

Android编程 (影印版)

第二版



*Programming*

# Android

O'REILLY®

東南大學出版社

*Zigurd Mednieks, Laird Dornin,  
G. Blake Meike & Masumi Nakamura 著*

第二版

---

# Android编程 (影印版)

## Programming Android

*Zigurd Mednieks, Laird Dornin,  
G. Blake Meike & Masumi Nakamura* 著

O'REILLY®

Beijing • Cambridge • Farnham • Köln • Sebastopol • Tokyo

O'Reilly Media, Inc. 授权东南大学出版社出版

南京 东南大学出版社

## 图书在版编目 (CIP) 数据

Android 编程: 第2版: 英文/(美)梅德尼克斯(Mednieks, Z.)等著. —影印本. —南京: 东南大学出版社, 2013.5

书名原文: Programming Android, 2E

ISBN 978-7-5641-4201-8

I. ① A… II. ①梅… III. ①移动终端—应用程序—程序设计—英文 IV. ① TN929.53

中国版本图书馆 CIP 数据核字 (2013) 第 097343 号

江苏省版权局著作权合同登记

图字: 10-2013-117 号

©2012 by O'Reilly Media, Inc.

Reprint of the English Edition, jointly published by O'Reilly Media, Inc. and Southeast University Press, 2013. Authorized reprint of the original English edition. 2013 O'Reilly Media, Inc., the owner of all rights to publish and sell the same.

All rights reserved including the right of reproduction in whole or in part in any form.

英文原版由 O'Reilly Media, Inc. 出版 2012。

英文影印版由东南大学出版社出版 2013。此影印版的出版和销售得到出版权和销售权的所有者——O'Reilly Media, Inc. 的许可。

版权所有, 未得书面许可, 本书的任何部分和全部不得以任何形式复制。

## Android 编程 第二版 (影印版)

出版发行: 东南大学出版社

地 址: 南京四牌楼 2 号 邮编: 210096

出 版 人: 江建中

网 址: <http://www.seupress.com>

电子邮件: [press@seupress.com](mailto:press@seupress.com)

印 刷: 扬中市印刷有限公司

开 本: 787 毫米 × 980 毫米 16 开本

印 张: 35.25

字 数: 690 千字

版 次: 2013 年 5 月第 1 版

印 次: 2013 年 5 月第 1 次印刷

书 号: ISBN 978-7-5641-4201-8

定 价: 78.00 元 (册)

本社图书若有印装质量问题, 请直接与营销部联系。电话 (传真): 025-83791830

---

# Preface

The purpose of this book is to enable you to create well-engineered Android applications that go beyond the scope of small example applications.

This book is for people coming to Android programming from a variety of backgrounds. If you have been programming iPhone or Mac OS applications in Objective-C, you will find coverage of Android tools and Java language features relevant to Android programming that will help you bring your knowledge of mobile application development to Android. If you are an experienced Java coder, you will find coverage of Android application architecture that will enable you to use your Java expertise in this newly vibrant world of client Java application development. In short, this is a book for people with some relevant experience in object-oriented languages, mobile applications, REST applications, and similar disciplines who want to go further than an introductory book or online tutorials will take them.

## How This Book Is Organized

We want to get you off to a fast start. The chapters in the first part of this book will step you through using the SDK tools so that you can access example code in this book and in the SDK, even as you expand your knowledge of SDK tools, Java, and database design. The tools and basics covered in the first part might be familiar enough to you that you would want to skip to Part II where we build foundational knowledge for developing larger Android applications.

The central part of this book is an example of an application that uses web services to deliver information to the user—something many applications have at their core. We present an application architecture, and a novel approach to using Android's framework classes that enables you to do this particularly efficiently. You will be able to use this application as a framework for creating your own applications, and as a tool for learning about Android programming.

In the final part of this book, we explore Android APIs in specific application areas: multimedia, location, sensors, and communication, among others, in order to equip you to program applications in your specific area of interest.

By the time you reach the end of this book, we want you to have gained knowledge beyond reference material and a walk-through of examples. We want you to have a point of view on how to make great Android applications.

## Conventions Used in This Book

The following typographical conventions are used in this book:

### *Italic*

Indicates new terms, URLs, email addresses, filenames, and file extensions

### **Constant width**

Used for program listings, as well as within paragraphs to refer to program elements such as variable or function names, databases, data types, environment variables, statements, and keywords

### **Constant width bold**

Shows commands or other text that should be typed literally by the user

### *Constant width italic*

Shows text that should be replaced with user-supplied values or by values determined by context



This icon signifies a tip, suggestion, or general note.



This icon indicates a warning or caution.

## Using Code Examples

This book is here to help you get your job done. In general, you may use the code in this book in your programs and documentation. You do not need to contact us for permission unless you're reproducing a significant portion of the code. For example, writing a program that uses several chunks of code from this book does not require permission. Selling or distributing a CD-ROM of examples from O'Reilly books does require permission. Answering a question by citing this book and quoting example code does not require permission. Incorporating a significant amount of example code from this book into your product's documentation does require permission.

We appreciate, but do not require, attribution. An attribution usually includes the title, author, publisher, and ISBN. For example: "*Programming Android, Second*

Edition by Zigurd Mednieks, Laird Dornin, G. Blake Meike, and Masumi Nakamura.  
Copyright 2012 O'Reilly Media, Inc., 978-1-449-31664-8.”

If you feel your use of code examples falls outside fair use or the permission given here, feel free to contact us at [permissions@oreilly.com](mailto:permissions@oreilly.com).

## Safari® Books Online



Safari Books Online ([www.safaribooksonline.com](http://www.safaribooksonline.com)) is an on-demand digital library that delivers expert content in both book and video form from the world's leading authors in technology and business.

Technology professionals, software developers, web designers, and business and creative professionals use Safari Books Online as their primary resource for research, problem solving, learning, and certification training.

Safari Books Online offers a range of product mixes and pricing programs for organizations, government agencies, and individuals. Subscribers have access to thousands of books, training videos, and prepublication manuscripts in one fully searchable database from publishers like O'Reilly Media, Prentice Hall Professional, Addison-Wesley Professional, Microsoft Press, Sams, Que, Peachpit Press, Focal Press, Cisco Press, John Wiley & Sons, Syngress, Morgan Kaufmann, IBM Redbooks, Packt, Adobe Press, FT Press, Apress, Manning, New Riders, McGraw-Hill, Jones & Bartlett, Course Technology, and dozens more. For more information about Safari Books Online, please visit us online.

## How to Contact Us

Please address comments and questions concerning this book to the publisher:

O'Reilly Media, Inc.  
1005 Gravenstein Highway North  
Sebastopol, CA 95472  
800-998-9938 (in the United States or Canada)  
707-829-0515 (international or local)  
707-829-0104 (fax)

We have a web page for this book, where we list errata, examples, and any additional information. You can access this page at [http://oreil.ly/prog\\_android\\_2e](http://oreil.ly/prog_android_2e).

To comment or ask technical questions about this book, send email to [bookquestions@oreilly.com](mailto:bookquestions@oreilly.com).

For more information about our books, courses, conferences, and news, see our website at <http://www.oreilly.com>.

Find us on Facebook: <http://facebook.com/oreilly>

Follow us on Twitter: <http://twitter.com/oreillymedia>

Watch us on YouTube: <http://www.youtube.com/oreillymedia>

## Acknowledgments

The authors have adapted portions of this book from their previously released title, *Android Application Development* (O'Reilly).

Drafts of this book were released on the O'Reilly Open Feedback Publishing System (OFPS) in order to get your feedback on whether and how we are meeting the goals for this book. We are very grateful for the readers who participated in OFPS, and we owe them much in correcting our errors and improving our writing. Open review of drafts will be part of future editions, and we welcome your views on every aspect of this book.

### Zigurd Mednieks

I am eternally grateful to Terry, my wife, and Maija and Charles, my children, who gave me the time to do this. This book exists because our agent, Carole Jelen, at Waterside Productions, whipped our proposal material into shape, and because Mike Hendrickson kicked off the project within O'Reilly. Brian Jepson and Andy Oram, our editors, kept this large troupe of authors unified in purpose and result. Thanks to Johan van der Hoeven, who provided review comments that contributed much to accuracy and clarity. Thanks to all the reviewers who used the Open Feedback Publishing System to help make this a better book.

### Laird Dornin

Thanks to my wonderful Norah for encouraging me to take part in this project, even though you had no idea of the amount of effort involved in writing a book. Cheers to trips to Acadia, trips to New Hampshire, and late nights writing. I'm glad this book did not stall our truly important project, the arrival of our beautiful daughter Claire. Thanks to Andy our editor, and my coauthors for giving me this opportunity. Thanks to Larry for reviewing and enabling me to work on this project. I'm glad that ideas I developed at SavaJe could find a voice in this book. Finally, thanks to our main reviewers Vijay and Johan, you both found solid ways to improve the content.

### G. Blake Meike

My thanks to our agent, Carole Jelen, Waterside Productions, without whom this book would never have been more than a good idea. Thanks, also, to editors Brian Jepson and Andy Oram, masters of the "gentle way." Everyone who reads this book benefits from the efforts of Johan van der Hoeven and Vijay Yellapragada, technical reviewers; Sumita Mukherji, Adam Zaremba, and the rest of the O'Reilly production team; and all those who used O'Reilly's OFPS to wade through early and nearly incomprehensible drafts, to produce salient comments and catch egregious errors. Thanks guys! Speaking of "thanks guys," it was quite an honor and certainly a pleasure to collaborate with my coauthors, Zigurd, Laird, and Masumi. Of course, last, best, and as ever, thanks and

love to my wife Catherine, who challenges me in the good times and provides support when it's dark. Yeah, I know, the bookcase still isn't done.

**Masumi Nakamura**

I would like to thank my friends and family for bearing with me as I worked on this and other projects. An especially big thank you to Jessamyn for dealing with me all these years. I also would like to thank Brian and Andy for getting us through the fine points of writing and publishing, as well as my coauthors for bringing me in to work on this piece. Also, a quick shout out to all the people at WHERE, Inc. who have been very supportive in my technological wanderings. Finally, a thank you to you, the readers, and all you developers working tirelessly to make Android a great platform to work on and enjoy using.



---

# Table of Contents

Preface .....	xiii
---------------	------

---

## Part I. Tools and Basics

<b>1. Installing the Android SDK and Prerequisites .....</b>	<b>3</b>
Installing the Android SDK and Prerequisites	3
The Java Development Kit (JDK)	4
The Eclipse Integrated Development Environment (IDE)	5
The Android SDK	7
Adding Build Targets to the SDK	8
The Android Developer Tools (ADT) Plug-in for Eclipse	9
Test Drive: Confirm That Your Installation Works	12
Making an Android Project	12
Making an Android Virtual Device (AVD)	16
Running a Program on an AVD	19
Running a Program on an Android Device	20
Troubleshooting SDK Problems: No Build Targets	21
Components of the SDK	21
The Android Debug Bridge (adb)	21
The Dalvik Debug Monitor Server (DDMS)	21
Components of the ADT Eclipse Plug-in	23
Android Virtual Devices	25
Other SDK Tools	26
Keeping Up-to-Date	27
Keeping the Android SDK Up-to-Date	28
Keeping Eclipse and the ADT Plug-in Up-to-Date	28
Keeping the JDK Up-to-Date	29
Example Code	30
SDK Example Code	30
Example Code from This Book	30
On Reading Code	31

<b>2. Java for Android .....</b>	<b>33</b>
Android Is Reshaping Client-Side Java	33
The Java Type System	34
Primitive Types	34
Objects and Classes	35
Object Creation	35
The Object Class and Its Methods	37
Objects, Inheritance, and Polymorphism	39
Final and Static Declarations	41
Abstract Classes	45
Interfaces	46
Exceptions	48
The Java Collections Framework	51
Garbage Collection	55
Scope	55
Java Packages	56
Access Modifiers and Encapsulation	57
Idioms of Java Programming	59
Type Safety in Java	59
Using Anonymous Classes	62
Modular Programming in Java	64
Basic Multithreaded Concurrent Programming in Java	67
Synchronization and Thread Safety	68
Thread Control with wait() and notify() Methods	71
Synchronization and Data Structures	72
<b>3. The Ingredients of an Android Application .....</b>	<b>75</b>
Traditional Programming Models Compared to Android	75
Activities, Intents, and Tasks	77
Other Android Components	79
Service	79
Content Providers	80
BroadcastReceiver	83
Component Life Cycles	83
The Activity Life Cycle	83
On Porting Software to Android	85
Static Application Resources and Context	86
Organizing Java Source	87
Resources	88
Application Manifests	90
Initialization Parameters in AndroidManifest.xml	91
Packaging an Android Application: The .apk File	94
The Android Application Runtime Environment	94

The Dalvik VM	95
Zygote: Forking a New Process	95
Sandboxing: Processes and Users	95
The Android Libraries	96
Extending Android	98
The Android Application Template	98
Overrides and Callbacks	99
Polymorphism and Composition	101
Extending Android Classes	102
Concurrency in Android	104
AsyncTask and the UI Thread	105
Threads in an Android Process	116
Serialization	118
Java Serialization	119
Parcelable	120
Classes That Support Serialization	124
Serialization and the Application Life Cycle	125
<b>4. Getting Your Application into Users' Hands .....</b>	<b>127</b>
Application Signing	127
Public Key Encryption and Cryptographic Signing	127
How Signatures Protect Software Users, Publishers, and	
Secure Communications	129
Signing an Application	130
Placing an Application for Distribution in the Android Market	135
Becoming an Official Android Developer	135
Uploading Applications in the Market	136
Getting Paid	138
Alternative Distribution	139
Verizon Applications for Android	139
Amazon Applications for Android	141
Google Maps API Keys	143
Specifying API-Level Compatibility	144
Compatibility with Many Kinds of Screens	144
Testing for Screen Size Compatibility	145
Resource Qualifiers and Screen Sizes	145
<b>5. Eclipse for Android Software Development .....</b>	<b>147</b>
Eclipse Concepts and Terminology	148
Plug-ins	148
Workspaces	149
Java Environments	150
Projects	151

Builders and Artifacts	151
Extensions	151
Associations	153
Eclipse Views and Perspectives	153
The Package Explorer View	154
The Task List View	154
The Outline View	155
The Problems View	155
Java Coding in Eclipse	156
Editing Java Code and Code Completion	156
Refactoring	156
Eclipse and Android	158
Preventing Bugs and Keeping Your Code Clean	158
Static Analyzers	158
Applying Static Analysis to Android Code	163
Limitations of Static Analysis	166
Eclipse Idiosyncrasies and Alternatives	166

---

## Part II. About the Android Framework

<b>6. Building a View .....</b>	<b>171</b>
Android GUI Architecture	171
The Model	171
The View	172
The Controller	173
Putting It Together	173
Assembling a Graphical Interface	175
Wiring Up the Controller	180
Listening to the Model	182
Listening for Touch Events	187
Multiple Pointers and Gestures	190
Listening for Key Events	192
Choosing an Event Handler	193
Advanced Wiring: Focus and Threading	195
The Menu and the Action Bar	199
View Debugging and Optimization	202
<b>7. Fragments and Multiplatform Support .....</b>	<b>205</b>
Creating a Fragment	206
Fragment Life Cycle	209
The Fragment Manager	210
Fragment Transactions	211

The Support Package	216
Fragments and Layout	217
<b>8. Drawing 2D and 3D Graphics</b>	<b>225</b>
Rolling Your Own Widgets	225
Layout	226
Canvas Drawing	231
Drawables	242
Bitmaps	247
Bling	248
Shadows, Gradients, Filters, and Hardware Acceleration	251
Animation	253
OpenGL Graphics	258
<b>9. Handling and Persisting Data</b>	<b>263</b>
Relational Database Overview	263
SQLite	264
The SQL Language	264
SQL Data Definition Commands	265
SQL Data Manipulation Commands	268
Additional Database Concepts	270
Database Transactions	271
Example Database Manipulation Using sqlite3	271
SQL and the Database-Centric Data Model for Android Applications	275
The Android Database Classes	276
Database Design for Android Applications	277
Basic Structure of the SimpleVideoDbHelper Class	277
Using the Database API: MJAndroid	280
Android and Social Networking	280
The Source Folder (src)	282
Loading and Starting the Application	283
Database Queries and Reading Data from the Database	283
Modifying the Database	287
<hr/>	
<b>Part III. A Skeleton Application for Android</b>	
<b>10. A Framework for a Well-Behaved Application</b>	<b>295</b>
Visualizing Life Cycles	296
Visualizing the Activity Life Cycle	296
Visualizing the Fragment Life Cycle	308
The Activity Class and Well-Behaved Applications	311
The Activity Life Cycle and the User Experience	311

Life Cycle Methods of the Application Class	312
<b>11. Building a User Interface</b>	<b>315</b>
Top-Level Design	316
Fragment, Activity, and Scalable Design	317
Visual Editing of User Interfaces	319
Starting with a Blank Slate	319
Laying Out the Fragments	323
Lay Out Fragments Using the Visual Editor	324
Multiple Layouts	325
Folding and Unfolding a Scalable UI	326
Decisions about Screen Size and Resolution	326
Delegating to Fragment Classes	330
Making Activity, Fragment, Action Bar, and Multiple Layouts Work Together	333
Action Bar	333
Tabs and Fragments	333
The Other Activity	336
<b>12. Using Content Providers</b>	<b>341</b>
Understanding Content Providers	342
Implementing a Content Provider	343
Browsing Video with Finch	344
Defining a Provider Public API	345
Defining the CONTENT_URI	346
Creating the Column Names	348
Declaring Column Specification Strings	348
Writing and Integrating a Content Provider	350
Common Content Provider Tasks	350
File Management and Binary Data	352
Android MVC and Content Observation	354
A Complete Content Provider: The SimpleFinchVideoContentProvider Code	355
The SimpleFinchVideoContentProvider Class and Instance Variables	355
Implementing the onCreate Method	357
Implementing the getType Method	358
Implementing the Provider API	358
Determining How Often to Notify Observers	363
Declaring Your Content Provider	363
<b>13. A Content Provider as a Facade for a RESTful Web Service</b>	<b>365</b>
Developing RESTful Android Applications	366
A “Network MVC”	367

Summary of Benefits	369
Code Example: Dynamically Listing and Caching YouTube Video Content	370
Structure of the Source Code for the Finch YouTube Video Example	371
Stepping Through the Search Application	372
Step 1: Our UI Collects User Input	373
Step 2: Our Controller Listens for Events	373
Step 3: The Controller Queries the Content Provider with a managedQuery on the Content Provider/Model	374
Step 4: Implementing the RESTful Request	374
Constants and Initialization	375
Creating the Database	375
A Networked Query Method	375
insert and ResponseHandlers	388
File Management: Storing Thumbnails	390

---

## Part IV. Advanced Topics

<b>14. Search</b>	<b>395</b>
Search Interface	395
Search Basics	395
Search Dialog	402
Search Widget	403
Query Suggestions	404
Recent Query Suggestions	404
Custom Query Suggestions	405
<b>15. Location and Mapping</b>	<b>411</b>
Location-Based Services	412
Mapping	413
The Google Maps Activity	413
The MapView and MapActivity	414
Working with MapViews	415
MapView and MyLocationOverlay Initialization	415
Pausing and Resuming a MapActivity	418
Controlling the Map with Menu Buttons	419
Controlling the Map with the Keypad	421
Location Without Maps	422
The Manifest and Layout Files	422
Connecting to a Location Provider and Getting Location Updates	423
Updating the Emulated Location	426
StreetView	430

<b>16. Multimedia .....</b>	<b>433</b>
Audio and Video	433
Playing Audio and Video	434
Audio Playback	435
Video Playback	437
Recording Audio and Video	438
Audio Recording	439
Video Recording	442
Stored Media Content	443
 <b>17. Sensors, NFC, Speech, Gestures, and Accessibility .....</b>	 <b>445</b>
Sensors	445
Position	447
Other Sensors	449
Near Field Communication (NFC)	450
Reading a Tag	451
Writing to a Tag	457
P2P Mode and Beam	459
Gesture Input	461
Accessibility	463
 <b>18. Communication, Identity, Sync, and Social Media .....</b>	 <b>467</b>
Account Contacts	467
Authentication and Synchronization	470
Authentication	471
Synchronization	478
Bluetooth	485
The Bluetooth Protocol Stack	485
BlueZ: The Linux Bluetooth Implementation	487
Using Bluetooth in Android Applications	487
 <b>19. The Android Native Development Kit (NDK) .....</b>	 <b>501</b>
Native Methods and JNI Calls	502
Conventions in Native Method Calls	502
Conventions on the Java Side	503
The Android NDK	504
Setting Up the NDK Environment	504
Editing C/C++ Code in Eclipse	504
Compiling with the NDK	505
JNI, NDK, and SDK: A Sample App	506
Native Libraries and Headers Provided by the NDK	507
Building Your Own Custom Library Modules	509
Native Activities	512



<b>Index .....</b>	<b>519</b>
--------------------	------------