Embedded Systems Programming - PA8001

http://goo.gl/cu8OOH

Lecture 10

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User interfaces

Views

A data structure storing the layout parameters and content for a specific rectangular area of the screen.

Layouts

Views putting together a hierarchy of views. The top of the hierarchy associated to the screen using `setContentView`.

Widgets

Views ready for user interaction. Both pre-defined and custom-defined widgets possible.

Events

Capture interaction with the user using event listeners.

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Describing layouts in XML

A complete description of what is available can be found in
`http://developer.android.com/guide/topics/resources/layout-resource.html`

What we will show is what you place in the directory *res/layout* in the android project for your application in a file *filename.xml*.

In the Java code for the activity

The view described in *res/layout/filename.xml* can be attached to the view using

```
setContentView(R.layout.filename);
```

`R` is a class created by the compiler from the *res* directory.

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Linear layouts

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
>

    A list of views (widgets or other layouts)

</LinearLayout>
```

A linear layout with buttons and text views

```
<LinearLayout ... >
    <TextView
        android:id="@+id/text"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="Hello, I am a TextView"
    />
    <Button
        android:id="@+id/button"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="Hello, I am a Button"
    />
</LinearLayout>
```

Attaching the view to the activity

```
public class MyActivity extends Activity{

  public void onCreate(Bundle savedInstanceState){

    super.onCreate(savedInstanceState);

    setContentView.(R.layout.filename);

    TextView tv = (TextView)findViewById(R.id.text);
    Button b    = (Button)  findViewById(R.id.button);
  }

}
```

Toast messages

In order to explore a number of widgets we will make use of Toast notifications:

> *a message that pops up on the surface of the window. It only fills the amount of space required for the message and the user's current activity remains visible and interactive. The notification automatically fades in and out, and does not accept interaction events.*

Using a Toast notification

```
Toast.makeText(context, text, duration).show();
```

An editable text field

In the xml layout file

```
<EditText
      android:id="@+id/edittext"
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"/>
```

An editable text field

In the `onCreate()` method of `MainActivity`

```
final EditText et = (EditText)findViewById(R.id.edit_message )
et.setOnKeyListener(new OnKeyListener() {
    public boolean onKey(View v,
                         int keyCode, KeyEvent event) {
        if ((event.getAction() == KeyEvent.ACTION_DOWN) &&
            (keyCode == KeyEvent.KEYCODE_ENTER)) {
                Toast.makeText(MainActivity.this,
                               et.getText(),
                               Toast.LENGTH_SHORT).show();
                return true;
        }
        return false;
    }
});
```

An editable text field

Remarks

- The `View.OnKeyListener` must implement the `onKey(View, int, KeyEvent)` method, which defines the action to be made when a key is pressed while the widget has focus.
- In this case, the method is defined to listen for the Enter key (when pressed down),
- The `onKey(View, int, KeyEvent)` method should always return true if the event has been handled, so that the event doesn't bubble-up (which would result in a carriage return in the text field).

A check box

In the xml layout file

```
<CheckBox
    android:id="@+id/checkbox"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:text="check it out" />
```

A check box

In the `onCreate()` method of `MainActivity`

```
final CheckBox cb = (CheckBox) findViewById(R.id.checkbox);
cb.setOnClickListener(new OnClickListener() {
   public void onClick(View v) {
      if (((CheckBox) v).isChecked())
         Toast.makeText(MainActivity.this,
                        "Selected",
                        Toast.LENGTH_SHORT).show();
      else
         Toast.makeText(MainActivity.this,
                        "Not selected",
                        Toast.LENGTH_SHORT).show();
  }
});
```

A check box

Remark

If you need to change the state yourself (such as when loading a saved CheckBoxPreference), use the `setChecked(boolean)` or `toggle()` method.

Radio buttons

In the xml layout file

```
<RadioGroup
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:orientation="vertical">
    <RadioButton android:id="@+id/radio_red"
          android:layout_width="wrap_content"
          android:layout_height="wrap_content"
          android:text="Red" />
    <RadioButton android:id="@+id/radio_blue"
          android:layout_width="wrap_content"
          android:layout_height="wrap_content"
          android:text="Blue" />
</RadioGroup>
```

Radio buttons

In the `onCreate()` method of `MainActivity`

```
final RadioButton radio_red =
    (RadioButton) findViewById(R.id.radio_red);
final RadioButton radio_blue =
   (RadioButton) findViewById(R.id.radio_blue);
radio_red.setOnClickListener(radio_listener);
radio_blue.setOnClickListener(radio_listener);
```

The listener that is used twice

```
private OnClickListener radio_listener=new OnClickListener(){
  public void onClick(View v) {
      RadioButton rb = (RadioButton) v;
      Toast.makeText(MainActivity.this,
                     rb.getText(), Toast.LENGTH_SHORT).show();
  }
```

Custom views

A custom view

You might want to define a view to visualize something. Then you need to define your own view class and include it in the xml file.

In the xml layout file

```
<se.hh.examples.forms.BallView
      android:id="@+id/bv"
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:layout_marginBottom = "350dip"/>
```

Remarks

Perhaps this is not a good use of *the rest of the space*. The other view has to have a `android:layout_marginTop = "-350dip"`

The BallView class

```
public class BallView extends View {

  public BallView(Context c, AttributeSet a){
     super(c,a);
  }

  public void onDraw(Canvas canvas) {
    Paint p = new Paint();
    p.setColor(Color.RED);
    canvas.drawColor(Color.WHITE);
    canvas.drawCircle(getWidth()/2,getHeight()/2,10,p);
  }
}
```

Remark

Nothing to do for the activity class.

Processes in Android

Upon starting an application: a new Linux process with a single thread of execution.

By default, all components in the same process and thread (called the "main" thread).

Upon starting a component within an existing application: component is started within that process and uses the same thread of execution.

Keeping the UI reactive

Single thread model: challenge for reactivity.
Time consuming operations: separate threads ("background" or "worker" threads).

Note: the Android UI toolkit should not be accessed from outside the UI thread (not thread-safe UI methods)

The main thread

Run event listener and rest otherwise!

Posting *runnables*

To ask the UI thread to run some code:

```
public boolean post (Runnable action)
public boolean postDelayed (Runnable action,
                            long delayMillis)
```

Runnable

The interface `java.lang.Runnable` represents a command that can be executed.
A class that implements `Runnable` has to provide a method

```
public void run()
```

Threads in Java

Also used to start new threads in a Java program. This is how:

- Create a `Thread` passing a `Runnable` in the constructor.
- To start the thread use the method `start()`; it calls the `run()` method in the runnable.

Example

See the ManyThreads program to illustrate the constructs.

Another example

The prime calculator

We input a number N and get the prime number of order N. We use an extra button to test whether the UI is reactive even when calculating large prime numbers.

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Calculating in the same thread

What we want to do when a number is given

```
int nr = Integer.parseInt(edittext.getText().toString());

long prime = primeNr( nr );

showtext.setText(""+ prime);
```

Place this code in the `OnKeyListener` for the `EditText`.

For large values it will make the UI unusable: the calculation takes a long time and the main thread cannot take care of other events.

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Starting another thread to calculate

What we could do when a number is given

```
new Thread(new Runnable() {
  public void run() {
   int nr = Integer.parseInt(edittext.getText().toString());
   final long prime = primeNr( nr );
   showtext.setText(""+prime);
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The main UI thread and this new worker thread take turns to execute.

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But it does not work!

We are not allowed to update the UI from other threads!

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  }
}).start();
```

Posting to the UI thread

Posting *runnables*

Views have a couple of methods that allow you to ask the UI thread to run some code:

```
public boolean post (Runnable action)
public boolean postDelayed (Runnable action,
                            long delayMillis)
```

The prime calculator again

What we do when a number is given

```
new Thread(new Runnable() {
  public void run() {
   int nr = Integer.parseInt(edittext.getText().toString());
   final long prime = primeNr( nr );
   showtext.post(new Runnable() {
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          showtext.setText(""+ prime);
       }
   });
  }
}).start();
```

Services

Applications might need to do work even when the user is not interacting with the app.

Services: to be created and started from other components by passing Intents.
Run in the background and do not provide a UI.
May generate Notifications to start an Activity (with a UI)

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Services or worker threads?

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The echo client app

The launcher Activity

1. A button to start a Service to handle a TCP connection.
2. The Activity finishes directly after calling the Service.
3. An Intent is passed to the method that starts the service.
4. All this is done in the listener for the button.

The Service

1. Runs in the main thread.
2. We have to define the methods that are used by the system:
   - `void onCreate()`
   - `int onStartCommand(Intent i, int flags, int id)`
   - `void onDestroy()`
3. Must be terminated explicitely
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Services and threads

Activities and Services of an app run in the same main thread. If we want to do things in other threads we have to do it explicitly.

We would also like the worker thread of a Service to be very much like the main thread: doing nothing but waiting for messages to work on.

Loopers, Handlers, HandlerThreads

1. Every thread in android can be associated with a Looper (listens to messages)
2. We can associate Handlers to Loopers: they can receive messages that are put in a queue and dealt with in order.
3. HandlerThreads are already associated to a looper.

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A Service with a ServiceHandler

The following is the program structure we suggest for a Service that can be asked to do several things.

Define a ServiceHandler inside your Service class

```
private final class ServiceHandler extends Handler{
  public ServiceHandler(Looper looper){
    super(looper);
  }
  // override handleMessage:
  public void handleMessage(Message msg){
    // Normally we would do some work here!
    // switch on  msg.what (integer)
    // to distinguish between different things to do!
  }
}
```

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A Service with a ServiceHandler (ctd.)

onCreate starts a HandlerThread and associates a ServiceHandler to its Looper

```
public class TheService extends Service{
  private Looper mServiceLooper;
  private ServiceHandler mServiceHandler;

  public void onCreate() {
    HandlerThread thread =
      new HandlerThread("TheServiceWorkerThread",
                        Process.THREAD_PRIORITY_BACKGROUND);
    thread.start();
    mServiceLooper = thread.getLooper();
    mServiceHandler = new ServiceHandler(mServiceLooper);
}
```

A Service with a ServiceHandler (ctd.)

onStartCommand just sends messages to the ServiceHandler

```
public class TheService extends Service{
  public int onStartCommand(Intent intent,
                            int flags,
                            int startId) {
    Message msg = mServiceHandler.obtainMessage();
    msg.what = intent.getExtras().getString("WhatToDo"));
    mServiceHandler.sendMessage(msg);
    return START_STICKY;
  }
}
```

How does a Service start an Activity?

Services that have done what was required of them and want the app to start an Activity to interact with the user should not start the Activity themselves! (the user might be using some other app!).

Instead they should produce a Notification that the user can select in order to start an Activity.

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An application with two Activities and a Service

Check the code we distribute with this lecture!