Android Activity LifeCycle
Starting Activities

- Android applications don't start with a call to main(String[])
- Instead callbacks invoked corresponding to app state.
- Examples:
  - When activity is created, its `onCreate()` method invoked (like constructor)
  - When activity is paused, its `onPause()` method invoked
- Callback methods also invoked to destroy Activity /app
Activity Callbacks

- `onCreate()` (Already saw this (initially called))
- `onStart()`
- `onResume()`
- `onPause()`
- `onStop()`
- `onRestart()`
- `onDestroy()`

Android OS invokes specific callbacks when specific events occur.

IMPORTANT: Android OS invokes all callbacks!!
Understanding Android Lifecycle

- Many **disruptive** things could happen while app is running
  - Incoming call or text message, user switches to another app, etc

- Well designed app should NOT:
  - Crash if interrupted, or user switches to other app
  - Lose the user's state/progress (e.g. state of chess game app) if they leave your app and return later
  - Crash or lose the user's progress when the screen rotates between landscape and portrait orientation.
    - E.g. Youtube video should continue at correct point after rotation

- To handle these situations, appropriate callback methods must be invoked appropriately

http://developer.android.com/training/basics/activity-lifecycle/starting.html
OnCreate()

- Initializes activity once created
- Operations typically performed in `onCreate()` method:
  - Inflate widgets and place them on screen
    - (e.g. using layout files with `setContentView()`)  
  - Getting references to inflated widgets (using `findViewById()`)
  - Setting widget listeners to handle user interaction
- Example

```java
public class QuizActivity extends Activity {
    private Button mTrueButton;
    private Button mFalseButton;

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

        mTrueButton = (Button) findViewById(R.id.true_button);
        mFalseButton = (Button) findViewById(R.id.false_button);
    }
}
```

- **Note:** Android OS calls apps’ `onCreate()` method
Activity State Diagram: Running App

- A running app is one that user is currently using or interacting with
  - Visible, in foreground
Activity State Diagram: Paused App

- An app is **paused** if it is **visible but no longer in foreground**
- E.g. blocked by a pop-up dialog box
- App’s **onPause( )** method is called during transition from running to paused state
Activity State Diagram: onPause( ) Method

- Typical actions taken in onPause( ) method
  - Stop animations or CPU intensive tasks
  - Stop listening for GPS, broadcast information
  - Release handles to sensors (e.g. GPS, camera)
  - Stop audio and video if appropriate
Activity State Diagram: Resuming Paused App

- A **paused** app resumes **running** if it becomes fully visible and in foreground
  - E.g. pop-up dialog box blocking it goes away
- App’s **onResume()** method is called during transition from **paused** to **running** state
  - Restart videos, animations, GPS checking, etc
An app is **stopped** if it **no longer visible and no longer in foreground**

- E.g. user starts using another app
- App’s `onStop()` method is called during transition from paused to stopped state
onStop() Method

- An activity is stopped when:
  - User receives phone call
  - User starts another app
  - Activity 1 launches new Activity 2
- Activity instance and variables of stopped app are retained but no code is being executed by the activity
- If activity is stopped, in onStop() method, well behaved apps should
  - save progress to enable seamless restart later
  - Release all resources, save info (persistence)
Activity State Diagram: Stopped App

- A **stopped** app can go back into **running** state if becomes visible and in foreground
- App’s **onStart()** and **onResume()** methods called to transition from **stopped** to **running** state
Activity State Diagram: Starting New App

- To start new app, app is launched
- App’s `onCreate()` , `onStart()` and `onResume()` methods are called
- Afterwards new app is **running**
Logging Errors in Android
Logging Errors in Android

- Android can log and display various types of errors/warnings

- Error logging is in Log class of android.util package
  
  ```java
  import android.util.Log;
  ```

- Turn on logging of different message types by calling appropriate method

- Logged errors/warnings displayed in Android Studio window

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<table>
<thead>
<tr>
<th>Method</th>
<th>Purpose</th>
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<tbody>
<tr>
<td>Log.e()</td>
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Ref: Introduction to Android Programming, Annuzzi, Darcey & Conder
QuizActivity.java

● A good way to understand Android lifecycle methods is to print debug messages when they are called
● E.g. print debug message from onCreate method below

```java
package com.beginnerbranch.android.geoquiz;

import android.app.Activity;
import android.os.Bundle;
import android.view.Menu;

public class QuizActivity extends Activity {

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_quiz);
    }
}
```
QuizActivity.java

- Debug (d) messages have the form
  
  ```java
  public static int d(String tag, String msg)
  ```

- E.g.
  
  ```java
  Log.d(TAG, "onCreate(Bundle) called");
  ```

- Example declaration:
  
  ```java
  public class QuizActivity extends Activity {
      private static final String TAG = "QuizActivity";
      ...
  }
  ```


QuizActivity.java

• Putting it all together

```java
public class QuizActivity extends Activity {

    ...

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        Log.d(TAG, "onCreate(Bundle) called");
        setContentView(R.layout.activity_quiz);
        ...
    }
}
```
QuizActivity.java

- Can override more lifecycle methods
- Print debug messages from each method
- Superclass calls called in each method

```java
// End of onCreate(Bundle)

@Override
public void onStart() {
    super.onStart();
    Log.d(TAG, "onStart() called");
}

@Override
public void onPause() {
    super.onPause();
    Log.d(TAG, "onPause() called");
}

@Override
public void onResume() {
    super.onResume();
    Log.d(TAG, "onResume() called");
}

@Override
public void onStop() {
    super.onStop();
    Log.d(TAG, "onStop() called");
}

@Override
public void onDestroy() {
    super.onDestroy();
    Log.d(TAG, "onDestroy() called");
}
```
QuizActivity.java Debug Messages

- Launching GeoQuiz app **creates, starts and resumes** an activity.

- Pressing **Back** button destroys the activity (calls onPause, onStop and onDestroy)
Rotating Device
Rotating Device: Using Different Layouts

- Rotating device (e.g. portrait to landscape) kills current activity and creates new activity in landscape mode.
- Rotation changes **device configuration**
- **Device configuration**: screen orientation/density/size, keyboard type, dock mode, language, etc.
- Apps can specify different resources (e.g. XML layout files, images) to use for different device configurations.

E.g. use different app layouts for portrait vs landscape screen orientation.

Use portrait XML file

Use landscape XML file

Use portrait XML file
Rotating Device: Using Different Layouts

- When device in landscape, uses layout (XML) file in `res/layout-land/`
- Copy XML layout file (activity_quiz.xml) from `res/layout` to `res/layout-land/` and tailor it
- When configuration changes, current activity destroyed, `onCreate (setContentView (R.layout.activity_quiz)` called again

onCreate called whenever user switches between portrait and landscape
Dead or Destroyed Activity

- `onDestroy()` called to destroy a stopped app
Saving State Data
Activity Destruction

- App may be destroyed
  - On its own by calling `finish`
  - If user presses `back button`
- Before Activity destroyed, system calls `onSaveInstanceState`
- Saves state required to recreate Activity later
  - E.g. Save current positions of game pieces
**onSaveInstanceState**  
**onRestoreInstanceState()**

- Systems write info about views to Bundle  
- other (app-specific) information must be saved by programmer  
  - E.g. board state in a board game such as mastermind  
- When Activity recreated Bundle sent to **onCreate** and **onRestoreInstanceState()**  
- Can use either method to restore state data/instance variables
Saving State on Activity Destruction

Can restore state data in either method
Saving Data Across Device Rotation

- Since rotation causes activity to be destroyed and a new one created, values of variables lost or reset.
- To stop lost or reset values, save them using `onSaveInstanceState` before activity is destroyed.
  - E.g. called before portrait layout is destroyed.
- System calls `onSaveInstanceState` before `onPause()`, `onStop()` and `onDestroy()`.
Saving Data Across Device Rotation

- For example, if we want to save the value of a variable `mCurrentIndex` during rotation.
- First, create a constant as a key for storing data in the bundle.

```java
private static final String KEY_INDEX = "index";
```

- Then override `onSaveInstanceState` method.

```java
@Override
public void onSaveInstanceState(Bundle savedInstanceState) {
    super.onSaveInstanceState(savedInstanceState);
    Log.i(TAG, "onSaveInstanceState");
    savedInstanceState.putInt(KEY_INDEX, mCurrentIndex);
}
```
Quiz

- Whenever I watch YouTube video on my phone, if I receive a phone call and video stops at 2:31, after call, when app resumes, it should restart at 2:31.
- How do you think this is implemented?
  - In which Activity life cycle method should code be put into?
  - How?
Intents
**Intent**

- **Intent**: a messaging object used by a component to request action from another app or component
- 3 main use cases for Intents
- **Case 1 (Activity A starts Activity B, no result back):**
  - Call `startActivity()`, pass an Intent
  - Intent describes Activity to start, carries any necessary data
Intent: Result Received Back

- **Case 2 (Activity A starts Activity B, gets result back):**
  - Call `startActivityForResult( )`, pass an Intent
  - Separate Intent received in Activity A’s `onActivityResult( )` callback

- **Case 3 (Activity A starts a Service):**
  - E.g. Activity A starts service to download big file in the background
  - Activity A calls `StartService( )`, passes an Intent
  - Intent describes Service to start, carries any necessary data
Implicit Vs Explicit Intents

- **Explicit Intent:** If components sending and receiving Intent are in same app
  - E.g. Activity A starts Activity B in same app

- **Implicit Intent:** If components sending and receiving Intent are in different apps
Intent Example:
Starting Activity 2 from Activity 1
Allowing User to Cheat
Ref: Android Nerd Ranch (2nd edition) pg 87

- **Goal:** Allow user to cheat by getting answer to quiz
- **Screen 2 pops up to show Answer**

**Activity 1**
- User clicks here to cheat

**Activity 2**
- Correct Answer
- If user cheated
- Ask again. Click here to cheat
Add Strings for Activity 1 and Activity 2 to strings.xml

```xml
<?xml version="1.0" encoding="utf-8"?>
<resources>

...<string name="question_asia">Lake Baikal is the world's oldest and deepest freshwater lake.</string>
<string name="warning_text">Are you sure you want to do this?</string>
<string name="show_answer_button">Show Answer</string>
<string name="cheat_button">Cheat!</string>
<string name="judgment_toast">Cheating is wrong.</string>

</resources>
```
Create Blank Activity (for Activity 2) in Android Studio
Specify Name and XML file for Activity 2

Screen 2 Java code in CheatActivity.java

Layout uses activity_cheat.xml
Design Layout for Screen 2

```xml
<LinearLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical"
    android:gravity="center">
    <TextView
        android:id="@+id/answerTextView"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:padding="24dp"
        android:text="@string/warning_text"/>
    <TextView
        android:id="@+id/showAnswerButton"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:padding="24dp"
        android:text="@string/show_answer_button"/>
</LinearLayout>
```
Write XML Layout Code for Screen 2

```xml
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:gravity="center"
    android:orientation="vertical"
    tools:context="com.bignerdranch.android.geoquiz.CheatActivity">

    <TextView
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:padding="24dp"
        android:text="@string/warning_text"/>

    <TextView
        android:id="@+id/answer_text_view"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:padding="24dp"
        android:text="Answer"/>

    <Button
        android:id="@+id/show_answer_button"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="@string/show_answer_button"/>

</LinearLayout>
```

Activity 2
Declare New Activity in AndroidManifest.xml

- Create new activity (CheatActivity) in Android Studio

```xml
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
  package="com.beginnerd ranch.android.geoquiz">

  <application
    android:allowBackup="true"
    android:icon="@mipmap/ic_launcher"
    android:label="@string/app_name"
    android:theme="@style/AppTheme">
    <activity
      android:name="QuizActivity"
      android:label="@string/app_name">
      <intent-filter>
        <action android:name="android.intent.action.MAIN" />
        <category android:name="android.intent.category.LAUNCHER" />
      </intent-filter>
    </activity>
    <activity
      android:name=".CheatActivity"
      android:label="@string/title_activity_cheat">
    </activity>
  </application>
</manifest>
```
Starting Activity 2 from Activity 1

- Activity 1 starts activity 2
  - *through* the Android OS
  - *by calling* `startActivity(Intent)`
- Passes Intent (object for communicating with Android OS)

- Intent specifies which (target) Activity Android `ActivityManager` should start
Starting Activity 2 from Activity 1

- Intents have many different constructors. We will use form:

  ```
  public Intent(Context packageContext, Class<?> cls)
  ```

- Actual code looks like this

```java
mCheatButton = (Button) findViewById(R.id.cheat_button);
mCheatButton.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        // Start CheatActivity
        Intent i = new Intent(QuizActivity.this, CheatActivity.class);
        startActivity(i);
    }
});
```
Implicit vs Explicit Intents

- Previous example is called an **explicit intent**
  - Activity 1 and activity 2 are in same app
- If Activity 2 were in another app, an **implicit intent** would have to be created instead
- Can also pass data between Activities 1 and 2
  - E.g. Activity 1 can tell new activity correct answer (True/False)
Passing Data Between Activities

- Need to pass answer (True/False from QuizActivity to CheatActivity)

- Pass answer as **extra** on the Intent passed into **StartActivity**
- **Extras** are arbitrary data calling activity can include with intent
Passing Answer (True/False) as Intent Extra

- To add extra to Intent, use `putExtra()` command
- Encapsulate Intent creation into a method `newIntent()`

```java
public static Intent newIntent(Context packageContext, boolean answerIsTrue) {
    Intent i = new Intent(packageContext, CheatActivity.class);
    i.putExtra(EXTRA_ANSWER_IS_TRUE, answerIsTrue);
    return i;
}
```

- When user clicks cheat button, build Intent, start new Activity

```java
mCheatButton.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        // Start CheatActivity
        Intent i = new Intent(QuizActivity.this, CheatActivity.class);
        boolean answerIsTrue = mQuestionBank[mCurrentIndex].isAnswerTrue();
        Intent i = CheatActivity.newIntent(QuizActivity.this, answerIsTrue);
        startActivity(i);
    }
});
updateQuestion();
```
Passing Answer (True/False) as Intent Extra

- Activity receiving the Intent retrieves it using `getBooleanExtra()`

```java
public class CheatActivity extends AppCompatActivity {
    private static final String EXTRA_ANSWER_IS_TRUE = 
            "com.bignerdranch.android.geoquiz.answer_is_true";

    private boolean mAnswerIsTrue;

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

        mAnswerIsTrue = getIntent().getBooleanExtra(EXTRA_ANSWER_IS_TRUE, false);
    }
}
```

**Important:** Read Android Nerd Ranch (2nd edition) pg 87
Implicit Intents

- **Implicit Intent**: Does not name component to start.
- Specifies
  - **Action** (what to do, example visit a web page)
  - **Data** (to perform operation on, e.g. web page url)
- System decides component to receive intent based on **action, data, category**
- Example Implicit Intent to share data

```java
// Create the text message with a string
Intent sendIntent = new Intent();
sendIntent.setAction(Intent.ACTION_SEND);
sendIntent.putExtra(Intent.EXTRA_TEXT, textMessage);
sendIntent.setType("text/plain");
ACTION (No receiving Activity specified)
Data type
```
References

- Android Nerd Ranch, 1st edition
- Busy Coder’s guide to Android version 4.4
- CS 65/165 slides, Dartmouth College, Spring 2014
- CS 371M slides, U of Texas Austin, Spring 2014