CPSC475/575
Threads

Also what happes when an Activity is destroyed while a thread is running.

Today

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

No Synchronization between Threads Yet

The 2 Rules

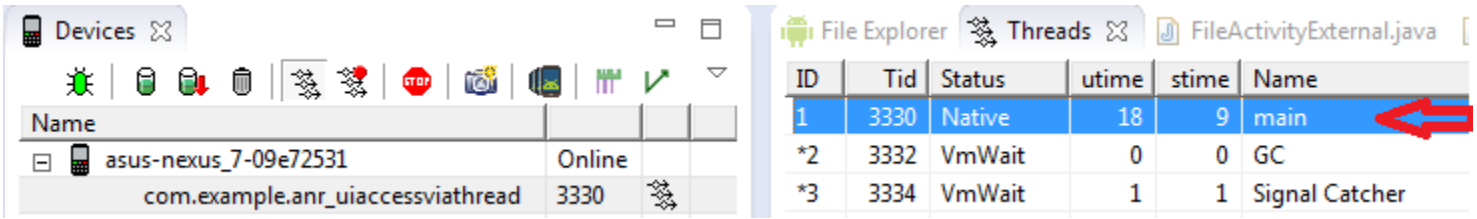
DO NOT BLOCK THE UI THREAD

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*

- **Threads (runnable)**– 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. Recently depracated.

Threads Cannot Update UI

Android UI toolkit is not threadsafe, you cannot update UI from other threads.

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)
- Can use thread to divide tasks between background and UI threads

Threads in Android

Java Threads- the old and the new way, google reccomends using these

AsyncTasks – the old way, recently deprecated (as of API 30) but embedded in many code bases, prefer Java Threads.

Java Threads

Relatively simple;

1. **create a class that derives from Thread**

```
private static class UpdateTask extends Thread {
```

2. **Implement a run() method in that class**

```
@Override
public void run() {
```

3. **Create an instance of the thread**

```
UpdateTask mt= new UpdateTask()
```

4. **And start it**

```
mt.start();
```

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4. And start it

```
mt.start();
```

Be sure to call start() though and not run()

If you call mt.run(), UpdateTask runs in the same thread you are already in, not a new thread

Java Threads

How can thread interact with UI thread?

Add the following to the threads run() method

```
@Override
public void run() {
    super.run();
    //do thread work here
    act.runOnUiThread(new Runnable() {
        @Override
        public void run() {
            //this code runs on UI thread
        }
    });
}
```

This means that the Java thread needs a ref to the activity, so add 1 in the constructor

```
public UpdateTask(MainActivity act) {
    this.act = act;
```

But this makes the thread ‘heavily coupled’ with the activity

What happens when the phone rotates?

Configuration changes

Problem

- Start an thread and then phone rotates
- Activity is destroyed and restarted
- Thread however is still running
- What about all the references the Thread has to original activity?
- Solution:
- Use singleton to hold thread
- In onStop() save ref to thread in singleton
- In onStart() check to see if a thread exists in singleton, if so, recapture thread

- see 7_Thread or 7_AsyncTask

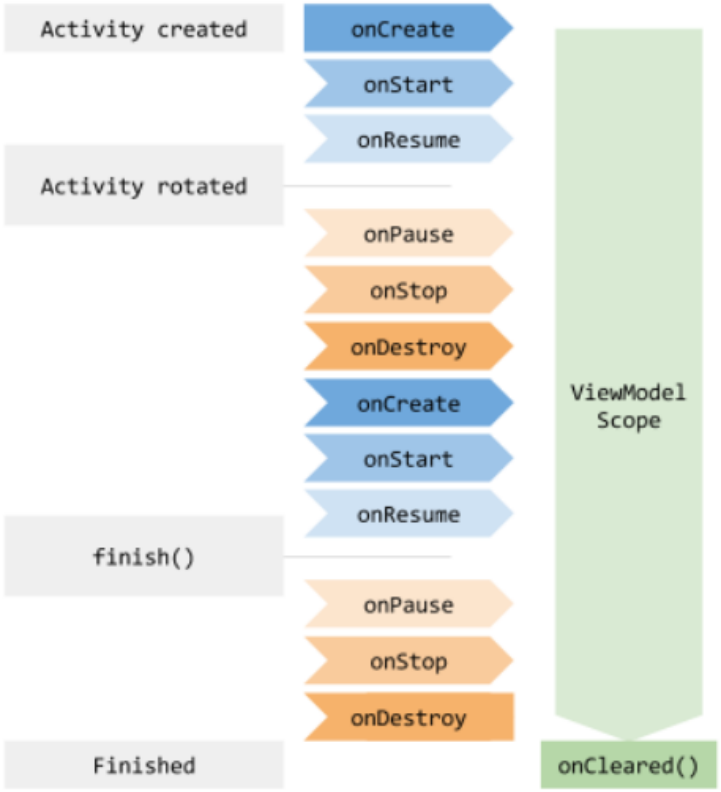
Configuration changes

Problem

- Start an thread and then phone rotates
- Activity is destroyed and restarted
- Thread however is still running
- What about all the references the Thread has to original activity?
- Solution:
- Or use a viewModel (androids version of a singleton)

Threads: Configuration changes- Use a ViewModel

ViewModel **class is designed to store and manage UI-related data in a lifecycle conscious way.**



- Notice ViewModel is created in onCreate
- Persists through Activity construction/ /destruction cycles
- Is finally destroyed when app is destroyed

Threads: Configuration changes

to use the view model you need to include some libraries in build.gradle (app) see ViewModel Overview on Course website for details.

ViewModel Overview | Part of Android Jetpack.

The `ViewModel` class is designed to store and manage UI-related data in a lifecycle conscious way. The `ViewModel` class allows data to survive configuration changes such as screen rotations.

> **Note:** To import `ViewModel` into your Android project, see the instructions for declaring dependencies in the Lifecycle release notes.

build.gradle (:app) × gradle-wrapper.properties ×

You can use the Project Structure dialog to view and edit your project configuration

```
22  dependencies {
23      implementation fileTree(dir: 'libs', include: ['*.jar'])
24      implementation 'androidx.lifecycle:lifecycle-viewmodel-savedstate:1.0.0-alpha01'
25      implementation 'androidx.appcompat:appcompat:1.1.0'
26      implementation 'com.google.android.material:material:1.1.0'
27      implementation 'androidx.constraintlayout:constraintlayout:1.1.3'
28      implementation 'androidx.navigation:navigation-fragment:2.0.0'
29      implementation 'androidx.navigation:navigation-ui:2.0.0'
30
31      def lifecycle_version = "2.2.0"
32      def arch_version = "2.1.0"
33      // ViewModel
34      implementation "androidx.lifecycle:lifecycle-viewmodel:$lifecycle_version"
35  }
```

Threads: Configuration changes- Use a ViewModel

ViewModel **class is designed to store and manage UI-related data in a lifecycle conscious way.**

```
public class DataVM extends ViewModel {
    AddTask myTask;

    @Override
    protected void onCleared() {
        super.onCleared();
        if(myTask != null)
            myTask.cancel( mayInterruptIfRunning: true);
    }
```

```
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_main);

    tv = (TextView)findViewById(R.id.textView2);
    butStart = (Button)findViewById(R.id.bStart);
    butCancel= (Button)findViewById(R.id.bCancel);
    pBar = (ProgressBar) findViewById(R.id.progressBar1);
    pBar.setMax(P_BAR_MAX);

    // Create a ViewModel the first time the system calls an activity's
    // onCreate() method.  Re-created activities receive the same
    // MyViewModel instance created by the first activity.
    myVM = new ViewModelProvider( owner: this).get(DataVM.class);

    //if we have a thread running then attach this activity
    if (myVM.myTask != null) {
        myVM.myTask.set(new WeakReference<MainActivity>( referent: this));

        //a thread is running have the UI show that
        setUIState(false);
    }
```

Some of the ViewModel
Its Thread is a static inner class

In Activity- get/create a ViewModel

If there is a running Thread then attach it to this activity by WeakReference

Threads: Configuration changes – WeakReference?

Problem: What if thread is holding a reference to an activity that has been destroyed/recreated (device rotates, phone call…)?

If thread dereferences the destroyed Activity, you will get a null pointer exception.

Worse, as long as thread holds this reference, Activity (and all its views and resources) cannot be Garbage Collected

Solution: Hold a weak reference to the Activity!

When activity destroyed the only ref to it will be the weakRef.

If JVM detects an object with only weak references (i.e. no strong or soft references linked to it), this object will be marked for garbage collection.

Threads: Configuration changes – WeakReference?

```
private static class UpdateTask extends Thread {
    //if an object can only be reached by a weak reference then its
    //eligible for garbage collection. So on a configuration change
    //event, when activity is destroyed, it can be GCed even
    //though it has a weak reference to it
    //but what about dere
    private WeakReference<MainActivity> act;
    private int numberInstances = 0;   //how many threads are running
    private boolean iscanceled=false;
    public UpdateTask(WeakReference<MainActivity> act, int cnt) {
        this.act = act;
        this.numberInstances=cnt;
        if(this.act.get()!=null)
            act.get().progressDialog_start();
    }
```

My WeakReference

Holding it

Verifying it

Threads: Configuration changes

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```

What if you are interrupted After verifying your activity here. And the activity is destroyed.

Threads: Configuration changes

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    }
```

What if you are interrupted After verifying your activity here. And the activity is destroyed.

What happens when you call act.get() on next line?
Null pointer exception

Threads: Configuration changes

You either need to synchronize all global data access
Or move to something else

Google recommends mutable live data
We will talk about this next.