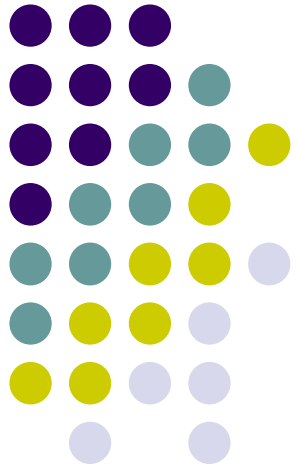
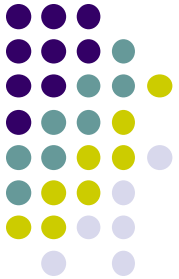
CS 528 Mobile and Ubicomp

Lecture 3b: Activity Lifecycle, Rotating Device, Saving Data & Intents

Emmanuel Agu

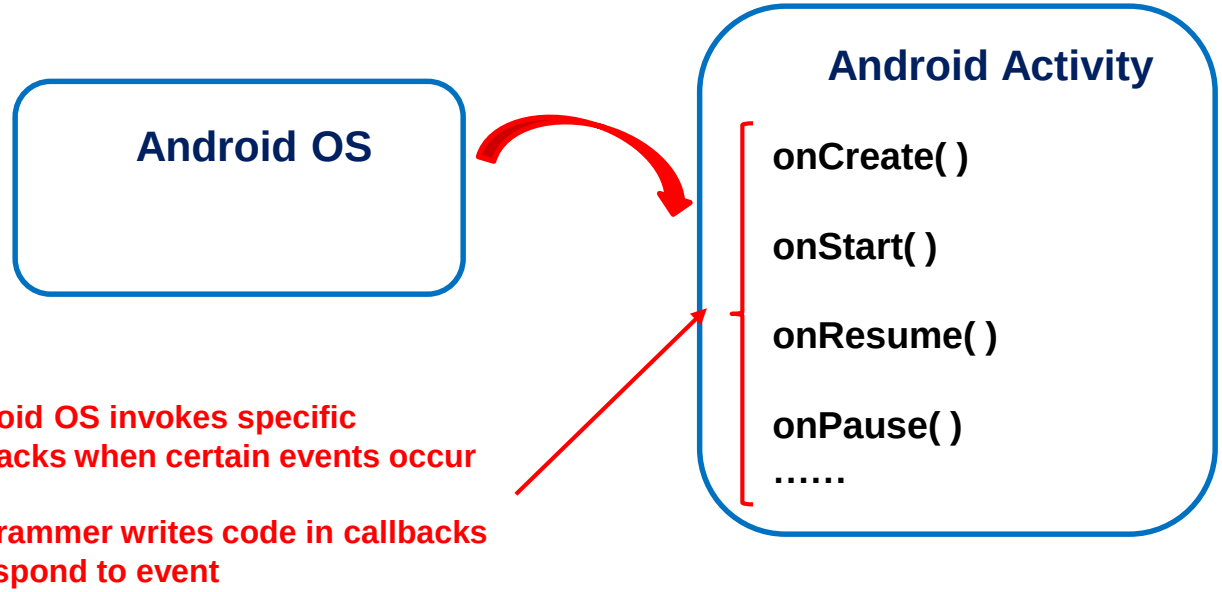




Android Activity LifeCycle

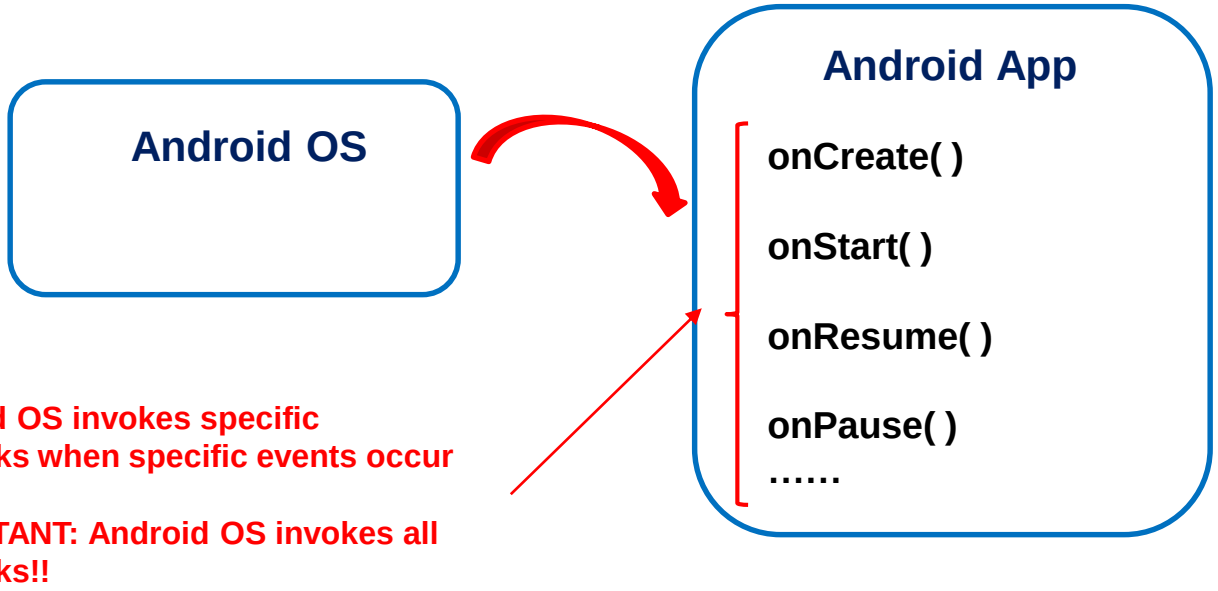
Starting Activities

- Android Activity 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



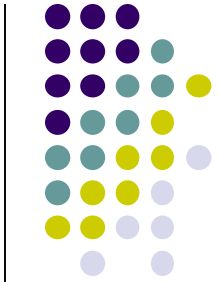
Activity Callbacks

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



Understanding Android Lifecycle

https://developer.android.com/guide/components/activities/activity-lifecycle.html



- 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 to “tidy up” before app gets bumped

OnCreate( )

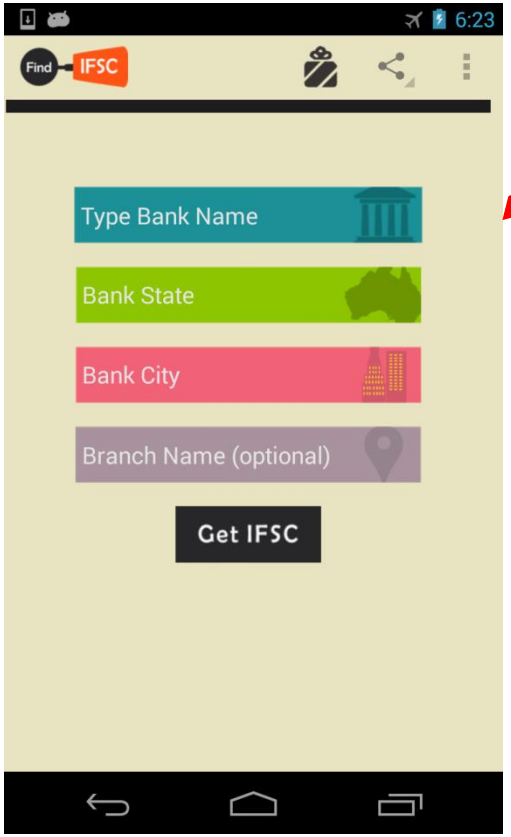
- Initializes activity once created
- Operations typically performed in onCreate() method:
  - Inflate (create) widgets and place them on screen
    - (e.g. using layout files with setContentView( ))
  - Getting references to inflated widgets (using findViewbyId( ))
  - Setting widget listeners to handle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

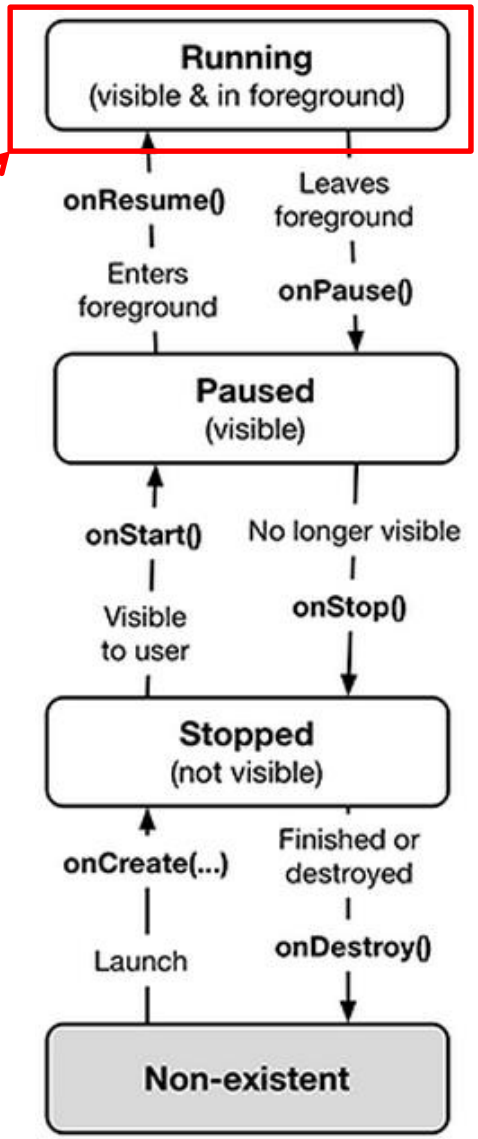
```
public class QuizActivity extends Activity {

    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

Running App

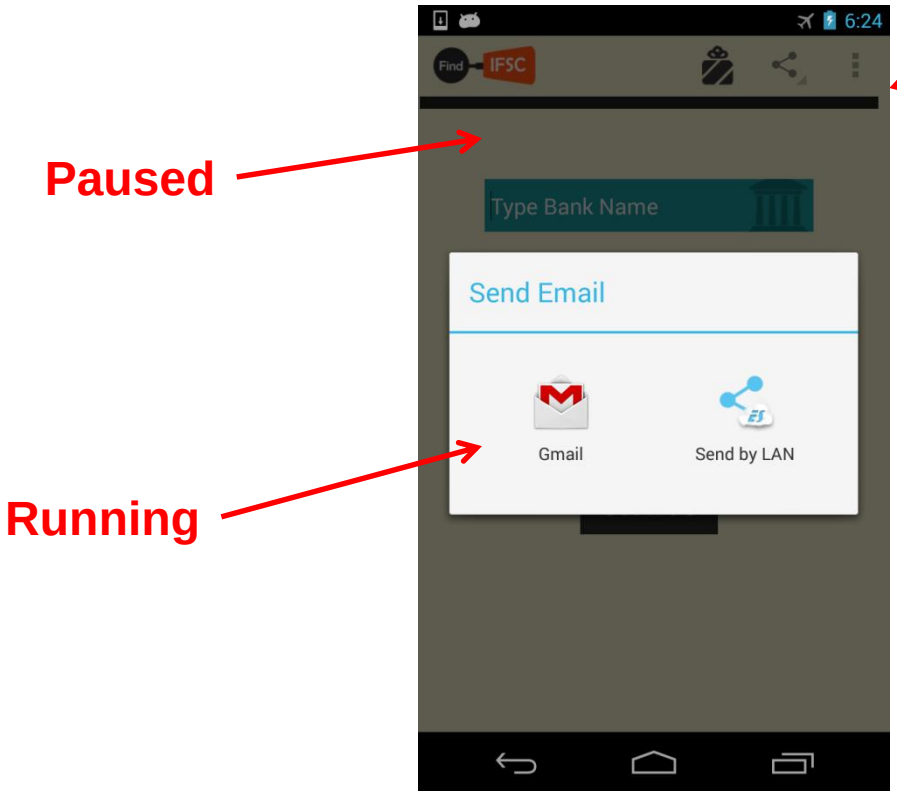
- A running app is one that user is currently using or interacting with
  - Visible, in foreground

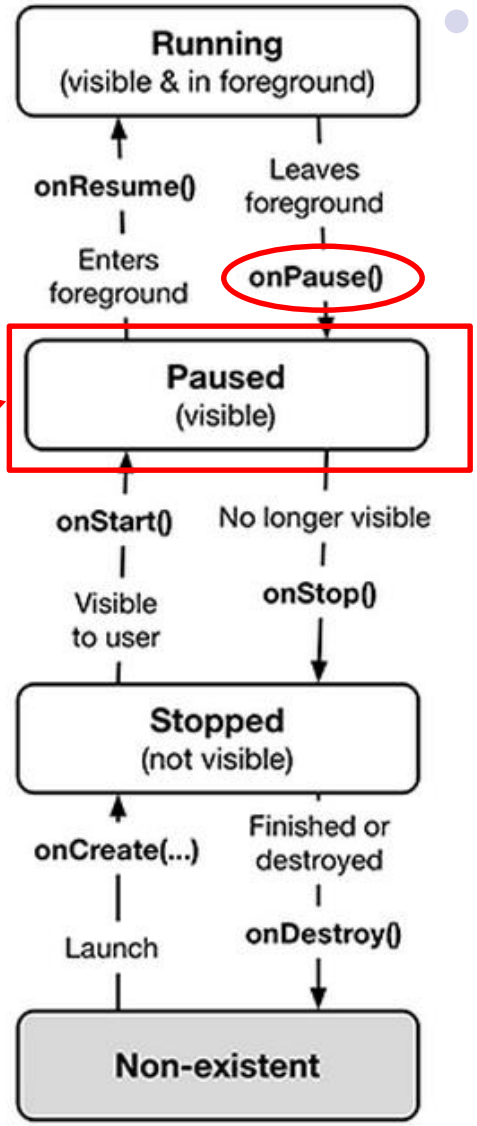




Paused App

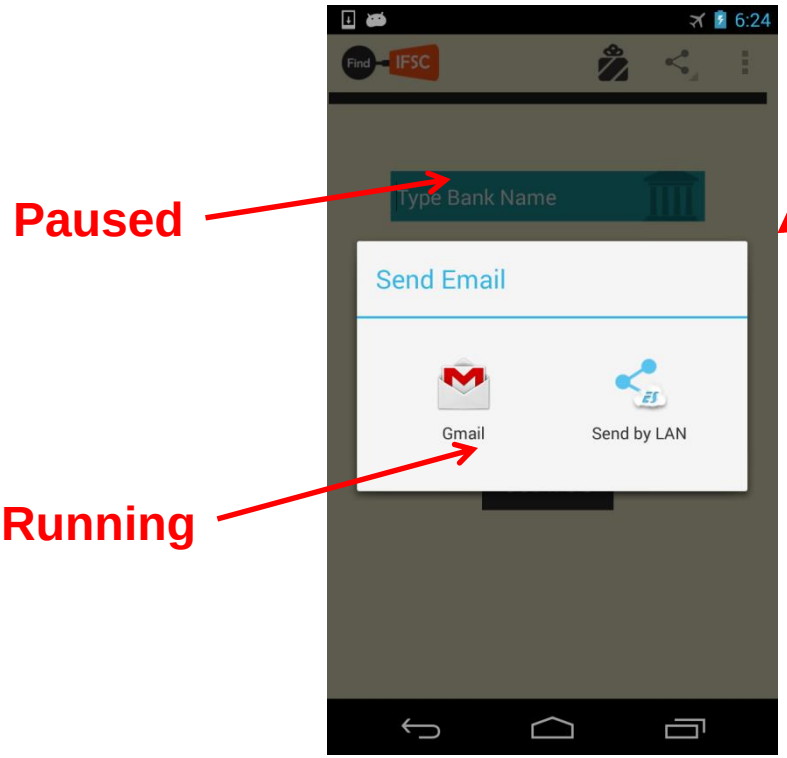
- An app is **paused** if it is **visible but no longer in foreground**
- E.g. blocked by a pop-up dialog box
- App's **onPause( )** method is called during transition from running to paused state

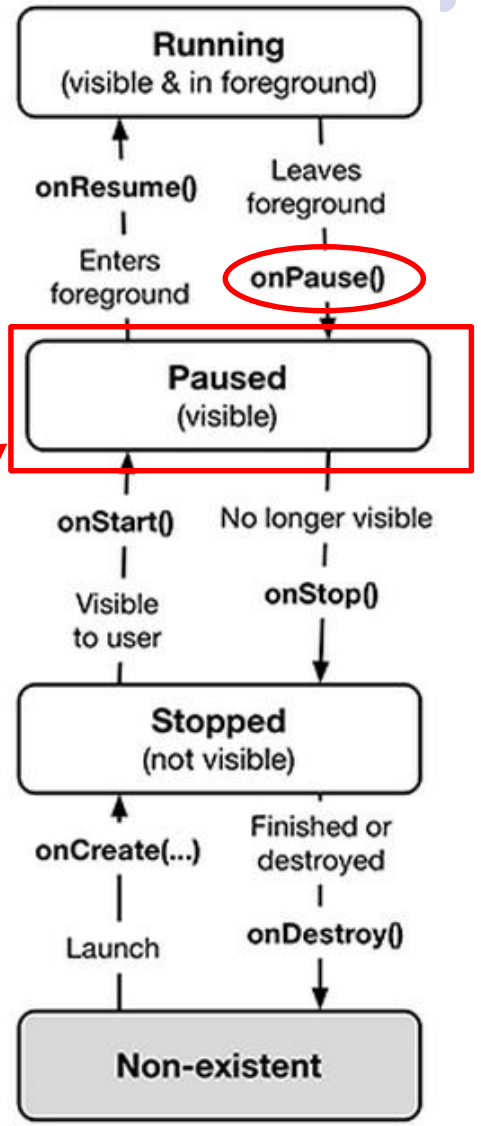




onPause( ) Method

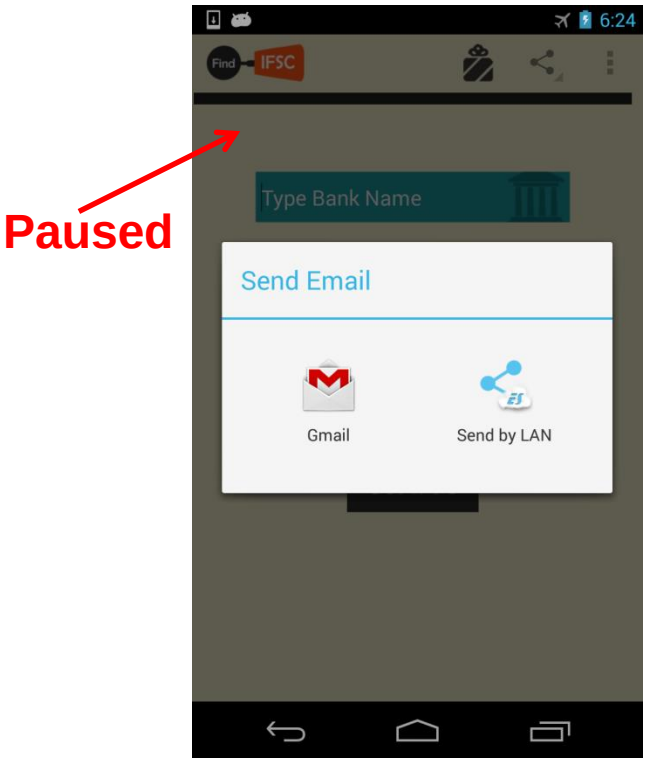
- Typical actions taken in onPause( ) method
  - Stop animations or CPU intensive tasks
  - Stop listening for GPS, broadcast information
  - Release handles to sensors (e.g GPS, camera)
  - Stop audio and video

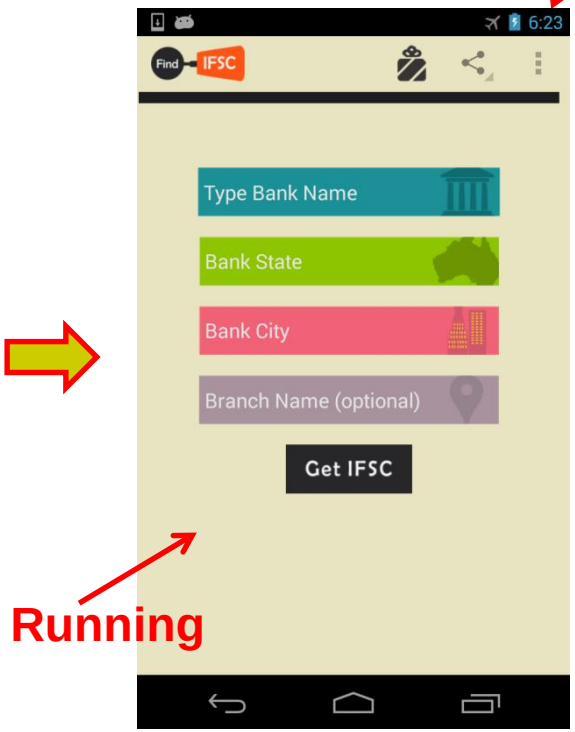


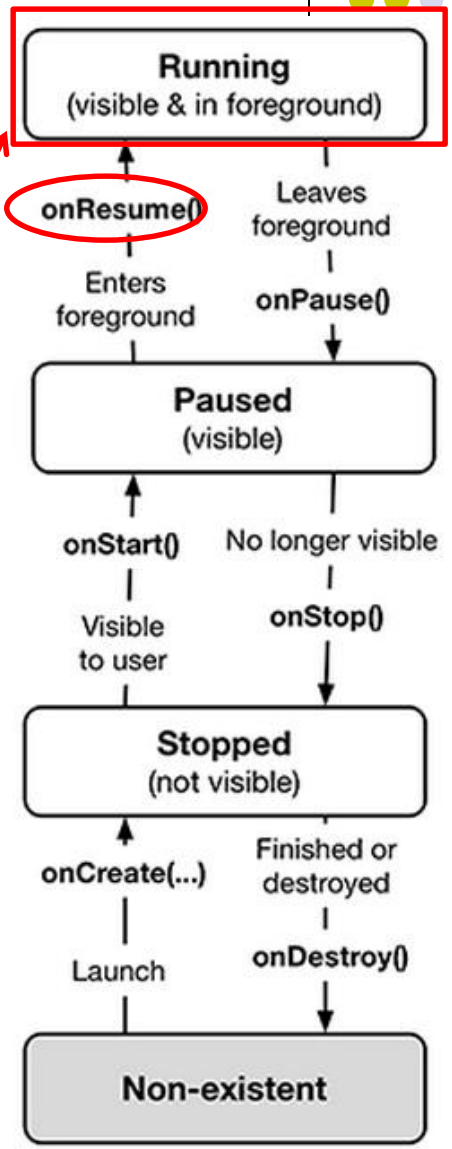


onResume( ): Resuming Paused App

- 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

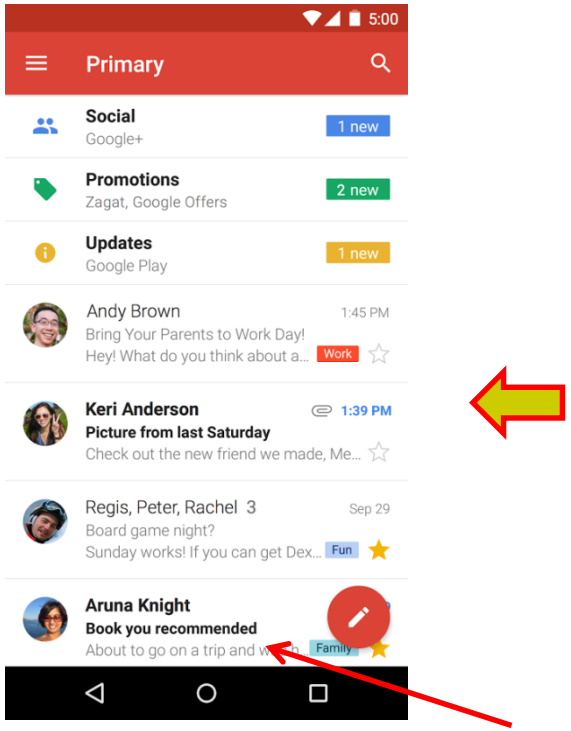




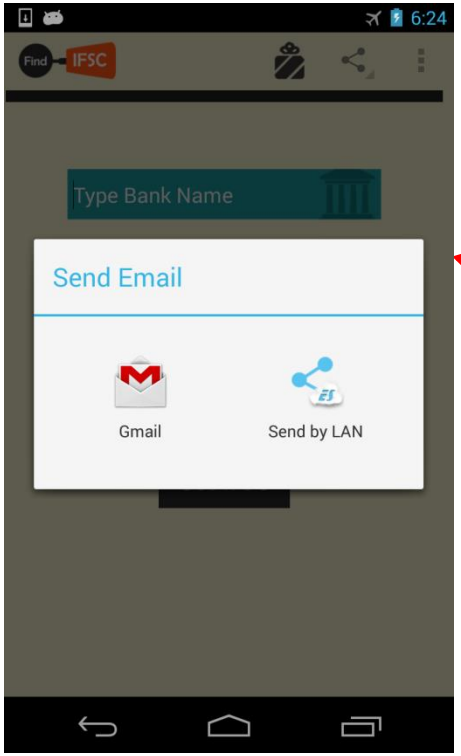


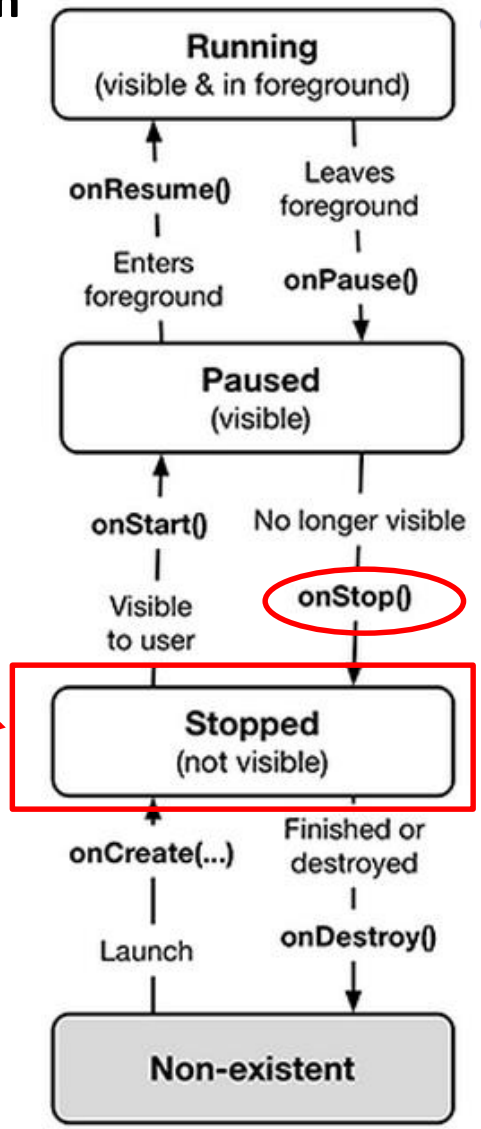
Stopped App

- An app is **stopped** if it's **no longer visible + no longer in foreground**
- E.g. user starts using another app
- App's **onStop( )** method is called during transition from paused to stopped state



Running



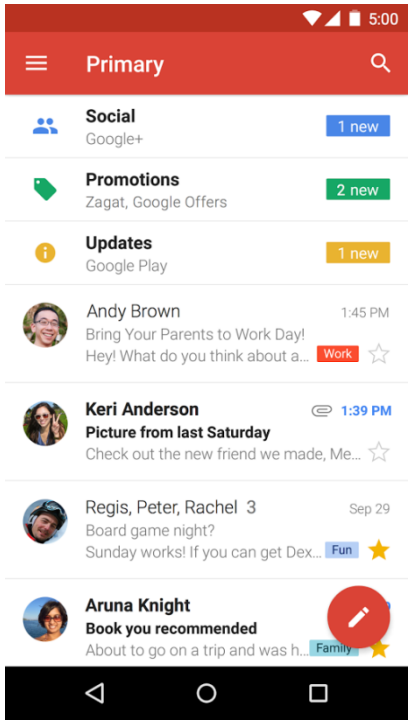


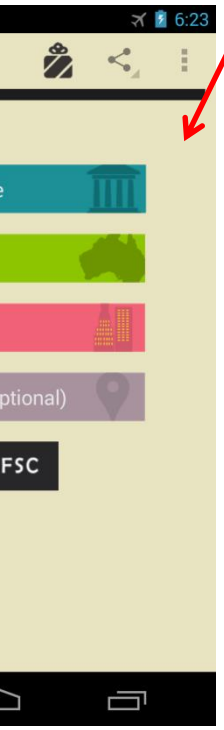
onStop() Method

- An activity is stopped when:
  - User receives phone call
  - User starts another app
- 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)

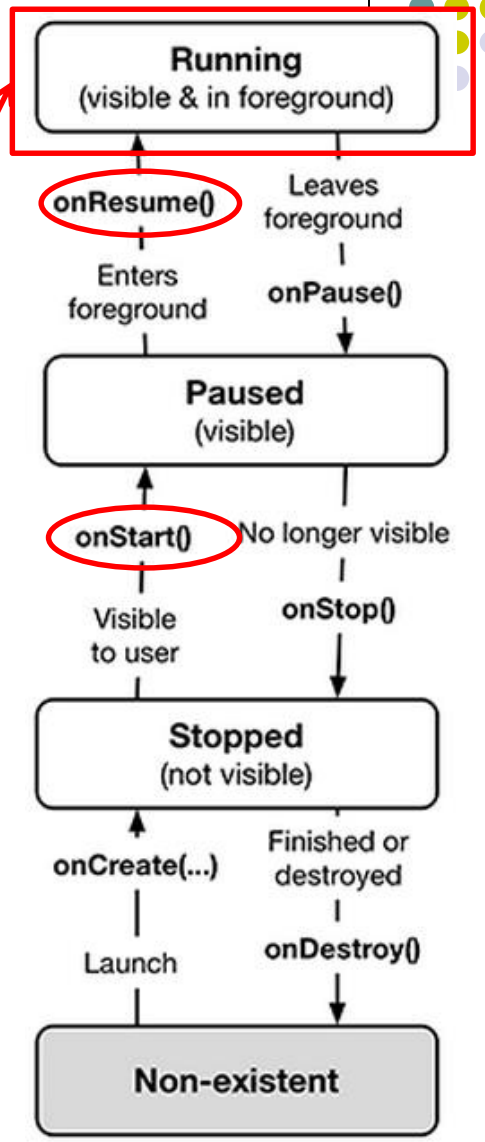
Resuming Stopped App

- 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



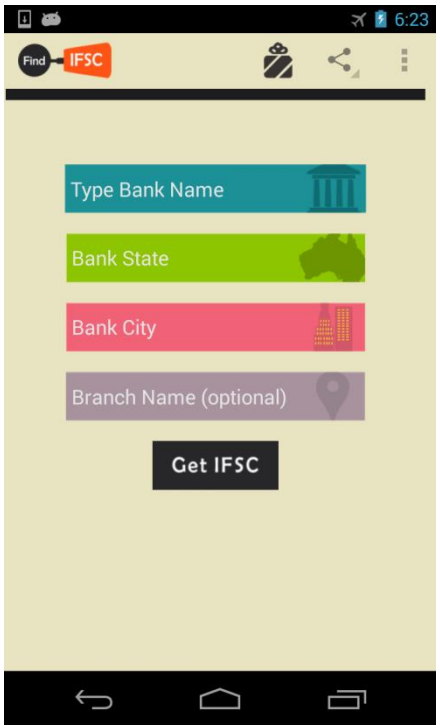


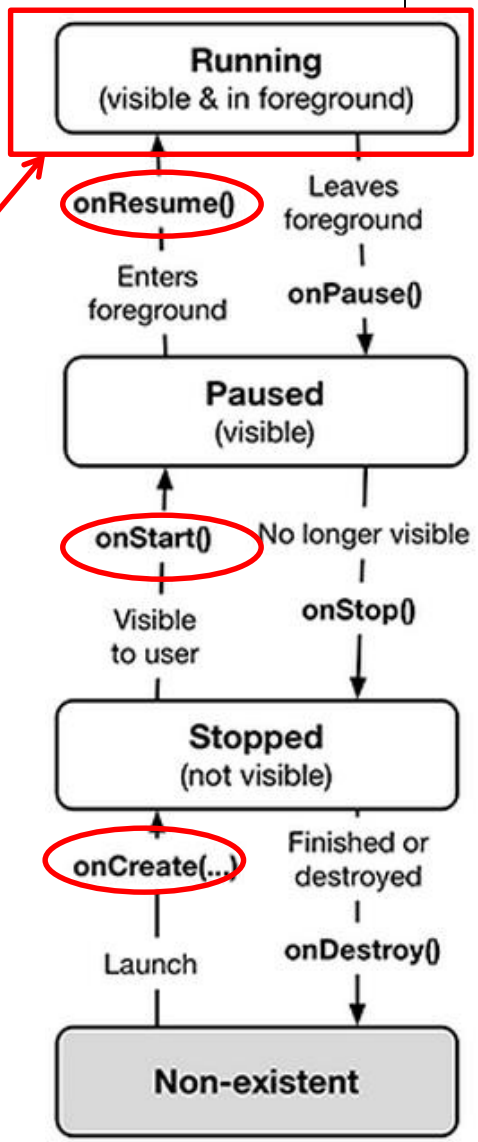
Running

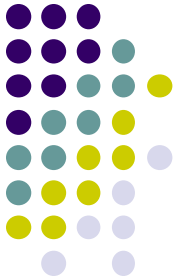


Starting New App

- To launch new app, get it to running
- App's **onCreate( )**, **onStart( )** and **onResume( )** methods are called
- Afterwards new app is **running**



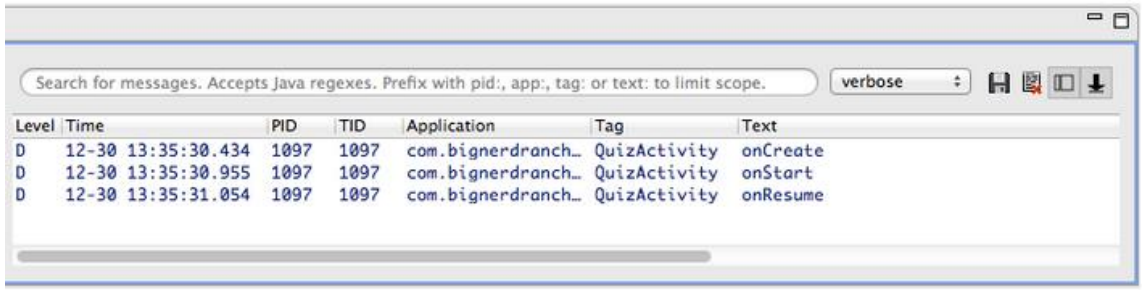




Logging Errors in Android

Logging Errors in Android

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



- Error logging is in **Log** class of **android.util** package, so need to

  import android.util.Log;

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

Method	Purpose
`Log.e()`	Log errors
`Log.w()`	Log warnings
`Log.i()`	Log informational messages
`Log.d()`	Log debug messages
`Log.v()`	Log verbose messages

Ref: Introduction to Android Programming, Annuzzi, Darcey & Conder

QuizActivity.java

- A good way to understand Android lifecycle methods is to print debug messages in Android Studio when they are called

onCreate( ){

… print message “OnCreate called”…

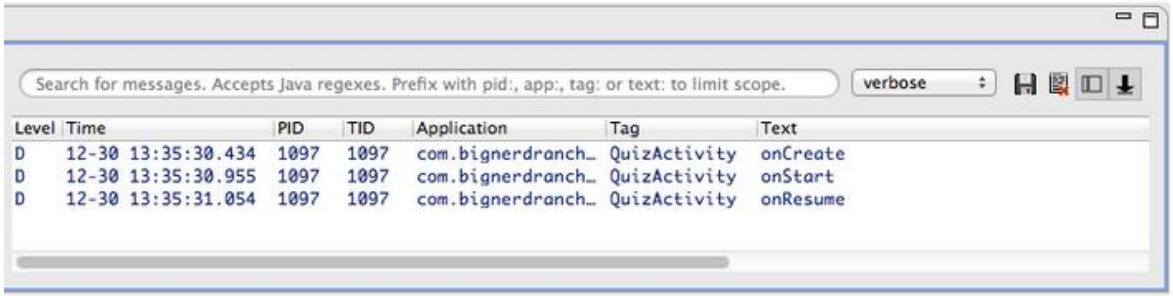
}

onStart( ){

… print message “OnStart called”…

}

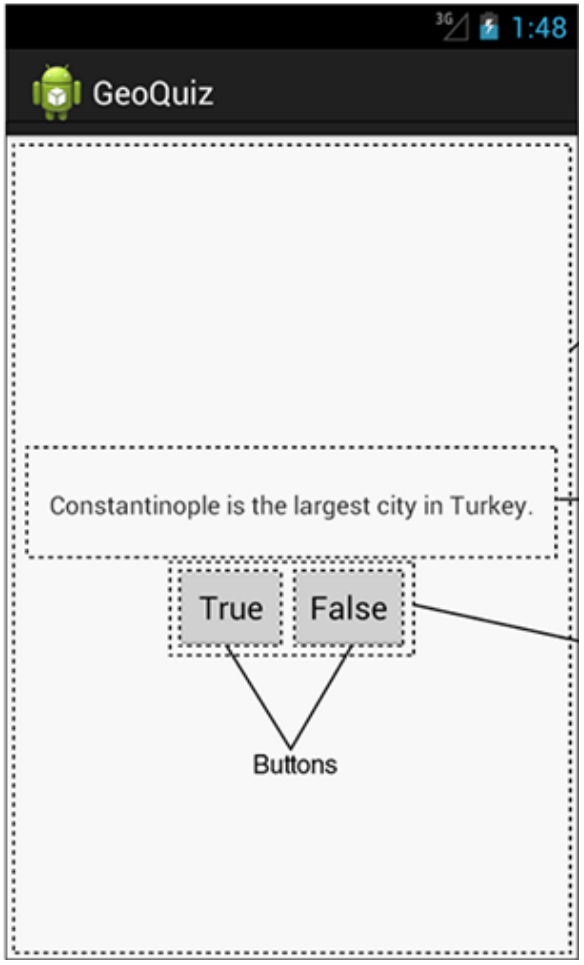
… etc



QuizActivity.java

- Example: print debug message from onCreate method below

```
package com.bignerdranch.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

```
public static int d(String tag, String msg)
```

- E.g.

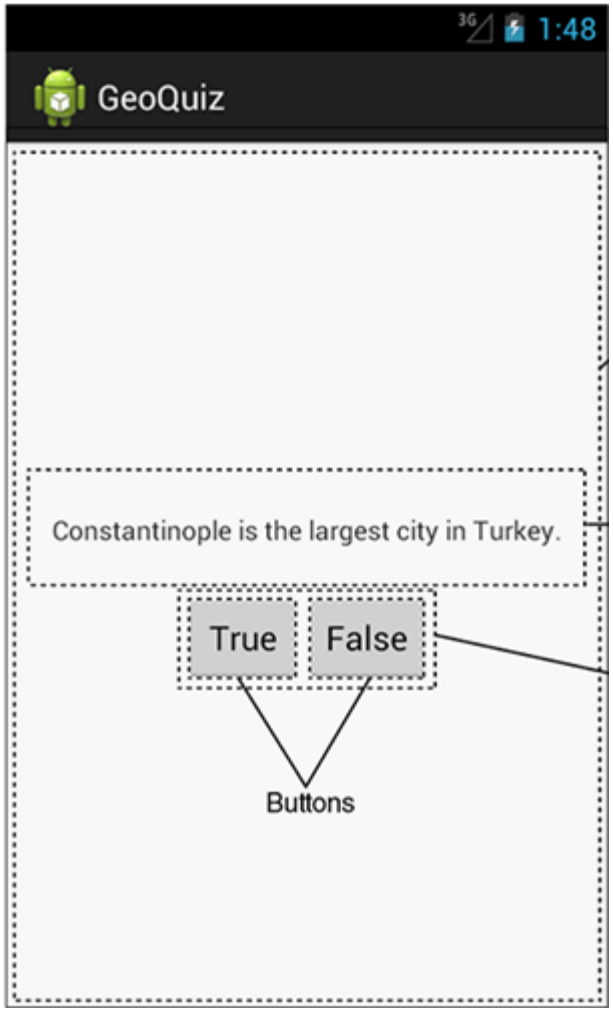
Tag → QuizActivity: Message → onCreate(Bundle) called

- Example declaration:

```
Log.d(TAG, "onCreate(Bundle) called");
```

- Then declare string for **TAG**

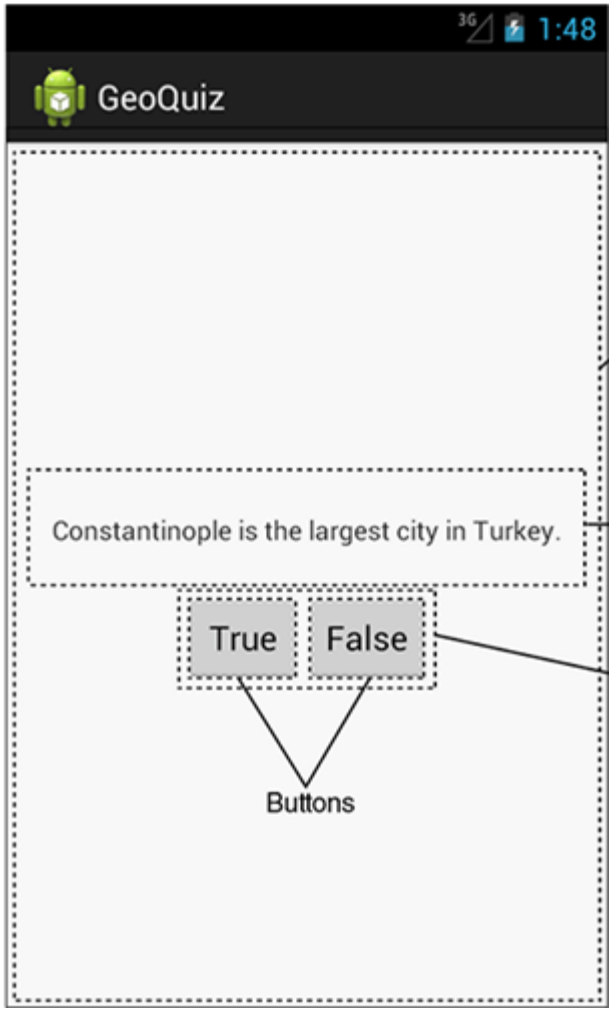
```
public class QuizActivity extends Activity {

    private static final String TAG = "QuizActivity";

    ...

}
```



QuizActivity.java

- Putting it all together

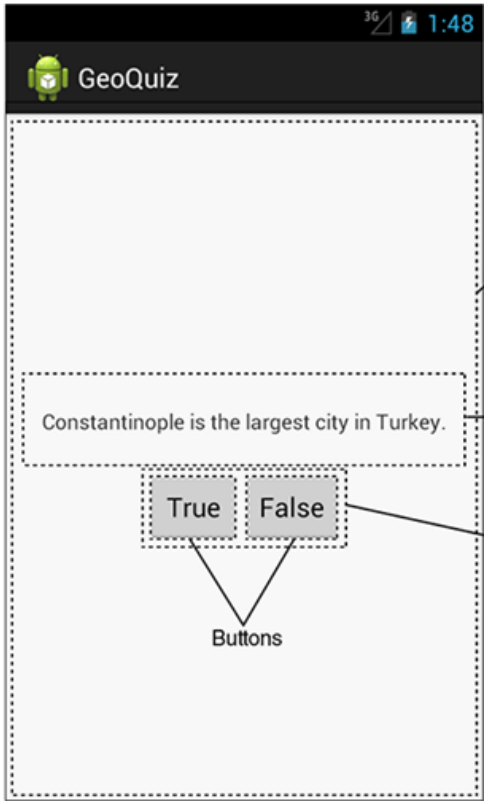
```
public class QuizActivity extends Activity {

    ...

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

        ...
```



QuizActivity.java

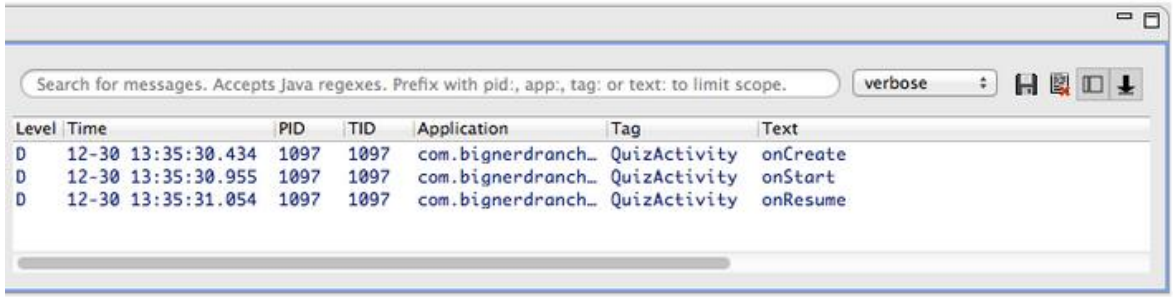
- Can overide more lifecycle methods
- Print debug messages from each method

```
} // 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");
}

}
```

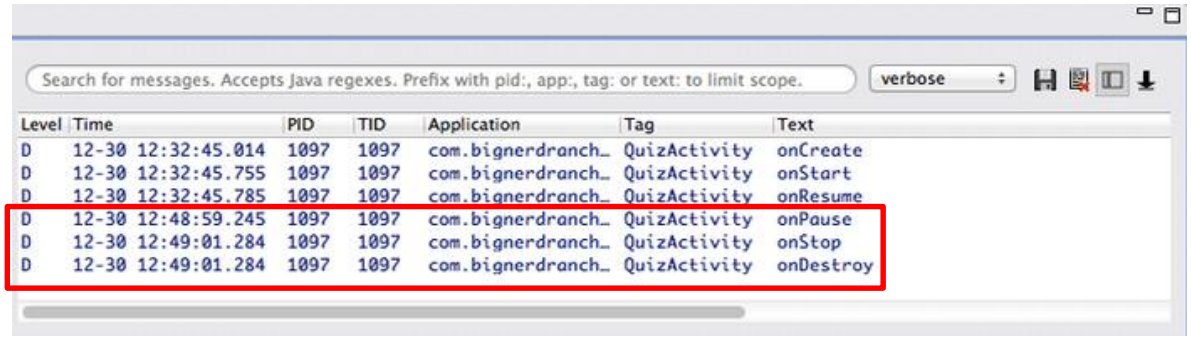


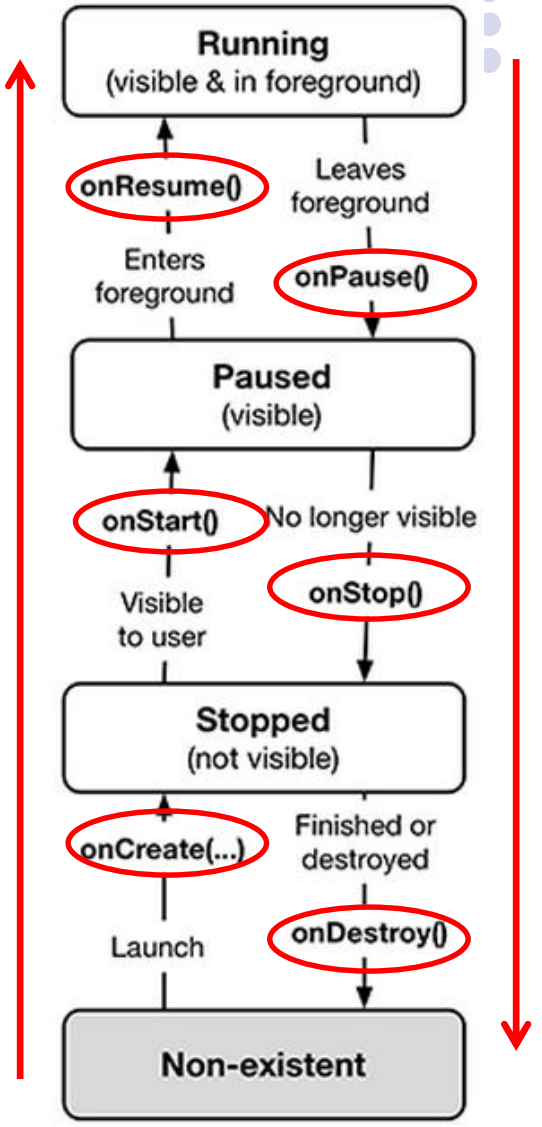
QuizActivity.java Debug Messages

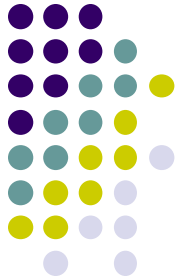
- Launching GeoQuiz app activities **OnCreate, OnStart and onResume** methods



- Pressing **Back** button destroys the activity (calls **onPause**, **onStop** and **onDestroy**)







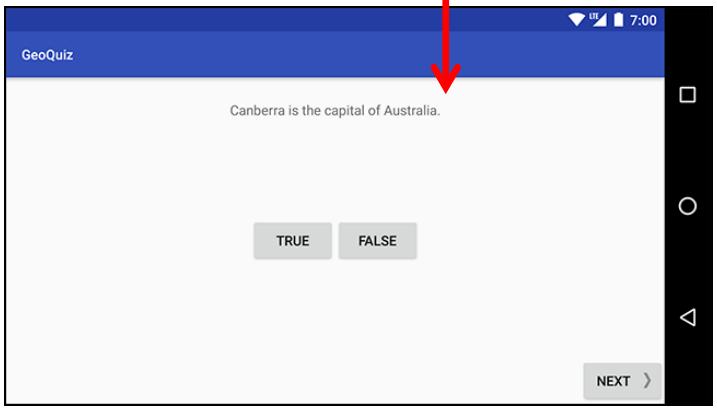
Rotating Device

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 layout

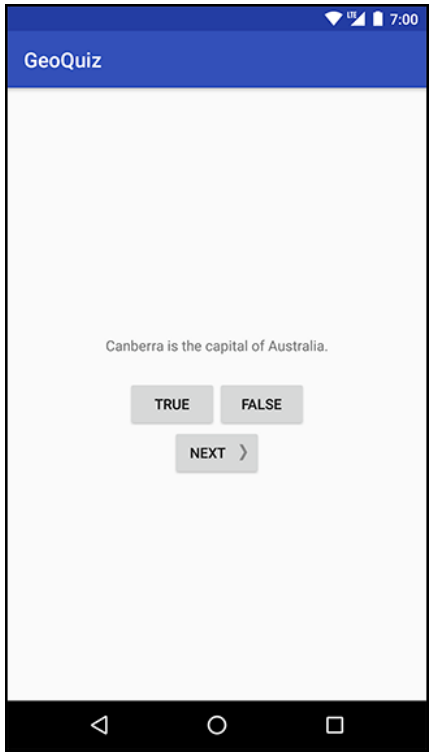


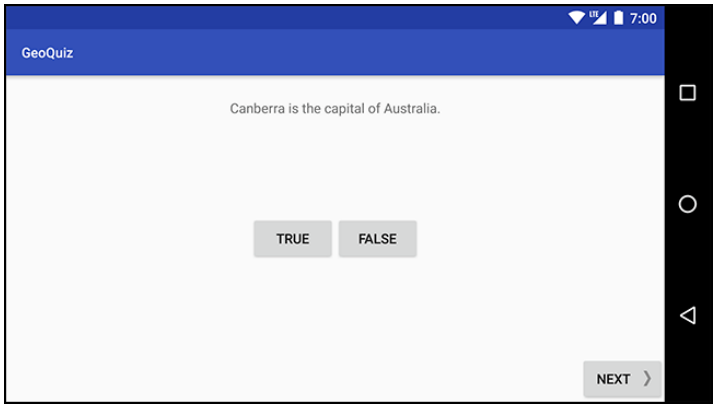
Use landscape XML layout

Rotating Device: Using Different Layouts

- **Portrait:** use XML layout file in **res/layout**
- **Landscape:** use XML layout file in **res/layout-land/**
- Copy XML layout file (activity_quiz.xml) from **res/layout** to **res/layout-land/** and customize it
- If configuration changes, current activity destroyed, **onCreate -> setContentView (R.layout.activity_quiz)** called again

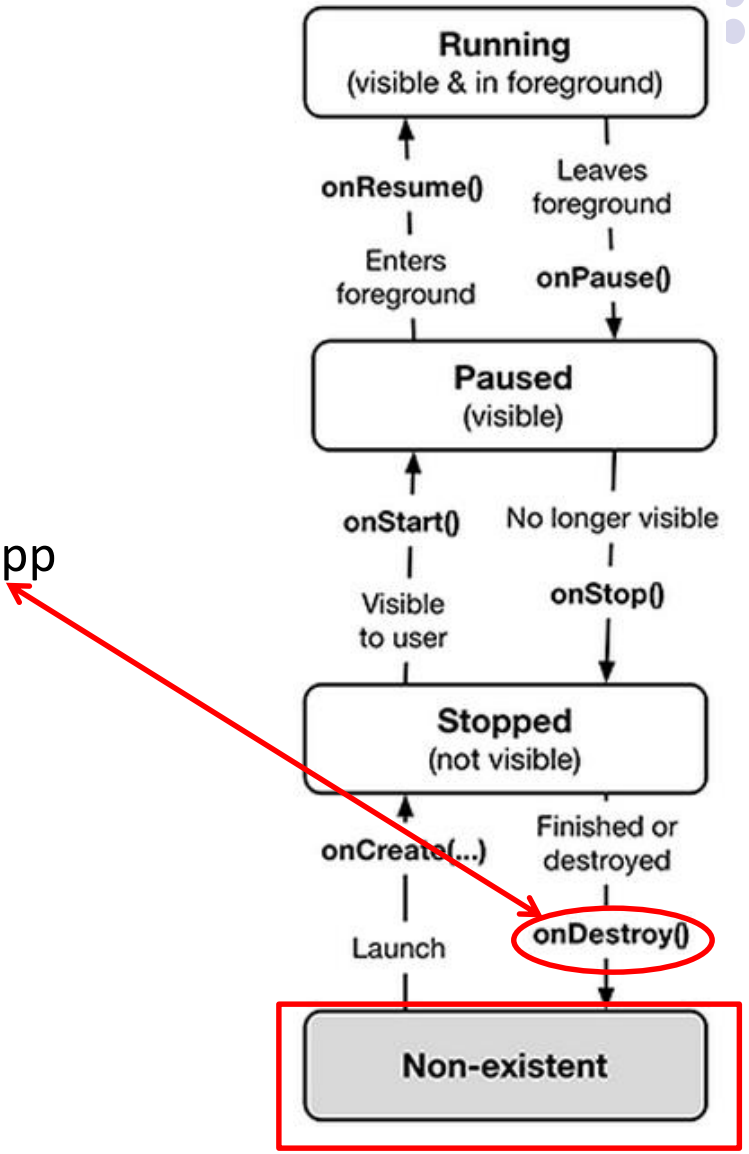
onCreate called whenever user switches between portrait and landscape

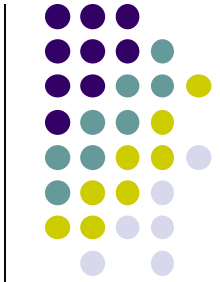




Dead or Destroyed Activity

- onDestroy( ) called to destroy a stopped app

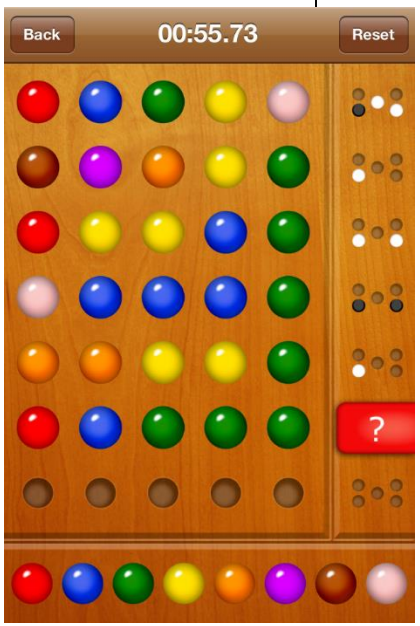




Saving State Data

Activity Destruction

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

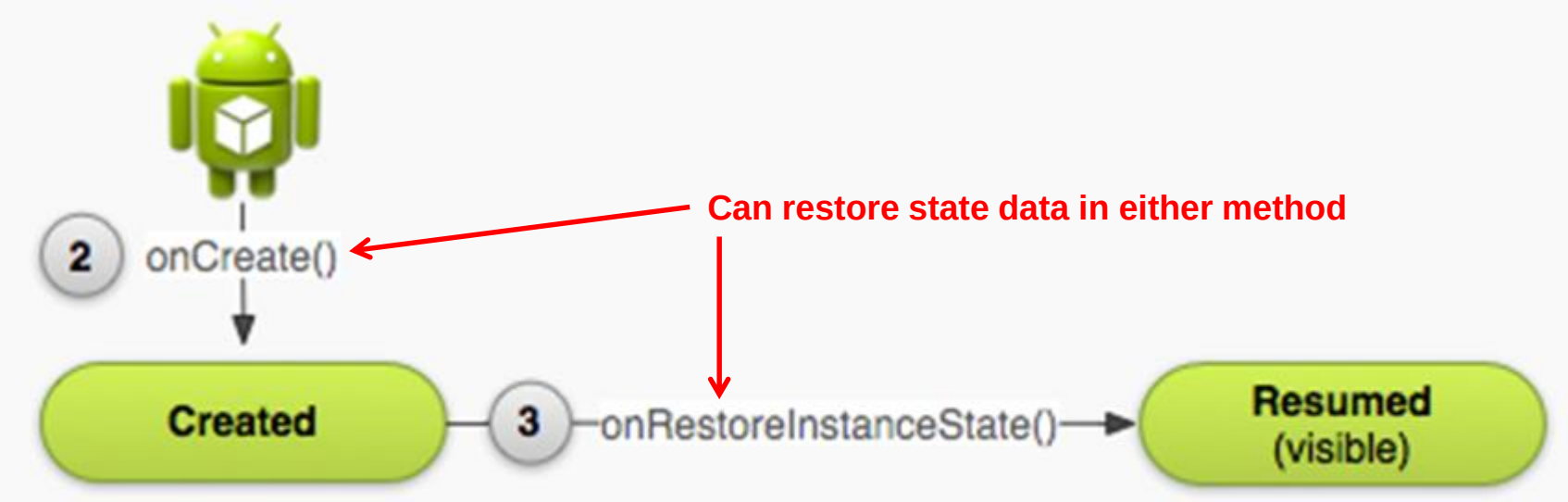


onSaveInstanceState: Saving App State

- Systems write info about views to Bundle
- Programmer must save other app-specific information using **onSaveInstanceState( )**
  - E.g. board state in a board game such as mastermind

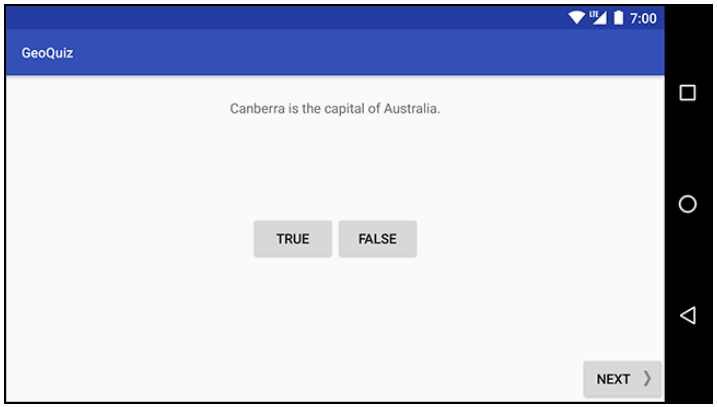
onRestoreInstanceState( ): Restoring State Data

- When an Activity recreated saved data sent to **onCreate** and **onRestoreInstanceState()**
- Can use either method to restore app state data



Saving Data Across Device Rotation

- Since rotation causes activity to be destroyed and new one created, values of variables lost or reset
- To avoid losing or resetting 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( )**



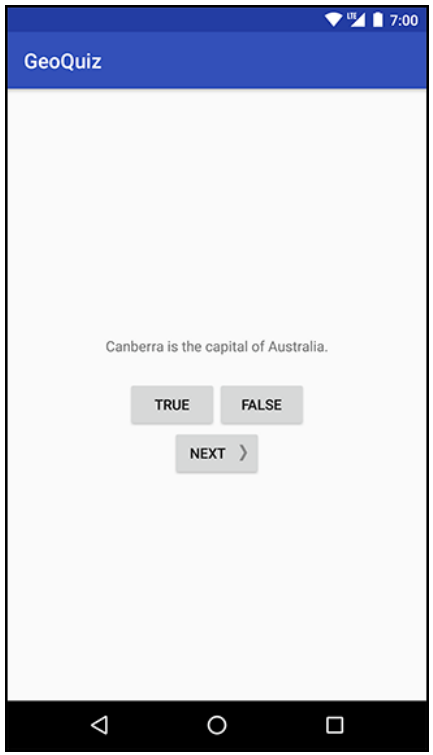
Saving Data Across Device Rotation

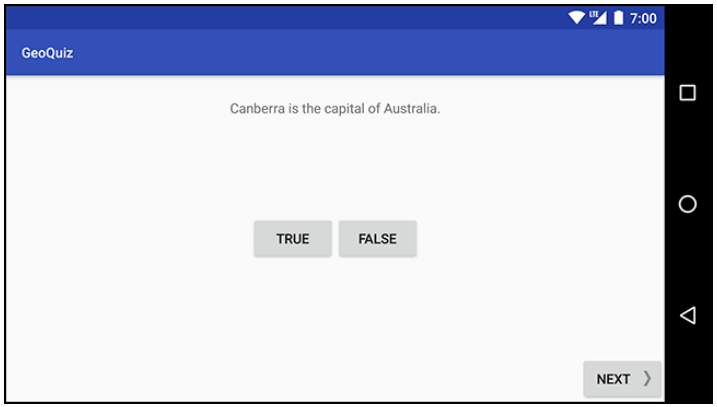
- For example, to save the value of a variable **mCurrentIndex** during rotation
- First, create a constant KEY_INDEX as a key for storing data in the bundle

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

- Then override **onSaveInstanceState** method

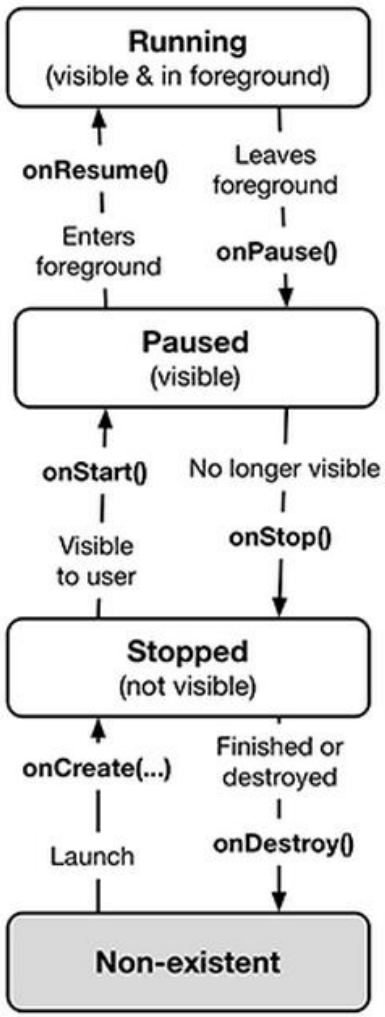
```
@Override
public void onSaveInstanceState(Bundle savedInstanceState) {
    super.onSaveInstanceState(savedInstanceState);
    Log.i(TAG, "onSaveInstanceState");
    savedInstanceState.putInt(KEY_INDEX, mCurrentIndex);
}
```

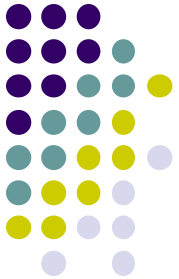




Question

- 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 Android methods should code be put into?
  - How?

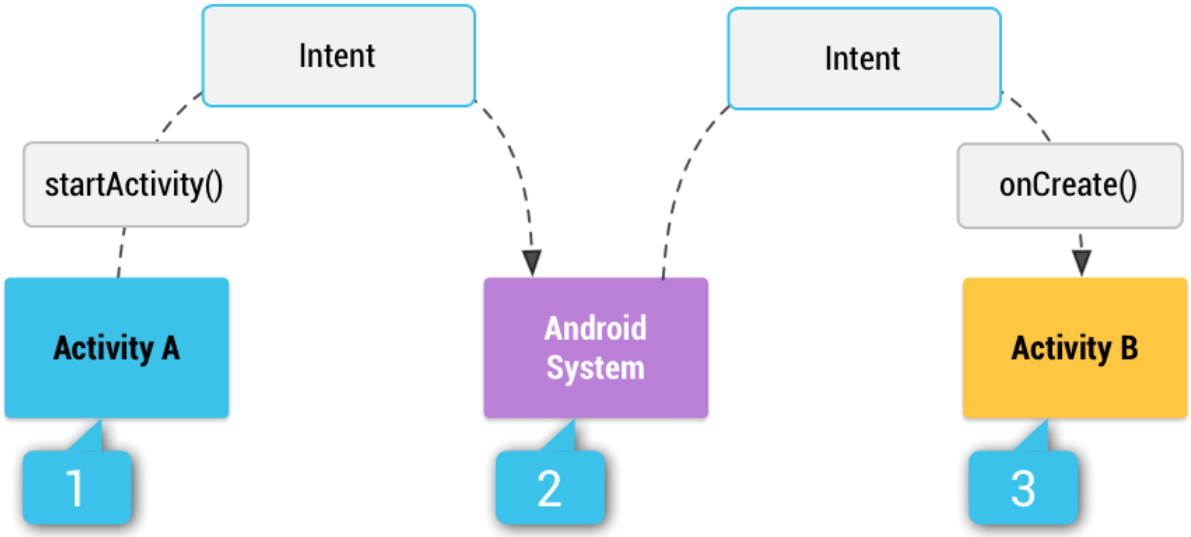




Intents

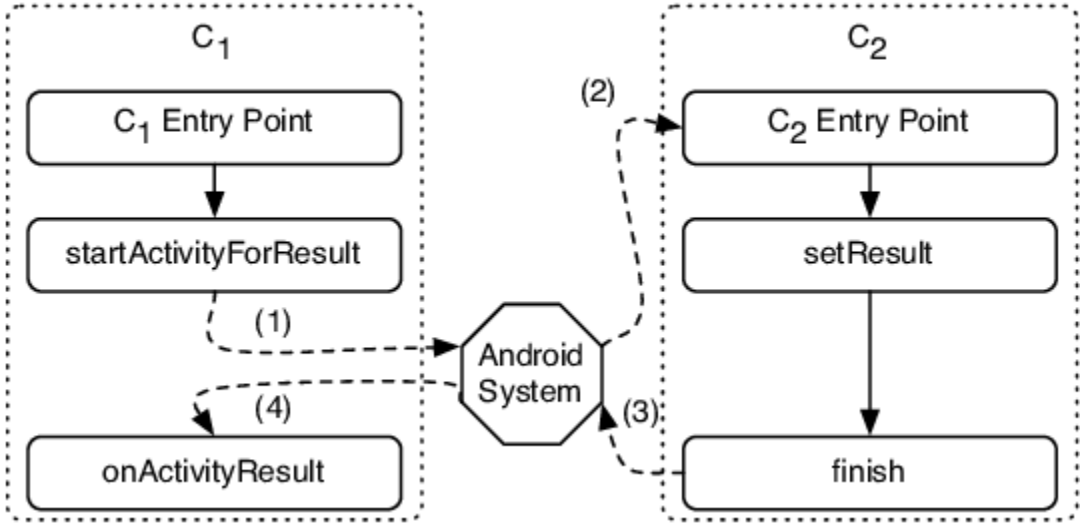
Intent

- **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 has information about Activity to start, plus any necessary data

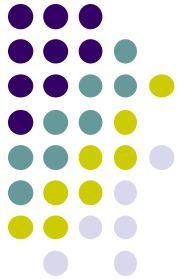


Intent: Result Received Back

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

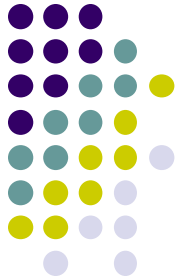


Intent: Result Received Back



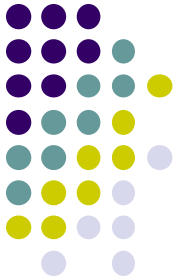
- **Case 3 (Activity A starts a Service):**
  - E.g. Activity A starts service to download big file in the background
  - Activity A calls **StartService( )**, passes an Intent
  - Intent contains information about Service to start, plus any necessary data

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
  - Activity A explicitly says what Activity (B) should be started

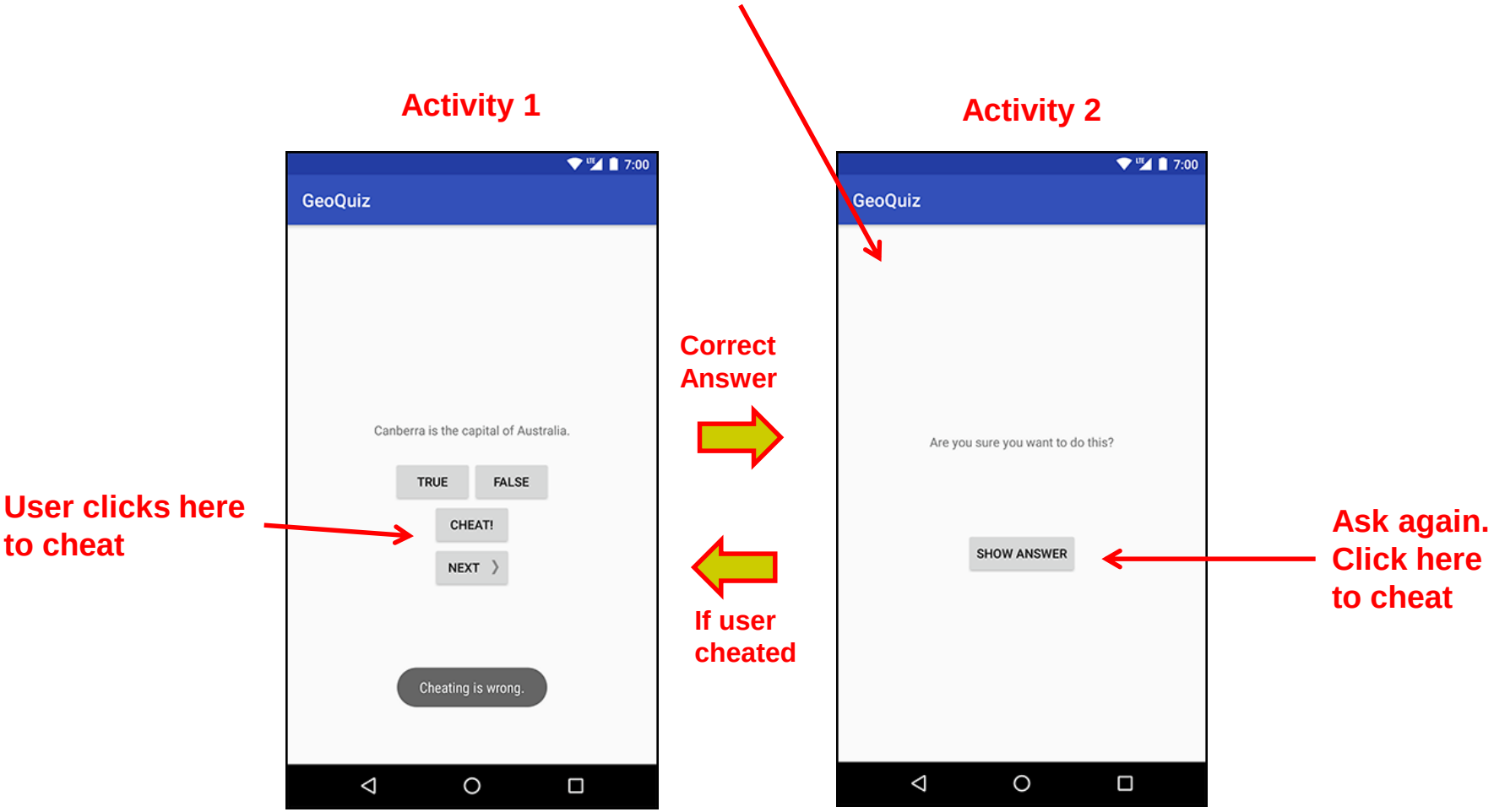
- **Implicit Intent:** If components sending and receiving Intent are in **different apps**
  - Activity B specifies what ACTION it needs done, doesn't specify Activity to do it
  - Example of Action: take a picture, any camera app can handle this



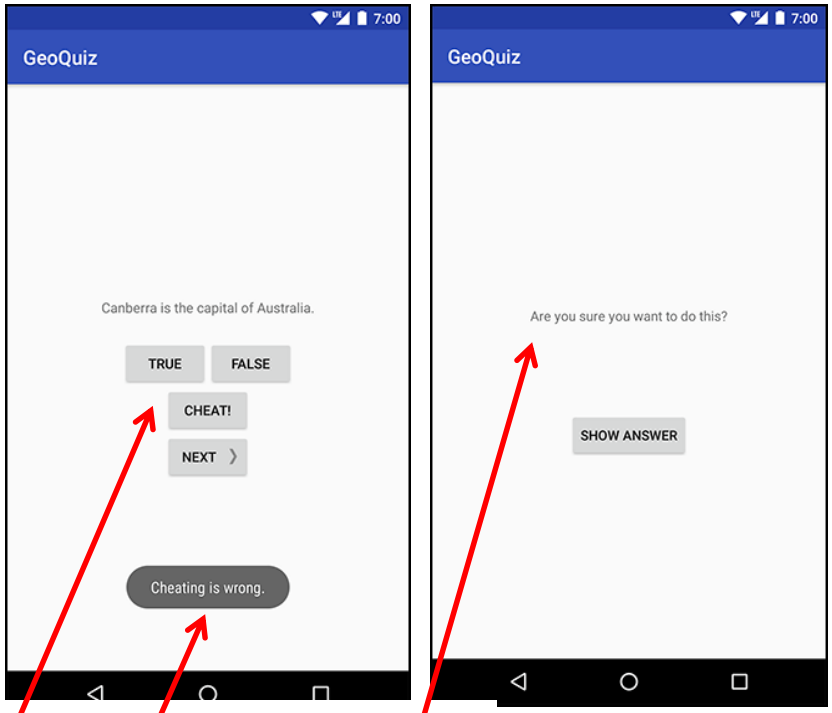
Intent Example: Starting Activity 2 from Activity 1

Allowing User to Cheat
Ref: Android Nerd Ranch (3rd edition) pg 91

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

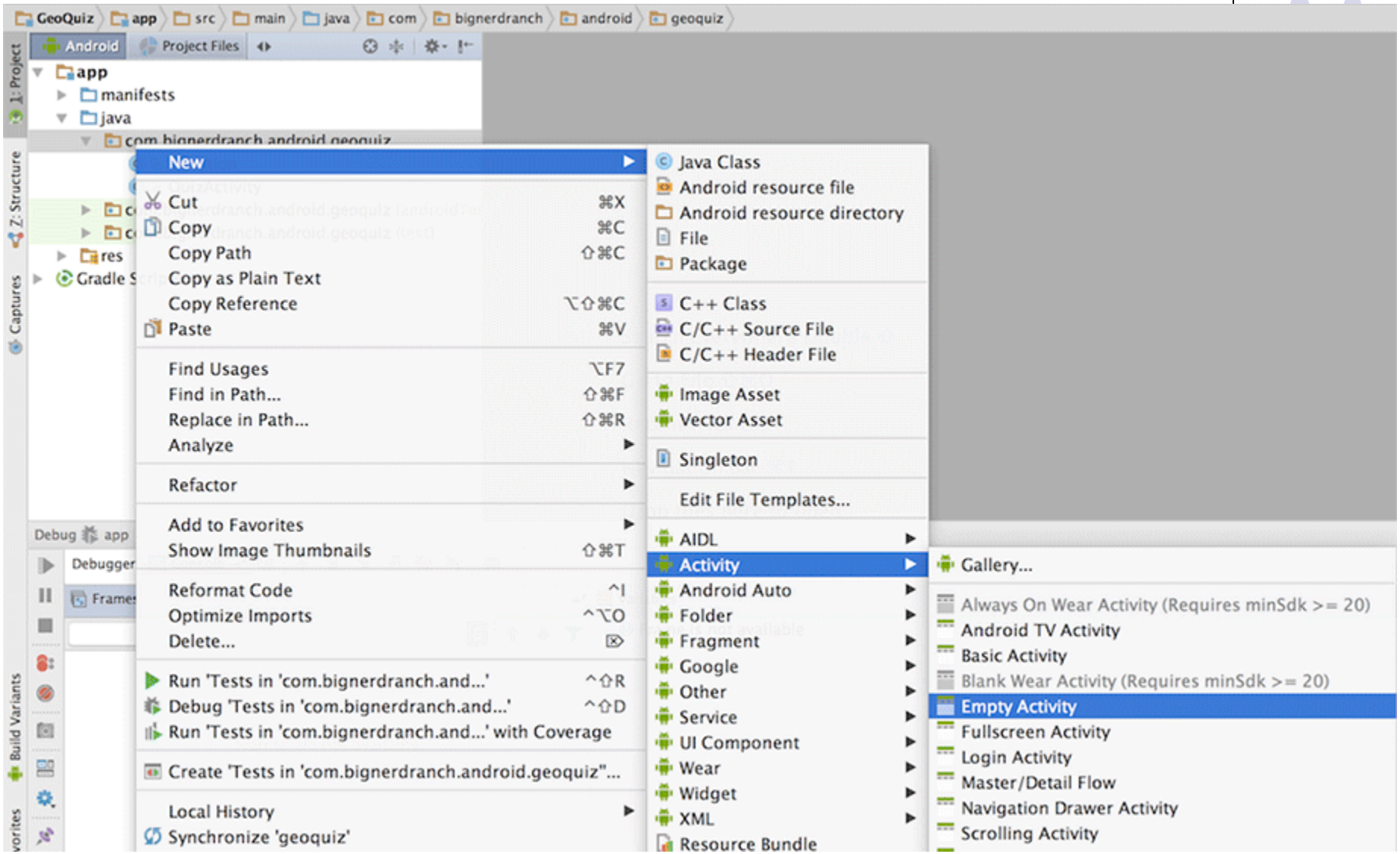


Add Strings for Activity 1 and Activity 2 to strings.xml

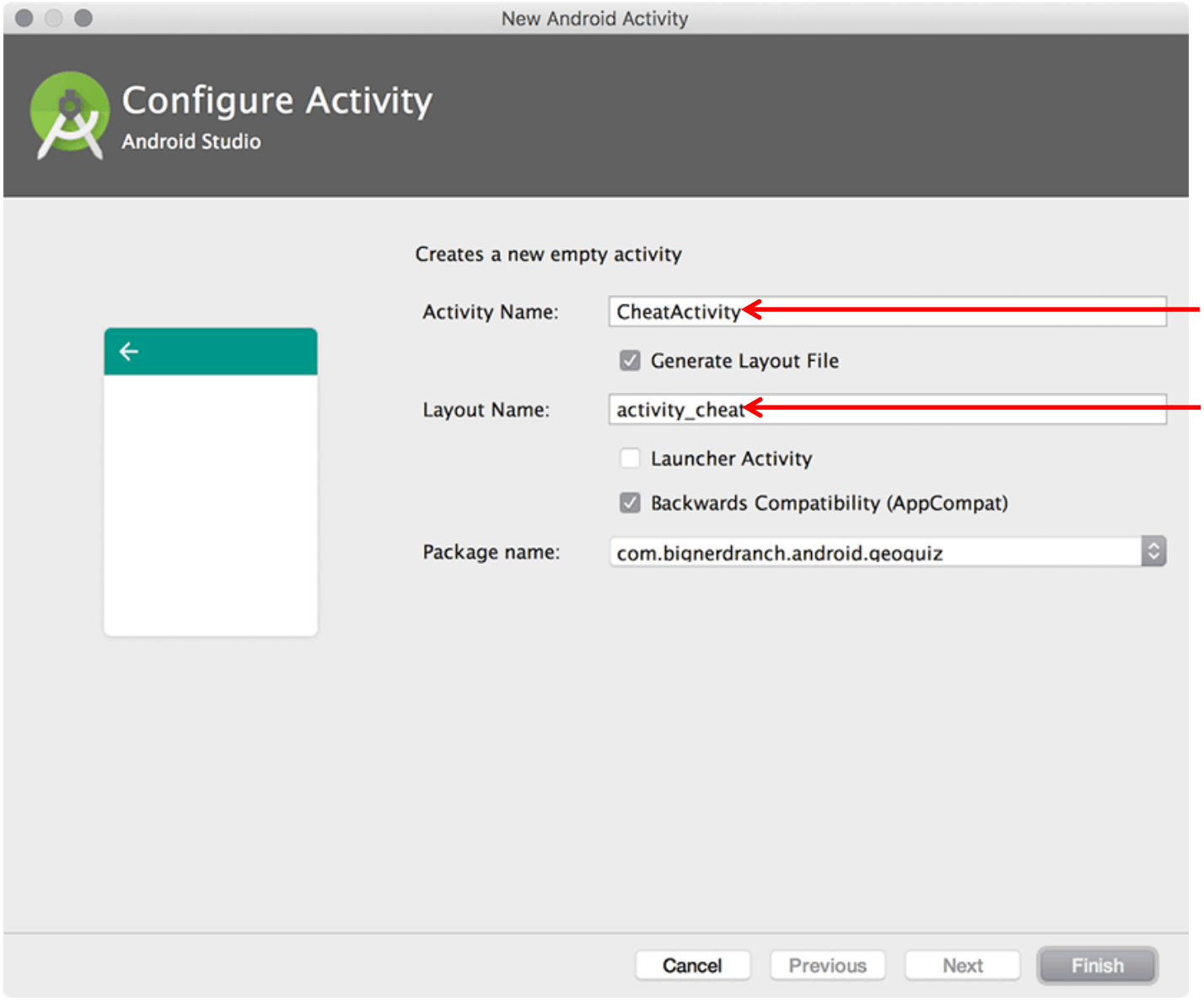



```
<?xml version="1.0" encoding="utf-8"?>
<resources>

    ...
    <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 Empty Activity (for Activity 2) in Android Studio



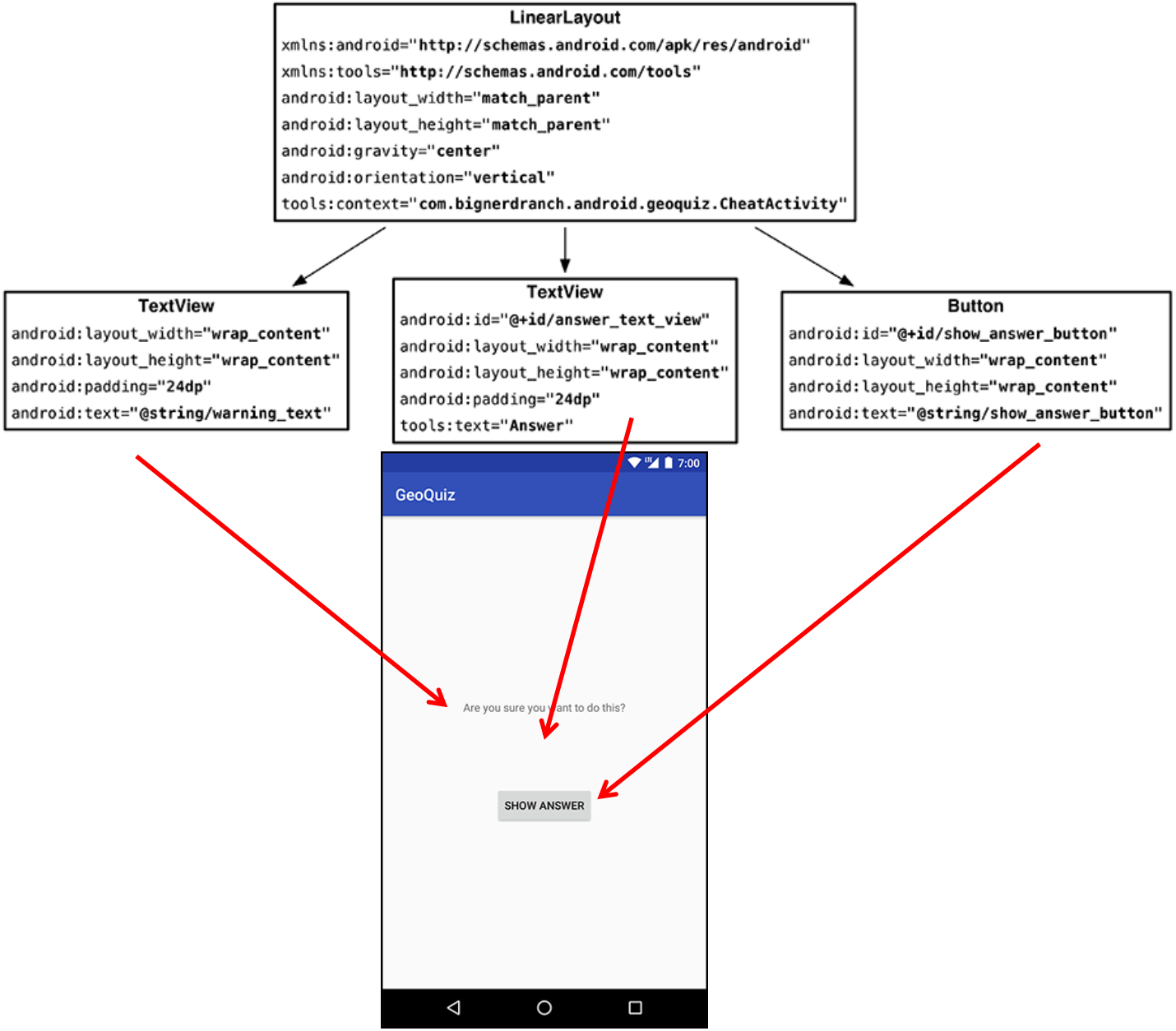
Specify Name and XML file for Activity 2



Screen 2 Java code in CheatActivity.java

Layout uses activity_cheat.xml

Design Layout for Screen 2



Write XML Layout Code for Screen 2

```
<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:orientation="vertical"
              android:gravity="center"
              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"
        tools: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>
```

Declare New Activity (CheatActivity) in AndroidManifest.xml

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

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

        <activity android:name=".QuizActivity">
            <intent-filter>
                <action android:name="android.intent.action.MAIN"/>

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

        <activity android:name=".CheatActivity">
        </activity>
    </application>

</manifest>
```

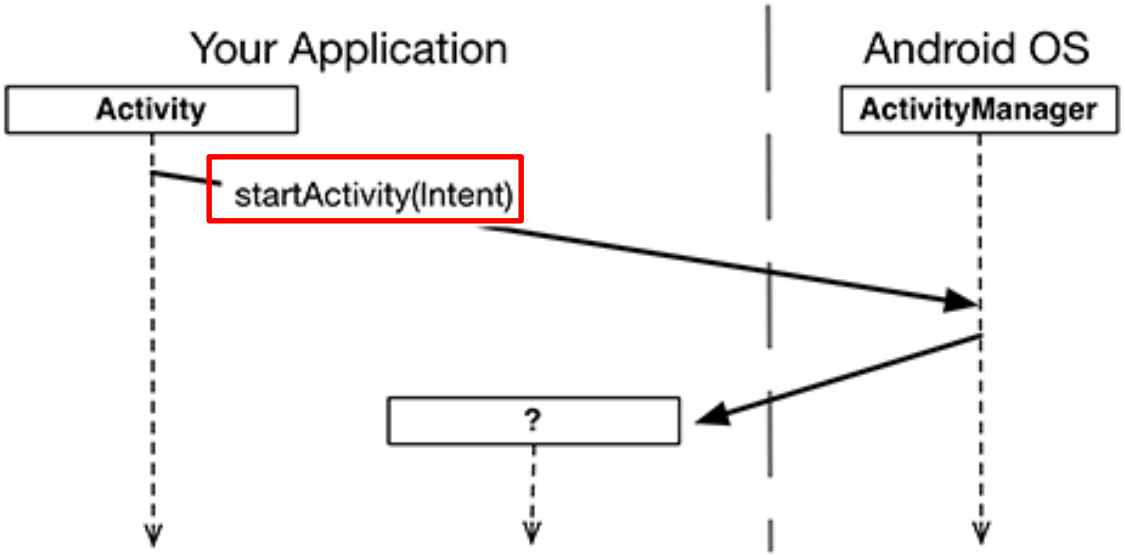
Activity 1

Activity 2 (CheatActivity)

Activity 2 (CheatActivity)

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)

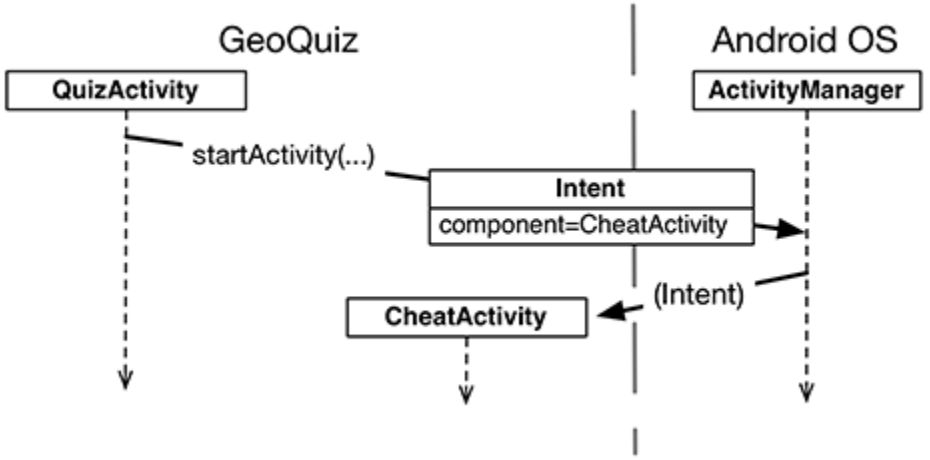


- Intent specifies which (target) Activity Android ActivityManager should start

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

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

Build Intent

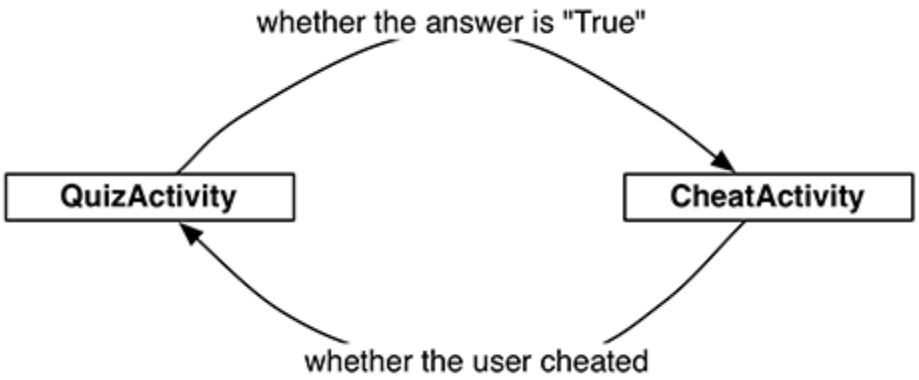
Use Intent to Start new Activity

Parent Activity

New Activity 2

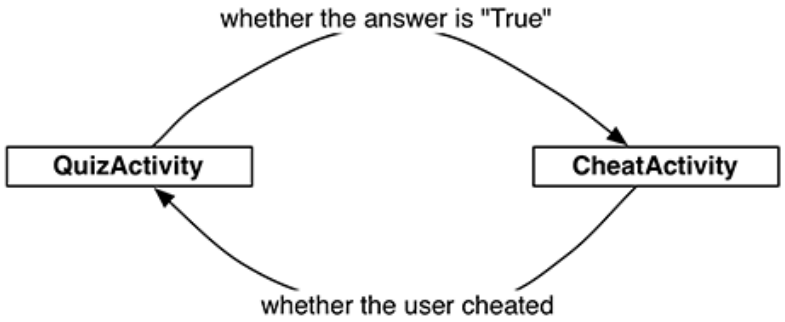
Implicit vs Explicit Intents

- 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 Activity 2 correct answer (True/False)

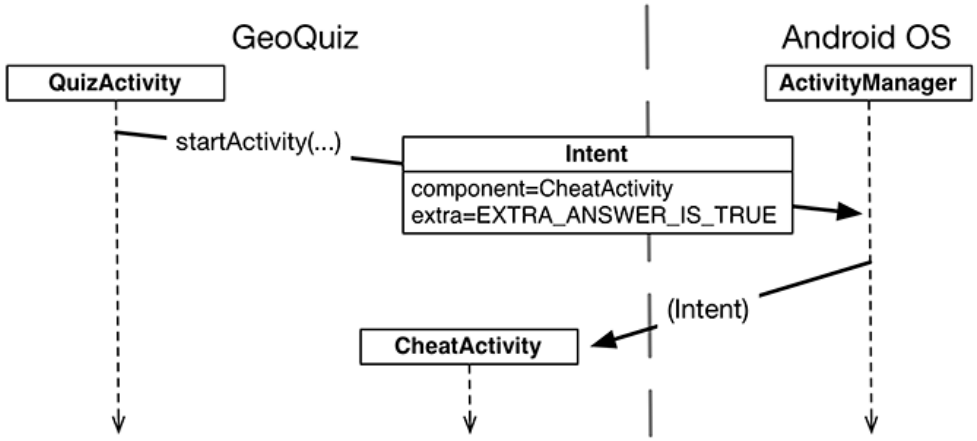


Passing Data Between Activities

- 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



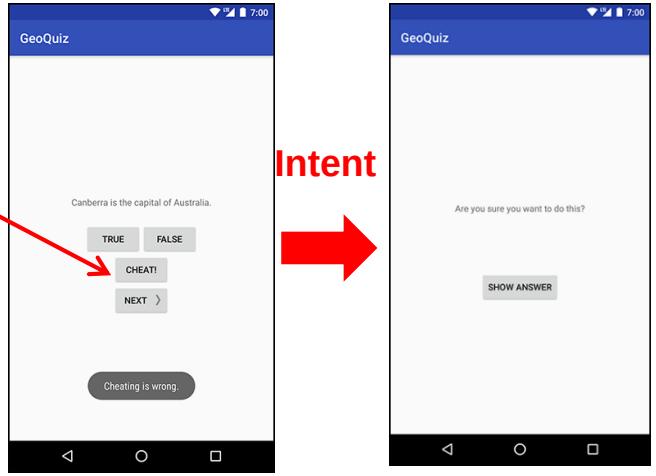
Passing Answer (True/False) as Intent Extra

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

```
public class CheatActivity extends AppCompatActivity {

    private static final String EXTRA_ANSWER_IS_TRUE =
            "com.bignerdranch.android.geoquiz.answer_is_true";

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

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

```
mCheatButton.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        // Start CheatActivity
        Intent intent = new Intent(QuizActivity.this, CheatActivity.class);
        boolean answerIsTrue = mQuestionBank[mCurrentIndex].isAnswerTrue();
        Intent intent = CheatActivity.newIntent(QuizActivity.this, answerIsTrue);
        startActivity(intent);
    }
});
```



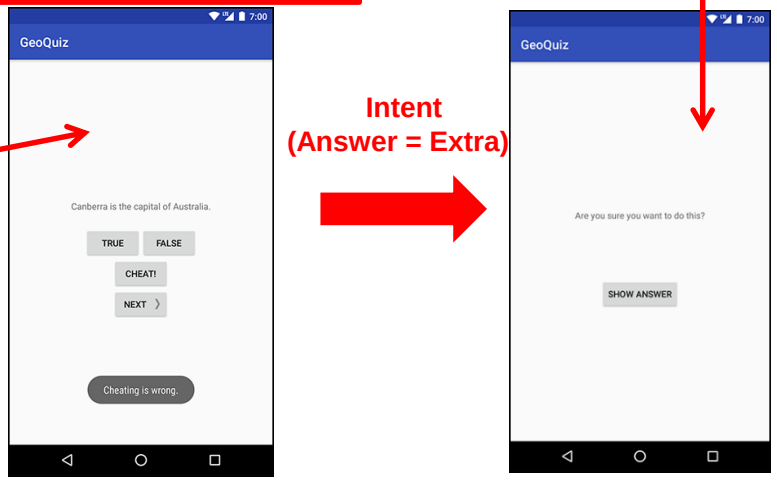
Passing Answer (True/False) as Intent Extra

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

```
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);
    }
    ...
}
```

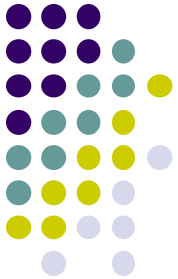
Calls getIntent( )

Calls startActivity(Intent)



Important: Read Android Nerd Ranch (3rd edition) pg 91

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)
- Typically, many components (apps) can take a given action
  - E.g. Many phones have installed multiple apps that can view images
- System decides component to receive intent based on **action**, **data, category**
- Example Implicit Intent to share data

```
// 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

- 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