CPSC475/575
Threads

Today

- The 2 rules
- Updating UI with AsyncTask
- Handling Rotations

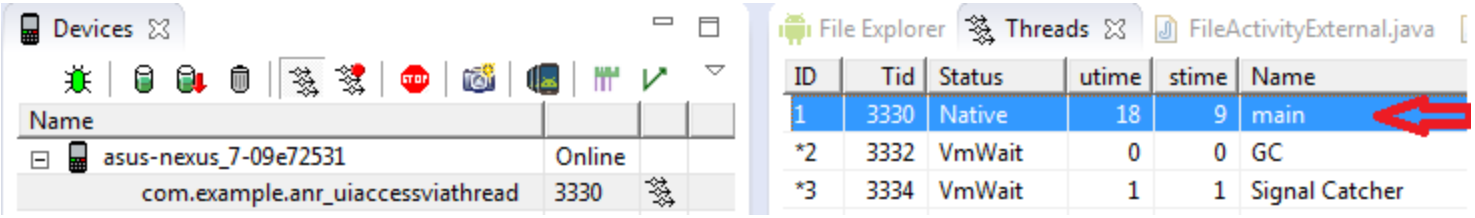
- No Synchronization between Threads Yet

The 2 Rules

- **DO NOT BLOCK THE UI THREAD**
  - Long-running code in main thread will make GUI controls nonresponsive and sometimes generate an ANR.

- **ONLY THE UI THREAD CAN ACCESS UI ELEMENTS**
  - Background threads are prohibited from updating UI.

what's the UI Thread? Its called main



Nonresponsive GUI Controls

- **Solution**
  - *Move time-consuming operations (network access, file access, database access, image manipulation or any long running task) to other threads*
  - **Runnables**– most granular, hardest to get right, useful for small tasks requiring 1 thread
  - **ExecutorService** – A framework to manage threadpools, lots of flexibility, much easier to get right
  - **AsyncTask** – Android specific wrapper around runnable
    - Very useful for task that are run off the UI thread that need to interact with UI Thread elements
    - Methods for starting and stopping, UI updating and returning a result

Threads Cannot Update UI

- **Solutions (alternatives)**
  - Wait until all threads are done, then update UI
    - When multithreading improves performance, but total wait time is small - If 1 thread then use runnable, if many use ExecutorService (not addressed here)
  - Use AsyncTask to divide tasks between background and UI threads
    - Especially when developing for Android from beginning and you have a lot of incremental GUI updates.

AsyncTask

- **Scenario**
  - Total wait time might be large, so you want to show intermediate results (progressbar) 
  - You are designing code to divide the work between GUI and non-GUI code
- **Approach (4 steps)**
  - onPreExecute
  - doInBackground
  - onProgressUpdate
    - publishProgress
  - onPostExecute or onCancelled

AsyncTask: Quick Example

- **Task itself**

```
private class ImageDownloadTask extends AsyncTask<String, Void, View> {
    public View doInBackground(String... urls) {
            //return view
    }

    public void onPostExecute(View viewToAdd) {
        //
    }
}
```

- **Invoking task**

```
String imageAddress = "http://…";
ImageDownloadTask task = new ImageDownloadTask();
task.execute(imageAddress);
```

AsyncTask Details: Constructor

- **Class is genericized with three arguments**
  - AsyncTask<ParamType, ProgressType, ResultType>
- **Interpretation**
  - ParamType
    - This is the type you pass to execute, which in turn is the type that is send to doInBackground. Both methods use varargs, so you can send any number of params.
  - ProgressType
    - This is the type that you pass to publishProgress, which in turn is passed to onProgressUpdate (which is called in UI thread). Use Void if you do not need to display intermediate progress.
  - ResultType
    - This is the type that you should return from doInBackground, which in turn is passed to onPostExecute (which is called in UI thread).

AsyncTask Details: doInBackground

- **Idea**
  - This is the code that gets executed in the background. It **must not** update the UI.
  - It takes as arguments whatever was passed to execute
  - It returns a result that will be later passed to onPostExecute in the UI thread.
- **Code**

```
private class SomeTask extends AsyncTask<Type1, Void, Type2> {
    public Type2 doInBackground(Type1... params) {
      return(doNonUiStuffWith(params));
    } …
}
…
new SomeTask().execute(type1VarA, type1VarB);
```

The … in the doInBackground declaration is actually part of the Java syntax, indicating varargs.

AsyncTask Details: onPostExecute

- **Idea**
  - This is the code that gets executed on the UI thread. It **can** update the UI.
  - It takes as argument whatever was returned by doInBackground
- **Code**

```
private class SomeTask extends AsyncTask<Type1, Void, Type2> {
    public Type2 doInBackground(Type1... params) {
      return(doNonUiStuffWith(params));
    }
    public void onPostExecute(Type2 result) { doUiStuff(result); }
}
…
new SomeTask(). execute(type1VarA, type1VarB);
```

AsyncTask Details: Other Methods

- **onPreExecute**
  - Invoked by the UI thread before doInBackground starts
- **publishProgress**
  - Sends an intermediate update value to onProgressUpdate. From background thread. You call this from code that is in doInBackground. The type is the middle value of the class declaration.
- **onProgressUpdate**
  - Invoked by the UI thread. Takes as input whatever was passed to publishProgress.
- **Note**
  - All of these methods can be omitted.

AsyncTask Details: Cancel()

- **Idea**
  - Call myAsyncTask.cancel(true);
  - Sets internal canceled flag
  - Periodically check isCanceled() in doInBackground Code
  - If canceled, onCancelled() is called verses onPostExecute

What happens when the phone rotates?

AsyncTask: Configuration changes

- **Problem**
  - Start an AsyncTask and then phone rotates
  - Activity is destroyed and restarted
  - AsyncTask however is still running
  - What about all the references the AsyncTask has to original activity?

  - Use onRetainCustomNonConfigurationInstance() when activity being destroyed to save ref to thread
  - Recapture thread in new Activities onCreate()..

AsyncTask: Configuration changes

- **Solution**
  - In Asynctask object, have get/set methods for setting its parent activity.

```
static class RotationAwareTask extends AsyncTask<Void, Void, Void> {
    int progress = 0;
    FixedAsyncTask activity = null;

    //==========================================
    //important do not hold a reference so garbage collector can grab old defunct dying activity
    void detach() {
        activity = null;
    }

    void attach(FixedAsyncTask activity) {
        this.activity = activity;
    }
    //==========================================
```

AsyncTask: Configuration changes

- **Solution**
  - Then when phone rotates have parent Activity listen for onRetainCustomNonConfigurationInstance()
  - Detach Async task from soon to die parent (GC happy)

```
public class FixedAsyncTask extends Activity {

    ¦
    ¦
    ¦
@Override
public Object onRetainNonConfigurationInstance() {
    task.detach();
    return (task);
}
```

AsyncTask: Configuration changes

- **Solution**
  - Then in onCreate recapture wayward thread with
  - getLastCustomNonConfigurationInstance()

```
@Override
public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.fixedasynctaskview);

    bar = (ProgressBar) findViewById(R.id.progressBar1);
    task = (RotationAwareTask) getLastNonConfigurationInstance();

    //if a thread was retained then grab it
    if (task == null) {
        task = new RotationAwareTask(this);
        task.execute();
    } else {
        task.attach(this);
        updateProgress(task.getProgress());

        if (task.getProgress() >= 100) {
            markAsDone();
        }
    }
}
```

AsyncTask: Configuration changes

- **Demo 6_Thread_Asynctask_OnRetainCustomNonConfigurationInstance**

AsyncTask: One last bit

- **Standard implementation will execute 1 AsyncTask at a time (even if you try to run many at once)**

```
UpdateTask myTask = new UpdateTask();
myTask.execute();
```

- **To do more than 1 at a time**

```
UpdateTask myTask = new UpdateTask();
myTask.executeOnExecutor(AsyncTask.THREAD_POOL_EXECUTOR);
```

Summary

- **Update UI incrementally with AsyncTask**
  - One update per task, but several updates per group of tasks
    - How to setup - genericized with three arguments
      AsyncTask<ParamType, ProgressType, ResultType>
    - How to Run - myUpdateTask.execute()
    - What is run in separate thread doInBackground and publishProgress
    - How to cancel - myUpdateTask.cancel(**true)**
    - **Results** onPostExecute and onCanceled
    - How to recover from orientation changes, keyboard slideouts etc

    - How to communicate? Not yet just publishProgress and onProgressUpdate

Reading

- **JavaDoc**
  - AsyncTask
    - http://developer.android.com/reference/android/os/AsyncTask.html
- **Tutorial: Processes and Threads**
  - http://www.javamex.com/