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Android Essentials

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Introduction to Android™ Application Development

Android Essentials

Fifth Edition

Joseph Annuzzi, Jr.
Lauren Darcey
Shane Conder

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❖

This book is dedicated to Cleopatra (Cleo).
—Joseph Annuzzi, Jr.

This book is dedicated to ESC.
—Lauren Darcey and Shane Conder

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When he is not working with technology, he has been known to lounge in the sun on the beaches of the Black Sea with international movie stars; he has trekked through the Bavarian forest in winter, has immersed himself in the culture of the Italian Mediterranean, and has narrowly escaped the wrath of an organized crime ring in Eastern Europe after his taxi dropped him off in front of the bank ATM they were liquidating. He also lives an active and healthy lifestyle, designs and performs custom fitness training routines to stay in shape, and adores his loyal beagle, Cleopatra.

Lauren Darcey is responsible for the technical leadership and direction of a small software company specializing in mobile technologies, including Android and iOS consulting services. With more than two decades of experience in professional software production, Lauren is a recognized authority in application architecture and the development of commercial-grade mobile applications. Lauren received a BS in computer science from the University of California, Santa Cruz.

She spends her copious free time traveling the world with her geeky mobile-minded husband and pint-sized geekling daughter. She is an avid nature photographer. Her work has been published in books and newspapers around the world. In South Africa, she dove with 4-meter-long great white sharks and got stuck between a herd of rampaging hippopotami and an irritated bull elephant. She's been attacked by monkeys in Japan, has gotten stuck in a ravine with two hungry lions in Kenya, has gotten thirsty in Egypt, narrowly avoided a coup d'état in Thailand, geocached her way through the Swiss Alps, drank her way through the beer halls of Germany, slept in the crumbling castles of Europe, and has gotten her tongue stuck to an iceberg in Iceland (while being watched by a herd of suspicious wild reindeer). Most recently, she can be found hiking along the Appalachian Trail with her daughter and documenting the journey with Google Glass.

Shane Conder has extensive application development experience and has focused his attention on mobile and embedded development for well over a decade. He has designed and developed many commercial applications for Android, iOS, BREW, BlackBerry, J2ME, Palm, and Windows Mobile—some of which have been installed on millions of phones worldwide. Shane has written extensively about the tech industry and is known for his keen insights regarding mobile development platform trends. Shane received a BS in computer science from the University of California, Santa Cruz.

A self-admitted gadget freak, Shane always has the latest smartphone, tablet, or wearable. He enjoys traveling the world with his geeky wife, even if she did make him dive with 4-meter-long great white sharks and almost get eaten by a lion in Kenya. He admits that he has to take at least three devices with him when backpacking ("just in case")—even where there is no coverage. Lately, his smartwatch collection has exceeded his number of wrists. Luckily, his young daughter is happy to offer her own. Such are the burdens of a daughter of engineers.

Introduction

Android is a popular, free, open-source mobile platform that has taken the world by storm. This book provides guidance for software development teams on designing, developing, testing, debugging, and distributing professional Android applications. If you're a veteran mobile developer, you can find tips and tricks to streamline the development process and take advantage of Android's unique features. If you're new to mobile development, this book provides everything you need to make a smooth transition from traditional software development to mobile development—specifically, the most promising platform: Android.

Who Should Read This Book

This book includes tips for successful mobile development based upon our years in the mobile industry and covers everything you need to know in order to run a successful Android project from concept to completion. We cover how the mobile software process differs from traditional software development, including tricks to save valuable time and pitfalls to avoid. Regardless of the size of your project, this book is for you.

This book was written for several audiences:

- **Software developers who want to learn to develop professional Android applications.** The bulk of this book is targeted at software developers with Java experience who do not necessarily have mobile development experience. More-seasoned developers of mobile applications can learn how to take advantage of Android and how it differs from the other technologies on the mobile development market today.
- **Quality assurance personnel tasked with testing Android applications.** Whether they are black-box or white-box testing, quality assurance engineers can find this book invaluable. We devote several chapters to mobile QA concerns, including topics such as developing solid test plans and defect-tracking systems for mobile applications, how to manage handsets, and how to test applications thoroughly using all the Android tools available.
- **Project managers planning and managing Android development teams.** Managers can use this book to help plan, hire for, and execute Android projects from start to finish. We cover project risk management and how to keep Android projects running smoothly.

- **Other audiences.** This book is useful not only to the software developer, but also to the corporation looking at potential vertical market applications, the entrepreneur thinking about a cool phone application, and the hobbyist looking for some fun with his or her new phone. Businesses seeking to evaluate Android for their specific needs (including feasibility analysis) can also find the information provided valuable. Anyone with an Android handset and a good idea for a mobile application can put the information in this book to use for fun and profit.

Key Questions Answered in This Book

This book answers the following questions:

1. What is Android? How do the SDK versions differ?
2. How is Android different from other mobile technologies? How should developers take advantage of these differences?
3. How do developers use Android Studio and the Android SDK tools to develop and debug Android applications on the emulator and handsets?
4. How are Android applications structured?
5. How do developers design robust user interfaces for mobile—specifically, for Android?
6. What capabilities does the Android SDK have and how can developers use them?
7. What is material design and why does it matter?
8. How does the mobile development process differ from traditional desktop development?
9. What strategies work best for Android development?
10. What do managers, developers, and testers need to look for when planning, developing, and testing a mobile application?
11. How do mobile teams deliver quality Android applications for publishing?
12. How do mobile teams package Android applications for distribution?
13. How do mobile teams make money from Android applications?
14. And, finally, what is new in this edition of the book?

How This Book Is Structured

Introduction to Android Application Development, Fifth Edition, focuses on Android essentials, including setting up the development environment, understanding the application lifecycle, user interface design, developing for different types of devices, and the mobile software process from design and development to testing and publication of commercial-grade applications.

The book is divided into six parts. Here is an overview of the various parts:

- **Part I: Platform Overview**
  Part I provides an introduction to Android, explaining how it differs from other mobile platforms. You become familiar with the Android SDK tools, install the development tools, and write and run your first Android application—on the emulator and on a handset. This section is of primary interest to developers and testers, especially white-box testers.
- **Part II: Application Basics**
  Part II introduces the principles necessary to write Android applications. You learn how Android applications are structured and how to include resources, such as strings, graphics, and user interface components, in your projects. You learn about the core user interface element in Android: the `View`. You also learn about the most common user interface controls and layouts provided in the Android SDK. This section is of primary interest to developers.
- **Part III: Application Design Essentials**
  Part III dives deeper into how applications are designed in Android. You learn about material design, styling, and common design patterns found among applications. You also learn how to design and plan your applications. This section is of primary interest to developers.
- **Part IV: Application Development Essentials**
  Part IV covers the features used by most Android applications, including storing persistent application data using preferences, working with files and directories, SQLite, and content providers. This section is of primary interest to developers.
- **Part V: Application Delivery Essentials**
  Part V covers the software development process for mobile, from start to finish, with tips and tricks for project management, software developers, user-experience designers, and quality assurance personnel.
- **Part VI: Appendixes**
  Part VI includes several helpful appendixes to help you get up and running with the most important Android tools. This section consists of tips and tricks for Android Studio, an overview of the Android SDK tools, three helpful quick-start guides for the Android development tools—the emulator, `Device Monitor`, and Gradle—as well as answers to the end-of-chapter quiz questions.

An Overview of Changes in This Edition

When we began writing the first edition of this book, there were no Android devices on the market. Today, there are hundreds of millions of Android devices (with thousands of different device models) shipping all over the world every quarter—phones, tablets, e-book readers, smartwatches, and specialty devices such as gaming consoles, TVs, and Google Glass. Other devices such as Google Chromecast provide screen sharing between Android devices and TVs.

The Android platform has gone through extensive changes since the first edition of this book was published. The Android SDK has many new features, and the development tools have received many much-needed upgrades. Android, as a technology, is now the leader within the mobile marketplace.

In this new edition, we took the opportunity to add a wealth of information. But don't worry, it's still the book readers loved the first, second, third, and fourth time around; it's just much bigger, better, and more comprehensive, following many best practices. In addition to adding new content, we've retested and upgraded all existing content (text and sample code) for use with the latest Android SDKs available, while still remaining backward compatible. We included quiz questions to help readers ensure they understand each chapter's content, and end-of-chapter exercises for readers to perform to dig deeper into all that Android has to offer. The Android development community is diverse and we aim to support all developers, regardless of which devices they are developing for. This includes developers who need to target nearly all platforms, so coverage in some key areas of older SDKs continues to be included because it's often the most reasonable option for compatibility.

Here are some of the highlights of the additions and enhancements we've made to this edition:

- The entire book has been overhauled to include coverage of the Android Studio IDE. Previous editions of this book included coverage of the Eclipse IDE. Where applicable, all content, images, and code samples have been updated for Android Studio. In addition, coverage of the latest and greatest Android tools and utilities is included.
- The chapter on defining the manifest includes coverage of the new Android 6.0 Marshmallow (API Level 23) permission model, and it provides a code sample demonstrating the new permission model.
- A brand new chapter on material design has been added and demonstrates how developers can integrate common material design features into their application, and it includes a code sample.
- A brand new chapter on working with styles has been included with tips on how to best organize styles and reuse common UI components for optimized display rendering, and it provides a code sample.
- A brand new chapter on common design patterns has been added with details on various ways to architect your application, and it offers a code sample.
- A brand new chapter on incorporating SQLite for working with persistent database-backed application data has been added, and it includes a code sample.
- An appendix providing tips and tricks for using Android Studio has been included.
- An appendix on the Gradle build system has been included to help you understand what Gradle is and why it's important.
- The `AdvancedLayouts` code sample has been updated so that the `GridView` and `ListView` components make use of `Fragment` and `ListFragment` classes respectively.

- Some code samples include an `ActionBar` by making use of the new `Toolbar`, and have done so using the support library for maintaining compatibility on devices running older APIs. When necessary, application manifests have been updated to support parent-child `Activity` relationships that support up-navigation.
- Many code samples make use of the `AppCompatActivity` class and the `appcompat-v7` support library.
- All chapters and appendixes include quiz questions and exercises for readers to test their knowledge of the subject matter presented.
- All existing chapters have been updated, often with some entirely new sections.
- All sample code and accompanying applications have been updated to work with the latest SDK.

As you can see, we cover many of the hottest and most exciting features that Android has to offer. We didn't take this review lightly; we touched every existing chapter, updated content, and added new chapters as well. Finally, we included many additions, clarifications, and, yes, even a few fixes based on the feedback from our fantastic (and meticulous) readers. Thank you!

Development Environments Used in This Book

The Android code in this book was written using the following development environments:

- Windows 7, 8, and Mac OS X 10.9
- Android Studio 1.3.2
- Android SDK API Level 23 (referred to in this book as Android Marshmallow)
- Android SDK Tools 24.3.4
- Android SDK Platform Tools 23.0.0
- Android SDK Build Tools 23.0.0
- Android Support Repository 17 (where applicable)
- Java SE Development Kit (JDK) 7 Update 55
- Android devices: Nexus 4, 5, and 6 (phones), Nexus 7 (first- and second-generation 7-inch tablet), Nexus 9 and 10 (large tablet), including various other popular devices and form factors.

The Android platform continues to grow aggressively in market share against competing mobile platforms, such as Apple iOS, Windows Phone, and BlackBerry OS. New and exciting types of Android devices reach consumers' hands at a furious pace. Developers have embraced Android as a target platform to reach the device users of today and tomorrow.

Android's latest major platform update, Android Marshmallow, brings many new features. This book covers the latest SDK and tools available, but it does not focus on them to the detriment of popular legacy versions of the platform. The book is meant to be an overall reference to help developers support as many popular devices as possible on the market today. As of the writing of this book, approximately 9.7% of users' devices are running a version of Android Lollipop, 5.0 or 5.1, and Android Marshmallow has yet to be released on real devices. Of course, some devices will receive upgrades, and users will purchase new Lollipop and Marshmallow devices as they become available, but for now, developers need to straddle this gap and support numerous versions of Android to reach the majority of users in the field. In addition, the next version of the Android operating system is likely to be released in the near future.

So what does this mean for this book? It means we provide legacy API support and discuss some of the newer APIs available in later versions of the Android SDK. We discuss strategies for supporting all (or at least most) users in terms of compatibility. And we provide screenshots that highlight different versions of the Android SDK, because each major revision has brought with it a change in the look and feel of the overall platform. That said, we are assuming that you are downloading the latest Android tools, so we provide screenshots and steps that support the latest tools available at the time of writing, not legacy tools. Those are the boundaries we set when trying to determine what to include and leave out of this book.

Supplementary Materials for This Book

The source code that accompanies this book is available for download from our book's website: *http://introductiontoandroid.blogspot.com/2015/08/5th-edition-book-code-samples.html*. The code samples are organized by chapter and downloadable in zip format or accessible from the command line with Git. You'll also find other Android topics discussed on our book's website (*http://introductiontoandroid.blogspot.com*).

Conventions Used in This Book

This book uses the following conventions:

- Code and programming terms are set in `monospace` text.
- Java import statements, exception handling, and error checking are often removed from printed code examples for clarity and to keep the book to a reasonable length.

This book also presents information in the following sidebars:

Tip

Tips provide useful information or hints related to the current text.

Note

Notes provide additional information that might be interesting or relevant.

> **Warning**
>
> Warnings provide hints or tips about pitfalls that may be encountered and how to avoid them.

Where to Find More Information

There is a vibrant, helpful Android developer community on the Web. Here are a number of useful websites for Android developers and followers of the mobile industry:

- Android Developer website: the Android SDK and developer reference site: *http://d.android.com/index.html* and *http://d.android.com*
- Google Plus: Android Developers Group: *https://plus.google.com/+AndroidDevelopers/posts*
- YouTube: Android Developers and Google Design: *https://www.youtube.com/user/androiddevelopers* *https://www.youtube.com/channel/UClKO7be7O9cUGL94PHnAeOA*
- Google Material Design: *https://www.google.com/design/spec/material-design/introduction.html*
- Stack Overflow: the Android website with great technical information (complete with tags) and an official support forum for developers: *http://stackoverflow.com/questions/tagged/android*
- Android Open Source Project: *https://source.android.com/index.html*
- Open Handset Alliance: Android manufacturers, operators, and developers: *http://openhandsetalliance.com*
- Google Play: buy and sell Android applications: *https://play.google.com/store*
- tuts+: Android development tutorials: *http://code.tutsplus.com/categories/android*
- Google Sample Apps: open-source Android applications hosted on GitHub: *https://github.com/googlesamples*
- Android Tools Project Site: the tools team discusses updates and changes: *https://sites.google.com/a/android.com/tools/recent*
- FierceDeveloper: a weekly newsletter for wireless developers: *http://fiercedeveloper.com*
- XDA-Developers Android Forum: *http://forum.xda-developers.com/android*
- Developer.com: a developer-oriented site with mobile articles: *http://developer.com*

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- Joseph Annuzzi, Jr.: *http://goo.gl/FBQeL*

16
Saving with SQLite

There are many different ways for storing your Android applications' data. As you learned in Chapter 14, "Using Android Preferences," and in Chapter 15, "Accessing Files and Directories," there is definitely more than one way for accessing and storing your data. But what if you need to store structured data for your application, such as data more suited for storing in a database? That's where SQLite comes in. In this chapter, we are going to be modifying the `SampleMaterial` application found in Chapter 12, "Embracing Material Design," so that `Card` data is stored persistently in a SQLite database on the device and will survive various lifecycle events. By the end of this chapter, you will be confident in adding a SQLite database for your application.

`SampleMaterial` Upgraded with SQLite

The `SampleMaterial` application found in Chapter 12, "Embracing Material Design," shows you how to work with data in the application but fails when it comes to storing the data permanently so that it survives Android lifecycle events. When adding, updating, and deleting cards from the `SampleMaterial` application, and then clearing the `SampleMaterial` application from the Recent apps, the application is not able to remember what cards were added, updated, and deleted. So we updated the application to store the information in a SQLite database to keep track of the data permanently. Figure 16.1 shows the `SampleSQLite` application, which looks the same as the `SampleMaterial` application, but is backed by a SQLite database.

Working with Databases

The first thing that must be done is to define the database table that should be created for storing the cards in the database. Luckily, Android provides a helper class for defining a SQLite database table through Java code. That class is called `SQLiteOpenHelper`. You need to create a Java class that extends from the `SQLiteOpenHelper`, and this is where you can define a database name and version, and where you define the tables and columns. This is also where you create and upgrade your database. For the `SampleSQLite` application,

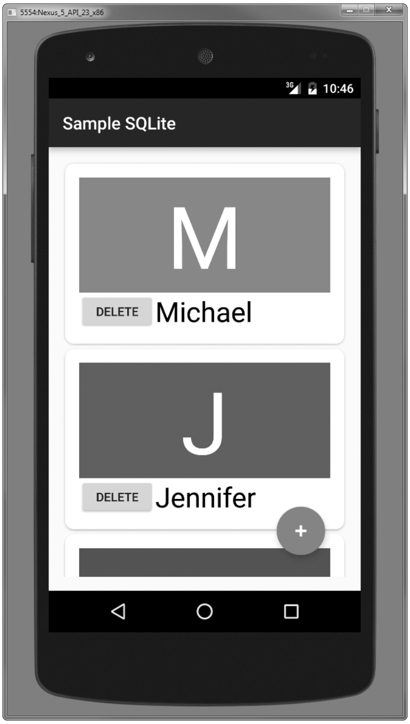


Figure 16.1 Showing the SampleSQLite application.

we created a `CardsDBHelper` class that extends from `SQLiteOpenHelper`, and here's the implementation that can be found in the `CardsDBHelper.java` file:

```
public class CardsDBHelper extends SQLiteOpenHelper {
    private static final String DB_NAME = "cards.db";
    private static final int DB_VERSION = 1;

    public static final String TABLE_CARDS = "CARDS";
    public static final String COLUMN_ID = "_ID";
    public static final String COLUMN_NAME = "NAME";
    public static final String COLUMN_COLOR_RESOURCE = "COLOR_RESOURCE";

    private static final String TABLE_CREATE =
            "CREATE TABLE " + TABLE_CARDS + " (" +
                    COLUMN_ID + " INTEGER PRIMARY KEY AUTOINCREMENT, " +
                    COLUMN_NAME + " TEXT, " +
                    COLUMN_COLOR_RESOURCE + " INTEGER" +
                    ")";

    public CardsDBHelper(Context context) {
        super(context, DB_NAME, null, DB_VERSION);
    }

    @Override
    public void onCreate(SQLiteDatabase db) {
        db.execSQL(TABLE_CREATE);    }

    @Override
    public void onUpgrade(SQLiteDatabase db, int oldVersion, int newVersion) {
        db.execSQL("DROP TABLE IF EXISTS " + TABLE_CARDS);
        onCreate(db);
    }
}
```

This class starts off by defining a few `static final` variables for providing a name and version number, and an appropriate table name with table column names. Further, the `TABLE_CREATE` variable provides the SQL statement for creating the table in the database. The `CardsDBHelper` constructor accepts a `context` and this is where the database name and version are set. The `onCreate()` and `onUpgrade()` methods either create the new table or delete an existing table, and then create a new table.

You should also notice that the table provides one column for the `_ID` as an `INTEGER`, one column for the `NAME` as `TEXT`, and one column for the `COLOR_RESOURCE` as an `INTEGER`.

> **Note**
>
> The `SQLiteOpenHelper` class assumes version numbers will be increasing for an upgrade. That means if you are at version 1, and want to update your database, set the version number to 2 and increase the version number incrementally for additional versions.

Providing Data Access

Now that you are able to create a database, you need a way to access the database. To do so, you will create a class that provides access to the database from the `SQLiteDatabase` class using the SQLiteOpenHelper class. This class is where we will be defining the methods for adding, updating, deleting, and querying the database. The class for doing this is provided in the CardsData.java file and a partial implementation can be found here:

```
public class CardsData {
    public static final String DEBUG_TAG = "CardsData";

    private SQLiteDatabase db;
    private SQLiteOpenHelper cardDbHelper;

    private static final String[] ALL_COLUMNS = {
            CardsDBHelper.COLUMN_ID,
            CardsDBHelper.COLUMN_NAME,
            CardsDBHelper.COLUMN_COLOR_RESOURCE
    };

    public CardsData(Context context) {
        this.cardDbHelper = new CardsDBHelper(context);
    }

    public void open() {
        db = cardDbHelper.getWritableDatabase();    }

    public void close() {
        if (cardDbHelper != null) {
            cardDbHelper.close();        }
    }
}
```

Notice the CardsData() constructor. This creates a new CardsDBHelper() object that will allow us to access the database. The open() method is where the database is created with the getWritableDatabase() method. The close() method is for closing the database. It is important to close the database to release any resources obtained by the object so that unexpected errors do not occur in your application during use. You also want to open and close the database during your application's particular lifecycle events so that you are only executing database operations at the times when you have the appropriate access.

Updating the SampleMaterialActivity Class

The onCreate() method of the SampleMaterialActivity now creates a new data access object and opens the database. Here is the updated onCreate() method:

```
public CardsData cardsData = new CardsData(this);


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

    names = getResources().getStringArray(R.array.names_array);
    colors = getResources().getIntArray(R.array.initial_colors);

    recyclerView = (RecyclerView) findViewById(R.id.recycler_view);
    recyclerView.setLayoutManager(new LinearLayoutManager(this));

    new GetOrCreateCardsListTask().execute();

    FloatingActionButton fab = (FloatingActionButton) findViewById(R.id.fab);
    fab.setOnClickListener(new View.OnClickListener() {
        @Override
        public void onClick(View v) {
            Pair<View, String> pair = Pair.create(v.findViewById(R.id.fab),
                    TRANSITION_FAB);

            ActivityOptionsCompat options;
            Activity act = SampleMaterialActivity.this;
options = ActivityOptionsCompat.makeSceneTransitionAnimation(act, pair);

Intent transitionIntent = new Intent(act, TransitionAddActivity.class);
            act.startActivityForResult(transitionIntent, adapter.getItemCount(),
options.toBundle());
        }
    });
}
```

Notice the new `GetOrCreateCardsListTask().execute()` method call. We cover this implementation later in this chapter. This method queries the database for all cards or fills the database with cards if it is empty.

Updating the `SampleMaterialAdapter` Constructor

An update in the `SampleMaterialAdapter` class is also needed, and the constructor is shown below:

```
public CardsData cardsData;

public SampleMaterialAdapter(Context context, ArrayList<Card> cardsList,
            CardsData cardsData) {
    this.context = context;
    this.cardsList = cardsList;
    this.cardsData = cardsData;
}
```

Notice a `CardsData` object is passed into the constructor to ensure the database is available to the `SampleMaterialAdapter` object once it is created.

> **Warning**
>
> Because database operations block the UI thread of your Android application, you should always run database operations in a background thread.

Database Operations Off the Main UI Thread

To make sure that the main UI thread of your Android application does not block during a potentially long-running database operation, you should run your database operations in a background thread. Here, we have implemented an `AsyncTask` for creating new cards in the database, and will subsequently update the UI only after the database operation is complete. Here is the `GetOrCreateCardsListTask` class that extends the `AsyncTask` class, which either retrieves all the cards from the database or creates them:

```
public class GetOrCreateCardsListTask extends AsyncTask<Void, Void,
ArrayList<Card>> {
    @Override
    protected ArrayList<Card> doInBackground(Void... params) {
        cardsData.open();
        cardsList = cardsData.getAll();
        if (cardsList.size() == 0) {
            for (int i = 0; i < 50; i++) {
                Card card = new Card();
                card.setName(names[i]);
                card.setColorResource(colors[i]);
                cardsList.add(card);
                cardsData.create(card);
                Log.d(DEBUG_TAG, "Card created with id " + card.getId() + ",
name " + card.getName() + ", color " + card.getColorResource());
            }
        }
        return cardsList;
    }

    @Override
    protected void onPostExecute(ArrayList<Card> cards) {
        super.onPostExecute(cards);
        adapter = new SampleMaterialAdapter(SampleMaterialActivity.this,
                cardsList, cardsData);
        recyclerView.setAdapter(adapter);
    }
}
```

When this class is created and executed in the `onCreate()` method of the `Activity`, it overrides the `doInBackground()` method and creates a background task for retrieving all the cards from the database with the call to `getAll()`. If no items are returned, that means the database is empty and needs to be populated with entries. The `for` loop creates 50 Cards and each `Card` is added to the `cardsList`, and then created in the database with the call to `create()`. Once the background operation is complete, the `onPostExecute()` method, which was also overridden from the `AsyncTask` class, receives the `cardsList` result from the `doInBackground()` operation. It then uses the `cardsList` and `cardsData` to create a new `SampleMaterialAdapter`, and then adds that `adapter` to the `recyclerView` to update the UI once the entire background operation has completed.

Notice the `AsyncTask` class has three types defined; the first is of type `Void`, the second is also `Void`, and the third is `ArrayList<Card>`. These map to the `Params`, `Progress`, and `Result` generic types of an `AsyncTask`. The first `Params` is used as the parameter of the `doInBackground()` method, which are `Void`, and the third `Result` generic is used as the parameter of the `onPostExecute()` method. In this case, the second `Void` generic was not used, but would be used as the parameter for the `onProgressUpdate()` method of an `AsyncTask`.

Note

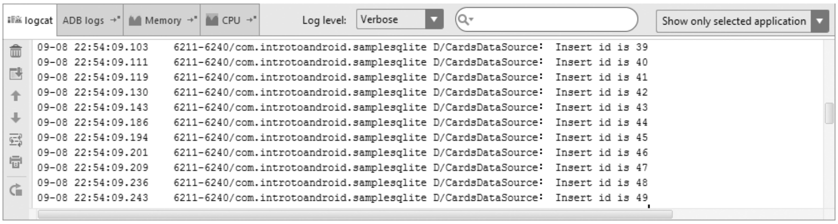
Note that you are not able to call UI operations on the `doInBackground()` method of an `AsyncTask`. Those operations need to be performed before or after the `doInBackground()` method, but if you need the UI to update only after the background operation has completed, you must perform those operations in the `onPostExecute()` method so the UI is updated appropriately.

Creating a Card in the Database

The magic happens in the call to `cardsData.create()`. This is where the `Card` is inserted into the database. Here is the `create()` method definition found in the `CardsData` class:

```
public Card create(Card card) {
    ContentValues values = new ContentValues();
    values.put(CardsDBHelper.COLUMN_NAME, card.getName());
    values.put(CardsDBHelper.COLUMN_COLOR_RESOURCE, card.getColorResource());
    long id = db.insert(CardsDBHelper.TABLE_CARDS, null, values);
    card.setId(id);
    Log.d(DEBUG_TAG, "Insert id is " + String.valueOf(card.getId()));
    return card;
}
```

The `create()` method accepts a `Card` data object. A `ContentValues` object is created to temporarily store the data that will be inserted into the database in a structured format. There are two `value.put()` calls that map the database column to a `Card` attribute. The `insert()` method is then called on the cards table and the temporary values are passed in for insertion. An `id` is returned from the call to `insert()` and that value is then set as the `id` for the `Card`, and finally a `Card` object is returned. Figure 16.2 shows the `logcat` output of cards being inserted into the database.



```
09-08 22:54:09.103   6211-6240/com.introtoandroid.samplesqlite D/CardsDataSource:  Insert id is 39
09-08 22:54:09.111   6211-6240/com.introtoandroid.samplesqlite D/CardsDataSource:  Insert id is 40
09-08 22:54:09.119   6211-6240/com.introtoandroid.samplesqlite D/CardsDataSource:  Insert id is 41
09-08 22:54:09.130   6211-6240/com.introtoandroid.samplesqlite D/CardsDataSource:  Insert id is 42
09-08 22:54:09.143   6211-6240/com.introtoandroid.samplesqlite D/CardsDataSource:  Insert id is 43
09-08 22:54:09.186   6211-6240/com.introtoandroid.samplesqlite D/CardsDataSource:  Insert id is 44
09-08 22:54:09.194   6211-6240/com.introtoandroid.samplesqlite D/CardsDataSource:  Insert id is 45
09-08 22:54:09.201   6211-6240/com.introtoandroid.samplesqlite D/CardsDataSource:  Insert id is 46
09-08 22:54:09.209   6211-6240/com.introtoandroid.samplesqlite D/CardsDataSource:  Insert id is 47
09-08 22:54:09.236   6211-6240/com.introtoandroid.samplesqlite D/CardsDataSource:  Insert id is 48
09-08 22:54:09.243   6211-6240/com.introtoandroid.samplesqlite D/CardsDataSource:  Insert id is 49
```

Figure 16.2 `logcat` output showing items inserted into the database.

Getting All Cards

Earlier, we mentioned the getAll() method that queries the database for all the cards in the cards table. Here is the implementation of the getAll() method:

```
public ArrayList<Card> getAll() {
    ArrayList<Card> cards = new ArrayList<>();
    Cursor cursor = null;
    try {
        cursor = db.query(CardsDBHelper.TABLE_CARDS,
                COLUMNS, null, null, null, null, null);
        if (cursor.getCount() > 0) {
            while (cursor.moveToNext()) {
                Card card = new Card();
                card.setId(cursor.getLong(cursor
                        .getColumnIndex(CardsDBHelper.COLUMN_ID)));
                card.setName(cursor.getString(cursor
                        .getColumnIndex(CardsDBHelper.COLUMN_NAME)));
                card.setColorResource(cursor
                        .getInt(cursor.getColumnIndex(CardsDBHelper
                                .COLUMN_COLOR_RESOURCE)));
                    cards.add(card);
            }
        }
    } catch (Exception e){
        Log.d(DEBUG_TAG, "Exception raised with a value of " + e);
    } finally{
        if (cursor != null) {
            cursor.close();
        }
    }
    return cards;
}
```

A query is performed on the cards table inside a try statement with a call to query() that returns all columns for the query as a Cursor object. A Cursor allows you to access the results of the database query. First, we ensure that the Cursor count is greater than zero, otherwise no results will be returned from the query. Next, we iterate through all the cursor objects by calling the `moveToNext()` method on the cursor, and for each database item, we create a `Card` data object from the data in the `Cursor` and set the `Cursor` data to `Card` data. We also handle any exceptions that we may have encountered, and finally the `Cursor` object is closed and all cards are returned.

Adding a New `Card`

You already know how to insert cards into the database because we did that to initialize the database. So adding a new `Card` is very similar to how we initialized the database. The `addCard()` method of the `SampleMaterialAdapter` class needs a slight modification. This method executes `AsyncTask` to add a new card in the background. Here is the updated implementation of the `addCard()` method creating a `CreateCardTask` and executing the task:

```
public void addCard(String name, int color) {
    Card card = new Card();
    card.setName(name);
    card.setColorResource(color);
    new CreateCardTask().execute(card);
}

private class CreateCardTask extends AsyncTask<Card, Void, Card> {
    @Override
    protected Card doInBackground(Card... cards) {
        cardsData.create(cards[0]);
        cardsList.add(cards[0]);
        return cards[0];
    }

    @Override
    protected void onPostExecute(Card card) {
        super.onPostExecute(card);
        ((SampleMaterialActivity) context).doSmoothScroll(getItemCount() - 1);
        notifyItemInserted(getItemCount());
        Log.d(DEBUG_TAG, "Card created with id " + card.getId() + ", name " +
                card.getName() + ", color " + card.getColorResource());
    }
}
```

The doInBackground() method makes a call to the create() method of the cardsData object, and in the onPostExecute() method, a call to the doSmoothScroll() method of the calling Activity is made, then the adapter is notified that a new Card has been inserted.

Updating a Card

To update a Card, we first need a way to keep track of the position of a Card within the list. This is not the same as the database id because the id of the item in the database is not the same as the position of the item in the list. The database increments the id of a Card, so each new Card has an id one higher than the previous Card. The RecyclerView list, on the other hand, shifts positions as items are added and removed from the list.

First, let's update the Card data object found in the Card.java file and add a new listPosition attribute with the appropriate getter and setter methods as shown here:

```
private int listPosition = 0;


public int getListPosition() {
    return listPosition;
}


public void setListPosition(int listPosition) {
    this.listPosition = listPosition;
}
```

Next, update the updateCard() method of the SampleMaterialAdapter class and implement an UpdateCardTask class that extends AsyncTask as follows:

```
public void updateCard(String name, int list_position) {
    Card card = new Card();
    card.setName(name);
    card.setId(getItemId(list_position));
    card.setListPosition(list_position);
    new UpdateCardTask().execute(card);
}


private class UpdateCardTask extends AsyncTask<Card, Void, Card> {
    @Override
    protected Card doInBackground(Card... cards) {
        cardsData.update(cards[0].getId(), cards[0].getName());
```

(*Continues*)

```
(Continued)
        cardsList.get(cards[0].getListPosition()).setName(cards[0].getName());
        return cards[0];
    }

    @Override
    protected void onPostExecute(Card card) {
        super.onPostExecute(card);
        Log.d(DEBUG_TAG, "list_position is " + card.getListPosition());
        notifyItemChanged(card.getListPosition());
    }
}
```

The UpdateCardTask calls the update() method of the cardsData object in the doInBackground() method and then updates the name of the corresponding Card in the cardsList object and returns the Card. The onPostExecute() method then notifies the adapter that the item has changed with the notifyItemChanged() method call.

Finally, the CardsData class needs to implement the update() method to update the particular Card in the database. Here is the update() method:

```
public void update(long id, String name) {
    String whereClause = CardsDBHelper.COLUMN_ID + "=" + id;
    Log.d(DEBUG_TAG, "Update id is " + String.valueOf(id));
    ContentValues values = new ContentValues();
    values.put(CardsDBHelper.COLUMN_NAME, name);
    db.update(CardsDBHelper.TABLE_CARDS, values, whereClause, null);
}
```

The update() method accepts id and name parameters. A whereClause is then constructed for matching the id of the Card with the appropriate id column in the database, and a new ContentValues object is created for adding the updated name for the particular Card to the appropriate name column. Finally, the update() method is executed on the database.

Deleting a Card

Now let's take a look at how to modify the deletion of cards. Remember the animateCircularDelete() method—this is where a Card was animated off the screen and deleted from the cardsList object. In the onAnimationEnd() method, construct a Card data object and pass that to the execute method of a DeleteCardTask object, which is an AsyncTask. Here are those implementations:

```
public void animateCircularDelete(final View view, final int list_position) {
    int centerX = view.getWidth();
    int centerY = view.getHeight();
    int startRadius = view.getWidth();
    int endRadius = 0;
    Animator animation = ViewAnimationUtils.createCircularReveal(view,
            centerX, centerY, startRadius, endRadius);

    animation.addListener(new AnimatorListenerAdapter() {
        @Override
        public void onAnimationEnd(Animator animation) {
            super.onAnimationEnd(animation);
            view.setVisibility(View.INVISIBLE);
            Card card = new Card();
            card.setId(getItemId(list_position));
            card.setListPosition(list_position);
            new DeleteCardTask().execute(card);
        }
    });
    animation.start();
}

private class DeleteCardTask extends AsyncTask<Card, Void, Card> {
    @Override
    protected Card doInBackground(Card... cards) {
        cardsData.delete(cards[0].getId());
        cardsList.remove(cards[0].getListPosition());
        return cards[0];
    }

    @Override
    protected void onPostExecute(Card card) {
        super.onPostExecute(card);
        notifyItemRemoved(card.getListPosition());
    }
}
```

The doInBackground() method of the DeleteCardTask calls the delete() method of the cardsData object and passes in the id of Card. Then the Card is removed from the cardsList object, and in the onPostExecute() method, the adapter is notified that an item has been removed by calling the notifyItemRemoved() method and passing in the list position of the Card that has been removed.

There is one last method to implement—the delete() method of the CardsData class. Here is that method:

```
public void delete(long cardId) {
    String whereClause = CardsDBHelper.COLUMN_ID + "=" + cardId;
    Log.d(DEBUG_TAG, "Delete position is " + String.valueOf(cardId));
    db.delete(CardsDBHelper.TABLE_CARDS, whereClause, null);
}
```

The delete() method of the CardsData class accepts an id of a Card, constructs a whereClause using that id, and then calls the delete() method on the cards table of the database, passing in the appropriate whereClause with the id of the Card to delete.

Summary

You now have a full implementation of a database that provides permanent storage for your application. In this chapter, you learned how to create a database. You also learned how to access the database for querying, inserting, updating, and deleting items from it. In addition, you also learned how to update the SampleMaterial application so that Card data is stored in a database. Finally, you learned how to perform your database operations off of the main UI thread by performing the operations in the background with an AsyncTask so as not to block the UI when running these blocking operations. You should now be ready to implement simple SQLite databases in your own applications.

Quiz Questions

1. What is the SQLiteDatabase method for creating a table?
2. What method provides access for reading and writing a database?
3. True or false: The async() method of an AsyncTask allows you to execute long-running operations off the main UI thread in the background.
4. True or false: The onAfterAsync() method of an AsyncTask allows you to execute UI methods after an AsyncTask completes.

Exercises

1. Read through the "Saving Data in SQL Databases" training in the Android documentation found here: *http://d.android.com/training/basics/data-storage/databases.html*.
2. Read through the "SQLiteDatabase" SDK reference to learn more about how to utilize a SQLite database here: *http://d.android.com/reference/android/database/sqlite/SQLiteDatabase.html*.
3. Modify the `SampleSQLite` application to support the deletion of all items from the database with a single database operation.

References and More Information

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http://d.android.com/tools/help/sqlite3.html
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Command Line Shell For SQLite:
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http://d.android.com/guide/topics/providers/content-providers.html
Android SDK Reference regarding the application `android.database.sqlite` package:
http://d.android.com/reference/android/database/sqlite/package-summary.html
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