CMSC436: Programming Handheld Systems

Fall 2017

Data Management

Today’s Topics

SharedPreferences

Internal Storage

External Storage

SQLite databases

Shared Preferences

Use when you want to store small amounts of primitive data

Internal Storage

Use when you want to store small to medium amounts of private data

External Storage

Use when you want to store larger amounts of non-private data

Databases

Use when you want to store store small to large amounts of private, structured data

SharedPreferences

A persistent map that holds key-value pairs of simple data types

Automatically persisted across application sessions

SharedPreferences

Often used for long-term storage of customizable application data, such as:

- Account name
- Favorite WiFi networks
- User customizations

Activity SharedPreferences

Get a SharedPreference Object associated with a given Activity

Activity.getPreferences (int mode)

- MODE_PRIVATE is default mode

Named SharedPreferences

Get named SharedPreferences file

Single SharedPreference object for a given name

Context.getSharedPreferences (
String name, int mode)

name – name of SharedPreferences file

mode – e.g., MODE_PRIVATE

Writing SharedPreferences

Call SharedPreferences.edit()

Returns a SharedPreferences.Editor instance

Writing SharedPreferences

Use SharedPreferences.Editor instance to add values to SharedPreferences

putInt(String key, int value)

putString(String key, String value)

remove(String key)

Writing SharedPreferences

Commit edited values with SharedPreferences.Editor.commit()

Reading SharedPreferences

Use SharedPreferences methods to read values

getAll()

getBoolean(String key, …)

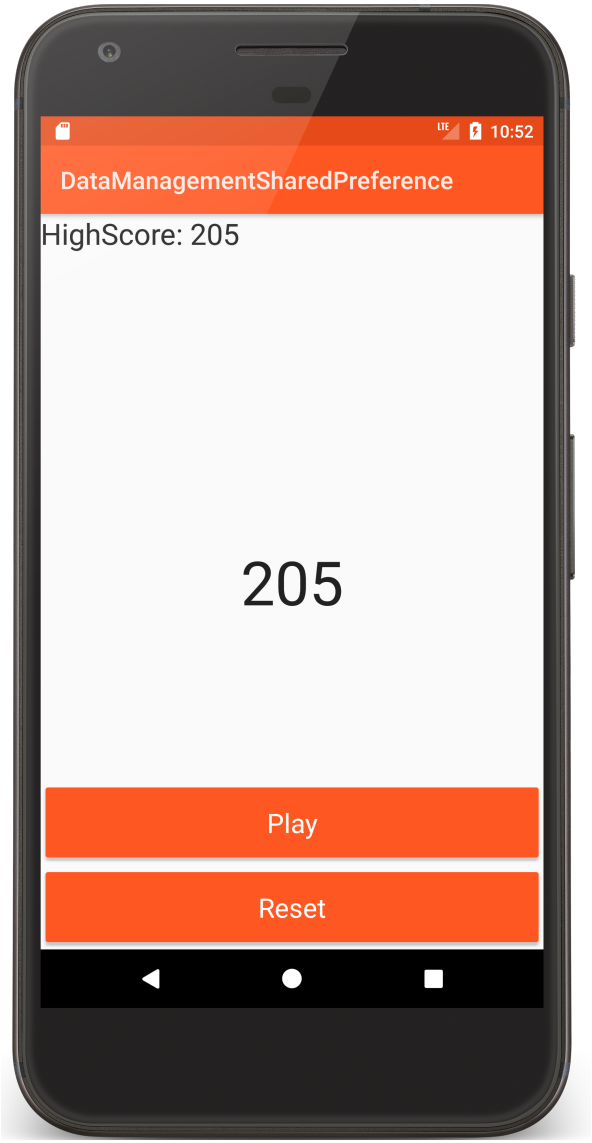
getString(String key, …)

DataManagementSharedPreferences

When the user presses the play button, the application displays a random number

The application keeps track of the highest number seen so far

DataManagement SharedPreferences



```
public class SharedPreferenceReadWriteActivity extends Activity {
  …
  public void onCreate(Bundle savedInstanceState) {
    final SharedPreferences prefs = getPreferences(MODE_PRIVATE);
    …
    final Button playButton = findViewById(R.id.play_button);
     playButton.setOnClickListener(new OnClickListener() {
       public void onClick(View v) {
         …
          // Get Stored High Score
         if (val > prefs.getInt(HIGH_SCORE_KEY, 0)) {
            // Get and edit high score
           SharedPreferences.Editor editor = prefs.edit();
            editor.putInt(HIGH_SCORE_KEY, val);
            editor.apply();
            …
```

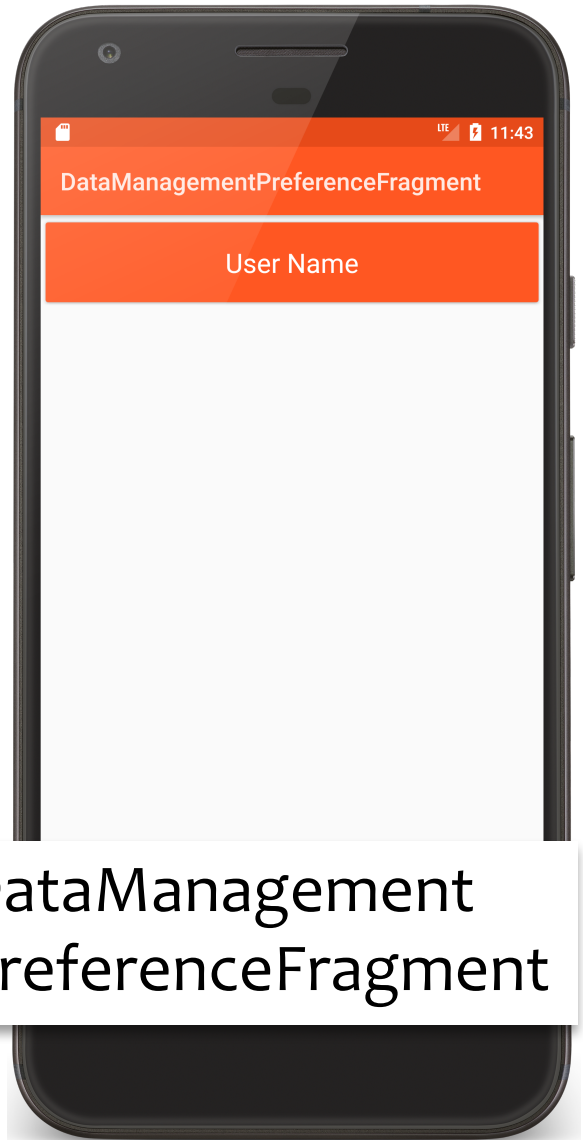
```
...
// Reset Button
final Button resetButton = findViewById(R.id.reset_button);
resetButton.setOnClickListener(new OnClickListener() {

    public void onClick(View v) {

        // Set high score to 0
        SharedPreferences.Editor editor = prefs.edit();
        editor.putInt(HIGH_SCORE_KEY, 0);
        editor.apply();
        ...
```

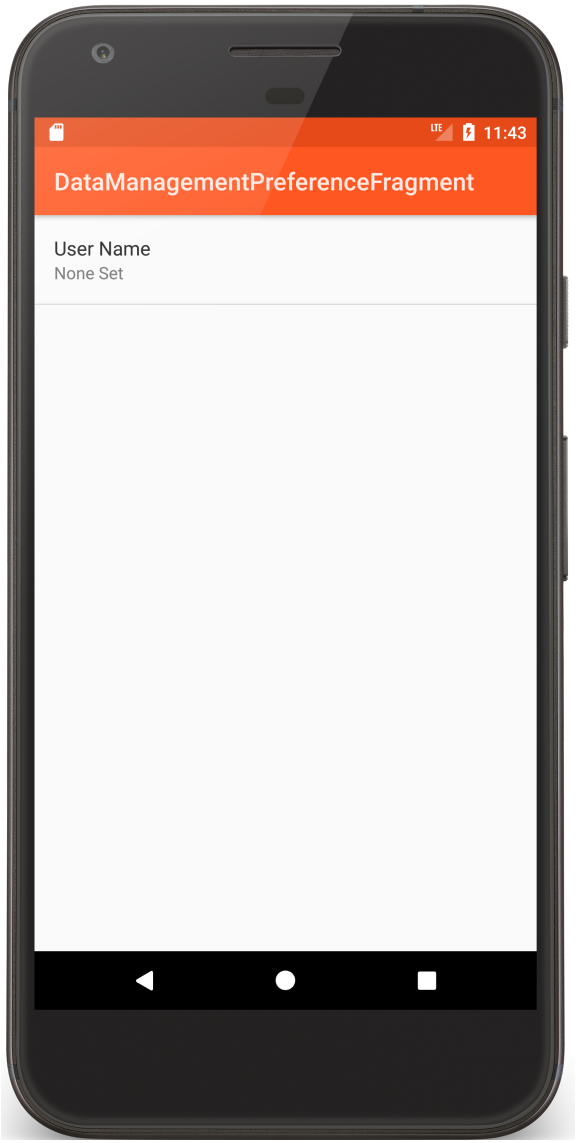
PreferenceFragment

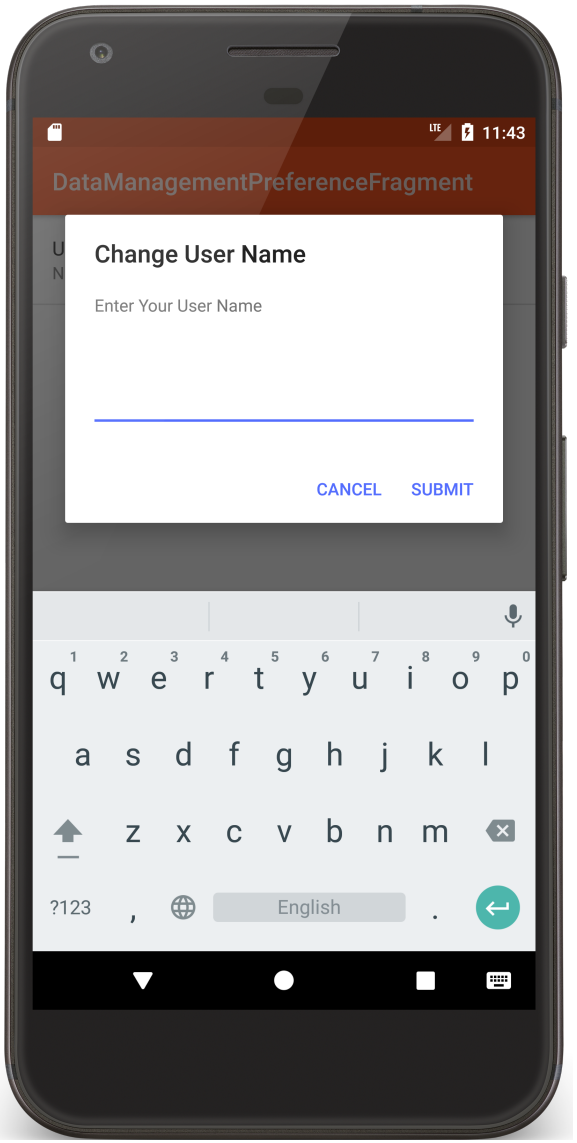
A Class that supports displaying & modifying user preferences

DataManagementPreferenceFragment

This application displays a PreferenceFragment, which allows the user to enter and change a persistent user name







DataManagement PreferenceFragment

```
<?xml version="1.0" encoding="utf-8"?>
<fragment xmlns:android="http://schemas.android.com/apk/res/android"
   android:id="@+id/userPreferenceFragment"
   class="course.examples.datamanagement.preferencefragment.
                  ViewAndUpdatePreferencesActivity$UserPreferenceFragment"
   android:layout_width="match_parent"
   android:layout_height="match_parent" />
```

```
// Fragment that displays the username preference
public static class UserPreferenceFragment extends PreferenceFragment {
  ...
  public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    // Load the preferences from an XML resource
    addPreferencesFromResource(R.xml.user_prefs);
    // Get the username Preference
    mUserNamePreference = getPreferenceManager() .findPreference(USERNAME);
    // Attach a listener to update summary when username changes
    mListener = new OnSharedPreferenceChangeListener() {
      public void onSharedPreferenceChanged(
                                          SharedPreferences sharedPreferences, String key) {
        mUserNamePreference.setSummary(
                                sharedPreferences.getString(USERNAME, "None Set"));   }
    };
```

```
        // Get SharedPreferences object managed by the PreferenceManager for this Fragment
        SharedPreferences prefs = getPreferenceManager() .getSharedPreferences();

        // Register a listener on the SharedPreferences object
        prefs.registerOnSharedPreferenceChangeListener(mListener);

        // Invoke callback manually to display the current username
        mListener.onSharedPreferenceChanged(prefs, USERNAME);
    }
  }
}
```

File

Class that represents a file system entity identified by a pathname

File

Storage areas are classified as internal or external

Internal memory usually used for smaller, application private data sets

External memory usually used for larger, non-private data sets

File API

FileOutputStream openFileOutput (String name, int mode)

Open private file for writing. Creates the file if it doesn't already exist

FileInputStream openFileInput (String name)

Open private file for reading

Many others. See documentation.

DataManagementFileInternalMemory

If a text file does not already exist, application writes text to that text file

Application then reads data from the text file and displays it

DataManagement
FileInternalMemory

```
private final static String fileName = "TestFile.txt";
public void onCreate(Bundle savedInstanceState) {
  if (!getFileStreamPath(fileName).exists()) {
    try { writeFile(); }
    catch (FileNotFoundException e) { … }
  }

  try { readFileAndDisplay(textView); }
  catch (IOException e) { … }
}
```

```
private void writeFile() throws FileNotFoundException {

  FileOutputStream fos = openFileOutput(fileName, MODE_PRIVATE);
  PrintWriter pw = new PrintWriter(new BufferedWriter( new OutputStreamWriter(fos)));

  pw.println("Line 1: This is a test of the File Writing API");
  pw.println("Line 2: This is a test of the File Writing API");
  pw.println("Line 3: This is a test of the File Writing API");

  pw.close();

}
```

```
private void readFileAndDisplay(TextView tv) throws IOException {

  FileInputStream fis = openFileInput(fileName);
  BufferedReader br = new BufferedReader(new InputStreamReader(fis));

  String line;
  String sep = System.getProperty("line.separator");

  while (null != (line = br.readLine())) {
    tv.append(line + sep);
  }

  br.close();

}
```

Using External Memory Files

Removable media may appear/disappear without warning

Using External Memory Files

String Environment.
getExternalStorageState()

MEDIA_MOUNTED - present & mounted with read/write access

MEDIA_MOUNTED_READ_ONLY - present & mounted with read-only access

MEDIA_REMOVED - not present

Etc.

Using External Memory Files

Permission to write external files

```
<uses-permission android:name=
    “android.permission.
        WRITE_EXTERNAL_STORAGE" />
```

DataManagementFileExternalMemory

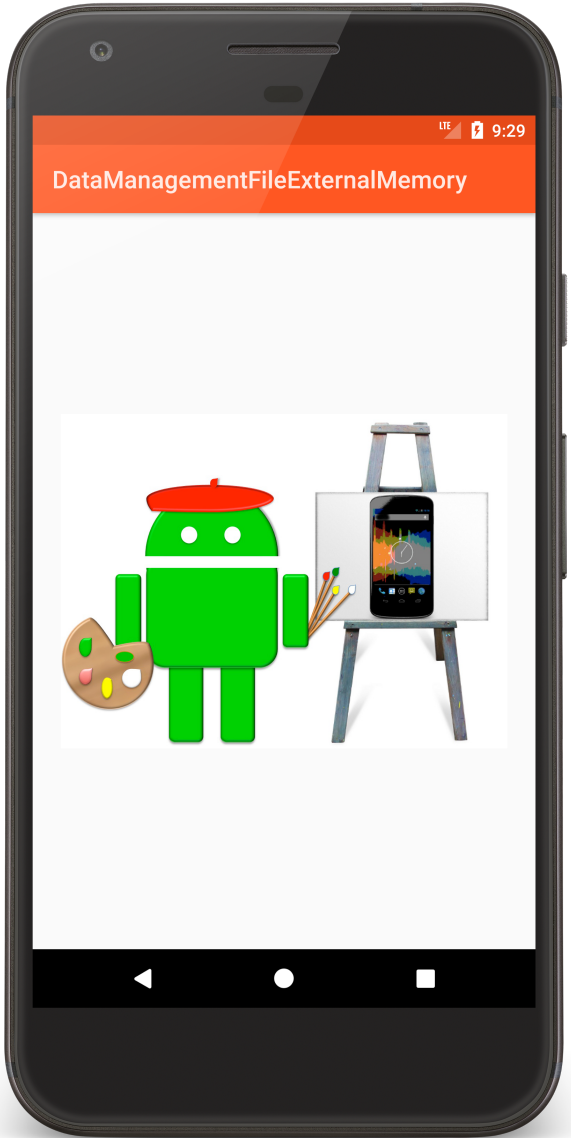
Application reads an image file from the resources directory

Copies that file to external storage

Reads image data from the file in external storage

then displays the image

DataManagement
FileExternalMemory



```
public void onCreate(Bundle savedInstanceState) {
…
    if (Environment.MEDIA_MOUNTED.equals(Environment.getExternalStorageState())) {
      String fileName = "painter.png";
      File outFile = new File (getExternalFilesDir(Environment.DIRECTORY_PICTURES),
                               fileName);
      if (!outFile.exists()) copyImageToMemory(outFile);

      ImageView imageview = findViewById(R.id.image);
      imageview.setImageURI(Uri.parse("file://" + outFile.getAbsolutePath()));

    }
  }
```

```
private void copyImageToMemory(File outFile) {
    try {

      BufferedOutputStream os = new BufferedOutputStream(
                                                    new FileOutputStream(outFile));

      BufferedInputStream is = new BufferedInputStream(
                                  getResources().openRawResource(R.raw.painter));

      copy(is, os);

    } catch (FileNotFoundException e) { … }
  }
```

```
private void copy(InputStream is, OutputStream os) {
    final byte[] buf = new byte[1024];
    int numBytes;
    try {
      while (-1 != (numBytes = is.read(buf))) {
        os.write(buf, 0, numBytes);
      }
    } catch (IOException e) {
      e.printStackTrace();
    } finally {
      try {
        is.close();
        os.close();
      } catch (IOException e) { … }
    }
  }
}
```

Cache Files

Temporary files that may be deleted by the system when storage is low

These files are removed when application is uninstalled

Cache Files

File Context.getCacheDir()

Returns absolute path to an application-specific directory that can be used for temporary files

Saving cache files

Context.getExternalCacheDir()

returns a File representing external storage directory for cache files

SQLite

- SQLite provides in-memory database
- Designed to operate within a very small footprint (e.g., <300kB)
- Implements most of SQL92
- Supports ACID transactions
  - Atomic, Consistent, Isolated & Durable

Using a Database

Recommended method relies on a helper class called SQLiteOpenHelper

Using a Database

Subclass SQLiteOpenHelper

Call super() from subclass constructor to initialize underlying database

Using a Database

Override onCreate()

Override onUpgrade()

Execute CREATE TABLE commands

Using a Database

Use SQLiteOpenHelper methods to open & return underlying database

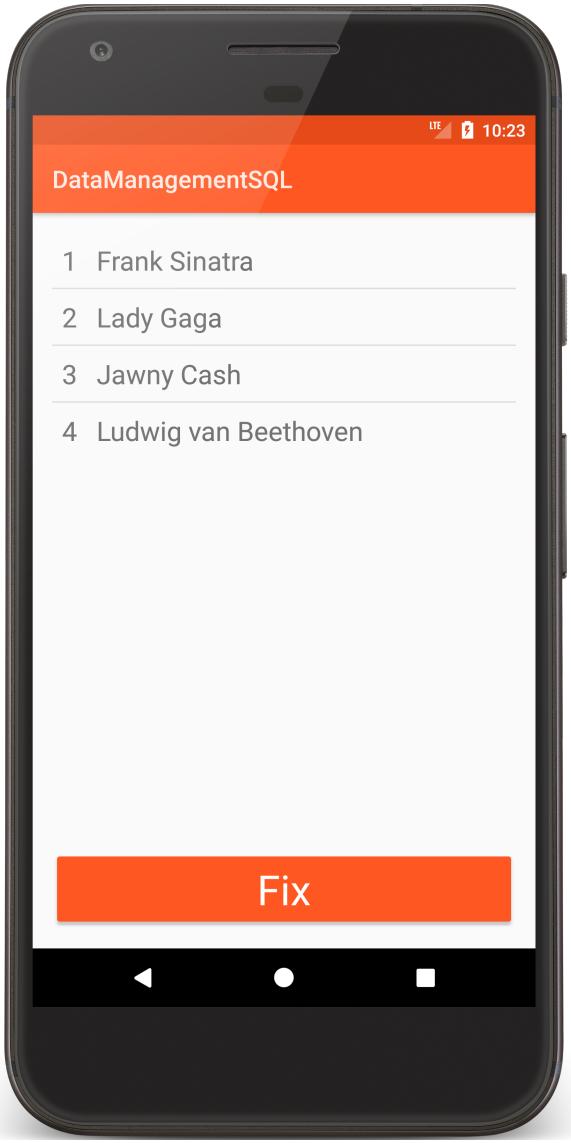
Execute operations on underlying database

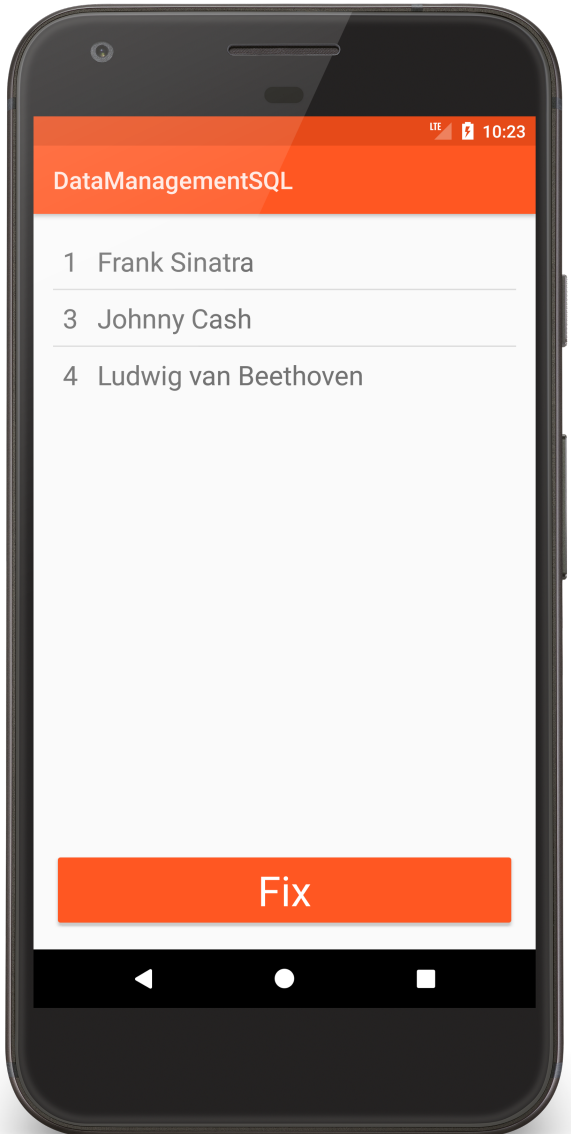
DataManagementSQL

Application creates an SQLite database and inserts records, some with errors, into it

When user presses the Fix button, the application deletes, updates and redisplays the corrected database records

DataManagement SQL





```
public class DatabaseExampleActivity extends ListActivity {
  private DatabaseOpenHelper mDbHelper;
  private SimpleCursorAdapter mAdapter;
  Cursor mCursor;

 public void onCreate(Bundle savedInstanceState) {
…
    mDbHelper = new DatabaseOpenHelper(this);
    clearAll();
    insertArtists();
    mCursor = readArtists();
    mAdapter = new SimpleCursorAdapter(this, R.layout.list_layout, mCursor,
        DatabaseOpenHelper.columns, new int[] { R.id._id, R.id.name },0);

    setListAdapter(mAdapter);

  }
```

```
// Delete all records
private void clearAll() {

  mDbHelper.getWritableDatabase()
                              .delete(DatabaseOpenHelper.TABLE_NAME, null, null);

}
```

```
// Insert several artist records
private void insertArtists() {

  ContentValues values = new ContentValues();

  values.put(DatabaseOpenHelper.ARTIST_NAME, "Frank Sinatra");
  mDbHelper.getWritableDatabase()
                                .insert(DatabaseOpenHelper.TABLE_NAME, null, values);
   …
  values.clear();

  values.put(DatabaseOpenHelper.ARTIST_NAME, "Ludwig van Beethoven");
  mDbHelper.getWritableDatabase()
                                        .insert(DatabaseOpenHelper.TABLE_NAME, null,
values);
}
```

```
// Returns all artist records in the database
private Cursor readArtists() {
  return mDbHelper.getWritableDatabase()
        .query(DatabaseOpenHelper.TABLE_NAME,
                DatabaseOpenHelper.columns, null, new String[] {}, null, null, null);
}
```

```
public void onClick(View v) {

    // Execute database operations
    fix();

    // Redisplay data
    mCursor = readArtists();
    mAdapter.changeCursor(mCursor);
}
```

```
// Modify the contents of the database
private void fix() {

  // Sorry Lady Gaga :-(
  mDbHelper.getWritableDatabase()
        .delete(DatabaseOpenHelper.TABLE_NAME,
                DatabaseOpenHelper.ARTIST_NAME + "=?",new String[] { "Lady Gaga" });

  // fix the Man in Black
  ContentValues values = new ContentValues();
  values.put(DatabaseOpenHelper.ARTIST_NAME, "Johnny Cash");

  mDbHelper.getWritableDatabase()
        .update(DatabaseOpenHelper.TABLE_NAME, values,
                DatabaseOpenHelper.ARTIST_NAME + "=?",
                new String[] { "Jawny Cash" });
}
```

Examining the Database Remotely

Databases stored in

/data/data/<package name>/databases/

Can examine database with sqlite3

adb -s emulator-5554 shell

sqlite3 /data/data/course.examples.datamanagement.sql/databases/artist_db

Next Time

Lifecycle-Aware Components