iPhone SDK 3 Programming

Advanced Mobile Development for Apple iPhone and iPod touch

Maher Ali, PhD
Bell Labs, Alcatel-Lucent
iPhone SDK 3 Programming
2.7 Exceptions and Errors  
  2.7.1 Exceptions 38  
  2.7.2 Errors 43  
2.8 Key-value coding (KVC)  
  2.8.1 An example illustrating KVC 46  
2.9 Multithreading 51  
2.10 Notifications 55  
2.11 The Objective-C Runtime  
  2.11.1 Required header files 57  
  2.11.2 The NSObject class 58  
  2.11.3 Objective-C methods 59  
  2.11.4 Examples 62  
2.12 Summary 79  
Problems 79

3 Collections 83  
3.1 Arrays 83  
  3.1.1 Immutable copy 86  
  3.1.2 Mutable copy 88  
  3.1.3 Deep copy 89  
  3.1.4 Sorting an array 93  
3.2 Sets 96  
  3.2.1 Immutable sets 97  
  3.2.2 Mutable sets 99  
  3.2.3 Additional important methods 100  
3.3 Dictionaries 101  
  3.3.1 Additional important methods 103  
3.4 Summary 103  
Problems 104

4 Anatomy of an iPhone Application 105  
4.1 Hello World Application 105  
  4.1.1 Create a main.m file 105  
  4.1.2 Create the application delegate class 106  
  4.1.3 Create the user interface subclasses 107  
4.2 Building the Hello World Application 108  
4.3 Summary 113  
Problems 113

5 The View 115  
5.1 View Geometry 115  
  5.1.1 Useful geometric type definitions 115  
  5.1.2 The UIScreen class 117  
  5.1.3 The frame and center properties 118
5.1.4 The bounds property 119
5.2 The View Hierarchy 121
5.3 The Multitouch Interface 121
  5.3.1 The UITapGestureRecognizer class 122
  5.3.2 The UIEvent class 123
  5.3.3 The UIResponder class 123
  5.3.4 Handling a swipe 128
  5.3.5 More advanced gesture recognition 132
5.4 Animation 137
  5.4.1 Using the UIView class animation support 137
  5.4.2 Sliding view 141
  5.4.3 Flip animation 142
  5.4.4 Transition animation 142
5.5 Drawing 145
5.6 Summary 147
Problems 147

6 Controls 149
6.1 The Foundation of all Controls 149
  6.1.1 UIControl attributes 149
  6.1.2 Target-action mechanism 150
6.2 The Text Field 153
  6.2.1 Interacting with the keyboard 155
  6.2.2 The delegate 158
  6.2.3 Creating and working with a UITextField 159
6.3 Sliders 160
6.4 Switches 161
6.5 Buttons 163
6.6 Segmented Controls 164
6.7 Page Controls 167
6.8 Date Pickers 168
6.9 Summary 170
Problems 170

7 View Controllers 171
7.1 The Simplest View Controller 171
  7.1.1 The view controller 171
  7.1.2 The view 173
  7.1.3 The application delegate 174
  7.1.4 Summary: creating a simple MVC application 175
7.2 Radio Interfaces 177
  7.2.1 A detailed example 177
  7.2.2 Some comments on tab bar controllers 182
7.3 Navigation Controllers 186
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>File Management</td>
<td>305</td>
</tr>
<tr>
<td>10.1</td>
<td>The Home Directory</td>
<td>305</td>
</tr>
<tr>
<td>10.2</td>
<td>Enumerating a Directory</td>
<td>306</td>
</tr>
<tr>
<td>10.3</td>
<td>Creating and Deleting a Directory</td>
<td>308</td>
</tr>
<tr>
<td>10.4</td>
<td>Creating Files</td>
<td>309</td>
</tr>
<tr>
<td>10.5</td>
<td>Retrieving and Changing Attributes</td>
<td>312</td>
</tr>
<tr>
<td>10.5.1</td>
<td>Retrieving attributes</td>
<td>314</td>
</tr>
<tr>
<td>10.5.2</td>
<td>Changing attributes</td>
<td>315</td>
</tr>
<tr>
<td>10.6</td>
<td>Working with Resources and Low-level File Access</td>
<td>317</td>
</tr>
<tr>
<td>10.7</td>
<td>Summary</td>
<td>320</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>321</td>
</tr>
<tr>
<td>11</td>
<td>Working with Databases</td>
<td>323</td>
</tr>
<tr>
<td>11.1</td>
<td>Basic Database Operations</td>
<td>323</td>
</tr>
<tr>
<td>11.1.1</td>
<td>Opening, creating, and closing databases</td>
<td>325</td>
</tr>
<tr>
<td>11.1.2</td>
<td>Table operations</td>
<td>325</td>
</tr>
<tr>
<td>11.2</td>
<td>Processing Row Results</td>
<td>327</td>
</tr>
<tr>
<td>11.3</td>
<td>Prepared Statements</td>
<td>330</td>
</tr>
<tr>
<td>11.3.1</td>
<td>Preparation</td>
<td>330</td>
</tr>
<tr>
<td>11.3.2</td>
<td>Execution</td>
<td>331</td>
</tr>
<tr>
<td>11.3.3</td>
<td>Finalization</td>
<td>331</td>
</tr>
<tr>
<td>11.3.4</td>
<td>Putting it together</td>
<td>331</td>
</tr>
<tr>
<td>11.4</td>
<td>User-defined Functions</td>
<td>333</td>
</tr>
<tr>
<td>11.5</td>
<td>Storing BLOBs</td>
<td>337</td>
</tr>
<tr>
<td>11.6</td>
<td>Retrieving BLOBs</td>
<td>341</td>
</tr>
<tr>
<td>11.7</td>
<td>Summary</td>
<td>343</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>343</td>
</tr>
<tr>
<td>12</td>
<td>XML Processing</td>
<td>345</td>
</tr>
<tr>
<td>12.1</td>
<td>XML and RSS</td>
<td>345</td>
</tr>
<tr>
<td>12.1.1</td>
<td>XML</td>
<td>345</td>
</tr>
<tr>
<td>12.1.2</td>
<td>RSS</td>
<td>347</td>
</tr>
<tr>
<td>12.1.3</td>
<td>Configuring the XCode project</td>
<td>350</td>
</tr>
<tr>
<td>12.2</td>
<td>Document Object Model (DOM)</td>
<td>351</td>
</tr>
<tr>
<td>12.3</td>
<td>Simple API for XML (SAX)</td>
<td>358</td>
</tr>
<tr>
<td>12.4</td>
<td>An RSS Reader Application</td>
<td>367</td>
</tr>
<tr>
<td>12.5</td>
<td>Putting It Together</td>
<td>369</td>
</tr>
<tr>
<td>12.6</td>
<td>Summary</td>
<td>371</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>371</td>
</tr>
<tr>
<td>13</td>
<td>Location Awareness</td>
<td>373</td>
</tr>
<tr>
<td>13.1</td>
<td>The Core Location Framework</td>
<td>373</td>
</tr>
<tr>
<td>13.1.1</td>
<td>The CLLocation class</td>
<td>375</td>
</tr>
<tr>
<td>13.2</td>
<td>A Simple Location-aware Application</td>
<td>377</td>
</tr>
</tbody>
</table>
13.3 Google Maps API
  13.3.1 A geocoding application
13.4 A Tracking Application with Maps
13.5 Working with ZIP Codes
13.6 Working with the Map Kit API
  13.6.1 The MKMapView class
  13.6.2 The MKCoordinateRegion structure
  13.6.3 The MKAnnotation protocol
  13.6.4 The MKAnnotationView class
  13.6.5 The MKUserLocation class
  13.6.6 The MKPinAnnotationView class
13.7 Summary
Problems

14 Working with Devices
  14.1 Working with the Accelerometer
    14.1.1 Basic accelerometer values
    14.1.2 Example
  14.2 Working with Audio
    14.2.1 Playing short audio files
    14.2.2 Recording audio files
    14.2.3 Playing audio files
    14.2.4 Using the media picker controller
    14.2.5 Searching the iPod library
  14.3 Playing Video
    14.3.1 Using the MPMoviePlayerController class
  14.4 Accessing Device Information
  14.5 Taking and Selecting Pictures
    14.5.1 Overall approach
    14.5.2 Detailed example
  14.6 Monitoring Device Battery
    14.6.1 Battery level
    14.6.2 Battery state
    14.6.3 Battery state and level notifications
    14.6.4 Putting it together
  14.7 Accessing the Proximity Sensor
    14.7.1 Enabling proximity monitoring
    14.7.2 Subscribing to proximity change notification
    14.7.3 Retrieving the proximity state
  14.8 Summary
Problems

15 Internationalization
  15.1 String Localization
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.2</td>
<td>Date Formatting</td>
<td>435</td>
</tr>
<tr>
<td>15.2.1</td>
<td>Custom formats</td>
<td>437</td>
</tr>
<tr>
<td>15.3</td>
<td>Number Formatting</td>
<td>438</td>
</tr>
<tr>
<td>15.4</td>
<td>Sorted List of Countries</td>
<td>441</td>
</tr>
<tr>
<td>15.5</td>
<td>Summary</td>
<td>441</td>
</tr>
<tr>
<td>Problems</td>
<td></td>
<td>441</td>
</tr>
<tr>
<td>16</td>
<td>Custom UI Components</td>
<td>443</td>
</tr>
<tr>
<td>16.1</td>
<td>Text Field Alert View</td>
<td>443</td>
</tr>
<tr>
<td>16.2</td>
<td>Table Alert View</td>
<td>447</td>
</tr>
<tr>
<td>16.3</td>
<td>Progress Alert View</td>
<td>452</td>
</tr>
<tr>
<td>16.4</td>
<td>Summary</td>
<td>456</td>
</tr>
<tr>
<td>Problems</td>
<td></td>
<td>456</td>
</tr>
<tr>
<td>17</td>
<td>Advanced Networking</td>
<td>459</td>
</tr>
<tr>
<td>17.1</td>
<td>Determining Network Connectivity</td>
<td>459</td>
</tr>
<tr>
<td>17.1.1</td>
<td>Determining network connectivity via EDGE or GPRS</td>
<td>460</td>
</tr>
<tr>
<td>17.1.2</td>
<td>Determining network connectivity in general</td>
<td>461</td>
</tr>
<tr>
<td>17.1.3</td>
<td>Determining network connectivity via WiFi</td>
<td>461</td>
</tr>
<tr>
<td>17.2</td>
<td>Uploading Multimedia Content</td>
<td>462</td>
</tr>
<tr>
<td>17.3</td>
<td>Computing MD5 Hash Value</td>
<td>465</td>
</tr>
<tr>
<td>17.4</td>
<td>Multithreaded Downloads</td>
<td>467</td>
</tr>
<tr>
<td>17.4.1</td>
<td>The application</td>
<td>467</td>
</tr>
<tr>
<td>17.5</td>
<td>Push Notification</td>
<td>474</td>
</tr>
<tr>
<td>17.5.1</td>
<td>Configuring push notification on the server</td>
<td>474</td>
</tr>
<tr>
<td>17.5.2</td>
<td>Configuring the client</td>
<td>481</td>
</tr>
<tr>
<td>17.5.3</td>
<td>Coding the client</td>
<td>484</td>
</tr>
<tr>
<td>17.5.4</td>
<td>Coding the server</td>
<td>487</td>
</tr>
<tr>
<td>17.6</td>
<td>Sending Email</td>
<td>487</td>
</tr>
<tr>
<td>17.6.1</td>
<td>Using the mail composition view controller</td>
<td>488</td>
</tr>
<tr>
<td>17.7</td>
<td>Summary</td>
<td>490</td>
</tr>
<tr>
<td>Problems</td>
<td></td>
<td>491</td>
</tr>
<tr>
<td>18</td>
<td>Working with the Address Book Database</td>
<td>493</td>
</tr>
<tr>
<td>18.1</td>
<td>Introduction</td>
<td>493</td>
</tr>
<tr>
<td>18.2</td>
<td>Property Types</td>
<td>494</td>
</tr>
<tr>
<td>18.3</td>
<td>Accessing Single-Value Properties</td>
<td>494</td>
</tr>
<tr>
<td>18.3.1</td>
<td>Retrieving single-value properties</td>
<td>495</td>
</tr>
<tr>
<td>18.3.2</td>
<td>Setting single-value properties</td>
<td>496</td>
</tr>
<tr>
<td>18.4</td>
<td>Accessing Multi-Value Properties</td>
<td>496</td>
</tr>
<tr>
<td>18.4.1</td>
<td>Retrieving multi-value properties</td>
<td>496</td>
</tr>
<tr>
<td>18.4.2</td>
<td>Setting multi-value properties</td>
<td>499</td>
</tr>
<tr>
<td>18.5</td>
<td>Person and Group Records</td>
<td>500</td>
</tr>
<tr>
<td>18.6</td>
<td>Address Book</td>
<td>501</td>
</tr>
</tbody>
</table>
## 21 Copy and Paste

21.1 Pasteboards
- 21.1.1 System pasteboards
- 21.1.2 Creating pasteboards
- 21.1.3 Properties of a pasteboard

21.2 Pasteboard Items
- 21.2.1 Pasteboard items
- 21.2.2 Manipulating pasteboard items

21.3 The Editing Menu
- 21.3.1 The standard editing actions
- 21.3.2 The UIMenuController class
- 21.3.3 The role of the view controller

21.4 Putting it Together
- 21.4.1 The image view
- 21.4.2 The view controller

21.5 Summary

Problems

## Appendices

A Saving and Restoring App State

B Invoking External Applications

C App Store Distribution

D Using XCode

- D.1 XCode Shortcuts
- D.2 Creating Custom Templates
  - D.2.1 Changing template macro definitions
- D.3 Build-Based Configurations
- D.4 Using Frameworks

E Unit Testing

- E.1 Adding a Unit Test Target
- E.2 Adapting to Foundation
- E.3 The Model
- E.4 Writing Unit Tests for the Employee Class
  - E.4.1 The setUp and tearDown methods
  - E.4.2 Testing for equality
  - E.4.3 Testing for nullity
Welcome to *iPhone SDK 3 Programming*, an introductory text to the development of mobile applications for the iPhone and the iPod touch. This text covers a wide variety of essential and advanced topics, including:

- The Objective-C programming language and runtime
- Collections
- Cocoa Touch
- Interface Builder
- Building advanced mobile user interfaces
- Core Animation and Quartz 2D
- Model-view-controller (MVC) designs
- Table views
- Core Data
- File management
- Parsing XML documents using SAX and DOM
- Working with the Map Kit API
- Push notification
- Working with the address book
- Consuming RESTful web services
- Building advanced location-based applications
- Developing database applications using the SQLite engine
- Cut, copy, and paste
- Undo management
- Unit testing
- Advanced networking
- Internationalization
- Building multimedia applications
Is this book for you?

This book is aimed primarily at application developers with a basic understanding of the C language and object orientation concepts such as encapsulation and polymorphism. You don’t need to be an expert C coder to follow this book. All you need is a basic understanding of structures, pointers, and functions. That said, you will find coverage of general topics such as databases and XML processing. These topics are covered assuming basic knowledge.

What else do you need?

To master iPhone SDK programming, you will need the following:

- Intel-based Mac running Mac OS X Leopard.
- Optional: membership of the iPhone Developer Program so that you can use the device for development. (You will need to pay a fee for membership.)
- Source code. The source code of the applications illustrated in this book is available online at: http://code.google.com/p/iphone3/.

Conventions used in this book

Constant width typeface is used for:

- Code examples and fragments.
- Anything that might appear in a program, including operators, method names, function names, class names, and literals.

Constant-width bold is used for:

- C, Objective-C, SQL, HTML, and XML keywords whether in text or in program listing.

Italic is used for:

- New terms and concepts when they are introduced.
- Specifying emphasis in text.

Organization

Chapter 1 This chapter serves as a quick introduction to the tools bundled with the SDK. It also shows you the basic development phases that include coding, UI design, and debugging.

Chapter 2 This chapter presents the main features of the Objective-C language under the Cocoa environment. We introduce the main concepts behind classes in Objective-C. You will learn how to declare a new class, define it, and use it from within other classes. You will also be
exposed to important Cocoa classes and data types. You will learn about memory management in the iPhone OS. You will learn how to create new objects as well as how to deallocate them. You will also learn about your responsibility when obtaining objects from Cocoa frameworks or other frameworks. We also introduce the topic of Objective-C protocols. You will learn how to adopt protocols and how to declare new ones as well. This chapter also covers language features such as properties, categories, and posing. Exceptions and error handling techniques are both covered in this chapter, and you will be exposed to the concept of key-value coding (KVC). You will also learn how to utilize multithreading, use notifications, and will be exposed to the Objective-C runtime system.

**Chapter 3** This chapter addresses the topic of collections in Cocoa. It discusses arrays, sets, and dictionaries. You will learn about immutable and mutable collections, the different approaches used for copying collections, and several sorting techniques.

**Chapter 4** In this chapter, we discuss the basic steps needed to build a simple iPhone application. First, we demonstrate the basic structure of a simple iPhone application and then we show the steps needed to develop the application using XCode.

**Chapter 5** This chapter explains the main concepts behind views. You will learn about view geometry, view hierarchy, the multitouch interface, animation, and basic Quartz 2D drawing.

**Chapter 6** In this chapter, you will learn about the base class for all controls, UIControl, and the important target-action mechanism. This chapter also presents several important graphical controls that can be used in building attractive iPhone applications.

**Chapter 7** In this chapter, you will learn about the available view controllers that are provided to you in the iPhone SDK. Although you can build iPhone applications without the use of these view controllers, you shouldn’t. As you will see in this chapter, view controllers greatly simplify your application. This chapter provides a gentle introduction to view controllers. After that, detailed treatment of tab bar controllers, navigation controllers, and modal view controllers is provided.

**Chapter 8** In this chapter, we present several important subclasses of the UIView class. We discuss picker views and show how they can be used for item selection. We investigate progress views and also talk about activity indicator views. After that, we show how to use scroll views in order to display large views. Next, we present text views used in displaying multiline text. After that, we show how to use alert views for the display of alert messages to the user. Similar to alert views are action sheets which are also discussed. We also deal with several aspects of web views.

**Chapter 9** This chapter will take you through a step-by-step journey to the world of table views. We start by presenting an overview of the main concepts behind table views. After that, we present a simple table view application and discuss the mandatory methods you need to implement in order to populate and respond to users’ interactions with the table view. We show how easy it is to add images to table rows. We introduce the concept of sections and provide a table view application that has sections, with section headers and footers. We introduce the
concept of editing a table view. An application that allows the user to delete rows is presented and the main ideas are clarified. We address the insertion of new rows in a table view. An application is discussed that presents a data entry view to the user and adds that new data to the table’s rows. We continue our discussion of the editing mode and present an application for reordering table entries. The main concepts of reordering rows are presented. We discuss the mechanism for presenting hierarchical information to the user. An application that uses table views to present three levels of hierarchy is discussed. We deal with grouped table views through an example. After that, we present the main concepts behind indexed table views. Next, we present a dynamic table view controller class which can be used to show cells with varying heights. Finally, we address the issue of turning the text color to white when a custom cell is selected.

Chapter 10  This chapter covers the topic of file management. Here, you will learn how to use both high- and low-level techniques for storing/retrieving data to/from files. First, we talk about the Home directory of the application. Next, we show how to enumerate the contents of a given directory using the high-level methods of NSFileManager. You will learn more about the structure of the Home directory and where you can store files. After that, you will learn how to create and delete directories. Next, we cover the creation of files. We also cover the topic of file and directory attributes. You will learn how to retrieve and set specific file/directory attributes in this chapter. We also demonstrate the use of application bundles and low-level file access.

Chapter 11  In this chapter, we will cover the basics of the SQLite database engine that is available to you, using the iPhone SDK. SQLite is an embedded database in the sense that there is no server running, and the database engine is linked to your application. First, we describe basic SQL statements and their implementation using SQLite function calls. Second, we discuss handling of result sets generated by SQL statements. Third, we address the topic of prepared statements. Fourth, we talk about extensions to the SQLite API through the use of user-defined functions. Finally, we present a detailed example for storing and retrieving BLOBs to/from the database.

Chapter 12  In this chapter, you will learn how to effectively use XML in your iPhone application. The chapter follows the same theme used in other chapters and exposes the main concepts through a working iPhone application: an RSS feed reader. First, we explain the main concepts behind XML and RSS. Next, we present a detailed discussion of DOM and SAX parsing. After that, we present a table-based RSS reader application. Finally, we provide a summary of the main steps you need to take in order to effectively harness the power of XML from within your native iPhone application.

Chapter 13  In this chapter, we will address the topic of location awareness. First, we will talk about the Core Location framework and how to use it to build location-aware applications. After that, we will discuss a simple location-aware application. Next, we cover the topic of geocoding. You will learn how to translate postal addresses into geographical locations. You will also learn how to sample movement of the device and display that information on maps. Next, we discuss how to relate ZIP codes to geographical information. Finally, we show you how to utilize the Map Kit API to add an interactive map to your view hierarchy.
Chapter 14 In this chapter, we demonstrate the use of the several devices available on the iPhone.  
We discuss the use of the accelerometer, show how to play small sound files, and show how to 
play video files. After that, we discuss how to obtain iPhone/iPod touch device information. 
Using the built-in camera and the photo library are also discussed in this chapter. After that, 
we show you how to obtain state information regarding the battery of the device. Finally, we 
discuss the proximity sensor.

Chapter 15 In this chapter, we start by looking at a step-by-step procedure for localizing strings for 
a set of supported languages. Next, we look at date formatting. After that, we cover formatting 
currencies and numbers. Finally, we discuss how to generate a sorted list of countries of the 
world.

Chapter 16 In this chapter, we show how to marry various UI components and build custom 
reusable ones. First, we show how to build an alert view with a text field in it. Next, we 
present a table view inside an alert view. Finally, we show how to build a progress alert view.

Chapter 17 This chapter addresses several advanced networking topics. We start by looking at 
how we can determine network connectivity of the device. After that, we tackle the issue 
of uploading multimedia content (e.g., photos) to remote servers. Next, we present a category 
on NSString that allows you to easily compute the MD5 digest of a string. This is important 
as some services, such as Flickr, require posting parameters with the appropriate signature. 
After that, we show you how to present a responsive table view whose data rows are fed 
from the Internet without sacrificing the user experience. Next, we address the topic of push 
notification. Finally, we discuss sending email from within your iPhone application.

Chapter 18 In this chapter, we discuss the foundation of the address book API and several 
UI elements that can be used to modify the contacts database. First, we provide a brief 
introduction to the subject. Next, we discuss property types. After that, we show how to 
access single- and multi-value properties. Next, we go into the details of the person record 
and the address book. Issues related to multithreading and identifiers are then addressed. After 
covering the foundation of the address book API, we provide several sample applications.

Chapter 19 In this chapter, you learn how to use the Core Data framework in your application. 
First, you learn about the main components in the Core Data application. Next, we talk about 
the major classes in the Core Data framework. After that, you learn how to use the graphical 
modeling tool to build a data model. Next, we address the basic operations in persistence 
storage using Core Data. After that, we show how to use relationships in the Core Data model. 
Finally, we present a search application that utilizes Core Data for storage.

Chapter 20 In this chapter, you learn about undo management support in the iPhone OS. First, we 
discuss the basic steps needed to utilize undo management. After that, we present a detailed 
example that shows how to use undo management. Finally, we summarize the main rules in 
using the undo capabilities in an application.

Chapter 21 This chapter examines the copy and paste capabilities of the iPhone OS and the 
supporting APIs. We start by discussing pasteboards. Next, you learn about pasteboard items