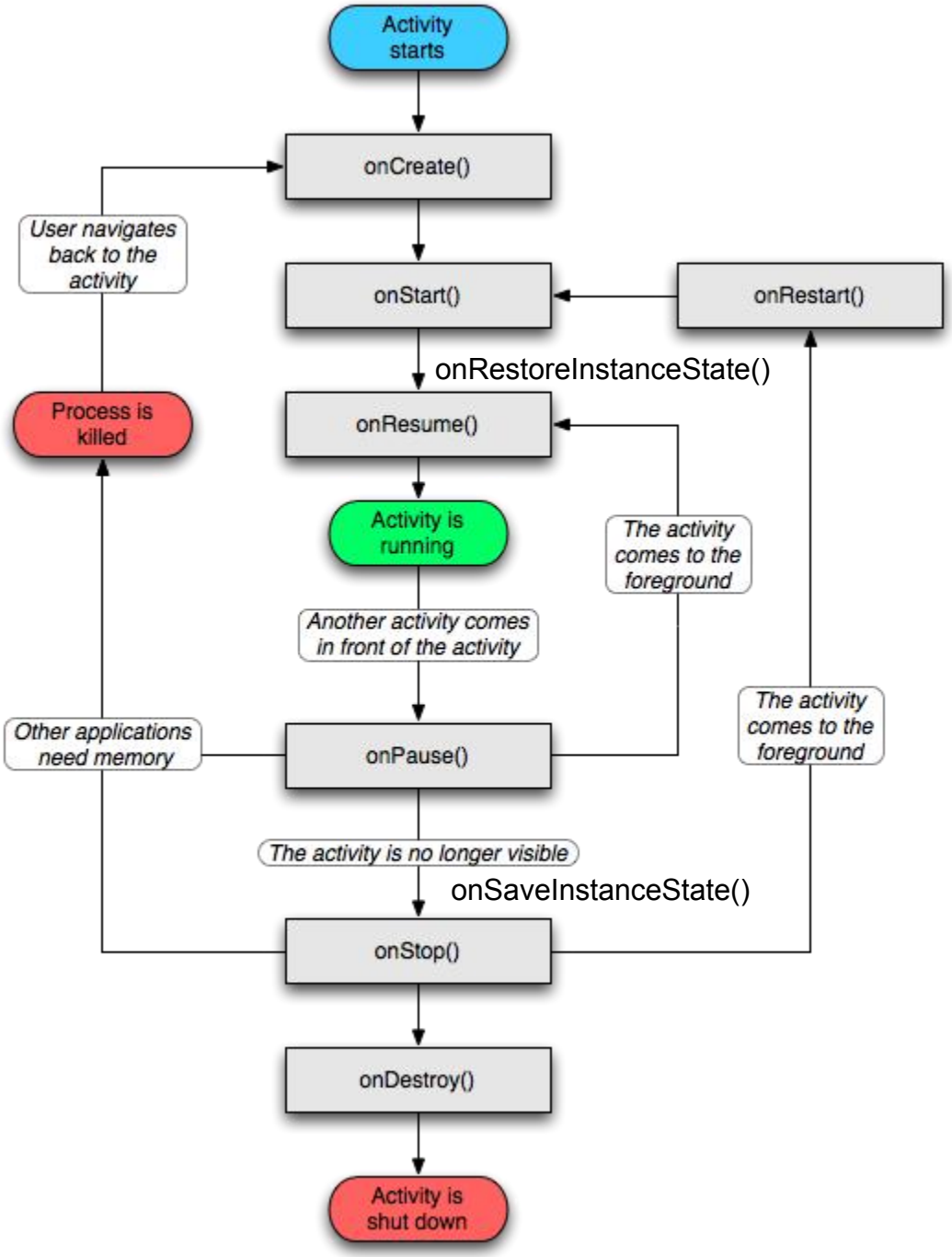
- **AndroidManifest.xml**
  - Declares all the app's components
  - Identifies permissions the app expects to be granted
- Java/packagename/**MainActivity.java**
  - Activity which is started (as defined in manifest) when app executes
- res/layout/**activity_main.xml**
  - Defines & lays out widgets for the activity, activity loads this in onCreate
- **Build.gradle** – one for project and one per module
  - Defines SDK targets, compiler, how to build, libraries etc.
- gen/**R.java** (DO NOT MODIFY!)
  - Auto-generated, auto-updated file with identifiers from main.xml, strings.xml, and elsewhere

Primary States

- Resume running
  - activity is in the foreground and user can interact with it
- Paused
  - activity partially obscured by another activity and user cannot interact with it (for example when working with a menu or dialog)
- Stopped
  - activity completely hidden and not visible to user. It is in the background.
  - Activity instance and variables are retained

References

- Android Introduction by Marko Gargenta, http://www.lecturemaker.com/2009/10/android-software-platform/
- Android Dev Guide http://developer.android.com/guide/topics/fundamentals.html http://developer.android.com/guide/topics/fundamentals/activities.html
- Mike Scott http://www.cs.utexas.edu/~scottm/cs378/schedule.htm



Activity Lifecycle

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Callback methods also used to tear down Activity / application

Not all callbacks shown