Android AsyncTask

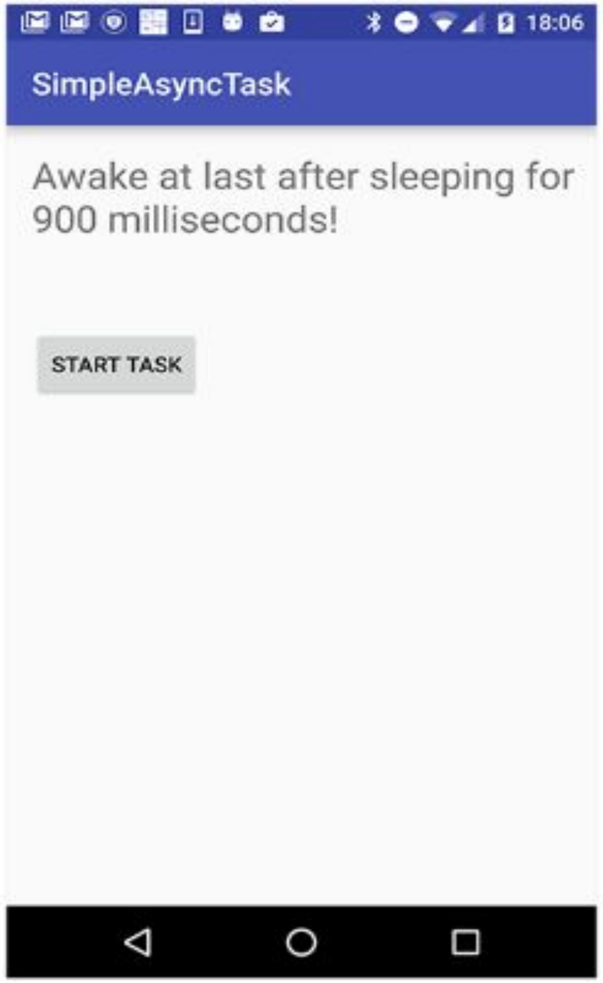
- **AsyncTask:**
- AsyncTask is an abstract Android class which helps the Android applications to handle the Main UI thread in efficient way. AsyncTask class allows us to perform long lasting tasks/background operations and show the result on the UI thread without affecting the main thread.
- **Android UI Main Thread:**
- Android handles input events/tasks with a single User Interface (UI) thread and the thread is called Main thread. Main thread cannot handle concurrent operations as it handles only one event/operation at a time.
- **Concurrent Processing in Android:**
- If input events or tasks are not handled concurrently, whole code of an Android application runs in the main thread and each line of code is executed one after each other. To bring good user experience in Android applications, all potentially slow running operations or tasks in an Android application should be made to run asynchronously.

- Create an Activity.
- Add a TextView to the layout for the Activity.
- Programmatically get the id for the TextView and set its content.
- Use Button views and their onClick functionality.

- How to add an AsyncTask to your app in order to run a task in the background of your app.
- The drawbacks of using AsyncTask for background tasks.

- Create a simple app that executes a background task using an AsyncTask.
- Run the app and see what happens when you rotate the device.
- Implement activity instance state to retain the state of a TextView message.

You will build an app that has one TextView and one Button. When the user clicks the Button, the app sleeps for a random amount of time, and then displays a message in the TextView when it wakes up. Here's what the finished app looks like:



Awake at last after sleeping for 900 milliseconds!

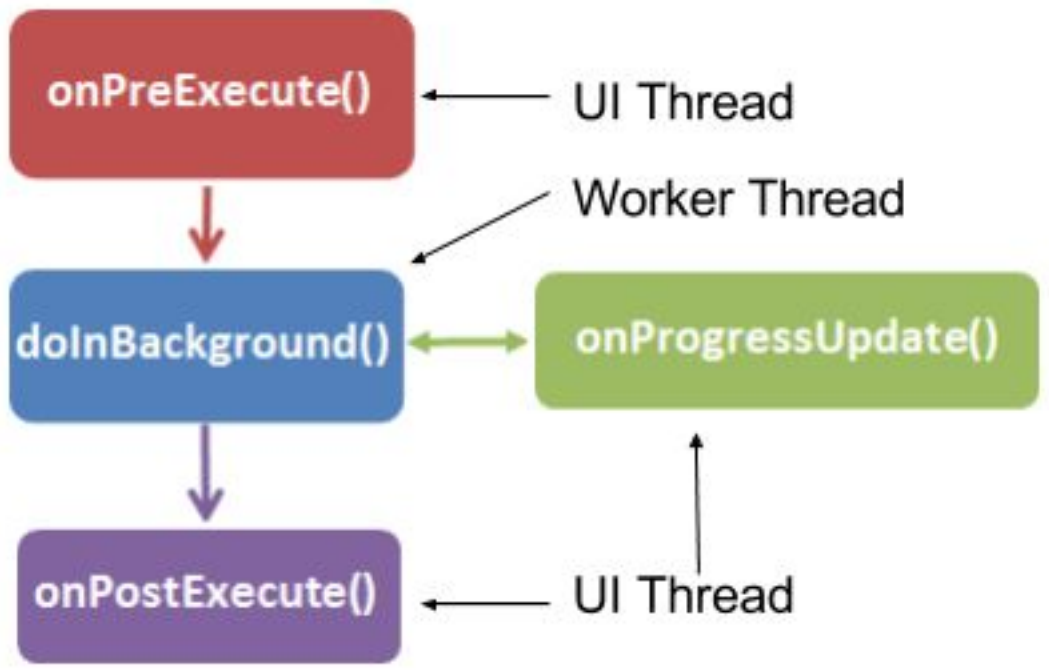
-
  ```
  <?xml version="1.0" encoding="utf-8"?>
  <android.support.constraint.ConstraintLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:layout_margin="16dp"
    tools:context=".MainActivity">

    <TextView
       android:id="@+id/textView1"
       android:layout_width="wrap_content"
       android:layout_height="wrap_content"
       android:text="@string/ready_to_start"
       android:textSize="24sp"
       app:layout_constraintStart_toStartOf="parent"
       app:layout_constraintTop_toTopOf="parent"/>

    <Button
       android:id="@+id/button"
       android:layout_width="wrap_content"
       android:layout_height="wrap_content"
       android:layout_marginTop="24dp"
       android:onClick="startTask"
       android:text="@string/start_task"
       app:layout_constraintStart_toStartOf="parent"
       app:layout_constraintTop_toBottomOf="@+id/textView1"/>

  </android.support.constraint.ConstraintLayout>
  ```

AsyncTask

- AsyncTask is an abstract class, which means you must subclass it in order to use it. In this example the AsyncTask performs a very simple background task: it sleeps for a random amount of time. In a real app, the background task could perform all sorts of work, from querying a database, to connecting to the internet, to calculating the next Go move to beat the current Go champion.

AsyncTask subclass

- An AsyncTask subclass has the following methods for performing work off of the main thread:
- onPreExecute(): This method runs on the UI thread, and is used for setting up your task (like showing a progress bar).
- doInBackground(): This is where you implement the code to execute the work that is to be performed on the separate thread.
- onProgressUpdate(): This is invoked on the UI thread and used for updating progress in the UI (such as filling up a progress bar)
- onPostExecute(): Again on the UI thread, this is used for updating the results to the UI once the AsyncTask has finished loading.


onPreExecute()
UI Thread
Worker Thread
doInBackground()
onProgressUpdate()
onPostExecute()
UI Thread

- When you create an AsyncTask subclass, you may need to give it information about the work which it is to perform, whether and how to report its progress, and in what form to return the result. When you create an AsyncTask subclass, you can configure it using these parameters:
- Params: The data type of the parameters sent to the task upon executing the doInBackground() override method.
- Progress: The data type of the progress units published using the onProgressUpdated() override method.
- Result: The data type of the result delivered by the onPostExecute() override method.

- For example, an AsyncTask subclass called MyAsyncTask with the following class declaration might take the following parameters:
- A String as a parameter in doInBackground(), to use in a query, for example.
- An Integer for onProgressUpdate(), to represent the percentage of job complete
- A Bitmap for the result in onPostExecute(), indicating the query result.
- public class MyAsyncTask
  extends AsyncTask <String, Integer, Bitmap>{}

- In this app, the AsyncTask subclass you create does not require a query parameter or publish its progress. You will only be using the doInBackground() and onPostExecute() methods.

1. Create a new Java class called SimpleAsyncTask that extends AsyncTask and takes three generic type parameters.

- Use Void for the params, because this AsyncTask does not require any inputs. Use Void for the progress type, because the progress is not published. Use a String as the result type, because you will update the TextView with a string when the AsyncTask has completed execution.
- public class SimpleAsyncTask extends AsyncTask <Void, Void, String>{}

2. At the top of the class, define a member variable mTextView of the type WeakReference<TextView>:

- private WeakReference<TextView> mTextView;

3. Implement a constructor for AsyncTask that takes a TextView as a parameter and creates a new weak reference for that TextView:

-
  ```
  SimpleAsyncTask(TextView tv) {
          mTextView = new WeakReference<>(tv);
  }
  ```

- The AsyncTask needs to update the TextView in the Activity once it has completed sleeping (in the onPostExecute() method). The constructor for the class will therefore need a reference to the TextView to be updated.

- What is the weak reference (the WeakReference class) for? If you pass a TextView into the AsyncTask constructor and then store it in a member variable, that reference to the TextView means the Activity cannot ever be garbage collected and thus leaks memory, even if the Activity is destroyed and recreated as in a device configuration change. This is called creating a *leaky context*, and Android Studio will warn you if you try it.
- The weak reference prevents the memory leak by allowing the object held by that reference to be garbage collected if necessary.

Implement doInBackground()

- The doInBackground() method is required for your AsyncTask subclass.

1. Place your cursor on the highlighted class declaration, press **Alt + Enter (Option + Enter** on a Mac) and select **Implement methods**. Choose doInBackground() and click **OK**. The following method template is added to your class:

-
  ```
  @Override
  protected String doInBackground(Void... voids) {
     return null;
  }
  ```

2. Add code to generate a random integer between 0 and 10. This is the number of milliseconds the task will pause. This is not a lot of time to pause, so multiply that number by 200 to extend that time.

-
  ```
  Random r = new Random();
  int n = r.nextInt(11);
  int s = n * 200;
  ```

3. Add a try/catch block and put the thread to sleep.

-
  ```
  try {
     Thread.sleep(s);
  } catch (InterruptedException e) {
     e.printStackTrace();
  }
  ```

4. Replace the existing return statement to return the String "Awake at last after sleeping for *xx* milliseconds", where *xx* is the number of milliseconds the app slept.

- `return "Awake at last after sleeping for " + s + " milliseconds!";`

- The complete doInBackground() method looks like this:

-
  ```
  @Override
  protected String doInBackground(Void... voids) {

    // Generate a random number between 0 and 10
    Random r = new Random();
    int n = r.nextInt(11);

    // Make the task take long enough that we have
    // time to rotate the phone while it is running
    int s = n * 200;

    // Sleep for the random amount of time
    try {
      Thread.sleep(s);
    } catch (InterruptedException e) {
      e.printStackTrace();
    }

    // Return a String result
    return "Awake at last after sleeping for " + s + " milliseconds!";
  }
  ```

Implement onPostExecute()

- When the doInBackground() method completes, the return value is automatically passed to the onPostExecute() callback.

1. Implement onPostExecute() to take a String argument and display that string in the TextView:

-
```
protected void onPostExecute(String result) {
   mTextView.get().setText(result);
}
```

- The String parameter to this method is what you defined in the third parameter of your AsyncTask class definition, and what your doInBackground() method returns.
- Because mTextView is a weak reference, you have to deference it with the get() method to get the underlying TextView object, and to call setText() on it.

Implement the method that starts the AsyncTask

- app now has an AsyncTask class that performs work in the background (or it would if it didn't call sleep() as the simulated work). You can now implement the onClick method for the "Start Task" button to trigger the background task.

1. In the MainActivity.java file, add a member variable to store the TextView.

- private TextView mTextView;

2. In the onCreate() method, initialize mTextView to the TextView in the layout.

- mTextView = findViewById(R.id.textView1);

3. In the startTask() method, Update the TextView to show the text "Napping...". Extract that message into a string resource.

- mTextView.setText(R.string.napping);

4. Create an instance of SimpleAsyncTask, passing the TextView mTextView to the constructor. Call execute() on that SimpleAsyncTask instance.

- new SimpleAsyncTask(mTextView).execute();

MainAtivity

- package com.example.android.simpleasynctask;

```
import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.view.View;
import android.widget.TextView;

/**
* The SimpleAsyncTask app contains a button that launches an AsyncTask
* which sleeps in the asynchronous thread for a random amount of time.
*/
public class MainActivity extends AppCompatActivity {

  // The TextView where we will show results
  private TextView mTextView;

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

      mTextView = findViewById(R.id.textView1);
  }

  public void startTask(View view) {
      // Put a message in the text view
      mTextView.setText(R.string.napping);

      // Start the AsyncTask.
      new SimpleAsyncTask(mTextView).execute();
  }
}
```

Implement onSaveInstanceState**()**

1. Run the app and click the **Start Task** button. How long does the app nap?
2. Click the **Start Task** button again, and while the app is napping, rotate the device. If the background task completes before you can rotate the phone, try again.

•

3. At the top of the class, add a constant for the key for the current text in the state bundle:

-
  ```
  private static final String TEXT_STATE = "currentText";
  ```

4. Override the onSaveInstanceState() method in **MainActivity** to preserve the text inside the TextView when the activity is destroyed:

-
  ```
  @Override
      protected void onSaveInstanceState(Bundle outState) {
          super.onSaveInstanceState(outState);
          // Save the state of the TextView
          outState.putString(TEXT_STATE,
              mTextView.getText().toString());
      }
  }
  ```

5. In onCreate(), retrieve the value of the TextView from the state bundle when the activity is restored.

-
  ```
  // Restore TextView if there is a savedInstanceState
  if(savedInstanceState!=null){
    mTextView.setText(savedInstanceState.getString(TEXT_STATE));
  ```

MainActivity.java

-
  ```
  package android.example.com.simpleasynctask;

  import android.os.Bundle;
  import android.support.v7.app.AppCompatActivity;
  import android.view.View;
  import android.widget.TextView;

  /**
   * The SimpleAsyncTask app contains a button that launches an AsyncTask
   * which sleeps in the asynchronous thread for a random amount of time.
   */
  public class MainActivity extends AppCompatActivity {

      //Key for saving the state of the TextView
      private static final String TEXT_STATE = "currentText";

      // The TextView where we will show results
      private TextView mTextView = null;

      /**
       * Initializes the activity.
       * @param savedInstanceState The current state data
       */
      @Override
      protected void onCreate(Bundle savedInstanceState) {
          super.onCreate(savedInstanceState);
          setContentView(R.layout.activity_main);
          //  Initialize mTextView
          mTextView = (TextView) findViewById(R.id.textView1);

          // Restore TextView if there is a savedInstanceState
          if(savedInstanceState!=null){
             mTextView.setText(savedInstanceState.getString(TEXT_STATE));
          }
      }
  ```

MainActivity.java

-
  ```
  /**`
   * Handles the onCLick for the "Start Task" button. Launches the AsyncTask
   * which performs work off of the UI thread.
   *
   * @param view The view (Button) that was clicked.
   */
  public void startTask (View view) {
      // Put a message in the text view
      mTextView.setText(R.string.napping);

      // Start the AsyncTask.
      // The AsyncTask has a callback that will update the text view.
      new SimpleAsyncTask(mTextView).execute();
  }


  /**
   * Saves the contents of the TextView to restore on configuration change.
   * @param outState The bundle in which the state of the activity is saved
   * when it is spontaneously destroyed.
   */
  @Override
  protected void onSaveInstanceState(Bundle outState) {
      super.onSaveInstanceState(outState);
      // Save the state of the TextView
      outState.putString(TEXT_STATE, mTextView.getText().toString());
  }
}
  ```