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CMSC436: Programming Handheld Systems

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

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 settings

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, …)

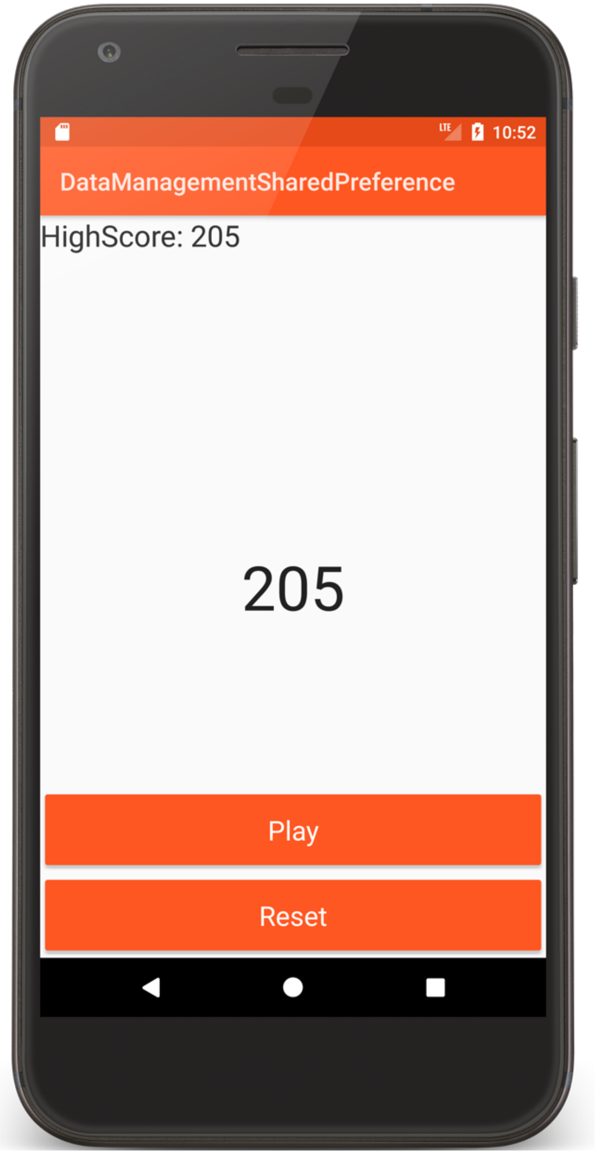
getString(String key, …)

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



SharedPreferenceReadWriteActivity.kt

```kotlin
fun onClickPlayButton(v: View) {

    val highScore = Random().nextInt(1000)
    mGameScore.text = highScore.toString()

    // Get Stored High Score
    if (highScore > mPrefs.getInt(HIGH_SCORE_KEY, 0)) {

        // Get and edit high score
        val editor = mPrefs.edit()
        editor.putInt(HIGH_SCORE_KEY, highScore)
        editor.apply()

        mHighScore.text = highScore.toString()

    }
}
```

SharedPreferenceReadWriteActivity.kt

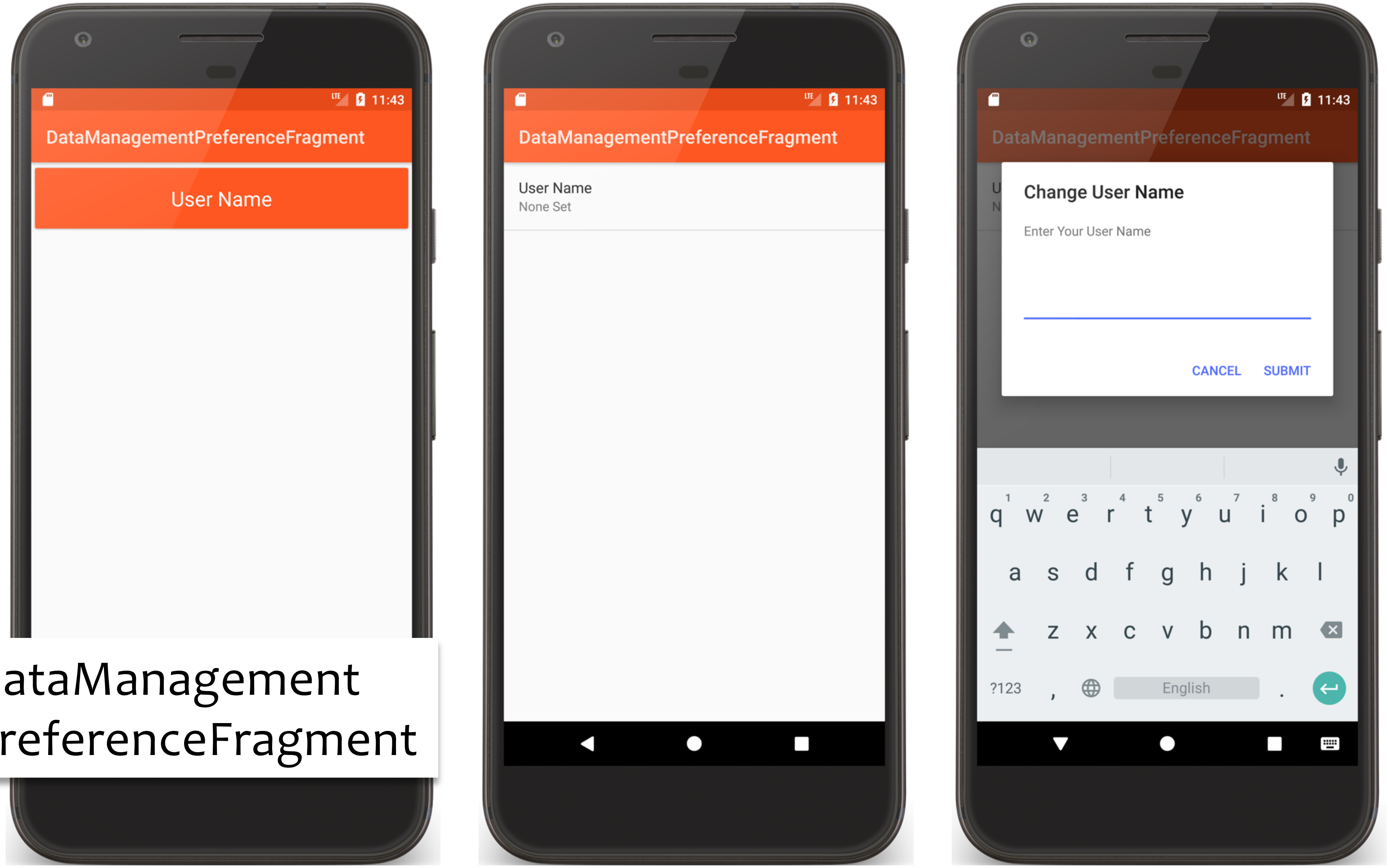
```
fun onClickResetButton(v: View) {

    // Set high score to 0
    val editor = mPrefs.edit()
    editor.putInt(HIGH_SCORE_KEY, 0)
    editor.apply()

    mHighScore.text = "0"
    mGameScore.text = "0"

}
```

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 username



DataManagementPreferenceFragment

User Name

DataManagementPreferenceFragment

User Name
None Set

DataManagementPreferenceFragment

Change User Name

Enter Your User Name

DataManagement
PreferenceFragment

user_prefs_fragment.xml

```
<androidx.fragment.app.FragmentContainerView
   xmlns:android="http://schemas.android.com/apk/res/android"
   android:id="@+id/pref_fragment"
   android:name=
"course.examples.datamanagement.preferencefragment.ViewAndUpdatePreferences
Activity$UserPreferenceFragment"
    android:layout_width="match_parent"
    android:layout_height="match_parent" />
```

user_prefs.xml

```
<androidx.preference.PreferenceScreen
    xmlns:android="http://schemas.android.com/apk/res/android">

    <androidx.preference.EditTextPreference
        android:dialogMessage="@string/enter_user_name_string"
        android:dialogTitle="@string/change_user_name_string"
        android:key="uname"
        android:negativeButtonText="@string/cancel_string"
        android:positiveButtonText="@string/submit_string"
        android:title="User Name" />
</androidx.preference.PreferenceScreen>
```

UserPreferenceFragment

```kotlin
// Fragment that displays the username preference
class UserPreferenceFragment : PreferenceFragmentCompat() {
    private lateinit var mListener: OnSharedPreferenceChangeListener
    private lateinit var mUserNamePreference: Preference

    override fun onCreatePreferences(p0: Bundle?, p1: String?) {
          // Load the preferences from an XML resource
          addPreferencesFromResource(R.xml.user_prefs)
    }

    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        // Get the username Preference
        mUserNamePreference = preferenceManager.findPreference(USERNAME)!!
```

UserPreferenceFragment

```
    // Attach a listener to update summary when username changes
    mListener = OnSharedPreferenceChangeListener { sharedPreferences, _ ->
      mUserNamePreference.summary = sharedPreferences.
                                          getString(USERNAME, "None Set")}

   // Get SharedPreferences object managed by the PreferenceManager for
   // this Fragment
        val prefs = preferenceManager.sharedPreferences

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

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

    }
}
```

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

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

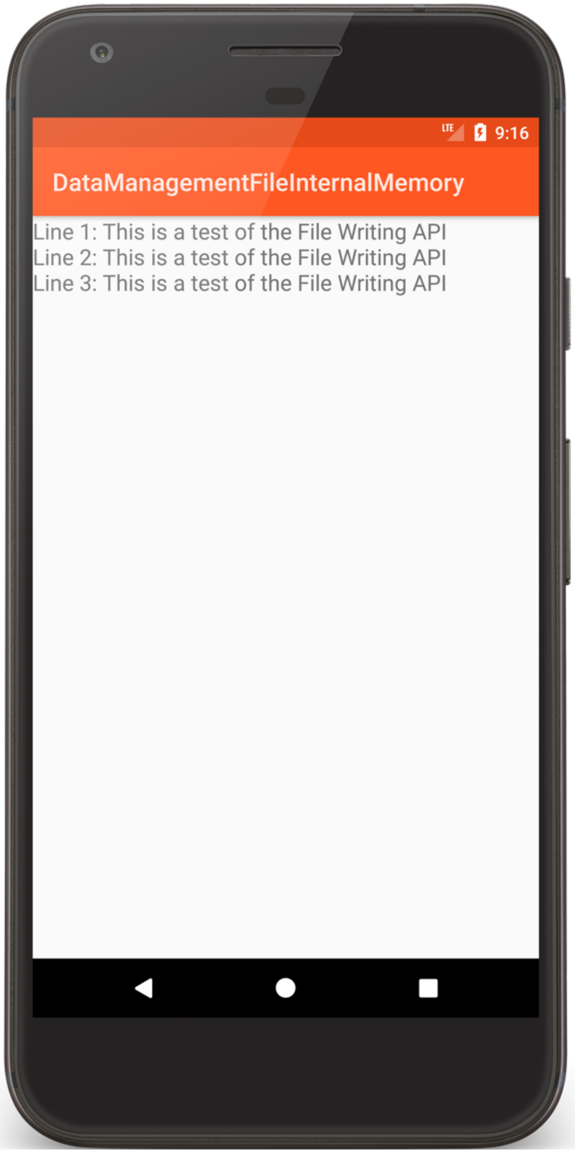
Many others. See documentation.

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



DataManagementFileInternalMemory

```
Line 1: This is a test of the File Writing API
Line 2: This is a test of the File Writing API
Line 3: This is a test of the File Writing API
```

InternalFileWriteReadActivity.kt

```
public override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)

        setContentView(R.layout.main)
        val textView = findViewById<TextView>(R.id.textview)

        if (!getFileStreamPath(FILE_NAME).exists()) {
            try {writeFile()}
            catch (e: FileNotFoundException) {…}
        }
         try {
            readFileAndDisplay(textView)
        } catch (e: IOException) {…}
    }
```

InternalFileWriteReadActivity.kt

```
@Throws(FileNotFoundException::class)
private fun writeFile() {
    val fos = openFileOutput(FILE_NAME, Context.MODE_PRIVATE)
    val pw = PrintWriter(BufferedWriter(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()

}
```

InternalFileWriteReadActivity.kt

```
    @Throws(IOException::class)
    private fun readFileAndDisplay(tv: TextView) {

        val sep = System.getProperty("line.separator")
        val fis = openFileInput(FILE_NAME)
        val br = BufferedReader(InputStreamReader(fis))

        br.forEachLine {
            tv.append(it + sep)
        }
        br.close()
    }
}
```

Using External Memory Files

Removable media may appear/disappear without warning

Using External Memory Files

String Environment.getExternalStorageState()

Returns

- MEDIA_MOUNTED - present & mounted with read/write access
- MEDIA_MOUNTED_READ_ONLY - present & mounted with read-only access
- MEDIA_REMOVED - not present

Using External Memory Files

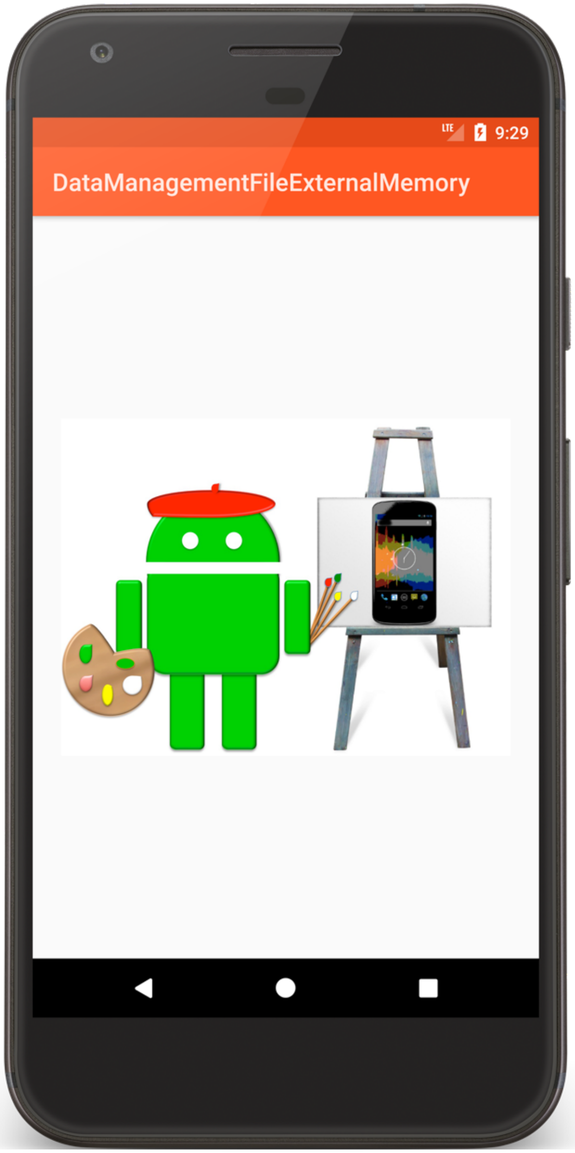
Permission to write external files

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

DataManagementFileExternalMemory

- If not done already, application reads an image file from its /res/raw directory
  - Copies that file to external storage
- Application then reads image data from the file in external storage and then displays the image

DataManagement FileExternalMemory



ExternalFileWriteReadActivity.kt

```kotlin
public override fun onCreate(savedInstanceState: Bundle?) {
  super.onCreate(savedInstanceState)
  setContentView(R.layout.main)
  if (Environment.MEDIA_MOUNTED == Environment.getExternalStorageState()){
        val fileName = "painter.png"
        val outFile = File(
            getExternalFilesDir(Environment.DIRECTORY_PICTURES), fileName)

        if (!outFile.exists())
            copyImageToMemory(outFile)

        val imageview = findViewById<ImageView>(R.id.image)
        imageview.setImageURI(Uri.parse("file://" + outFile.absolutePath))
    }
}
```

ExternalFileWriteReadActivity.kt

```kotlin
private fun copyImageToMemory(outFile: File) {
    var outputStream: BufferedOutputStream? = null
    var inputStream: BufferedInputStream? = null
    try {
        outputStream = BufferedOutputStream(FileOutputStream(outFile))
        inputStream = BufferedInputStream(
                          resources.openRawResource(R.raw.painter))
        inputStream.copyTo(outputStream)
    } catch (e: FileNotFoundException) {…}
      finally {
        try {
            inputStream?.close()
            outputStream?.close()
        } catch (e: IOException) {…}
    }
}
```

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

Databases

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

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

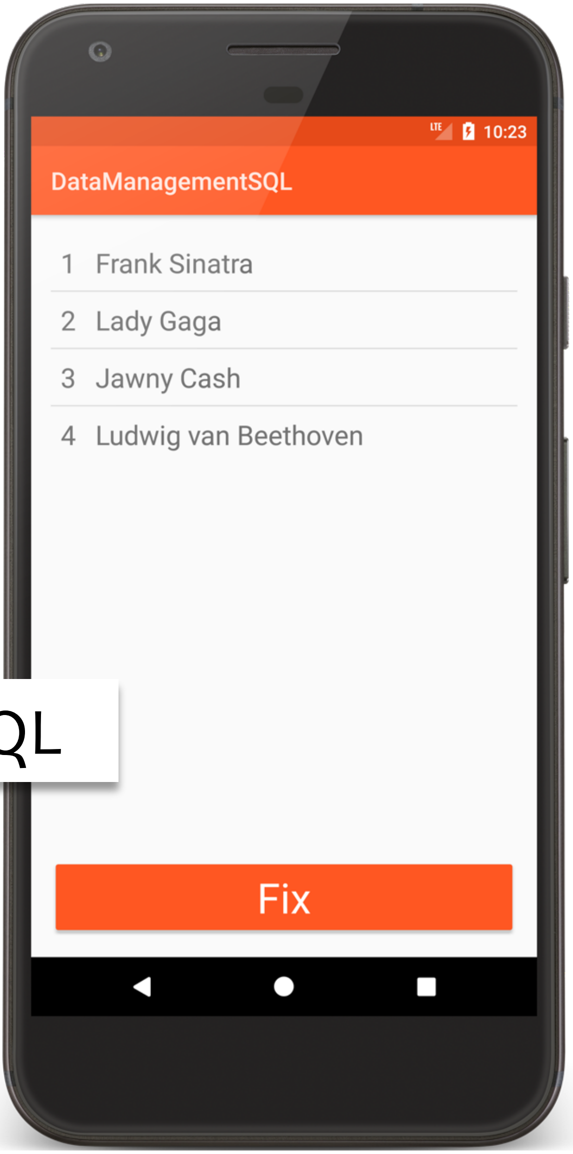
Execute operations on underlying database

DataManagementSQL

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

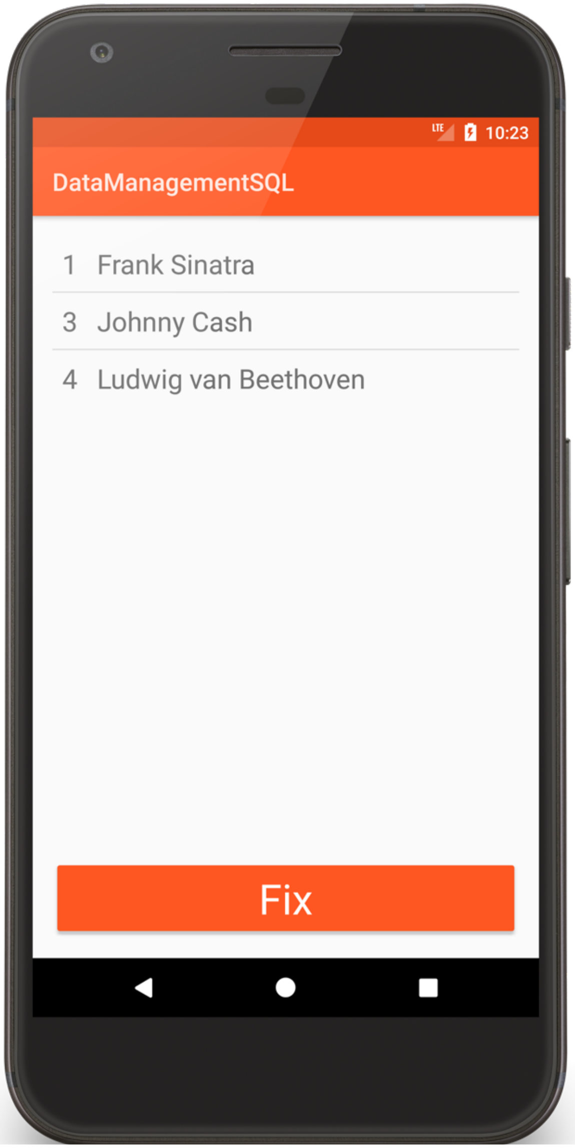
When user presses the Fix button, the application deletes, updates and redisplays the corrected database records

DataManagementSQL



DataManagementSQL

1 Frank Sinatra
2 Lady Gaga
3 Jawny Cash
4 Ludwig van Beethoven



DataManagementSQL

1 Frank Sinatra
3 Johnny Cash
4 Ludwig van Beethoven

DatabaseExampleActivity.kt

```
public override fun onCreate(savedInstanceState: Bundle?) {
    private lateinit var mDbHelper: DatabaseOpenHelper
    private lateinit var mAdapter: SimpleCursorAdapter
    private var mCursor: Cursor? = null
    …
    mDbHelper = DatabaseOpenHelper(this)
    clearAll()
    insertArtists()
    mCursor = readArtists()
    mAdapter = SimpleCursorAdapter(this, R.layout.list_layout, mCursor,
        DatabaseOpenHelper.columns, intArrayOf(R.id._id, R.id.name),0)

    listAdapter = mAdapter
}
```

DatabaseExampleActivity.kt

```
// Delete all records
private fun clearAll() {
    mDbHelper.writableDatabase.delete(
                         DatabaseOpenHelper.TABLE_NAME, null, null)
}
```

DatabaseExampleActivity.kt

```
private fun insertArtists() {
    val values = ContentValues()
    values.put(DatabaseOpenHelper.ARTIST_NAME, "Frank Sinatra")
    mDbHelper.writableDatabase.insert(
                         DatabaseOpenHelper.TABLE_NAME, null, values)
    values.clear()
    …
    values.clear()
    values.put(DatabaseOpenHelper.ARTIST_NAME, "Ludwig van Beethoven")
    mDbHelper.writableDatabase.insert(
                         DatabaseOpenHelper.TABLE_NAME, null, values)
}
```

DatabaseExampleActivity.kt

```
private fun readArtists(): Cursor {
    return mDbHelper.
        writableDatabase.query(DatabaseOpenHelper.TABLE_NAME,
        DatabaseOpenHelper.columns, null, arrayOf(), null, null, null
    )
}
```

DatabaseExampleActivity.kt

```
fun onClick(v: View) {

    // Execute database operations
    fix()

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

DatabaseExampleActivity.kt

```
private fun fix() {
    // Sorry Lady Gaga :-(
    mDbHelper.writableDatabase.delete(DatabaseOpenHelper.TABLE_NAME,
        DatabaseOpenHelper.ARTIST_NAME + "=?", arrayOf("Lady Gaga")
    )
    // fix the Man in Black
    val values = ContentValues()
    values.put(DatabaseOpenHelper.ARTIST_NAME, "Johnny Cash")

    mDbHelper.writableDatabase.update(DatabaseOpenHelper.TABLE_NAME,
         values,DatabaseOpenHelper.ARTIST_NAME + "=?", arrayOf("Jawny Cash")
    )

}
```

Examining the Database Remotely

Databases stored in

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

Can examine database with sqlite3

```
# adb -s emulator-5554 shell

# su

# sqlite3 \
/data/data/course.examples.datamanagement.sql/databases/artist_db
```

Next Time

Lifecycle-Aware Components

Sample code

DataManagementSharedPreferences

DataManagementPreferenceFragment

DataManagementFileInternalMemory

DataManagementFileExternalMemory

DataManagementSQL