CSC 472 / 372 Mobile Application Development for Android

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Outline

- Intents and intent filters
- Explicit and implicit intents
- Activity lifecycle
- Apps with multiple activities

Android Intents

Intent

- A messaging object to activate another app component
  - Communicate between an app and the host system
- Facilitate interactions and collaboration among components
  - Start an activity
  - Start a service
  - Deliver a broadcast message
  - Deliver data

Intent Types

- *Explicit intents*
  - Explicitly name the component to be started
  - Typically used to start a component within your own app
- *Implicit intents*
  - Do not name a specific component to be started
  - Indicate a general action to be performed
  - Allow another app, the receiver, to choose a suitable component to perform the action
    - e.g., to request another app to show a specified location on a map.

Intent Filter

- Declares the capabilities or intentions of an app of handling certain types of actions
- An expression in the app's manifest file
  - specifies the type of *Intents* that the component may receive or is capable to respond
- Makes it possible for other apps to start an activity in your app with an *implicit intent*.
  - Required: the LAUNCHER
- If no intent filter is declared for an activity, then it can be started only with an *explicit intent*.

Start an Activity

- An *Intent* object carries several types of information
  - When used as an explicit intent

  Component name – The name of the component to start.

  Extras – Key-value pairs that carry additional
- Start an activity with an explicit intent
  - in the context of an activity

```
Intent intent =
  new Intent(this, TargetActivity.class);
startActivity(intent);
```

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Android Activity Lifecycle

Android Activity

- A single, focused thing that the user can do.
  - Interact with the user
- Often presented as a full-screen window in handsets
- Can also be presented as
  - Floating windows, or
  - Embedded inside of another activity
- One of the smallest unit that can be independently created, paused, resumed, and destroyed

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Activity Lifecycle States

- An activity can be in one of the following lifecycle states:
- *Active* (*running, resumed*) – an activity is in the foreground, at the top of the *activity stack*.
- *Paused* – an activity has lost focus but is still visible
  - The foreground activity is partially transparent or not full-screen
- *Stopped* – an activity is completely obscured by another activity.
- *Destroyed* – an activity is killed by the system.

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Activity Lifecycle Methods

- *Activity lifecycle methods* are callback methods invoked by the systems during the transition between lifecycle states of an activity.

```
protected void onCreate(Bundle savedInstanceState);
protected void onStart();
protected void onRestart();
protected void onResume();
protected void onPause();
protected void onStop();
protected void onDestroy();
```

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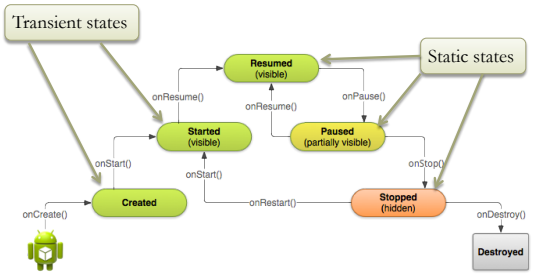
Activity Lifecycle States



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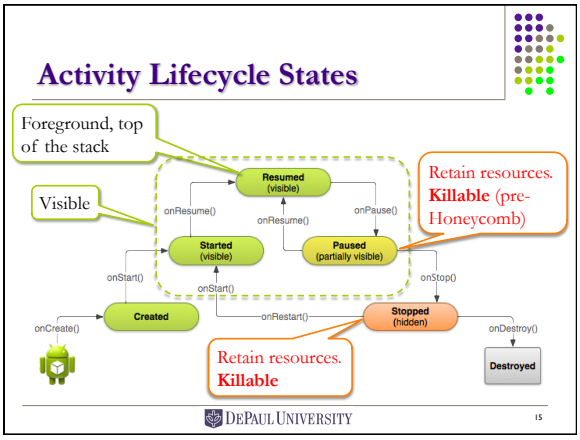
Activity Lifecycle States
Foreground, top of the stack
Visible
Retain resources. Killable (pre-Honeycomb)
Retain resources. Killable
Resumed (visible)
Started (visible)
Paused (partially visible)
Created
Stopped (hidden)
Destroyed
onCreate()
onStart()
onResume()
onPause()
onStop()
onRestart()
onDestroy()
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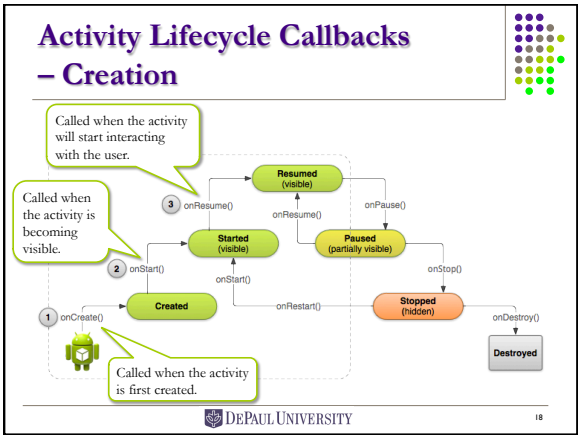
Activity Lifecycle Callbacks – Creation
Called when the activity will start interacting with the user.
Called when the activity is becoming visible.
Called when the activity is first created.
Resumed (visible)
Started (visible)
Paused (partially visible)
Created
Stopped (hidden)
Destroyed
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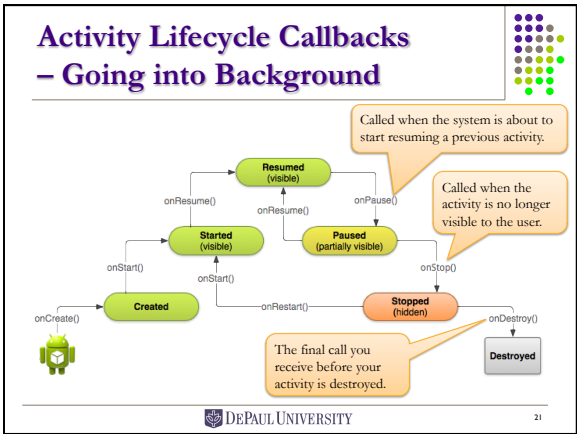
Activity Lifecycle Callbacks – Going into Background
Called when the system is about to start resuming a previous activity.
Called when the activity is no longer visible to the user.
The final call you receive before your activity is destroyed.
Resumed (visible)
Started (visible)
Paused (partially visible)
Created
Stopped (hidden)
Destroyed
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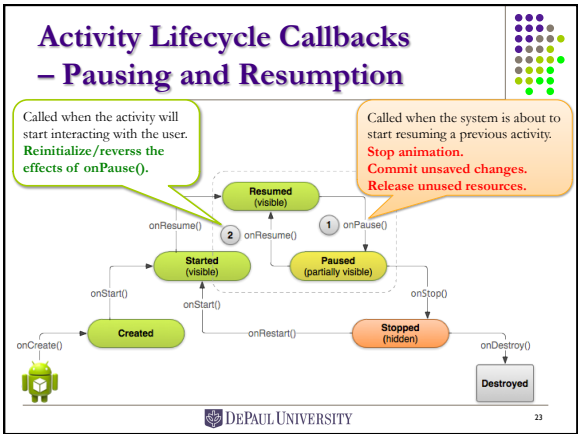
Activity Lifecycle Callbacks – Pausing and Resumption
Called when the activity will start interacting with the user. Reinitialize/reverss the effects of onPause().
Called when the system is about to start resuming a previous activity. Stop animation. Commit unsaved changes. Release unused resources.
Resumed (visible)
Started (visible)
Paused (partially visible)
Created
Stopped (hidden)
Destroyed
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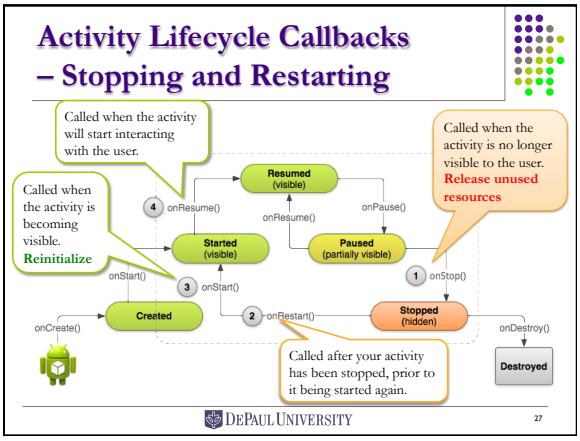
Activity Lifecycle Callbacks – Stopping and Restarting
Called when the activity will start interacting with the user.
Called when the activity is becoming visible. Reinitialize
Called when the activity is no longer visible to the user. Release unused resources
Called after your activity has been stopped, prior to it being started again.
Resumed (visible)
Started (visible)
Paused (partially visible)
Created
Stopped (hidden)
Destroyed
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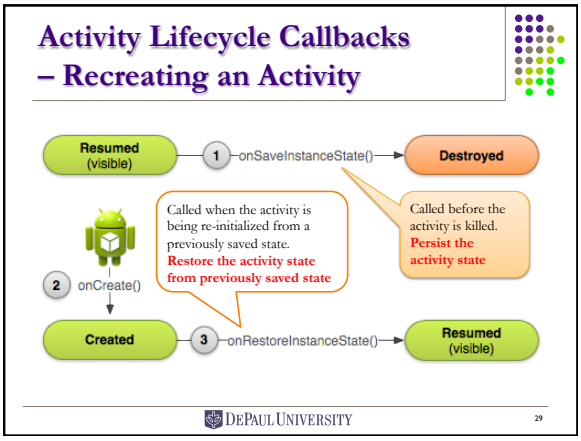
Activity Lifecycle Callbacks – Recreating an Activity
Resumed (visible)
onSaveInstanceState()
Destroyed
Called before the activity is killed. Persist the activity state
Called when the activity is being re-initialized from a previously saved state. Restore the activity state from previously saved state
onCreate()
Created
onRestoreInstanceState()
Resumed (visible)
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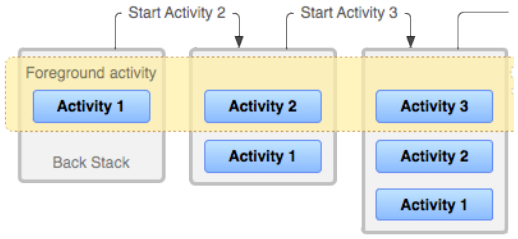
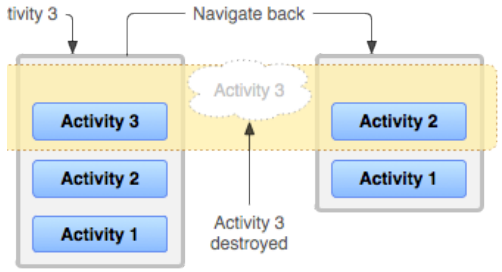
Tasks and the Back Stack

- An app usually contains multiple activities.
  - May even start activities in other apps
- A *task* is a collection of activities that users interact with when performing a certain job.
- The activities are arranged in a stack (the "*back stack*"), in the order in which each activity is opened.
  - Strictly LIFO ("last in, first out")
  - Push: launch an app from Home screen, or start an activity from another activity
  - Pop: *Back* button tapped, the current activity is popped

The Back Stack



The Back Stack



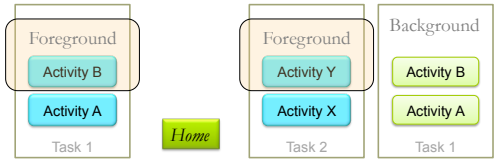
Activities and Tasks

- **Activity A** starts **Activity B**
  - **Activity A** is *stopped*, and its state is retained.
  - **Activity B** is pushed onto the top of the stack.
- Tap the *Back* button,
  - **Activity B** is popped and *destroyed*, and its state is not retained
  - **Activity A** resumes with its state restored.

Background Tasks

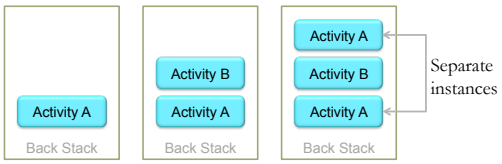
- Tap the *Home* button, leaves a task
  - The current activity is *stopped*.
  - The current task goes into the *background*
  - The state of every activity in the task is retained
- The task can be *resumed* through
  - Launcher icon on *Home* screen, or
  - The *Recent Tasks*

Background Tasks



Multiple Instances of Activities

- Activities can be instantiated multiple times
  - Multiple instances of the same activity may exists in the back stack



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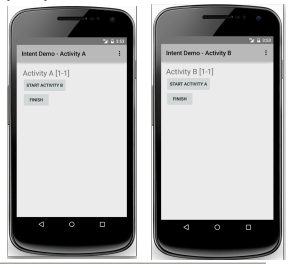
Intent Demo App

The Intent Demo App

- An app with two screens, i.e., two activities
- *Activity A* can
  - Start *Activity B*, with an explicit intent
  - Finish itself
- *Activity B* can
  - Start *Activity A*, with an explicit intent
  - Finish itself



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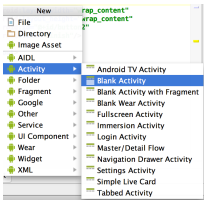
Building the Intent Demo App – Adding a New Activity

- New Project "Intent Demo"
  - Start with a blank activity
  - Change Activity name to: "ActivityA"
  - Change Layout name to: "activity_a"
- File | New …
  - Activity | Blank Activity
  - Choose Activity name: "ActivityB"
  - Choose Layout name: "activity_b"
  - Do not check "launcher activity"
  - Finish



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The Android Manifest

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://…"
          package="edu.depaul.csc472.intentdemo" >
  <application … >
    <activity android:name=".ActivityA"
              android:label="@string/title_a">
      <intent-filter>
        <action android:name="android.intent.action.MAIN"/>
        <category android:name="android.intent.category.LAUNCHER"/>
      </intent-filter>
    </activity>
    <activity android:name=".ActivityB"
              android:label="@string/title_b">
    </activity>
  </application>
</manifest>
```

Activity names should be fully qualified. '.' – the current package.

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The Layout of the Screens

- Layout file: **activity_a.xml**

```
<LinearLayout …>
  <TextView …
    android:id="@+id/title"
    android:text="Activity A"/>
  <Button …
    android:id="@+id/button1"
    android:text="Start Activity B"/>
  <Button …
    android:id="@+id/button2"
    android:text="Finish"/>
</LinearLayout>
```

- Layout file: **activity_b.xml** is nearly identical

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Keep Track of Activities – onCreate and onStart

```
public class ActivityA extends Activity {
  private static int INSTANCE_COUNTER = 0;
  private int instanceID;
  private int counter = 0;
  protected void onCreate(Bundle savedInstanceState) {
    instanceID = ++INSTANCE_COUNTER;
    Log.d(TAG, "onCreate() instanceID=" + instanceID);
    …
  }
  protected void onStart() {
     super.onStart();
     Log.d(TAG, "onStart() counter=" + ++counter);
  }
…
```

# of instances

# of starts

Start a New Activity – ActivityA.java

```
protected void onCreate(Bundle savedInstanceState) {
  super.onCreate(savedInstanceState);
  setContentView(R.layout.activity_a);
  Button button1 = (Button) findViewById(R.id.button1);
  button1.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View view) {
      Intent intent =
         new Intent(ActivityA.this, ActivityB.class);
      startActivity(intent);
    }
  });
  …
}
```


Finish the Current Activity – ActivityA.java

```
protected void onCreate(Bundle savedInstanceState) {
  …
  Button button2 = (Button) findViewById(R.id.button2);
  button2.setOnClickListener(new View.OnClickListener() {
     @Override
     public void onClick(View view) {
       finish();
     }
  });
}
```

Finish the current activity. The activity will be popped and destroyed. Not a callback.

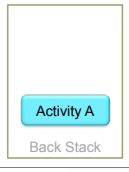
Activity onStart() – ActivityA.java

```
@Override
protected void onStart() {
  super.onStart();
  Log.d(TAG, "onStart() counter=" + ++counter);
  TextView title = (TextView) findViewById(R.id.title);
  title.setText("Activity A [" + instanceID +
                "-" + counter + "]");
}
```

- Other lifecycle callbacks simply log a message
- **ActivityB.java** is nearly identical
  - It starts *ActivityA*

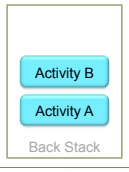
The Intent Demo

1. Launch the demo
   - *ActivityA*



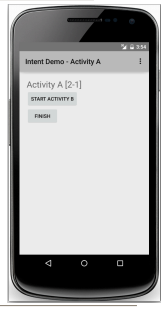
The Intent Demo

1. Launch the demo
   - *ActivityA*
2. Start Activity
   - *ActivityB*



The Intent Demo

1. Launch the demo
   - *ActivityA*
2. Start Activity
   - *ActivityB*
3. Start Activity
   - A new instance of *ActivityA*



The Intent Demo

1. Launch the demo
   - *ActivityA*
2. Start Activity
   - *ActivityB*
3. Start Activity
   - A new instance of *ActivityA*
4. Finish
   - Pop *ActivityA*
   - *ActivityB* counter incremented

The Intent Demo

1. Launch the demo
   - *ActivityA*
2. Start Activity
   - *ActivityB*
3. Start Activity
   - A new instance of *ActivityA*
4. Finish
   - Pop *ActivityA*
   - *ActivityB* counter incremented
5. Finish
   - Pop *ActivityB*
   - *ActivityA* counter incremented

Tip: To Rename a File

- Do not manually change file names.
- Use the *Refactoring* feature of Android Studio
  - It will search for references to the file in your project, and will replace all the references with the new name
- Select the file, or other item, that you want to rename in the navigator, then
  - Right-click (Ctrl-Click on Mac) or
  - From the menu bar
  - Refactor | Rename

Passing Data Between Activities

The Bundle Class

```
protected void onCreate(Bundle savedInstanceState) {
  …
}
```

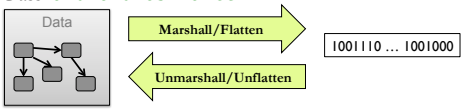
A *Bundle* object representing the state of the *Activity* in its previous incarnation

What is Parcelable?

- Class: `android.os.Bundle`
- A mapping from *String* keys to various *Parcelable* values.
- Used extensively in Android for passing and saving data.

Parcelable

- An interface: `android.os.Parcelable`
  - Representing data that can be written to and restored from a *Parcel*
- A *Parcel* is a container of data that can be *flattened* and *unflattened*, or *marshalled* and *unmarshalled*
  - Class: `android.os.Parcel`



Serializable vs. Parcelable

- *Serializable* is a Java standard mechanism
  - Simple. A marker interface, no methods.
  - Slow. JVM does the work for you. Use reflection!
- *Parcelable* is an Android specific mechanism
  - Common types are *Parcelable*.
  - More code for user-defined classes.
    - Developers are responsible for handling the reading and writing of data
  - Much faster! As much as 10x improvement.

Will have an example in the next lecture

Get Results from Another Activity

- Start an activity and expect a result
  - an explicit intent and a request code (int)

```
Intent intent =
  new Intent(this, TargetActivity.class);
startActivityForResult(intent, req_code);
```

- Implement a callback

```
protected void onActivityResult(int requestCode,
                    int resultCode, Intent data) {
  if (requestCode == req_code) {
    if (resultCode == RESULT_OK) {  …  }
  }
}
```


Return Results to the Caller

- Set the result that your activity will return to its caller.
- Normal return, provide the result in an intent

```
Intent data = new Intent();
data.putExtra(key, value);
setResult(RESULT_OK, data);
```

The *extra* of an *Intent* is a *Bundle*

- Cancel

```
setResult(RESULT_CANCELLED);
```


Storing Data in and Retrieving Data from an Intent

- An *Intent* object may carry *extra* data
- Store extra data in an intent

```
intent.putExtra(key, value);
```

  - key is a string
  - value can be any *Parcelable* data, including, primitive types, arrays, and strings
- Retrieve data from an intent

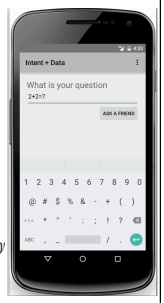
```
intent.getTypeExtra(key);
```

  - *Type* is the name of the type of the value to be retrieved
  - e.g., `getFloatExtra(key); getStringExtra(key);`

Intent + Data Demo App

Who Wants to be a Millionaire? – Ask a Friend

- An app with two activities
- *Main Activity*
  - Asks a question
  - Starts the *Friend Activity*, pass the question as the data
- *Friend Activity*
  - Retrieve the question
  - Give an answer, send back to *Main Activity*
  - Finish



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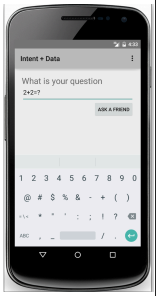
The Main Activity – The Layout

```
<LinearLayout … >
  <TextView …
    android:text="What is your question" />
  <EditText …
    android:id="@+id/question"
    android:hint="type a question"/>
  <Button …
    android:id="@+id/ask"
    android:text="Ask a friend"
    android:layout_gravity="right"/>
</LinearLayout>
```



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The Main Activity – Ask a Friend

```
public class MainActivity extends Activity {
  private static final int ASK_QUESTION = 100; // request code
  protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_main);
    Button button = (Button) findViewById(R.id.ask);
    button.setOnClickListener(new View.OnClickListener() {
      @Override
      public void onClick(View view) {
        Intent intent = new Intent(MainActivity.this,
                                   FriendActivity.class);
        EditText question = (EditText) findViewById(R.id.question);
        intent.putExtra("Question", question.getText());
        startActivityForResult(intent, ASK_QUESTION);
      }
    });
  }
…
```

Pass the question as an extra in the intent.

The Friend Activity – The Layout

```
<LinearLayout … >
  <TextView … />
  <TextView android:id="@+id/question" … />
  <TextView … />
  <EditText android:id="@+id/answer" … />
  <LinearLayout … >
    <Button android:id="@+id/dontknow"
      android:text="I don't know" … />
    <Button android:id="@+id/reply"
      android:text="Reply" … />
  </LinearLayout>
</LinearLayout>
```

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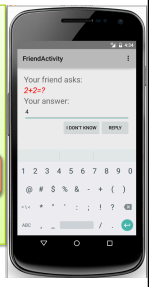
The Friend Activity – Show Me the Question

```
@Override
protected void onStart() {
  super.onStart();
  Intent intent = getIntent();
  if (intent != null) {
    TextView question =
      (TextView) findViewById(R.id.question);
    question.setText(
      intent.getCharSequenceExtra("Question"));
  }
}
```

What is CharSequence?



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Side Bar: Char Sequence

- *Char Sequence* is an interface in Java
  - `java.lang.CharSequence`
  - It represents a sequence of characters
- Java *String* class implements the *Char Sequence* interface
- Android API uses *Char Sequence* extensively, where you would normally expect *String*
  - It allows different classes that implement the *Char Sequence* interface to be used
  - For better performance, Android framework internally uses an alternative implementation of *Char Sequence* in lieu of *String*

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The Friend Activity – Replay to the Question

```
protected void onCreate(Bundle savedInstanceState) {
  Button reply = (Button) findViewById(R.id.reply);
  reply.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View view) {
      EditText answer = (EditText) findViewById(R.id.answer);
      Intent data = new Intent();
      data.putExtra("Answer", answer.getText());
      setResult(RESULT_OK, data);
      finish();
    }
  });
  …
}
```


The Friend Activity – I Don't Know

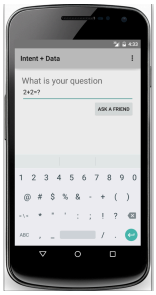
```
protected void onCreate(Bundle savedInstanceState) {
  …
  Button dontKnow = (Button) findViewById(R.id.dontknow);
  dontKnow.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View view) {
      setResult(RESULT_CANCELED);
      finish();
    }
  });
}
```


The Main Activity – Receive the Result

```
@Override
protected void onActivityResult(int requestCode,
                                int resultCode, Intent data) {
  if (requestCode == ASK_QUESTION) {
    if (resultCode == RESULT_OK) {
      Toast.makeText(this, "Your friend replied.\nThe answer is " +
        data.getCharSequenceExtra("Answer"),
        Toast.LENGTH_LONG).show();
    } else {
      Toast.makeText(this, "Your friend doesn't know the answer.",
        Toast.LENGTH_LONG).show();
    }
  }
}
```


Intent + Data Demo

- *Main Activity*
  - Type a question



Intent + Data Demo

- *Main Activity*
  - Type a question
- *Friend Activity*
  - Type an answer, "Reply" or
  - "I don't know"

Intent + Data Demo

- *Main Activity*
  - Type a question
- *Friend Activity*
  - Type an answer, "Reply" or
  - "I don't know"
- *Main Activity*
  - Receive the answer, or
  - Receive "I don't know"

Sharing Data Among Activities

Sharing Data Among Activities within the Same App

- Each *Activity* is an independent component
  - Has its own lifecycle
  - Managed by the system
- It is general not safe to assume that another activity is alive and its data are available.
  - Each *Activity* manages its own data
- How to share data among *Activities*?

The Preferred Methods of Sharing Data

- Passing data via *Intents*
  - Using the extra attribute
  - Safe and restricted
- Using a Singleton object
  - A unique instance shared by all components within an app
  - Not managed by the system
  - App-wide sharing

Using a Singleton Class

```
public class Singleton {
  private static Singleton theInstance;
  public String data;

  public static Singleton getInstance() {
    if (theInstance == null) {
      theInstance = new Singleton(); // Create the instance
    }
    return theInstance;
  }
  private Singleton() {} // The constructor is private

}
```


Using a Singleton Class – The Client Code

- Anywhere in your app

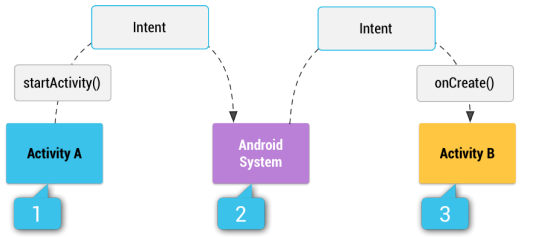
```
…
Singleton s = Singleton.getInstance();
s.data = "You had me at 'Hello'";
…
```


Other Methods of Sharing Data

- In the *Application* object
  - A unique *Application* instance for each app
  - Need to extend the Application
- In the *Shared Preferences*
  - System-wide persistent storage
  - Lives beyond app lifetime
- Static variables
  - Shared among all components within an app
  - Managed separately from instance variables
  - But, it violates the principles and best practice of OOP

Implicit Intents

Delivering an Implicit Intent



Delivering an Implicit Intent

1. *Activity A* creates an *Intent* with an action description and passes it to `startActivity()`
2. The Android System searches all apps for an intent filter that matches the intent.
3. When a match is found, the system starts the matching activity (*Activity B*) by invoking its `onCreate()` method and passing it the *Intent*.

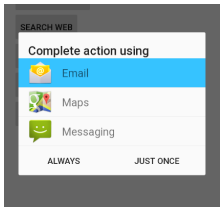
Delivering an Implicit Intent

- It is possible that a user doesn't have any app that can handle the *Intent* sent in `startActivity()`
  - If this happens, the call will fail and the app will crash.
- To ensure that an *Intent* can be handled by some activity

```
if (intent.resolveActivity(getPackageManager())
    != null) {
  startActivity(intent);
}
```


Delivering an Implicit Intent

- If multiple activities accept the intent, the system displays a dialog.



Building Implicit Intents

- Instead of specifying a component name, specifying an *action*
  - e.g., `ACTION_VIEW`, `ACTION_SEARCH`, `ACTION_SEND`
- Set data
  - A *Uri* object
    - Define a URI reference, e.g., `http://www.android.com`
    - Method: `URI.parse(string)`
- Set extras
  - key-value pairs of additional data

URI Syntax

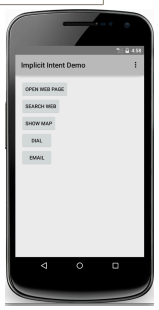
- URI – *Universal Resource Identifier*
  - An Internet standard (RFC 3986)
  - URL is a special case of URI
- URI scheme

  scheme-name : *hierarchical-part* [? *query*] [# *fragment*]

  Optional
  - Scheme name: `http:` `tel:`
  - Hierarchical part: `d.android.com/guide/ui`
  - Query: `?key1=value1;key2=value2`
  - Fragment: `#section2`

Implicit Intent Demo

- A simple app with button
- Each button invokes an action that uses an implicit intent to activate another app on your device or emulator
  - Open a web page
  - Perform a web search
  - Find a location on a map
  - Dial a phone number
  - Send an email

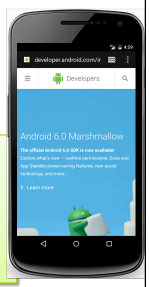


Implicit Intent Demo – Open Web Page

- Action: `ACTION_VIEW`
- Data URI Scheme

  `http:<URL>`

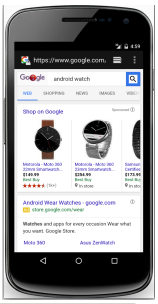
  `https:<URL>`



```
public void openWebPage(View view) {
  Intent intent =
    new Intent(Intent.ACTION_VIEW);
  intent.setData(
    Uri.parse("http://developer.android.com"));
  startActivity(intent);
}
```


Implicit Intent Demo – Search Web

- Action: `ACTION_SEARCH`
- Extras
  - `SearchManager.QUERY`
  - The search string.



```
public void searchWeb(View view) {
  Intent intent =
    new Intent(Intent.ACTION_SEARCH);
  intent.putExtra(SearchManager.QUERY,
                  "android watch");
  startActivity(intent);
}
```

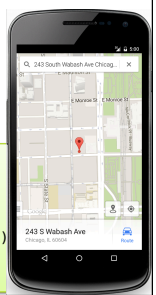

Implicit Intent Demo – Show Map Location

- Action: `ACTION_VIEW`
- Data URI Scheme

  `geo:lat,lng`

  `geo:lat,lng?z=zoom`

  `geo:0,0?q=my+street+address`



```
public void showMap(View view) {
  Intent intent =
    new Intent(Intent.ACTION_VIEW);
  intent.setData(Uri.parse(
    "geo:0,0?q=243+South+Wabash+Ave+Chicago+IL"));
  startActivity(intent);
}
```

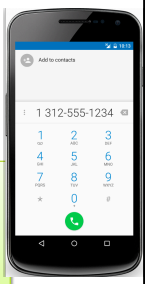

Implicit Intent Demo – Dial Phone

- Action:

  `ACTION_DIAL` – Opens the dialer or phone app.

  `ACTION_CALL` – Places a phone call (requires the `CALL_PHONE` permission)
- Data URI Scheme

  `tel:<phone-number>`



```
public void dial(View view) {
  Intent intent =
    new Intent(Intent.ACTION_DIAL);
  intent.setData(Uri.parse("tel:13125551234"));
  startActivity(intent);
}
```

Implicit Intent Demo – Email

- Action:
  - `ACTION_SENDTO` – for no attachment.
  - `ACTION_SEND` – for one attachment
  - `ACTION_SEND_MULTIPLE` – for multiple attachments
- Extras
  - `Intent.EXTRA_EMAIL` – recipients
  - `Intent.EXTRA_SUBJECT` – email subject
  - `Intent.EXTRA_TEXT` – email body

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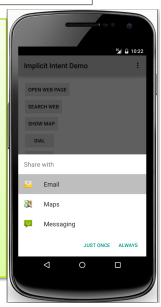
Implicit Intent Demo – Email

```
public void email(View view) {
  Intent intent =
    new Intent(Intent.ACTION_SEND);
  intent.setType("*/*");
  intent.putExtra(Intent.EXTRA_EMAIL,
      new String[] { "me@cdm.depaul.edu" });
  intent.putExtra(Intent.EXTRA_SUBJECT,
      "Email from Implicit Intent Demo");
  intent.putExtra(Intent.EXTRA_TEXT,
      "-- Send by my Android App");
  startActivity(intent);
}
```



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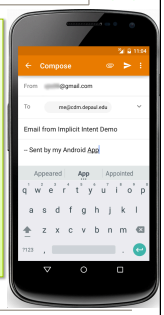
Implicit Intent Demo – Email

```
public void email(View view) {
  Intent intent =
    new Intent(Intent.ACTION_SEND);
  intent.setType("*/*");
  intent.putExtra(Intent.EXTRA_EMAIL,
      new String[] { "me@cdm.depaul.edu" });
  intent.putExtra(Intent.EXTRA_SUBJECT,
      "Email from Implicit Intent Demo");
  intent.putExtra(Intent.EXTRA_TEXT,
      "-- Send by my Android App");
  startActivity(intent);
}
```



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The Sample Code

- The sample apps in this lecture are available in D2L
  - IntentDemo.zip
  - Intent+DataDemo.zip
  - ImplicitIntentDemo.zip
- Each zip archive contains the entire project folder
- Unzip the file and import to Android Studio

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Next …

- *Adapters* and *Adapter Views*
- *Spinners*
- *List Views* and *List Activities*
- Customize *List Views* and *Adapters*

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