Mobila applikationer och trådlösa nät, HI1033, HT2014

Today:
- User Interface basics
- View components
- Event driven applications and callbacks
- Menu and Context Menu
- ListView and Adapters
- Android Application life cycle,
- Activity life cycle

Expect this when developing software for limited devices

- Limited memory capacity and processor speed
  Limited battery capacity

- Network: High latency, low speeds, possibly interrupted
  Communication (might) be associated with a cost!

- Small screens, of different sizes and different densities

- Application might get interrupted at any time!

- Hardware-imposed design considerations
  Fragmentation of platforms

- *Design with this in mind:*
  Be efficient and be responsive

Android SDK

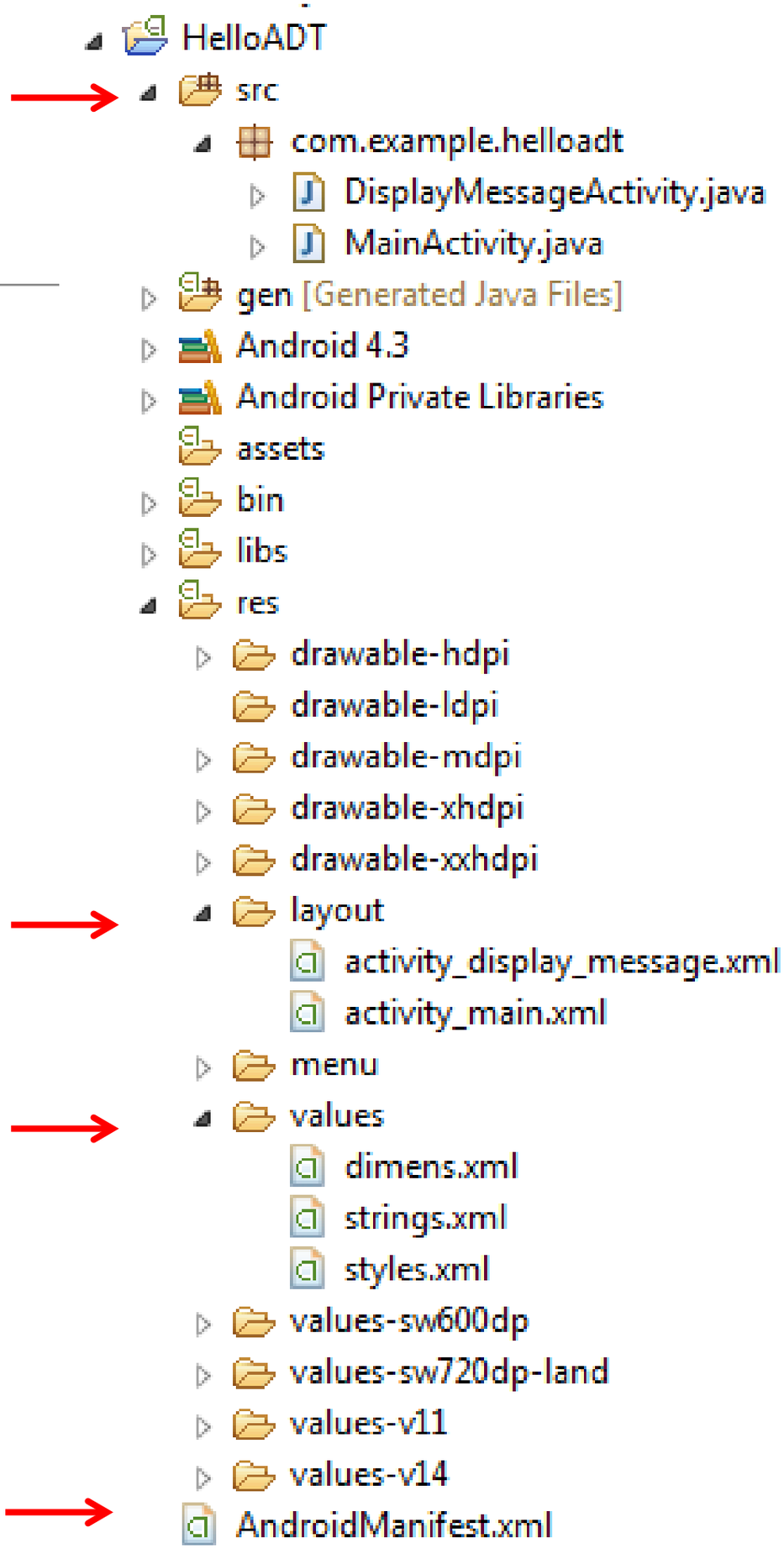
- API, Compiler, Debugger, …
- Android Virtual Device and Emulator
- Deployment tool

- Documentation, sample code, … at http://developer.android.com/

- The Eclipse IDE plugin adds:
  - Project management, project wizard
  - Editors for layouts and other resources
  - Automated building of projects
  - AVD manager
  - Debugger interface (Dalvik Debug Monitor Service, DDMS)

Anatomy of an Android Application

- Classes, including Activities (partly acting as controllers)
- Resources, e.g. strings, layouts, data files, …
- Application Manifest, defining the entry point (e.g. an Activity), and other application settings
- On installation, packaged into an installation bundle, an Android Package (APK) file:
  - META-INF
  - res
  - AndroidManifest.xml
  - classes.dex



The Android Manifest file

- Contains information on application components, entry point, permissions et c.

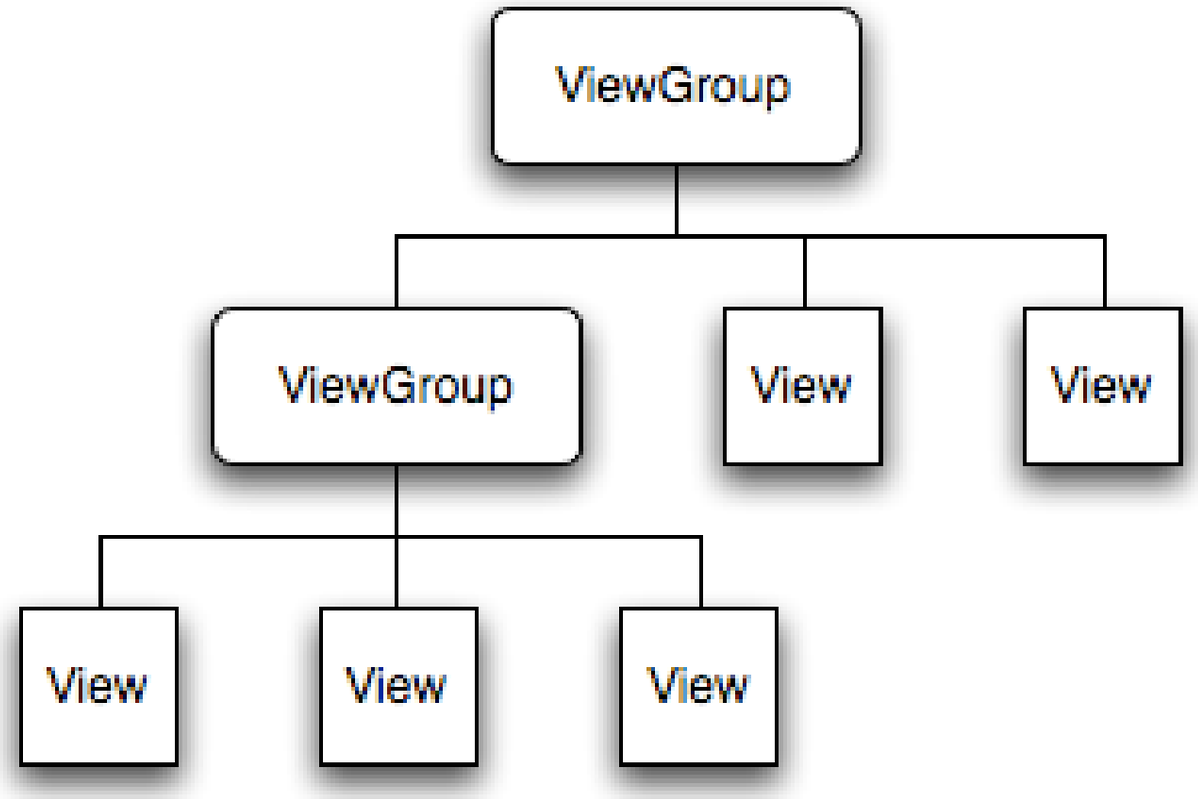
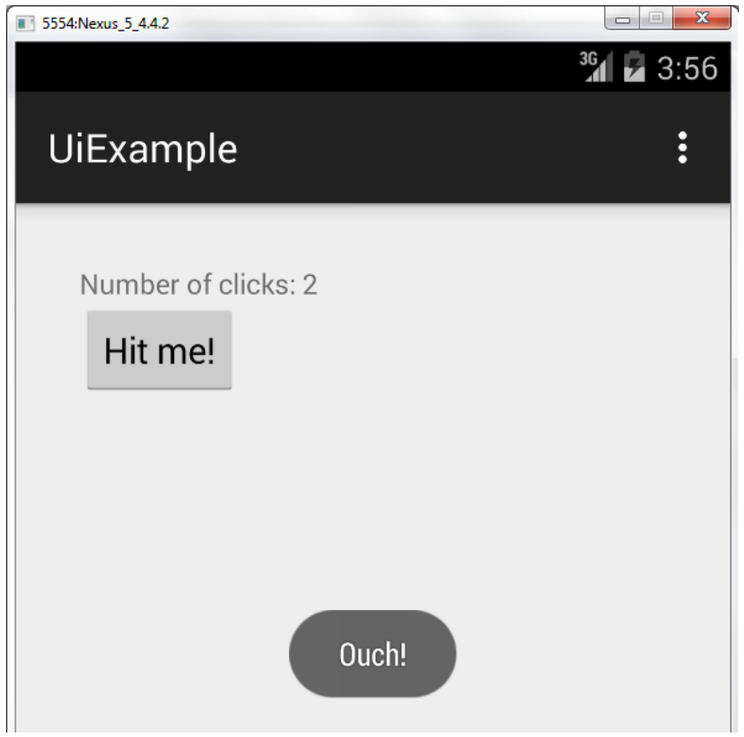
- ```
  <?xml version="1.0" encoding="utf-8"?>
  <manifest . . . >
      <application . . . >
          <activity
            android:name="com.example.project.GameActivity"
            android:icon="@drawable/small_pic.png"
            android:label="@string/myLabel"
              . . .  >
        </activity>
        . . .
    </application>
</manifest>
  ```
  ```

The Android Manifest file

- Multiple application components

- ```
  <activity
      android:name="com.example.project.GameActivity” >
      <intent-filter>
          <action
              android:name="android.intent.action.MAIN" />
          <category
              android:name="android.intent.category.LAUNCHER" />
      </intent-filter>
  </activity>

  <activity
      android:name="com.example.project.OtherActivity”
  . . .  >
  </activity>
  ```
  ```

The Android Manifest file

- By default, an application has not permission to perform operations considered potentially harmful to other applications, to the operating system or to the user.

- Reading or writing another application's files, performing network access, keeping the device awake, et c. requires permissions

- ```
  <manifest
  xmlns:android="http://schemas.android.com/apk/res/android"
      package="com.android.app.myapp" >
      <uses-permission
          android:name="android.permission.RECEIVE_SMS”
          android:name="android.permission.INTERNET” />
      ...
  </manifest>
  ```
  ```

User Interfaces, View components

- Super class View
  - ViewGroup extends View

- ViewGroup sub classes:
  LinearLayout, RelativeLayout,
  ListView, GridView, RadioGroup,
  …

- View sub classes (Widgets):
  TextView, EditText, Button,
  RadioButton, … , DatePicker,
  Clock, + custom widgets



User Interface, View Components

- The root node should(?) be of type ViewGroup

- The Activity calls `setContentView(layout_file)` to attach the root node to the screen

- Occupies a rectangular area of the screen

- Each view component has a set of properties representing layout parameters, text configuration, preferred size, …

- As an object in the user interface, a View is also a point of interaction for the user and the receiver of the interaction events

UI example



A RealtiveLayout, containing a TextView and a Button

- Separate presentation and actions
- Layout and widgets and together with their properties in an XML file, e.g. res/activity_main.xml
- The file must contain exactly one root component, that may contain child components
- Multiple layout files allowed
  At least one layout file per Activity

Layout file, res/main.xml

```
<RelativeLayout
    xmlns:android=http://schemas.android.com/apk/res/android . . .
    android:layout_width="match_parent” . . .
    android:paddingBottom="@dimen/activity_vertical_margin"
    . . .
    tools:context="se.kth.anderslm.uiexample.MainActivity" >

    <TextView
        android:id="@+id/textView"
        android:layout_width="wrap_content” . . .
        android:layout_marginTop="15dp"
        android:text="@string/text_info" />

    <Button
        android:id="@+id/button” . . .
        android:text="@string/button_text" />

</RelativeLayout>
```

Layout file

- The corresponding Activity

```
public class MainActivity extends ActionBarActivity {
    private TextView textView;
    private Button button;

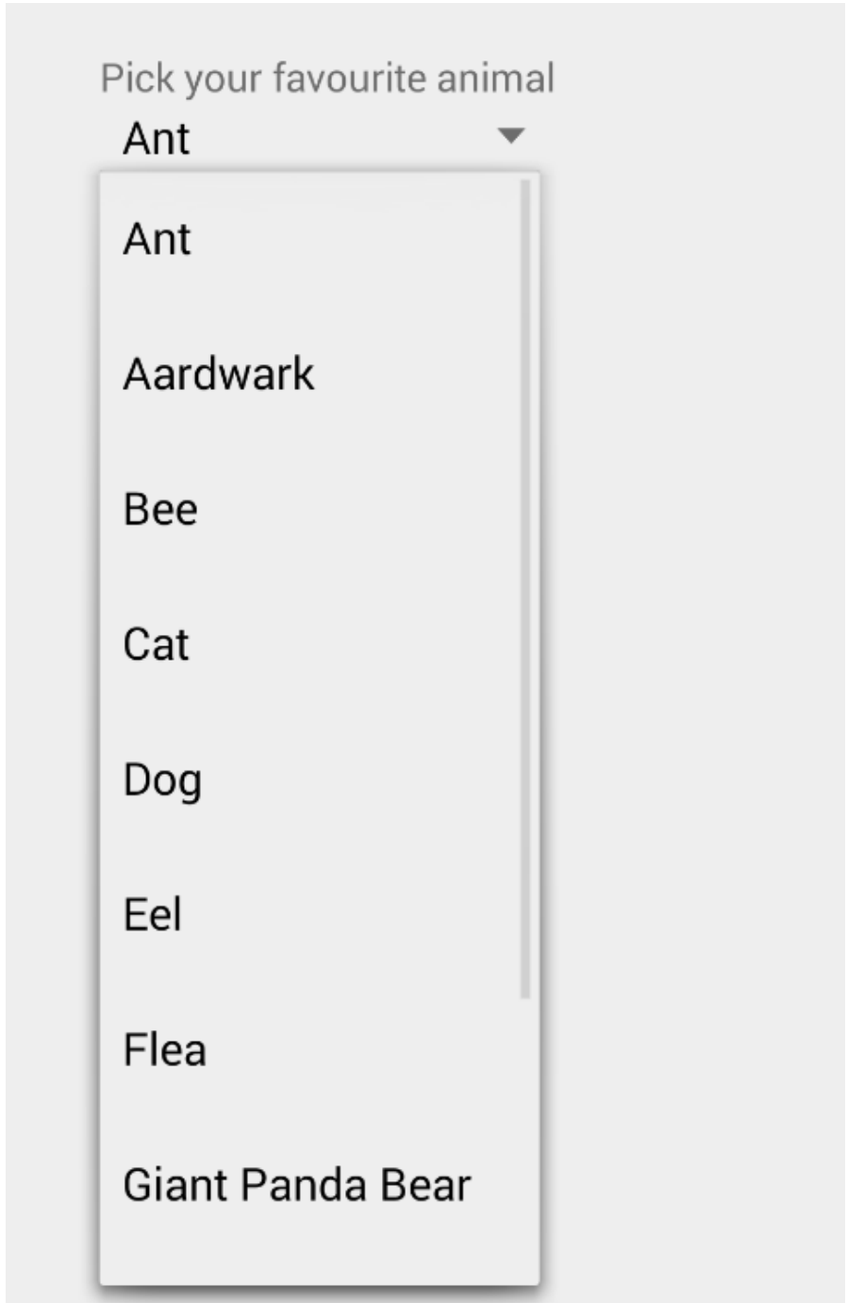
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);

        setContentView(R.layout.activity_main);

        button = (Button) findViewById(R.id.button);
        textView = (TextView) findViewById(R.id.textView);
    }
    . . .
```

- NB: setContentView should be called *before* findViewById

User interaction – listener interfaces

- Event-based application - the flow of control of the program is determined by events

- Callbacks: The (Android) system detects such events and calls the appropriate method defined in or registered on the View component
  - onClick() from View.OnClickListener
  - onLongClick() from View.OnLongClickListener
  - onFocusChange() from View.OnFocusChangeListener
  - onKey() from View.OnKeyListener.
    Called when the view has focus and a key is pressed
  - onTouch() from View.OnTouchListener – gestures

User interaction - Event Handlers

- View components also have their own callback methods for handling events, e.g.
  - onKeyDown(int, KeyEvent) - Called when a new key event occurs.
  - onKeyUp(int, KeyEvent) - Called when a key up event occurs.
  - onTouchEvent(MotionEvent) - Called when a touch screen motion event occurs.
  - onFocusChanged(boolean, int, Rect)

- Extend the View class and override the appropriate method

User interaction: OnClickListener

```
public class MainActivity extends ActionBarActivity {

    public void onCreate(Bundle savedInstanceState) {
        . . .
        button = (Button) findViewById(R.id.button);

        OnClickListener listener = new OnButtonClickListener();
        button.setOnClickListener(listener);
    }

    private class OnButtonClickListener implements OnClickListener {
        public void onClick(View v) {
            textView.setText("Number of clicks: " + ++clicks);
            showToast("Ouch!");
    }
    . . .
```

Lists and Adapters

- An Adapter represents a bridge between
  - data, such as an array, a List or data from a ContentProvider,
  - and a View, such as a ListView or a Spinner.

- The Adapter creates the child views representing individual data

- The adapter updates the view(s) if the underlying data is changed

- - ArrayAdapter (array, List)
  - CursorApdapter (ContentProvider via a Cursor)



Adapters

- The Spinner, defined in res/main.xml

```
<RelativeLayout … >

    <TextView … />

    <Spinner
        android:id="@+id/spinner"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_alignLeft="@+id/PetText"
        android:layout_below="@+id/PetText” />

</RelativeLayout>
```

Adapters

- Create a list or array:

```
private static final String[] PETS = { "Aardvark", "Ant", "Bee",… };
```

- In the Activity's onCreate(), bind the array PETS to the Spinner:

```
spinner = (Spinner) findViewById(R.id.PetSpinner);

ArrayAdapter<String> adapter = new ArrayAdapter<String>(this,
    android.R.layout.simple_spinner_item, PETS);

adapter.setDropDownViewResource(
    android.R.layout.simple_spinner_dropdown_item);

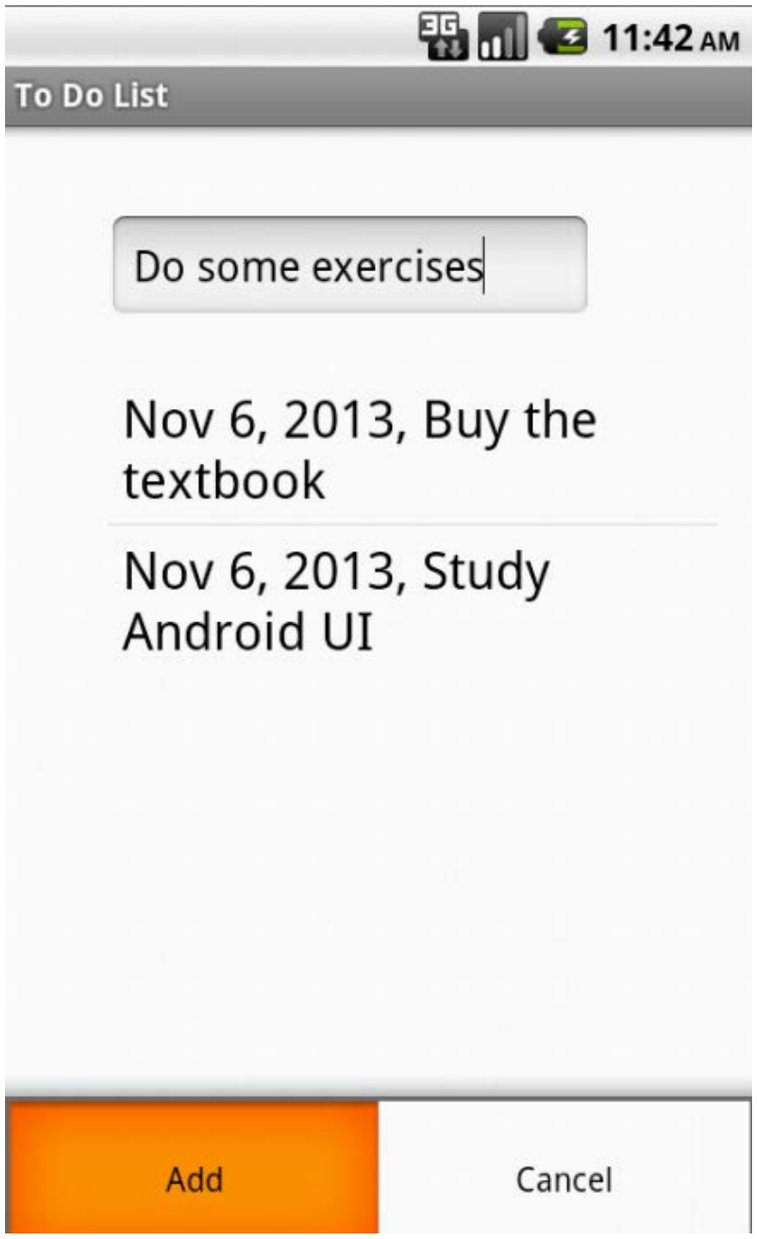
spinner.setAdapter(adapter);
spinner.setOnItemSelectedListener(new SpinnerListener());
```

Adapters

- The listener can access underlying data via the adapter

- ```
  private class SpinnerListener implements OnItemSelectedListener {

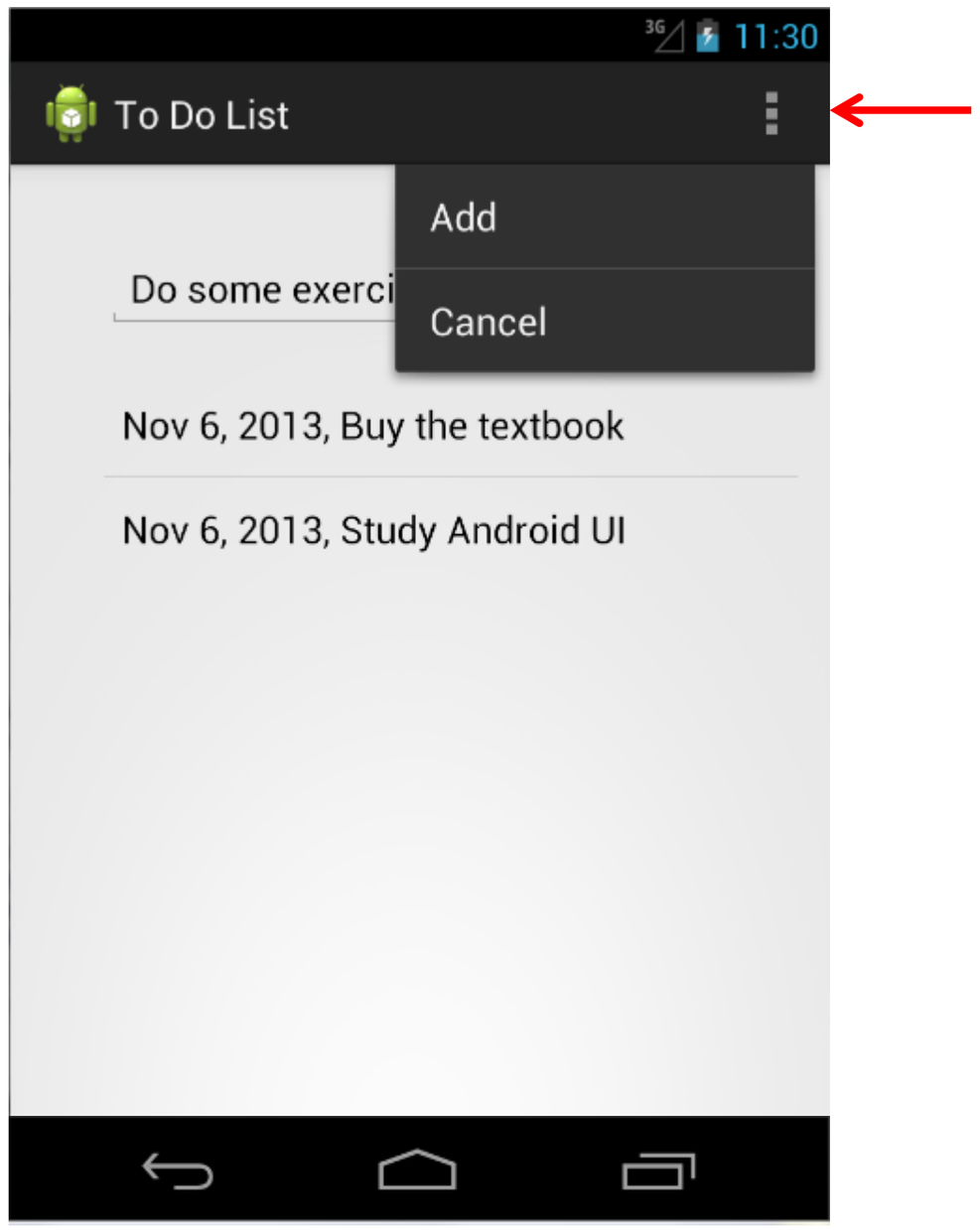
      public void onItemSelected(AdapterView<?> parent, View view, int
                                 pos, long id) {
          String pet = (String) spinner.getSelectedItem();
          showToast("Your favourite pet is a(n) " + pet);
      }

      public void onNothingSelected(AdapterView<?> parent) {}
  }
  ```
  ```

Options Menu

- Activated from the device's (hardware) menu button (v < 3.0),
  or at top right of screen (v > 2.3)





Options Menu

- Create a menu by overriding the Activity's onCreateOptionMenu method calling menu.add(…) for each item

- Define the menus widgets in a layout file, res/menu/some_menu.xml, and, in onCreateOptionMenu, use a MenuInflater to inflate the menu from XML

- Event Handler/Listener
  - Override Activity's onOptionsItemSelected, or
  - Create and add an OnMenuItemClickListener – inefficient, discouraged

Option Menu in Activity

```
public class ToDoActivity extends Activity {

  private EditText toDoInput;
  private ListView toDoListView;
  . . .

  public boolean onCreateOptionsMenu(Menu menu) {
      . . .
  }

  public boolean onOptionsItemSelected(MenuItem item) {
     super.onOptionsItemSelected(item);
     . . .
  }
```

Option Menu, onCreateOptionsMenu

- The layout file, e.g. *res/menu*/main, defining menu items

```
<menu . . .
    tools:context="se.kth.anderslm.todoes.MainActivity" >

    <item
        android:id="@+id/action_add_todo"
        app:showAsAction="ifRoom|withText"
        android:title="@string/menu_item_add"/>
    <item
        android:id="@+id/action_cancel"
        app:showAsAction="ifRoom|withText"
        android:title="@string/menu_item_cancel"/>

</menu>
```

Option Menu, onCreateOptionsMenu

- The corresponding Activity

```
public class MainActivity extends Activity {

    @Override
    public boolean onCreateOptionsMenu(Menu menu) {
        getMenuInflater().inflate(R.menu.main_activity_actions, menu);
        return super.onCreateOptionsMenu(menu);
    }
```

Option Menu, onCreateOptionsMenu, alternative

```
public boolean onCreateOptionsMenu(Menu menu) {

   menu.add(0, ADD_ITEM, Menu.NONE, "Add To-Do-item");
   menu.add(0, CANCEL_ITEM, Menu.NONE, "Cancel");

   return true;
 }
```

- If alternatives loaded dynamically, e.g. from database

- menu.add(. . .) arguments:
  - Menu group (for example for radio buttons),
  - unique id for this menu item (an integer),
  - order,
  - title, a text

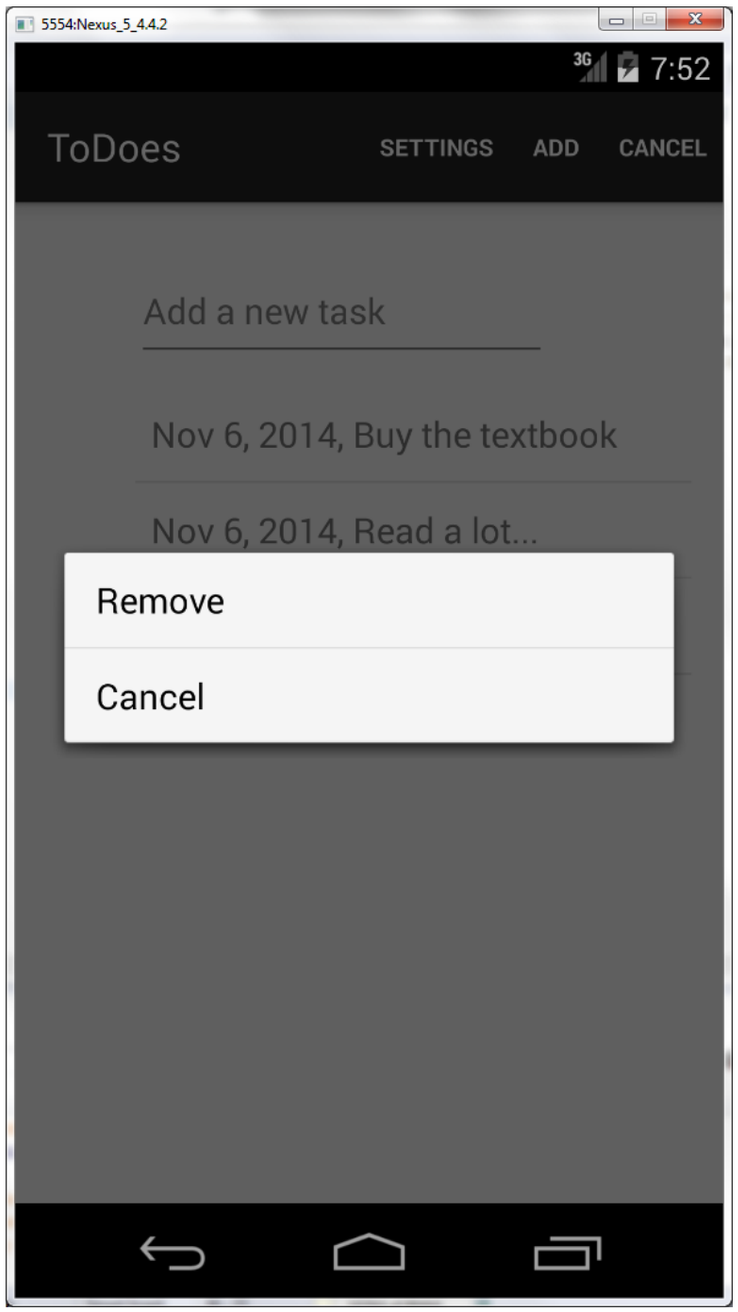
Options Menu, the Event Handler

```
@Override
public boolean onOptionsItemSelected(MenuItem item) {

    switch (item.getItemId()) {
        case R.id.action_add_todo:
            String text = toDoInput.getText().toString();
            ...
            return true;
        case R.id.action_cancel:
            toDoInput.setText("");
            return true;
        default:
            // Other alternatives -> default behavior
            return super.onOptionsItemSelected(item);
    }
}
```

Context Menu

- Associated with a specific widget, e.g. an item in a list view.

- Triggered on user event
  - long-click on widget or,
  - pressing the middle D-pad button or trackball (widget must be focused)



Context menu

- Create a context menu by overriding the *Activity*'s onCreateContextMenu method, or

- Define the menus widgets in a layout file, res/menu/somemenu.xml, and, in onCreateContextMenu, use a MenuInflater to inflate the menu from XML

- Event Handler/Listener
  - Override Activity's onContextItemSelected, or
  - Create and add an OnMenuItemClickListener – inefficient, discouraged

Context Menu, onCreateContextMenu

The layout file, e.g. *res/menu*/todolist_context_actions

```
<menu xmlns:android="http://schemas.android.com/apk/res/android" >

    <item
        android:id="@+id/action_remove_todo"
        android:title="@string/menu_item_remove"/>
    <item
        android:id="@+id/action_cancel"
        android:title="@string/menu_item_cancel"/>

</menu>
```

Context Menu, onCreateContextMenu

- The corresponding Activity

```
@Override
public void onCreate(Bundle savedInstanceState) {
      …
      // Register the ListView for this Activity's ContextMenu
      this.registerForContextMenu(toDoListView);
}

@Override
public void onCreateContextMenu(ContextMenu menu, View view,
                                ContextMenu.ContextMenuInfo menuInfo) {
      super.onCreateContextMenu(menu, view, menuInfo);
      getMenuInflater().inflate(
            R.menu.todolist_context_actions, menu);
}
```

Context Menu, onCreateContextMenu

- The corresponding Activity

```
@Override
public boolean onContextItemSelected(MenuItem item) {

   switch (item.getItemId()) {
      case R.id.action_remove_todo:
         …
         return true;
      case R.id.action_cancel:
         // Do nothing
         return true;
      default:
         // Other alternatives -> default behavior
         return super.onContextItemSelected(item);
   }
}
```

Alternative: Contextual action mode

- Contextual action mode, displays a *contextual action bar* at the top of the screen with action items that affect the selected item(s)
- It is possible select multiple items, e.g. from a list in this mode
- The contextual action mode is available on Android 3.0 (API level 11) and higher

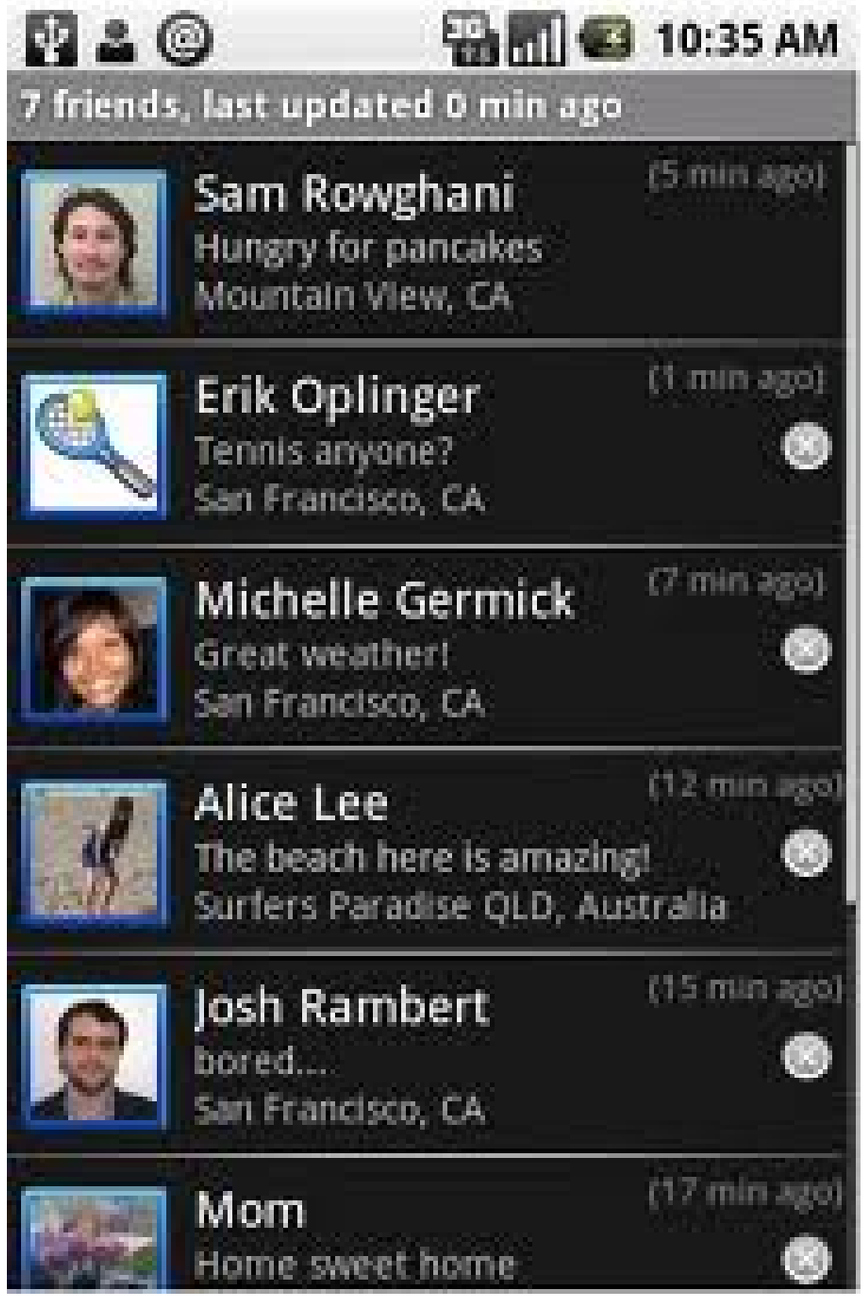
ListView

- Shows items in a vertically scrolling list

- Items come from a ListAdapter (or ArrayAdapter) associated with the list view.

- Simple list items: the data objects toString() method is called, or

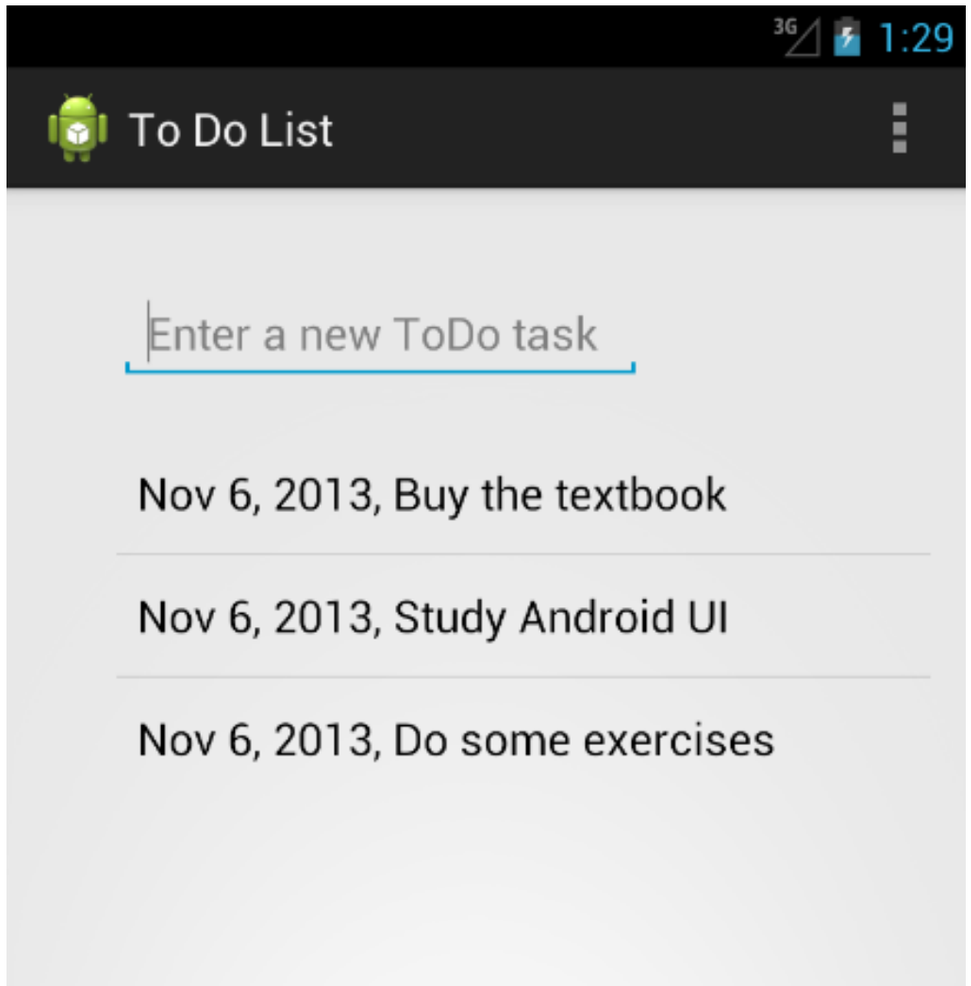
- Customized items



ListView, the To-Do list example

The layout file

```
<RelativeLayout . . . >

  <EditText
       android:id="@+id/InputText"
       . . .
  </EditText>

  <ListView
       android:id="@+id/ToDoListView"
       android:layout_width="fill_parent"
       android:layout_height="wrap_conten">
  </ListView>

</RelativeLayout>
```



ListView + Adapter

- Create an ArrayAdapter to bind the ListView to the data

```
public class ToDoActivity extends Activity {

   private ListView toDoListView;

   private ArrayList<ToDoItem> toDoItems;
   private ArrayAdapter<ToDoItem> adapter;

   public void onCreate(Bundle savedInstanceState) {
          . . .

          toDoItems = new ArrayList<ToDoItem>();

          adapter = new ArrayAdapter<ToDoItem>(
                this, android.R.layout.simple_list_item_1,
                toDoItems);
          toDoListView.setAdapter(adapter);
   }
```

ListView + Adapter

```
public boolean onContextItemSelected(MenuItem item) {
    switch(item.getItemId()) {
      case REMOVE_ITEM:
        AdapterView.AdapterContextMenuInfo menuInfo;
        menuInfo = (AdapterView.AdapterContextMenuInfo) item.getMenuInfo();
        int info = menuInfo.position;
        toDoItems.remove(info);
        adapter.notifyDataSetChanged();
        return true;
        . . .
```

- Complete examples with ListView, Adpater, OptionsMenu and ContextMenu:
  - ToDoes, menus defined in XML
  - ToDoListWithCustomAdapter (custom row-view + custom adapter)

Android application components

- Android applications don't have a single entry point (no main method) Instead: Consists of essential *components* that the system can instantiate and run as needed

- ***Activities*** *presents a visual user interface (holding View components)*

- ***Services*** *doesn't have a visual user interface, but rather runs in the background*

- **Broadcast receivers** receive and react to broadcast announcements, e.g. battery is low

- **Content providers** makes a specific set of the application's data available to other applications

Android **Application class**/object

- Whenever one of the applications components are requested a new process with a unique ID is created (if not already running)

- An objected of type Application (or sub type) is created providing the following **application** lifecycle methods

  - onCreate() - called before the first components of the application starts

  - onLowMemory() - called when the Android system requests that the application cleans up memory

  - onConfigurationChanged() - called whenever the configuration changes

- In practice a ”Singleton” – might hold references to objects representing the applications model et c.

Android **Application** Life Cycle

- *The application process remains running until it is no longer needed and the system needs to reclaim its memory*
  - *No explicit “exit”*

- Priorities

  1. A **foreground process**, holding an Activity at the top of the screen
  2. A **visible process**, holding an Activity that is visible
  3. A **service process**, holding a Service that has been started
  4. A **background process**, holding an Activity that is not currently visible to the user
  5. An **empty process**, that doesn't hold any active application components

- Youtube.com ”Androidology”, part 2

Android **Activity** Life Cycle

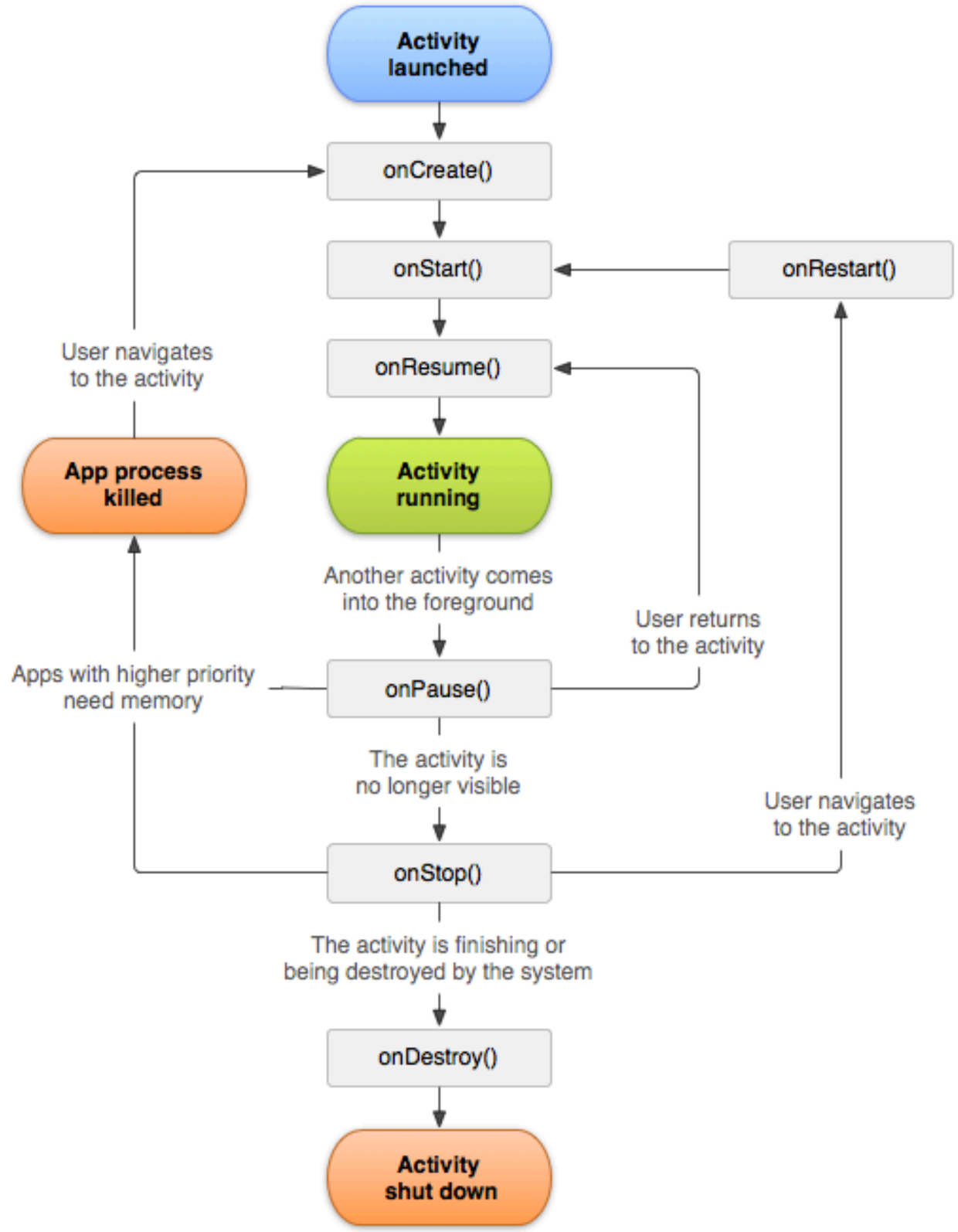
- An activity has essentially 3 states

1. *Active* or *running* when in the foreground
2. *Paused* if visible but not in focus.
   A paused activity is alive, it maintains all state and member information and remains attached to the window manager
3. *Stopped* if completely obscured by another activity.
   It still retains all state and member information

- 1, 2: The Activity might be dropped from memory.
  When it is displayed again to the user, it must be completely restarted and restored to its previous state.

- *If all activities in a process is paused or stopped, the process is "killable". The system can drop the activity from memory by either asking it to finish, or simply killing its process*

Activity Life Cycle



Activity Life Cycle Callbacks

- Behaviour on user actions
  - Home key pressed (the same as another Activity started)
    - onPause
    - onStop
  - Press back key – considered as the user has discarded the Activity (!)
    - onPause
    - onStop
    - onDestroy

    i.e. object deallocated (!)
- The activity might be destroyed and recreated on certain configuration changes, e.g. each time
  - the screen rotates (portrait to landscape or vice versa)
  - keyboard availability changes
  - language settings changes

Activity Life Cycle Callbacks – rules of thumb

- onPause or onStop
  - *Stop animations or other ongoing actions that consume CPU*
  - *Release system resources, such as broadcast receivers, handles to sensors (like GPS), or any resources that may affect battery life while your activity is paused and the user does not need them*
- Persistence:
  Commit unsaved changes, but only if users expect such changes to be permanently saved when they leave (such as a draft email)

Activity Life Cycle Callbacks – rules of thumb

- onResume or onStart
  - *Start animations and other actions that consume CPU*
  - *(Re-)load system resources, such as broadcast receivers, handles to sensors (like GPS), and other resources that may affect battery life while your activity is paused and the user does not need them*
- onCreate
  - Load data that were persisted in onPause or onStart
- onStop/onStart or onPause/onResume?
  The latter is called more frequently – put larger, more CPU intensive, shut-down operations in the former

Saving UI and similar state

- By default, the system uses a Bundle instance state to save information about each View object in your activity layout (UI state)

- Callbacks:
  - onSaveInstanceState(Bundle savedInstanceState), before the system stops the process
  - onRestoreInstanceState(Bundle savedInstanceState), called after onCreate, if a Bundle was saved

- Note: Because onSaveInstanceState() is not guaranteed to be called, you should use it only to record the transient state of the activity (the state of the UI)
  Use onPause() to store persistent data (such as data that should be saved to a database) when the user leaves the activity.

-

Saving UI and similar state state

```
@Override
public void onSaveInstanceState(Bundle savedInstanceState) {
    // Save the user's current game state
    savedInstanceState.putInt(STATE_SCORE, mCurrentScore);
    savedInstanceState.putInt(STATE_LEVEL, mCurrentLevel);

    // Save the view hierarchy state
    super.onSaveInstanceState(savedInstanceState);
}
```

Restoring UI and similar state

```
@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState); // Restore UI state

    // Are we recreating a previously destroyed instance?
    if (savedInstanceState != null) {
        // Restore value of members from saved state
        mCurrentScore = savedInstanceState.getInt(STATE_SCORE);
        mCurrentLevel = savedInstanceState.getInt(STATE_LEVEL);
    } else {
        // Initialize members with default values for a new instance
    }
    ...
}
```

- Alternative: Override onRestoreInstanceState (only called if a Bundle was saved)

Fragments

- A Fragment represents a portion of user interface in an Activity
  - Combine multiple fragments in a single activity to build a multi-pane UI
  - Reuse a fragment in multiple activities
  - Add or remove fragments while the activity is running
- A Fragment has its own lifecycle and receives its own input events ("sub activity")

Image from:
http://developer.android.com/training/basics/fragments/fragment-ui.html

Fragments

- The fragment should (at least) override these life-cycle call back methods
  - onCreate() - called when creating the fragment
    Initialize essential components of the fragment
  - onCreateView() - called when it's time for the fragment to draw its user interface for the first time
    Must return a View that is the root of the fragment's layout (return null if the fragment does not provide a UI)
  - onPause() - called when the first indication that the user is leaving the fragment
    Commit any changes that should be persisted beyond the current user session (because the user might not come back)

Fragments

- The Activity holding the fragment(s) must be a sub type of FragmentActivity or ActionBarActivity

- A Fragment should be a sub type of Fragment or DetailsFragment, DialogFragment, ListFragment, …

- API guides:
  http://developer.android.com/guide/components/fragments.html
  Examples:
  http://developer.android.com/training/basics/fragments/creating.html

Where to go from here?

- Introduction to User Interfaces
  http://developer.android.com/guide/topics/ui/index.html

- Application resources and application anatomy
  http://developer.android.com/guide/topics/resources/index.html

- Training
  http://developer.android.com/training/index.html

- Managing application lifecycle
  http://developer.android.com/training/basics/activity-lifecycle/

- The API documentation
  http://developer.android.com/reference/packages.html