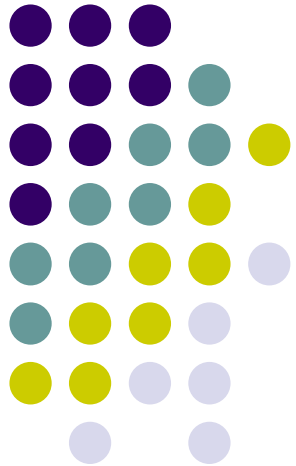
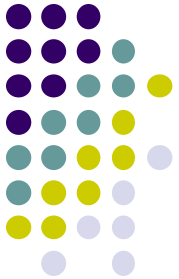
CS 528 Mobile and Ubiquitous Computing

Lecture 3a: Android Components, Activity Lifecycle, Rotating Device &Saving Data

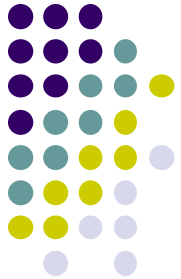
Emmanuel Agu



Announcement

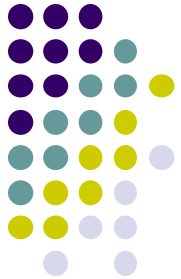


- No class next week
- I’m out of town for a grant meeting
- Next class in 2 weeks (Sept 27)



Android App Components

Android App Components



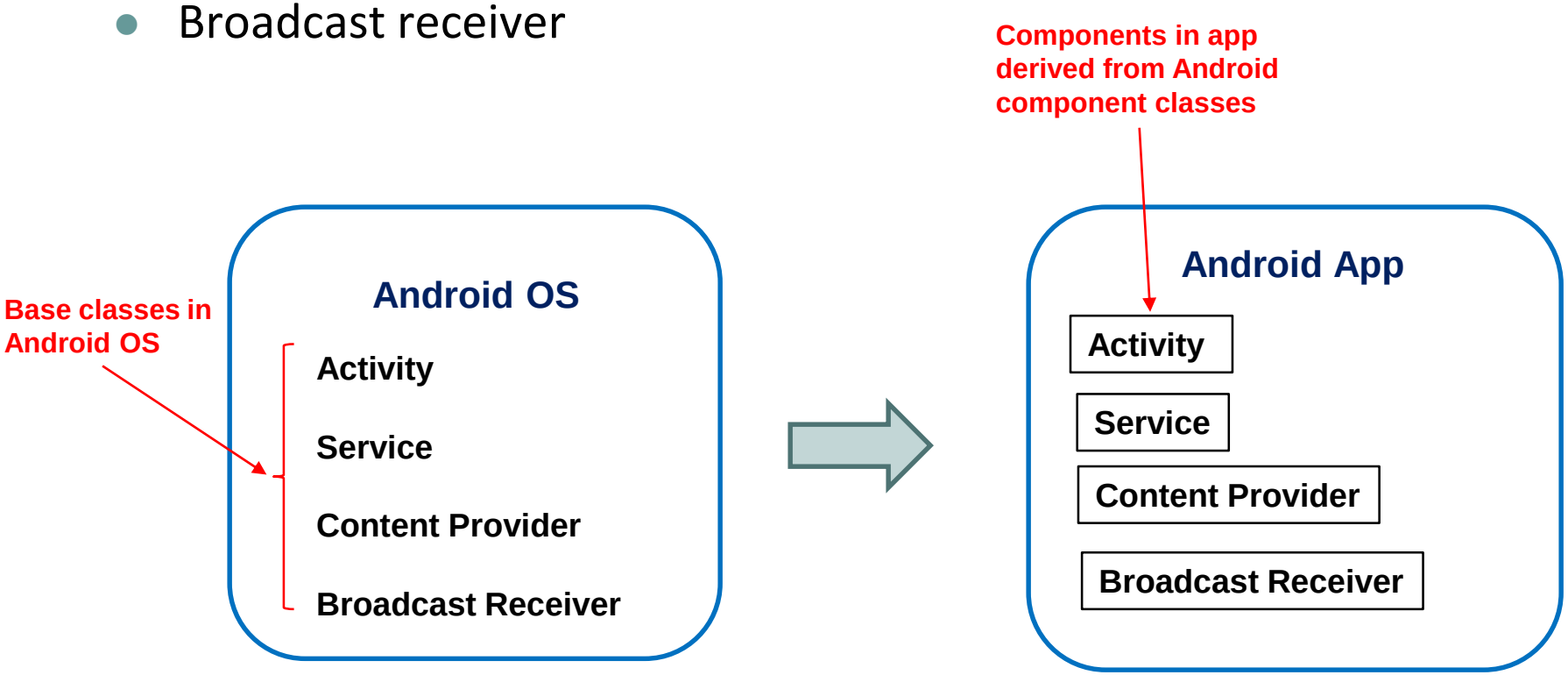
- Typical Java program starts from main( )

```
class SillyApp {
    public static void main(String[] args) {
        System.out.println("Hello World!");
    }
}
```

- Android app: No need to write a main
- Just define app components derived from base classes already defined in Android

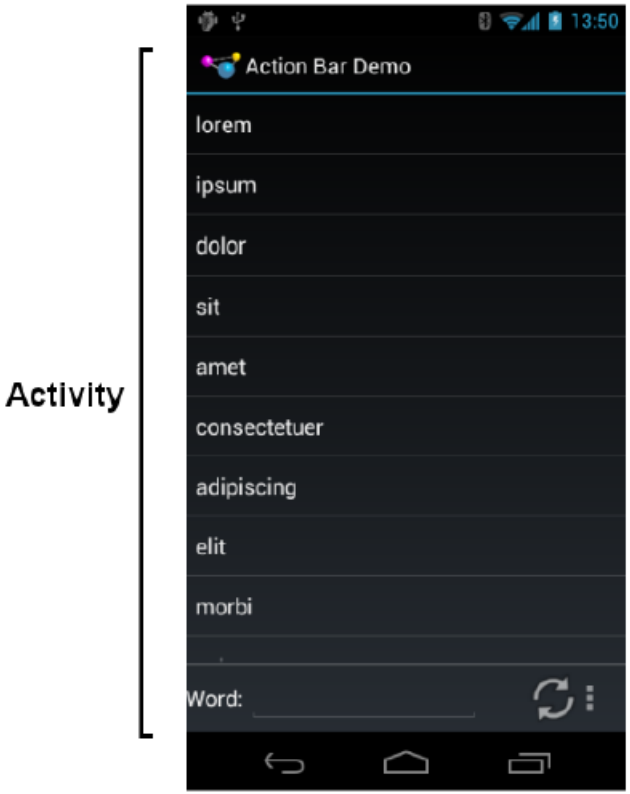
Android App Components

- 4 main types of Android app components:
  - Activity (already seen this)
  - Service
  - Content provider
  - Broadcast receiver



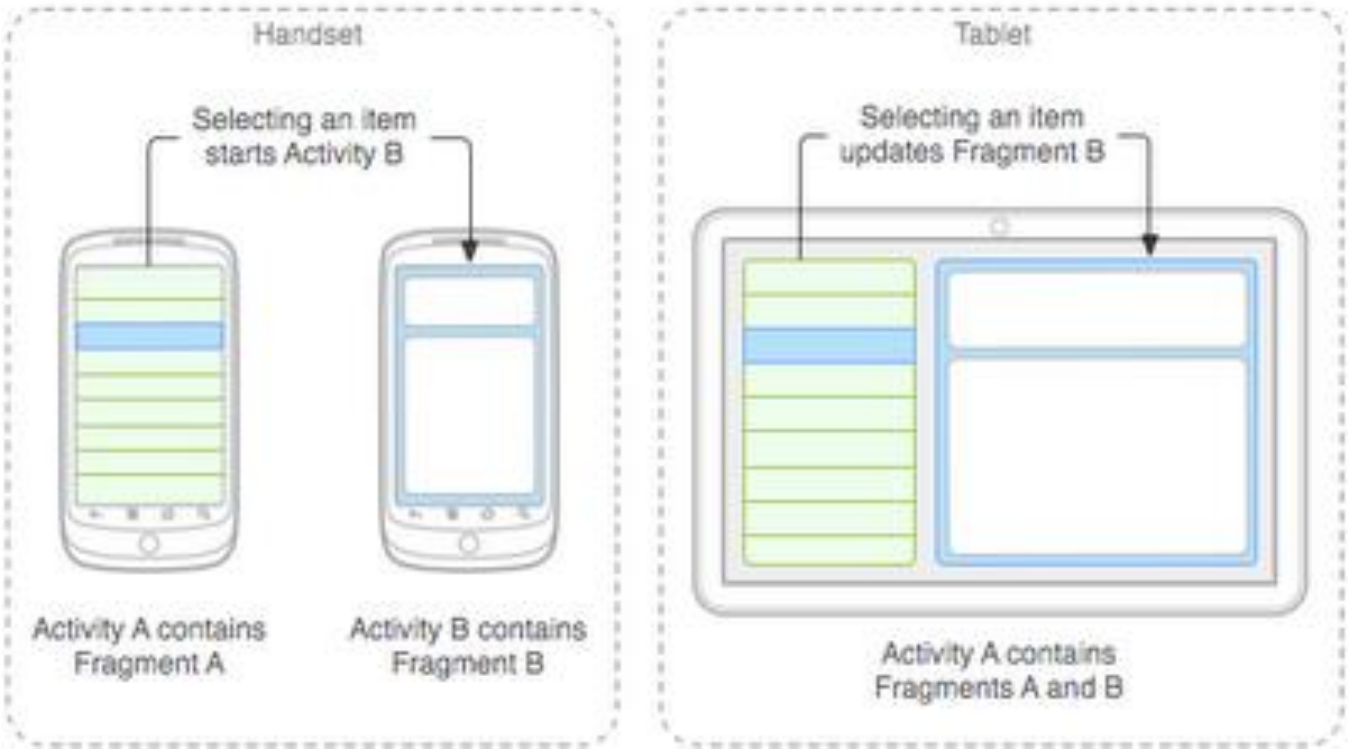
Recall: Activities

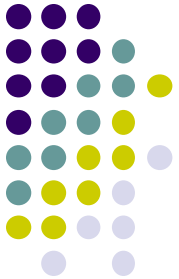
- Activity: main building block of Android UI
- Analogous to a window or dialog box in a desktop application
- Apps
  - have at least 1 activity that deals with UI
  - Entry point of app similar to **main( )** in C
  - typically have multiple activities
- Example: A camera app
  - **Activity 1:** to focus, take photo, start activity 2
  - **Activity 2:** to present photo for viewing, save it



Fragments

- Fragments
  - UI building blocks (pieces), can be arranged in Activities in different ways.
  - Enables app to look different on different devices (e.g. phone vs tablet)
- An activity can contain multiple fragments that are organized differently on different devices (e.g. for phone vs tablet)
- More later





Services

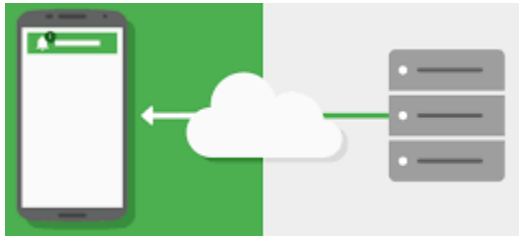
- Activities are short-lived, can be shut down anytime (e.g when user presses back button)
- Services keep running in background
- Similar to Linux/Unix CRON job
- Example uses of services:
  - Periodically check/update device's GPS location
  - Check for updates to RSS feed
- Independent of any activity, minimal interaction
- Typically an activity will control a service -- start it, pause it, get data from it
- Services in an App are sub-class of Android's **Services** class

Android Platform Services

- Android Services can either be on:
  - On smartphone or Android device (local)
  - Remote, on Google server/cloud

- Android platform local services examples (on smartphone):
  - **LocationManager:** location-based services.
  - **ClipboardManager:** access to device's clipboard, cut-and-paste content
  - **DownloadManager:** manages HTTP downloads in background
  - **FragmentManager:** manages the fragments of an activity.
  - **AudioManager:** provides access to audio and ringer controls.

Android services on smartphone

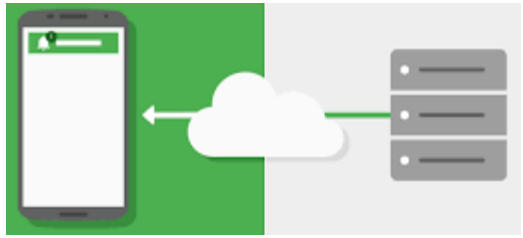


Android services In Google cloud

Google Services (In Google Cloud)

- Maps
- Location-based services
- Game Services
- Authorization APIs
- Google Plus
- Play Services
- In-app Billing
- Google Cloud Messaging
- Google Analytics
- Google AdMob ads

Typically need
Internet connection

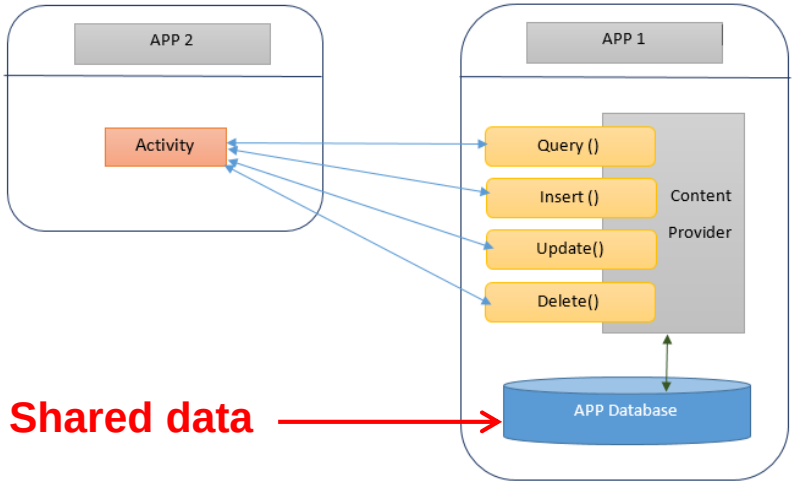


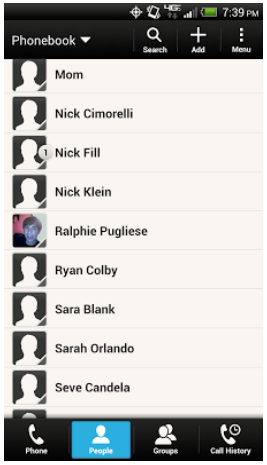
Android services
on smartphone

Android services
In Google cloud

Content Providers

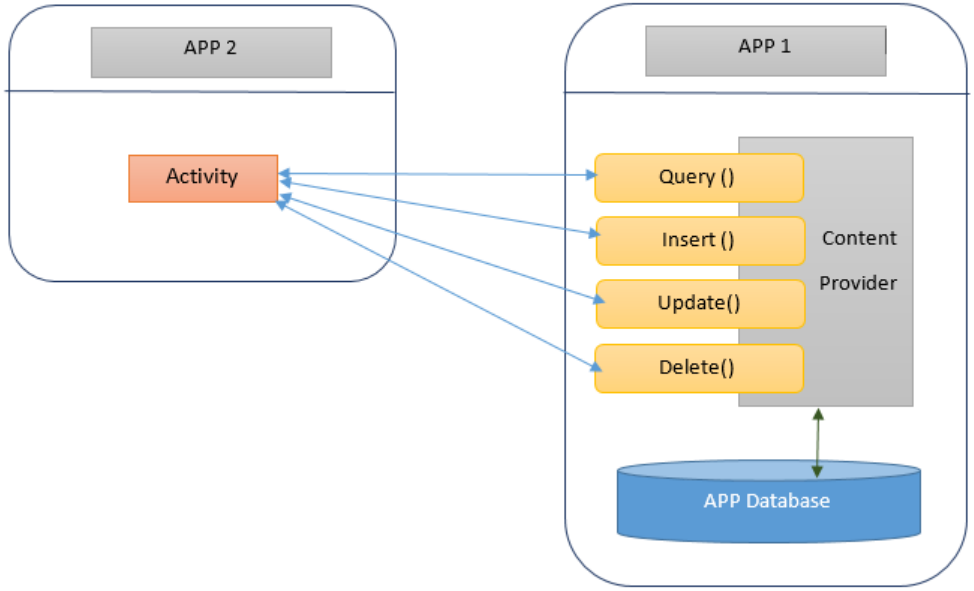
- Android apps can share data (e.g. User's contacts) as content provider
- Content Provider:
  - Abstracts shareable data, makes it accessible through methods
  - Applications can access that shared data by calling methods for the relevant **content provider**
  - E.g. Can query, insert, update, delete shared data (see below)

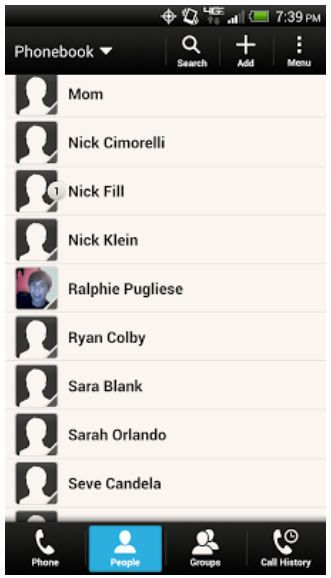




Content Providers

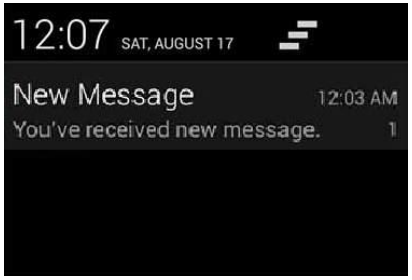
- **E.g.** Data stored in Android Contacts app can be accessed by other apps
- **Example:** We can write an app that:
  - Retrieve's contacts list from contacts content provider
  - Adds contacts to social networking (e.g. Facebook)
- Apps can also **ADD** to data through content provider. E.g. Add contact
- E.g. Our app can also share its data
- Content provider in an App are sub-class of Android's **ContentProvider** class





Broadcast Receivers

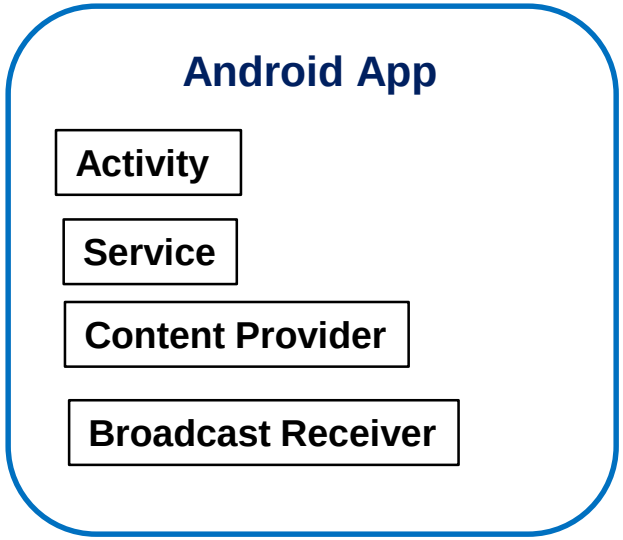
- Android OS (system), or applications, periodically ***broadcasts*** events
- Example broadcasts:
  - Battery getting low
  - Download completed
  - New email arrived
- Any app can create broadcast receiver to listen for broadcasts, respond
- Our app can also initiate broadcasts
- Broadcast receivers typically
  - Doesn't interact with the UI
  - Creates a status bar notification to alert the user when broadcast event occurs
- Broadcast Receiver in an App are sub-class of Android's **BroadcastReceiver** class

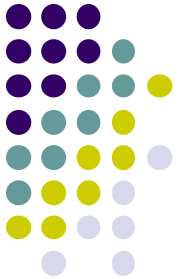


Quiz

- Pedometer App has the following Android components:
  - **Component A:** continously counts user's steps even when user closes app, does other things on phone (e.g. youtube, calls)
  - **Component B:** Displays user's step count
  - **Component C:** texts user's friends (from contacts list) every day with their step totals

- What should component A be declared as?
  - Activity, service, content provider, broadcast receiver?
- What of component B?
- Component C?

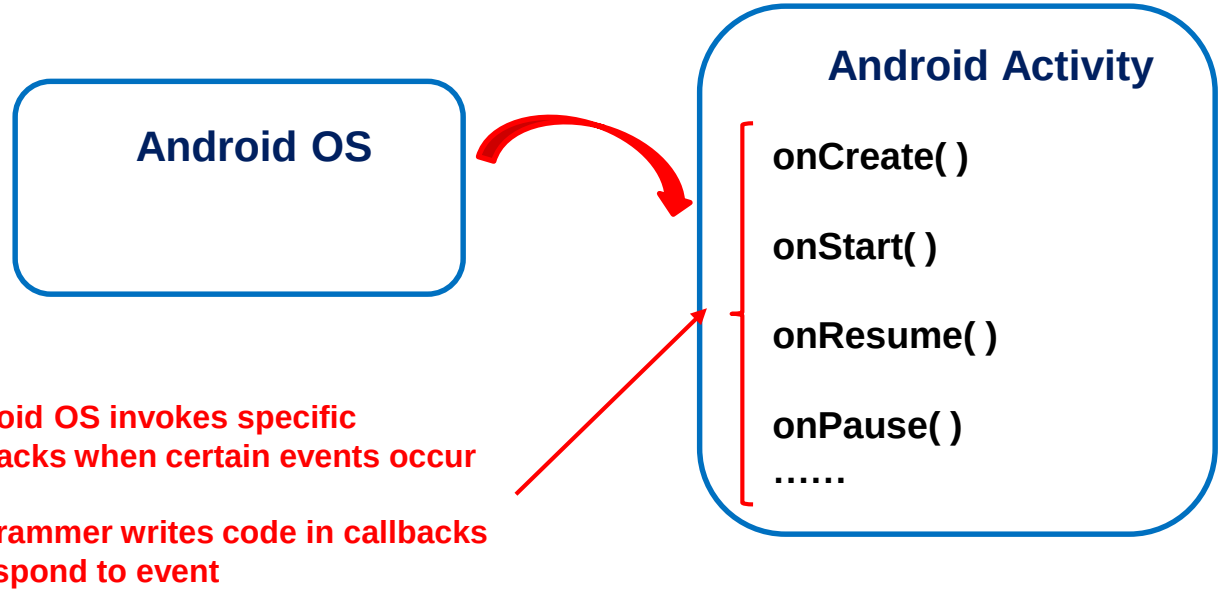




Android Activity LifeCycle

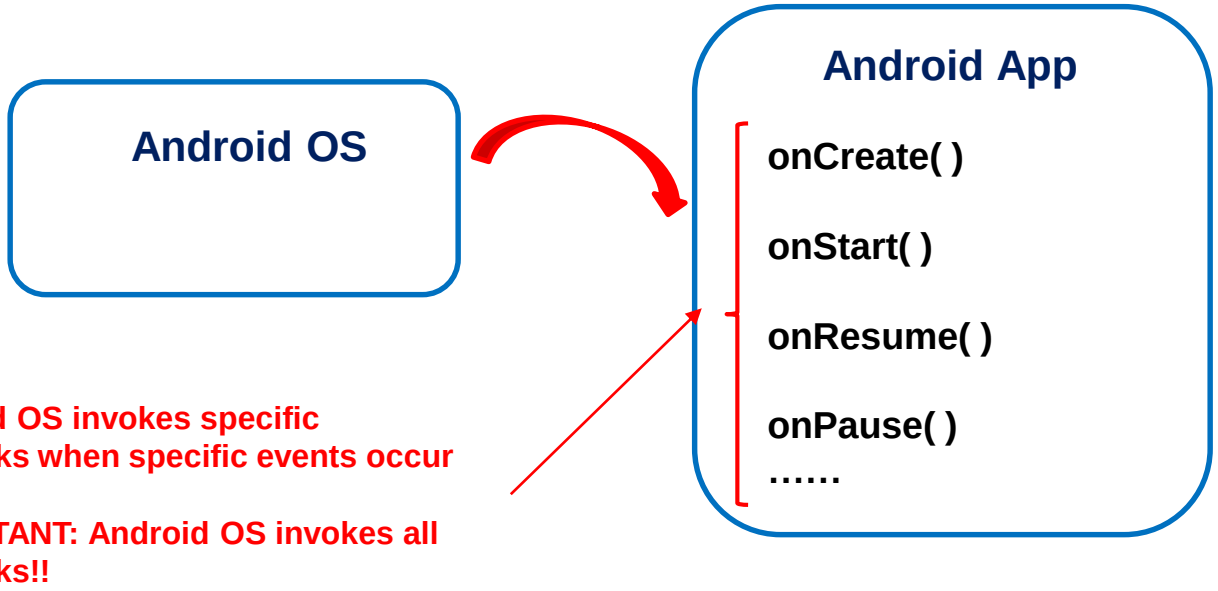
Starting Activities

- 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



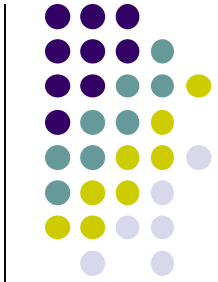
Activity Callbacks

- 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( )

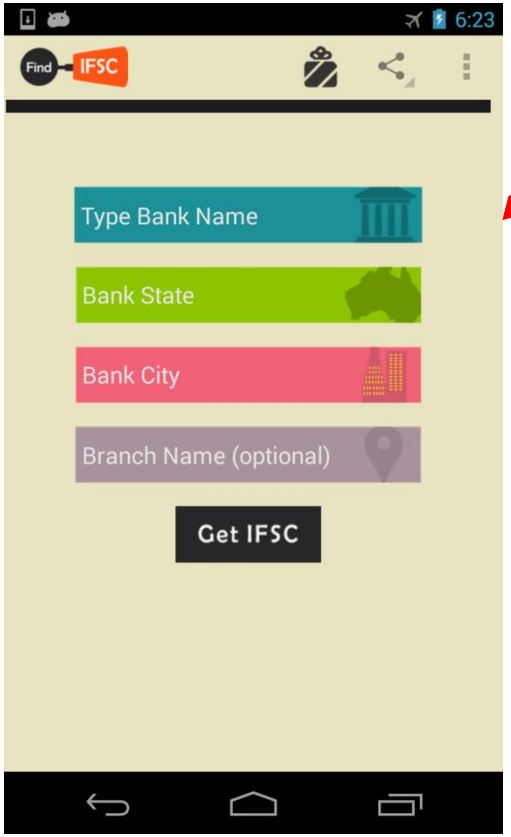
- Initializes activity once created
- Operations typically performed in onCreate() method:
  - Inflate (create) widgets and place them on screen
    - (e.g. using layout files with setContentView( ))
  - Getting references to inflated widgets (using findViewbyId( ))
  - Setting widget listeners to handle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

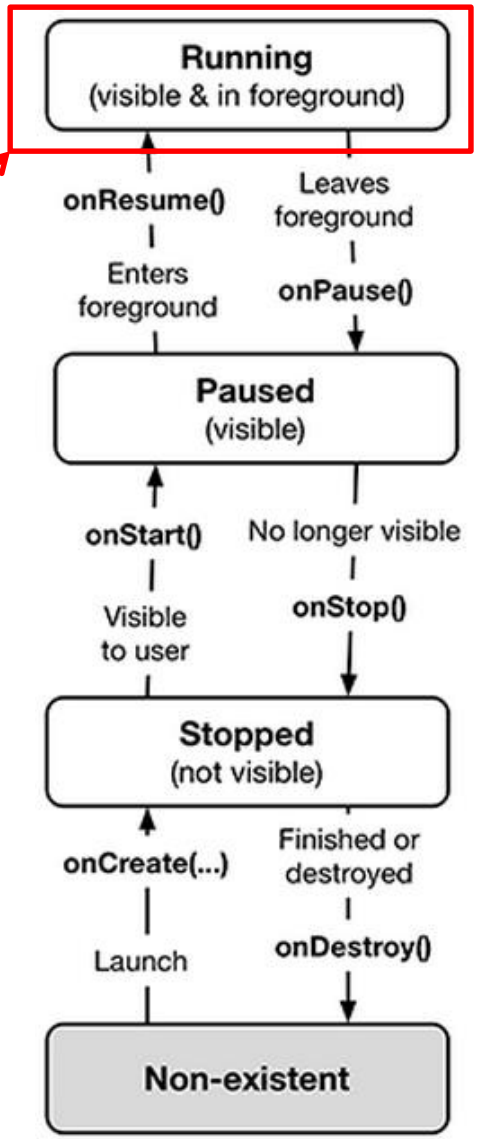
```
public class QuizActivity extends Activity {

    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

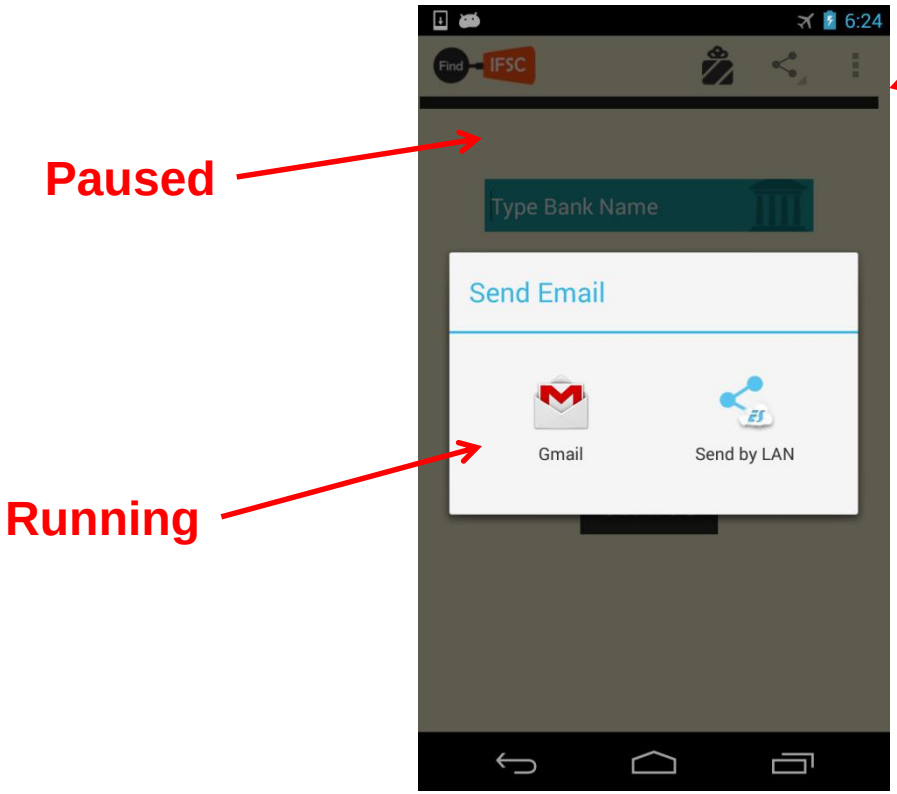
- A running app is one that user is currently using or interacting with
  - Visible, in foreground

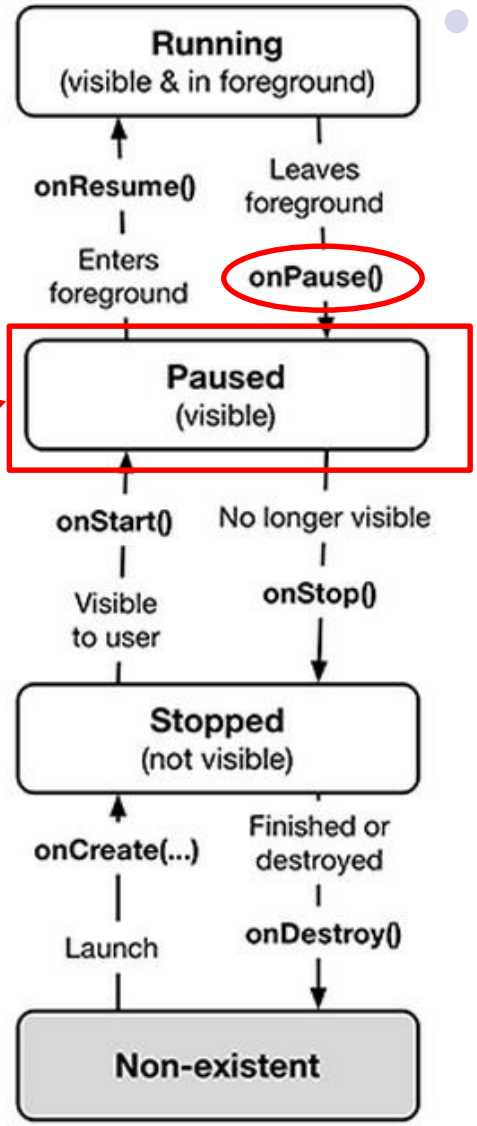




Paused App

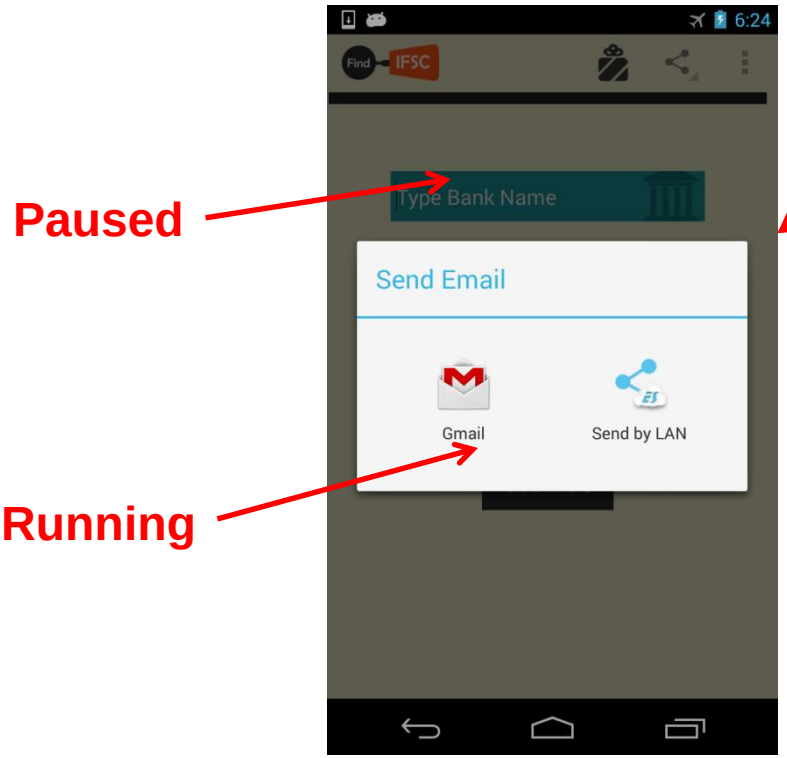
- An app is **paused** if it is **visible but no longer in foreground**
- E.g. blocked by a pop-up dialog box
- App's **onPause( )** method is called during transition from running to paused state

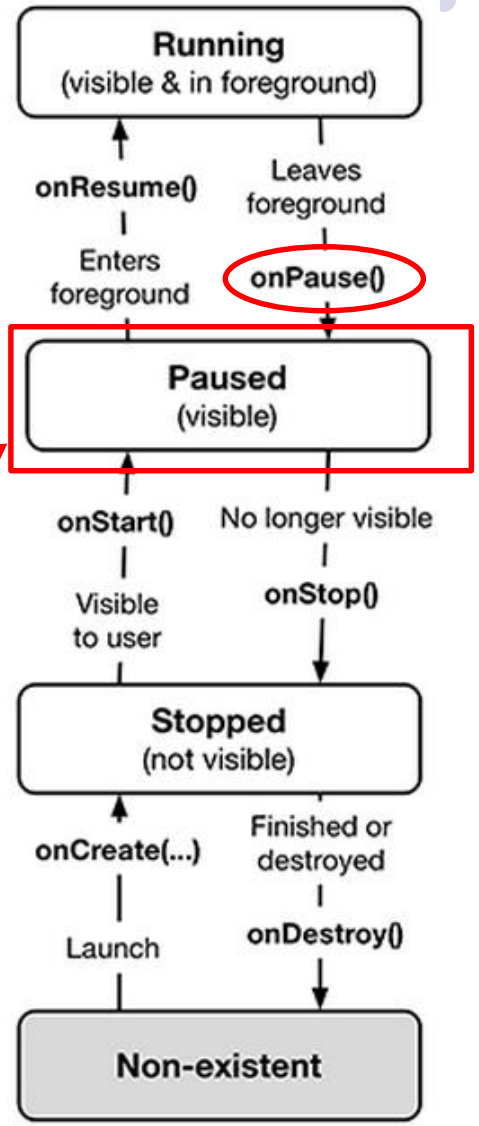




onPause( ) Method

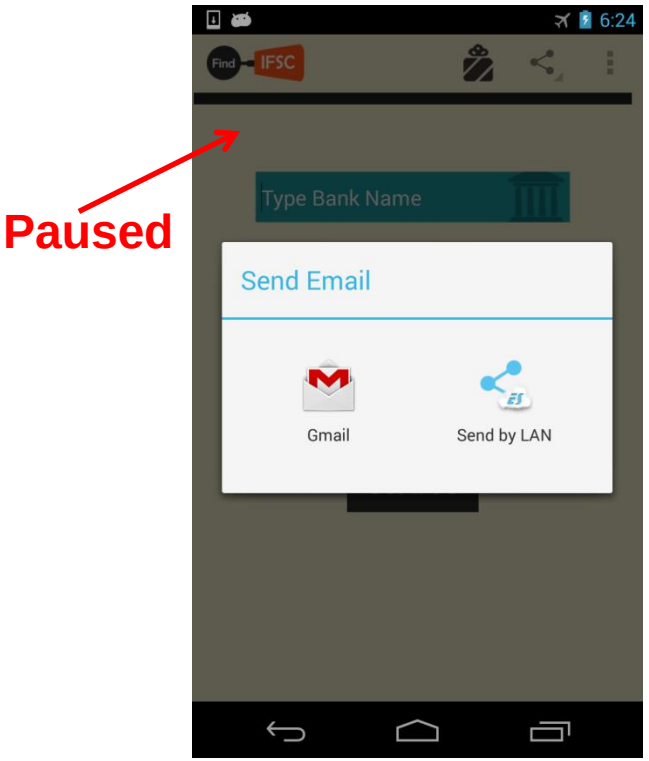
- Typical actions taken in onPause( ) method
  - Stop animations or CPU intensive tasks
  - Stop listening for GPS, broadcast information
  - Release handles to sensors (e.g GPS, camera)
  - Stop audio and video

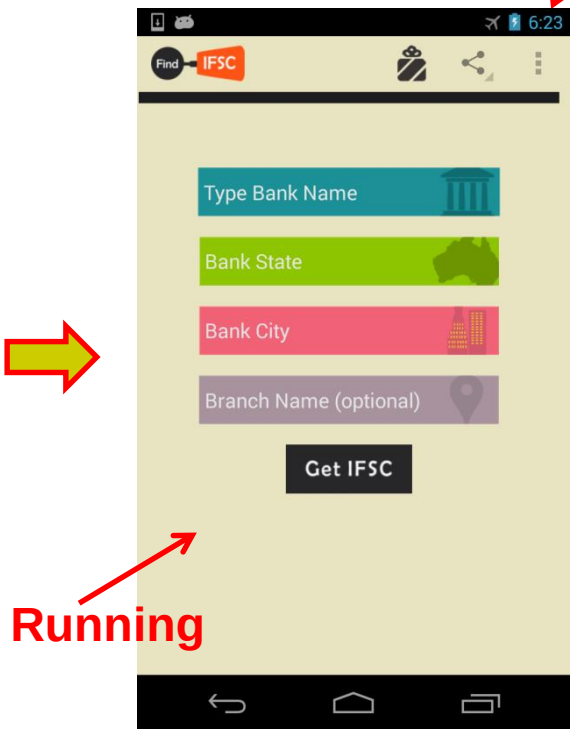


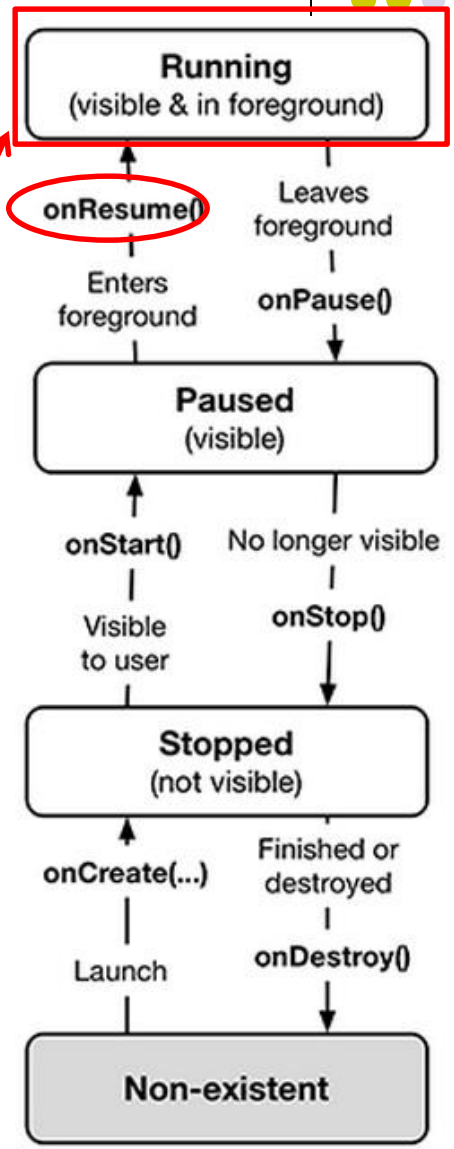


onResume( ): Resuming Paused App

- 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

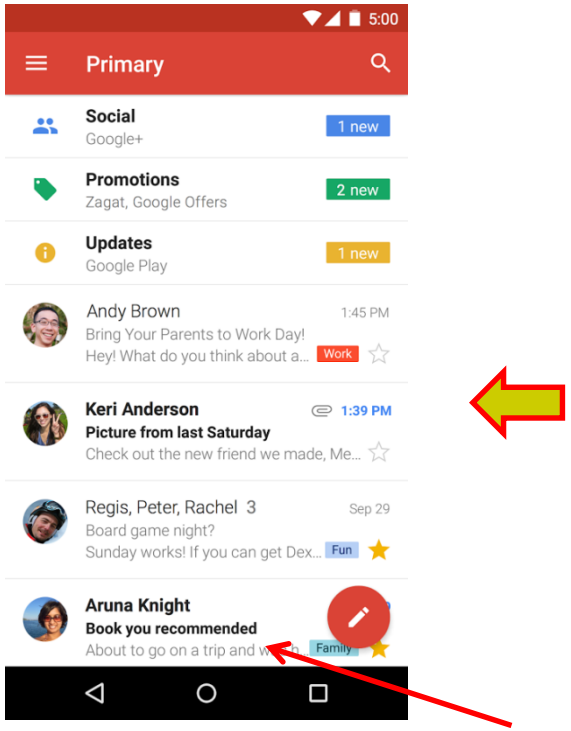




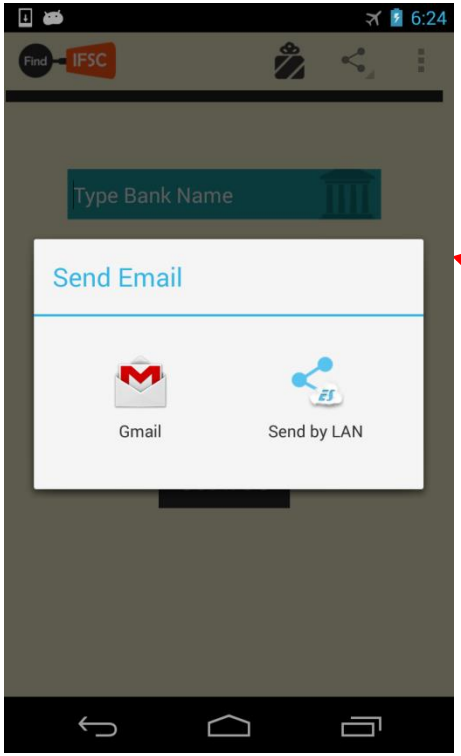


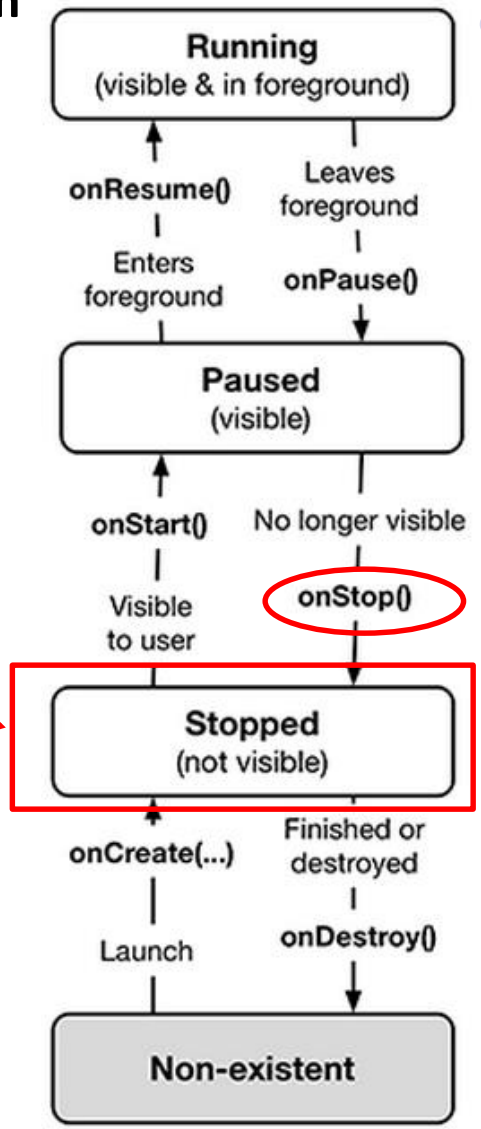
Stopped App

- 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



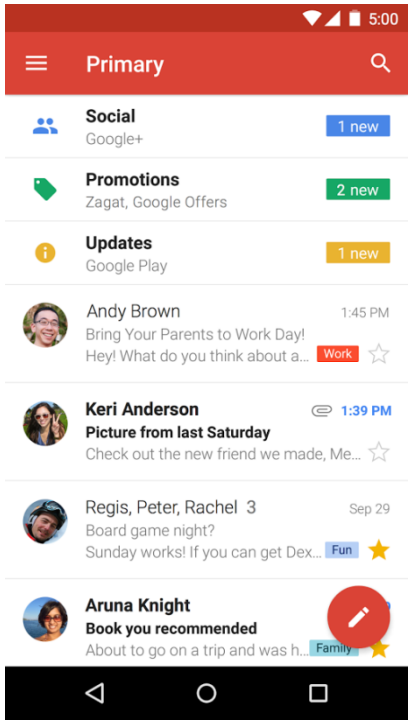


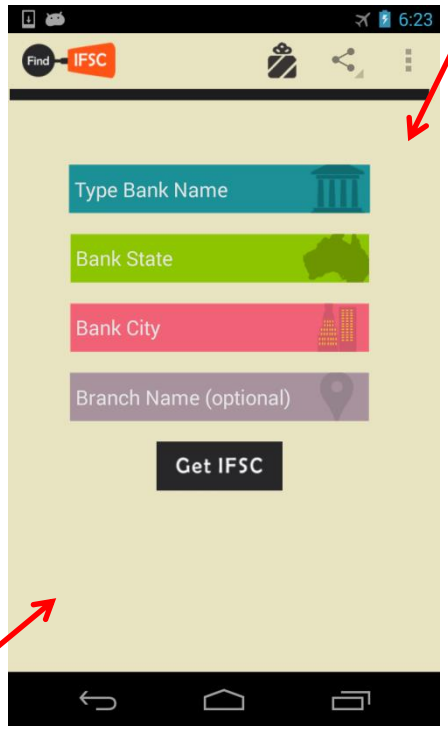
onStop() Method

- 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)

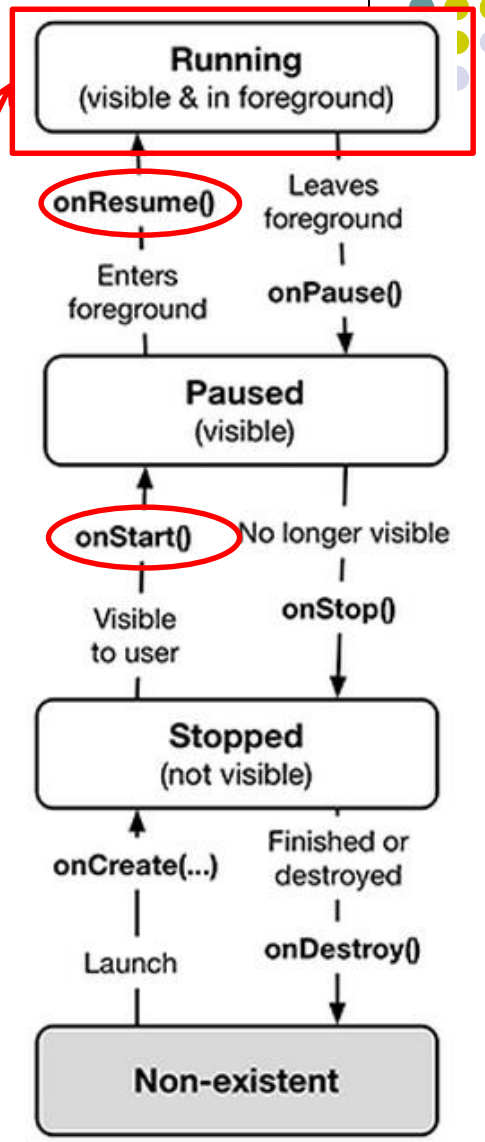
Resuming Stopped App

- 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



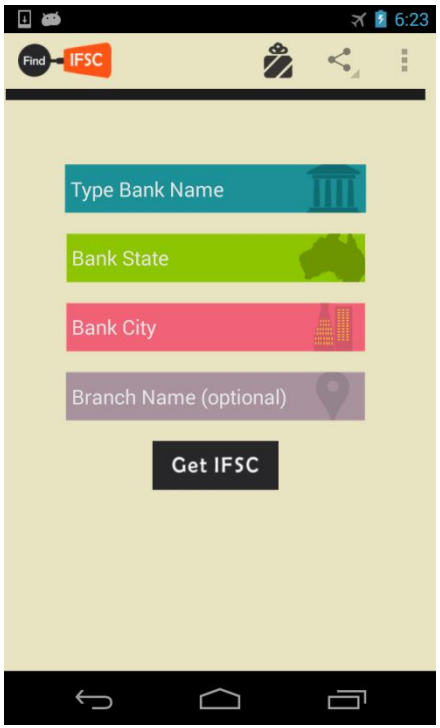


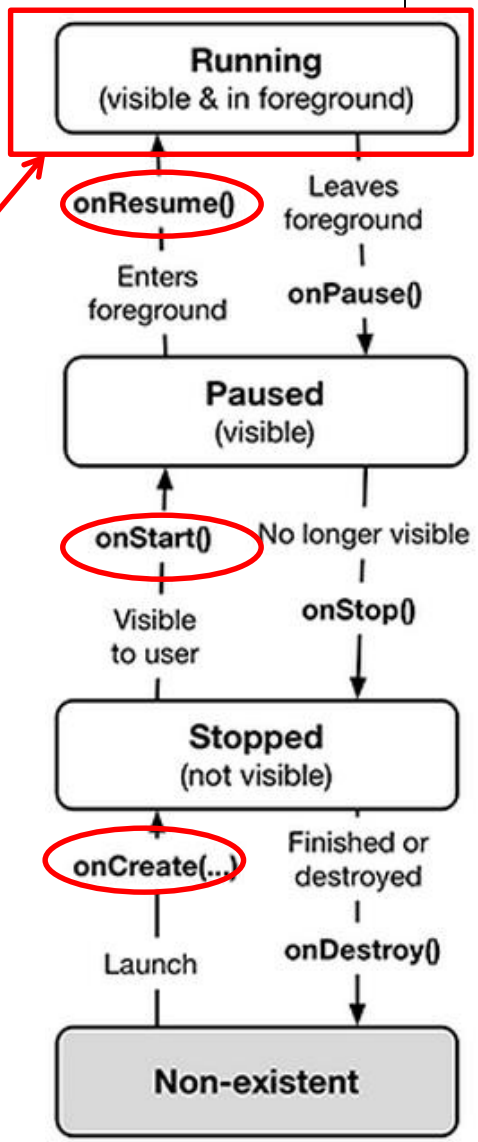
Running

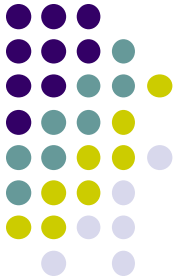


Starting New App

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



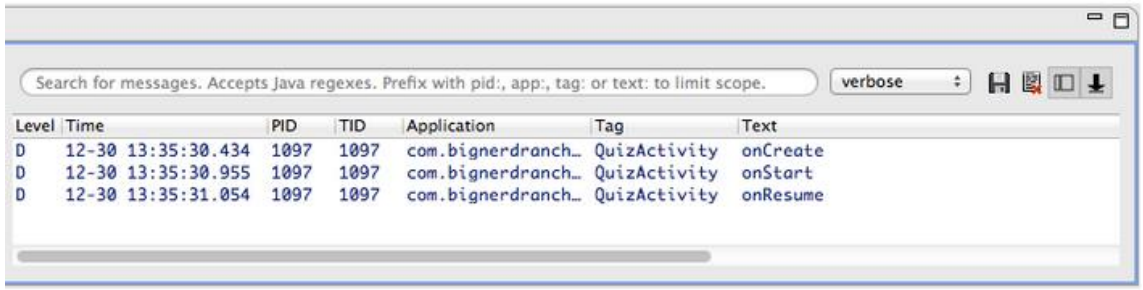




Logging Errors in Android

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”…

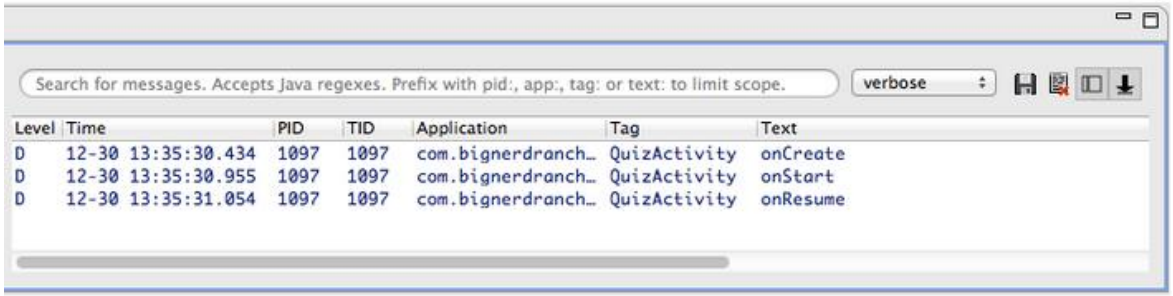
}

onStart( ){

… print message “OnStart called”…

}

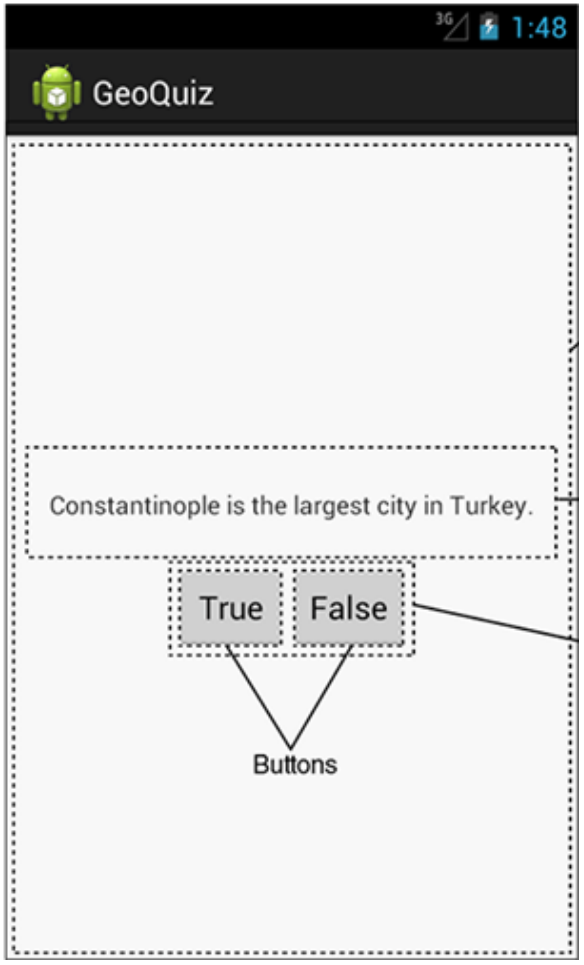
… etc



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.

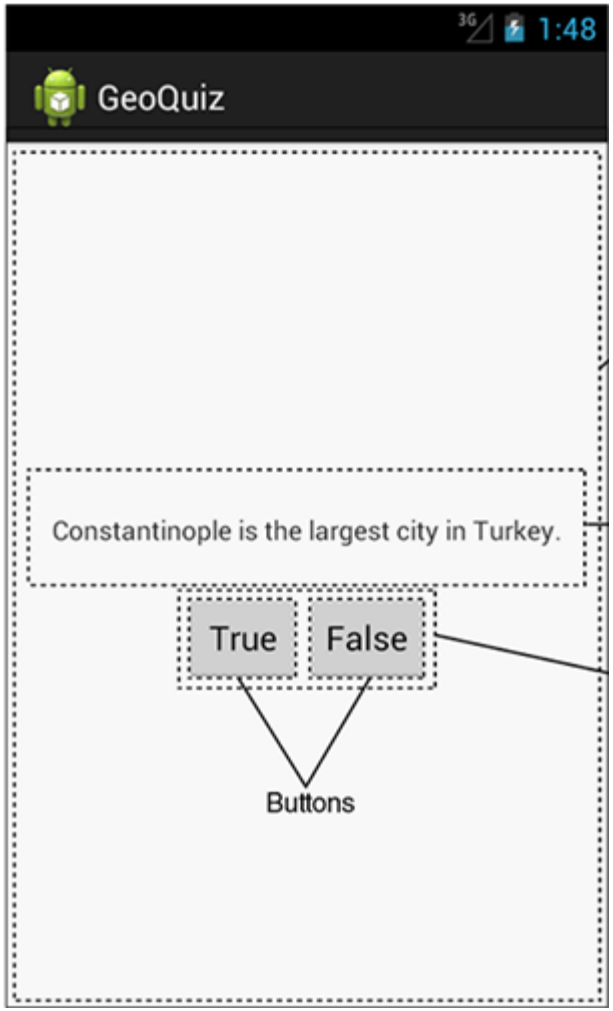
Tag → QuizActivity: Message → onCreate(Bundle) called

- Example declaration:

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

- Then declare string for **TAG**

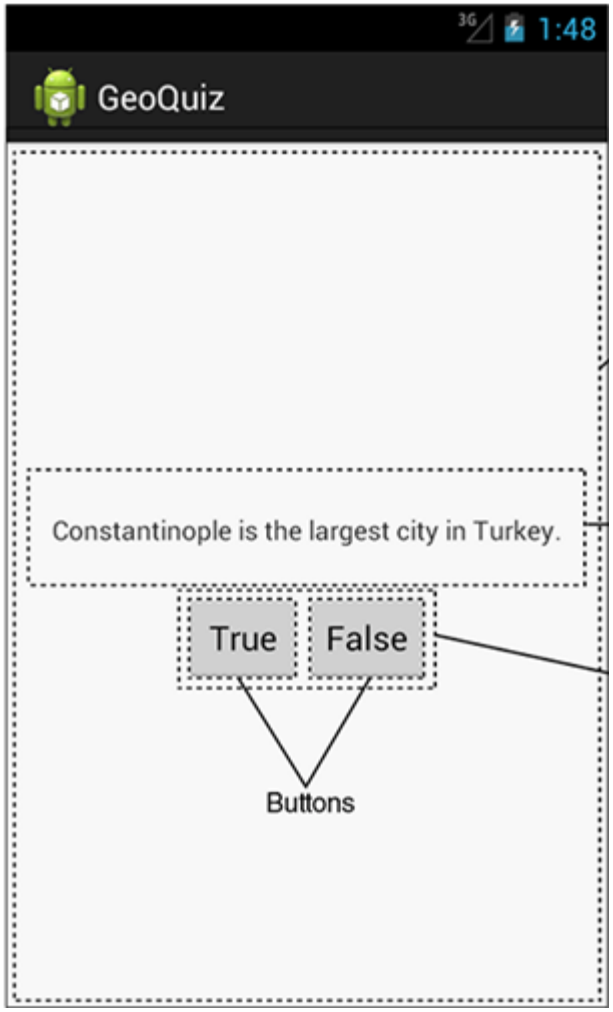
```
public class QuizActivity extends Activity {

    private static final String TAG = "QuizActivity";

    ...

}
```



QuizActivity.java

- Putting it all together

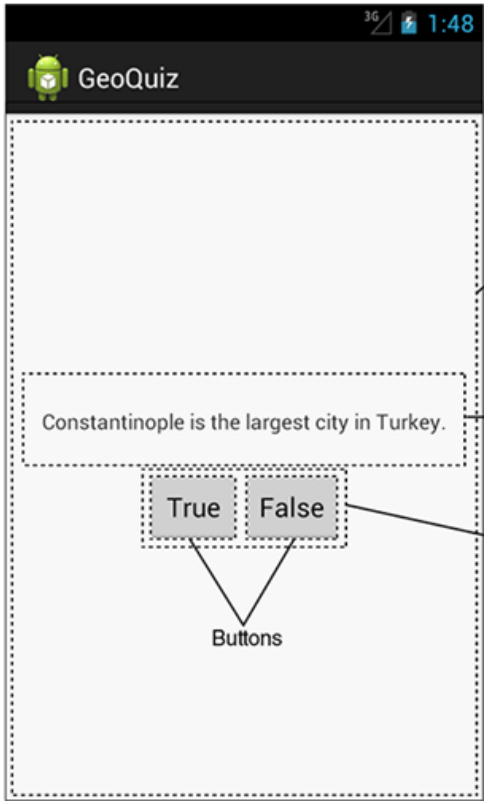
```
public class QuizActivity extends Activity {

    ...

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

        ...
```



QuizActivity.java

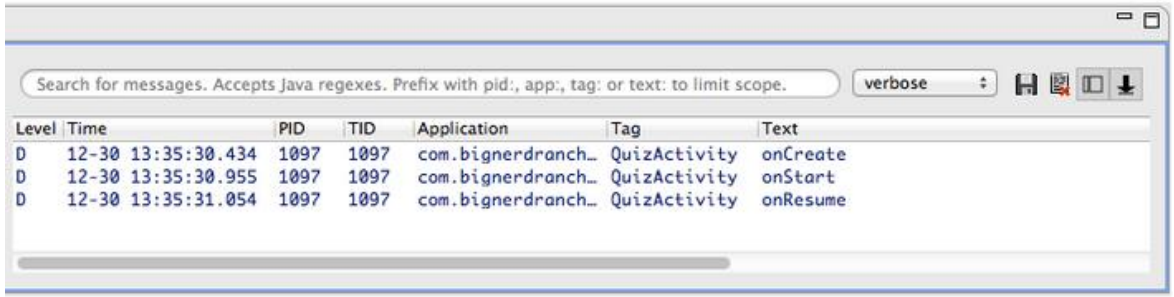
- Can overide more lifecycle methods
- Print debug messages from each method

```
} // 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");
}

}
```

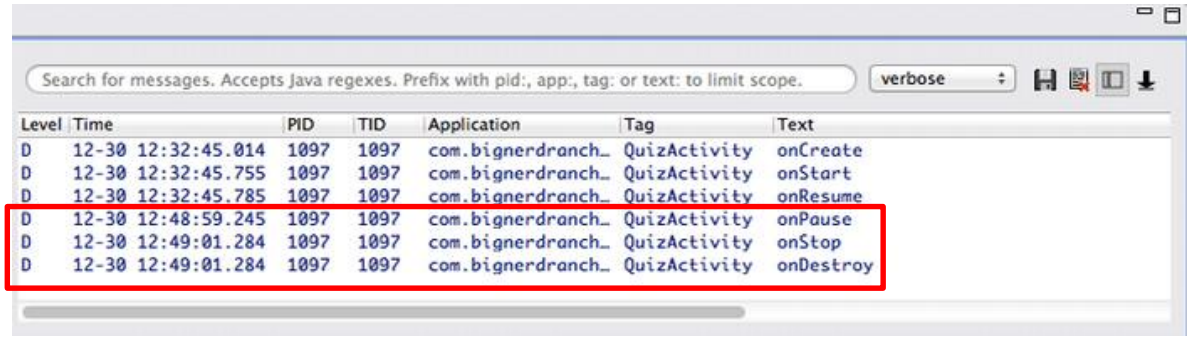


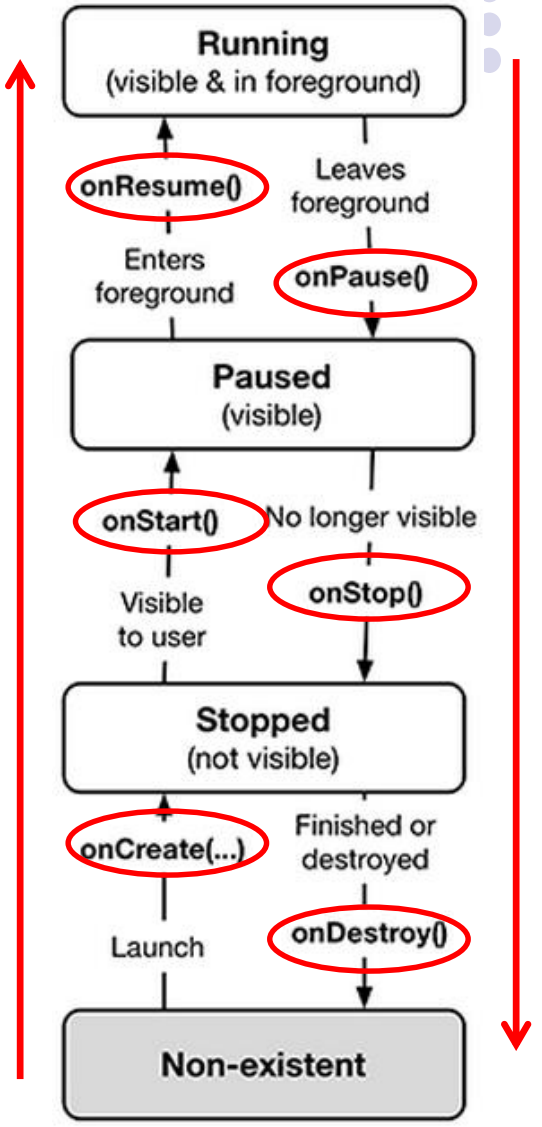
QuizActivity.java Debug Messages

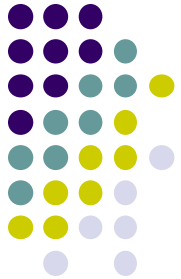
- Launching GeoQuiz app activities **OnCreate, OnStart and onResume** methods



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







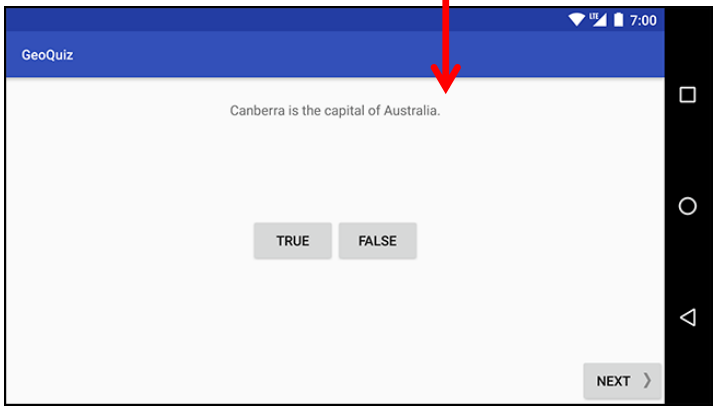
Rotating Device

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

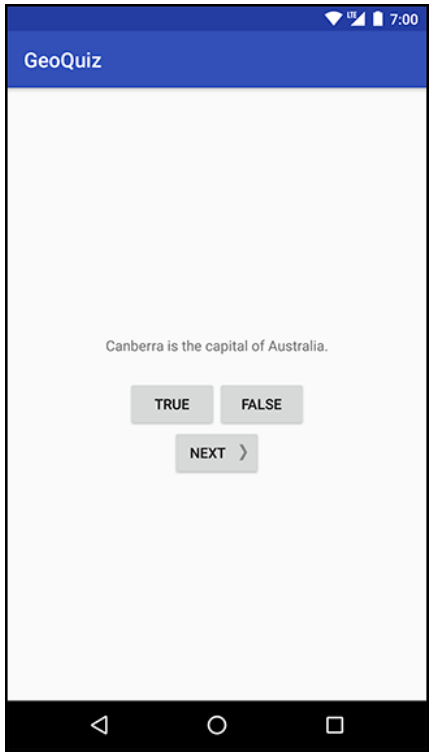


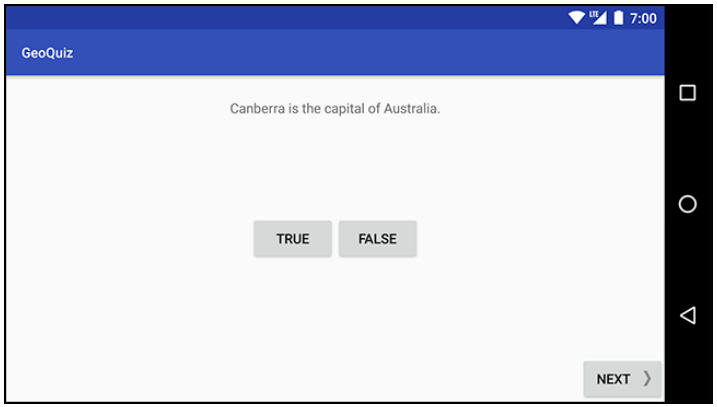
Use landscape XML layout

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

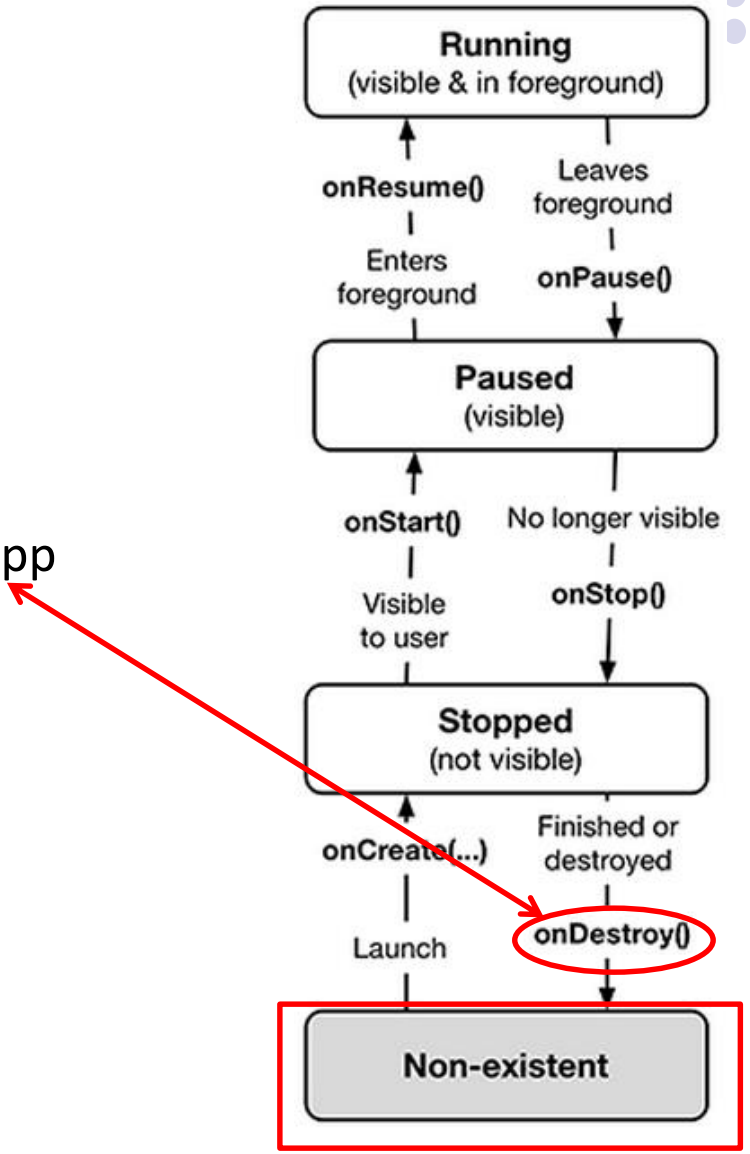
onCreate called whenever user switches between portrait and landscape

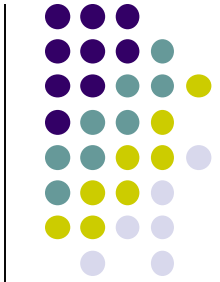




Dead or Destroyed Activity

- onDestroy( ) called to destroy a stopped app

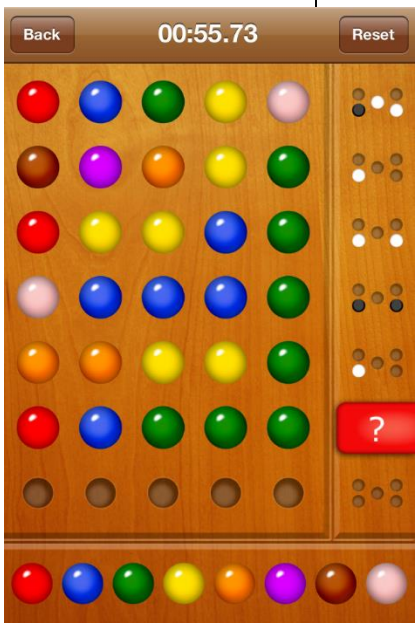




Saving State Data

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

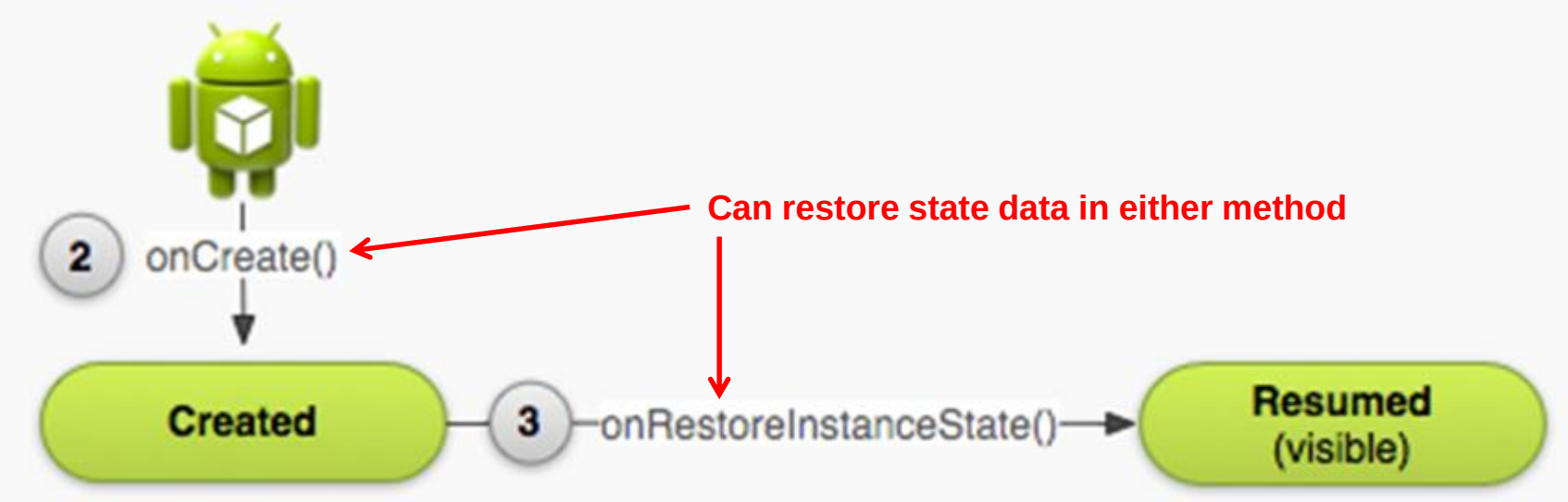


onSaveInstanceState: Saving App State

- 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

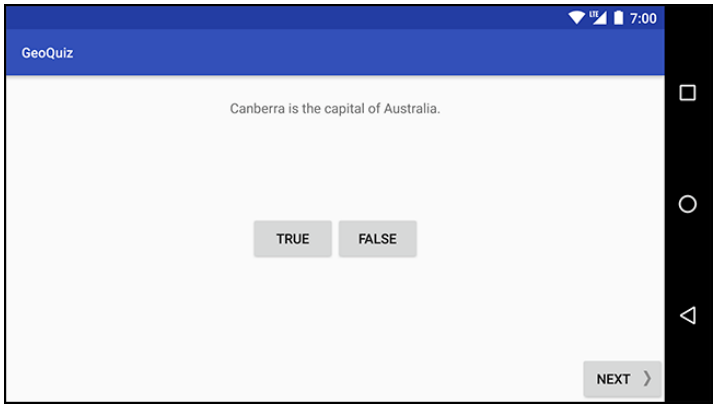
onRestoreInstanceState( ): Restoring State Data

- 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( )**



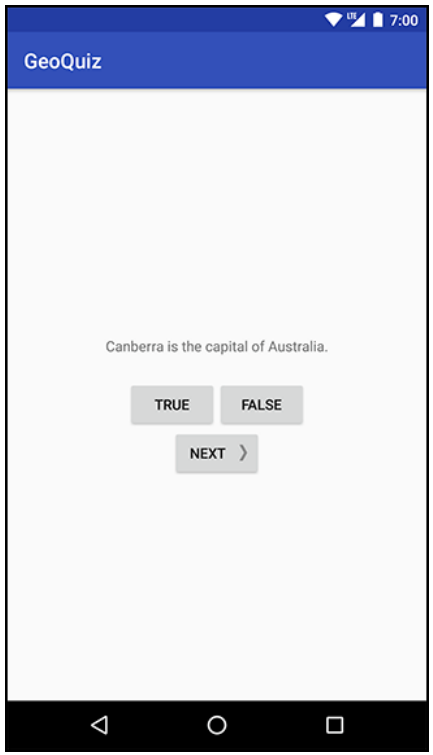
Saving Data Across Device Rotation

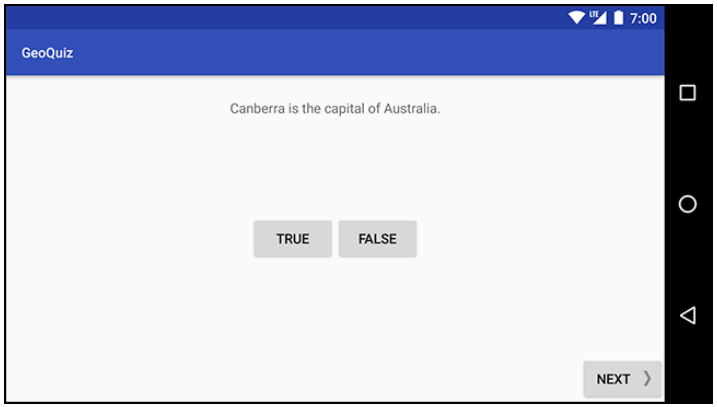
- For example, to save the value of a variable **mCurrentIndex** during rotation
- First, create a constant KEY_INDEX as a key for storing data in the bundle

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

- Then override **onSaveInstanceState** method

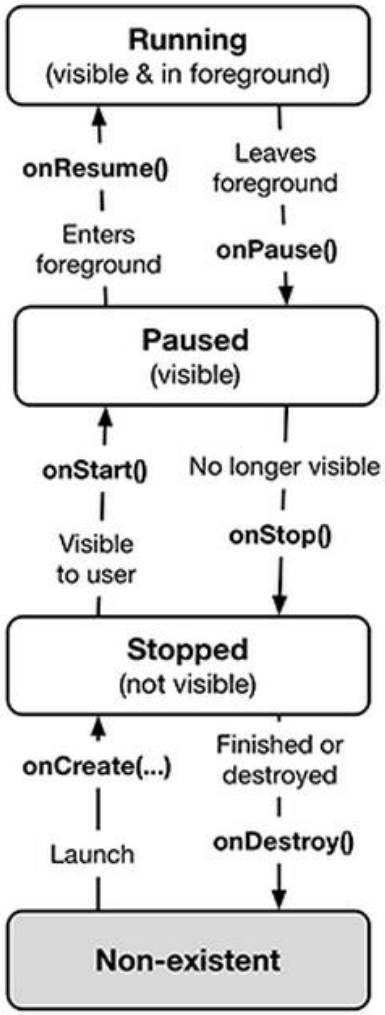
```
@Override
public void onSaveInstanceState(Bundle savedInstanceState) {
    super.onSaveInstanceState(savedInstanceState);
    Log.i(TAG, "onSaveInstanceState");
    savedInstanceState.putInt(KEY_INDEX, mCurrentIndex);
}
```





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?



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