

iPhone SDK 3 Programming

Advanced Mobile Development for Apple
iPhone and iPod touch

Maher Ali, PhD

Bell Labs, Alcatel-Lucent



A John Wiley and Sons, Ltd, Publication

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CONTENTS

Preface	xv
1 Getting Started	1
1.1 SDK and IDE Basics	1
1.1.1 Obtaining and installing the SDK	1
1.1.2 Creating a project	2
1.1.3 Familiarizing yourself with the IDE	3
1.1.4 Looking closely at the generated code	5
1.2 Creating Interfaces	6
1.2.1 Interface Builder	7
1.3 Using the Debugger	14
1.4 Getting More Information	15
1.5 Summary	16
Problems	17
2 Objective-C and Cocoa	19
2.1 Classes	20
2.1.1 Class declaration	20
2.1.2 How do I use other declarations?	21
2.1.3 Class definition	22
2.1.4 Method invocation and definition	22
2.1.5 Important types	23
2.1.6 Important Cocoa classes	24
2.2 Memory Management	24
2.2.1 Creating and deallocating objects	24
2.2.2 Preventing memory leaks	25
2.3 Protocols	27
2.3.1 Protocol conformance	28
2.4 Properties	29
2.4.1 Property declaration	29
2.4.2 Circular references	34
2.5 Categories	36
2.6 Posing	38

2.7	Exceptions and Errors	38
2.7.1	Exceptions	38
2.7.2	Errors	43
2.8	Key-value coding (KVC)	45
2.8.1	An example illustrating KVC	46
2.9	Multithreading	51
2.10	Notifications	55
2.11	The Objective-C Runtime	56
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 UITouch 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

7.3.1	A detailed example	187
7.3.2	Customization	193
7.4	Modal View Controllers	197
7.4.1	A detailed example	197
7.5	Summary	203
	Problems	203
8	Special-Purpose Views	205
8.1	Picker View	205
8.1.1	The delegate	206
8.1.2	An example	207
8.2	Progress Views	211
8.2.1	An example	213
8.3	Scroll View	215
8.4	Text View	217
8.4.1	The delegate	218
8.4.2	An example	218
8.5	Alert View	221
8.6	Action Sheet	224
8.7	Web View	225
8.7.1	A simple web view application	226
8.7.2	Viewing local files	230
8.7.3	Evaluating JavaScript	235
8.7.4	The web view delegate	242
8.8	Summary	247
	Problems	247
9	Table View	249
9.1	Overview	249
9.2	The Simplest Table View Application	250
9.3	A Table View with both Images and Text	255
9.4	A Table View with Section Headers and Footers	257
9.5	A Table View with the Ability to Delete Rows	258
9.6	A Table View with the Ability to Insert Rows	265
9.7	Reordering Table Rows	270
9.8	Presenting Hierarchical Information	275
9.8.1	Detailed example	278
9.9	Grouped Table Views	285
9.10	Indexed Table Views	288
9.11	Dynamic Table Views	294
9.12	Whitening Text in Custom Cells	297
9.13	Summary	302
	Problems	303

10 File Management	305
10.1 The Home Directory	305
10.2 Enumerating a Directory	306
10.3 Creating and Deleting a Directory	308
10.4 Creating Files	309
10.5 Retrieving and Changing Attributes	312
10.5.1 Retrieving attributes	314
10.5.2 Changing attributes	315
10.6 Working with Resources and Low-level File Access	317
10.7 Summary	320
Problems	321
11 Working with Databases	323
11.1 Basic Database Operations	323
11.1.1 Opening, creating, and closing databases	325
11.1.2 Table operations	325
11.2 Processing Row Results	327
11.3 Prepared Statements	330
11.3.1 Preparation	330
11.3.2 Execution	331
11.3.3 Finalization	331
11.3.4 Putting it together	331
11.4 User-defined Functions	333
11.5 Storing BLOBs	337
11.6 Retrieving BLOBs	341
11.7 Summary	343
Problems	343
12 XML Processing	345
12.1 XML and RSS	345
12.1.1 XML	345
12.1.2 RSS	347
12.1.3 Configuring the XCode project	350
12.2 Document Object Model (DOM)	351
12.3 Simple API for XML (SAX)	358
12.4 An RSS Reader Application	367
12.5 Putting It Together	369
12.6 Summary	371
Problems	371
13 Location Awareness	373
13.1 The Core Location Framework	373
13.1.1 The CLLocation class	375
13.2 A Simple Location-aware Application	377

13.3	Google Maps API	380
13.3.1	A geocoding application	380
13.4	A Tracking Application with Maps	386
13.5	Working with ZIP Codes	392
13.6	Working with the Map Kit API	394
13.6.1	The MKMapView class	395
13.6.2	The MKCoordinateRegion structure	395
13.6.3	The MKAnnotation protocol	396
13.6.4	The MKAnnotationView class	397
13.6.5	The MKUserLocation class	399
13.6.6	The MKPinAnnotationView class	401
13.7	Summary	401
	Problems	402
14	Working with Devices	403
14.1	Working with the Accelerometer	403
14.1.1	Basic accelerometer values	403
14.1.2	Example	405
14.2	Working with Audio	408
14.2.1	Playing short audio files	408
14.2.2	Recording audio files	410
14.2.3	Playing audio files	412
14.2.4	Using the media picker controller	412
14.2.5	Searching the iPod library	415
14.3	Playing Video	418
14.3.1	Using the MPMoviePlayerController class	418
14.4	Accessing Device Information	419
14.5	Taking and Selecting Pictures	420
14.5.1	Overall approach	420
14.5.2	Detailed example	421
14.6	Monitoring Device Battery	424
14.6.1	Battery level	424
14.6.2	Battery state	424
14.6.3	Battery state and level notifications	424
14.6.4	Putting it together	425
14.7	Accessing the Proximity Sensor	426
14.7.1	Enabling proximity monitoring	427
14.7.2	Subscribing to proximity change notification	427
14.7.3	Retrieving the proximity state	427
14.8	Summary	428
	Problems	428
15	Internationalization	429
15.1	String Localization	430

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

18.7 Multithreading and Identifiers	503
18.8 Person Photo Retriever Application	503
18.9 Using the ABUnknownPersonViewController Class	505
18.10 Using the ABPeoplePickerNavigationController Class	507
18.11 Using the ABPersonViewController Class	509
18.12 Using the ABNewPersonViewController Class	510
18.13 Summary	512
Problems	513
19 Core Data	515
19.1 Core Data Application Components	515
19.2 Key Players	516
19.2.1 Entity	516
19.2.2 Managed object model	516
19.2.3 Persistent store coordinator	517
19.2.4 Managed object context	517
19.2.5 Managed object	517
19.2.6 Summary	518
19.3 Using the Modeling Tool	521
19.4 Create, Read, Update and Delete (CRUD)	527
19.4.1 Create	527
19.4.2 Delete	527
19.4.3 Read and update	527
19.5 Working with Relationships	530
19.6 A Search Application	531
19.6.1 The UISearchDisplayController class	531
19.6.2 Main pieces	533
19.7 Summary	538
Problems	538
20 Undo Management	539
20.1 Understanding Undo Management	539
20.1.1 Basic idea	539
20.1.2 Creating an undo manager	540
20.1.3 Registering an undo operation	540
20.1.4 Hooking into the undo management mechanism	541
20.1.5 Enabling shake to edit behavior	542
20.2 Detailed Example	543
20.2.1 The view controller class	543
20.2.2 First responder status	543
20.2.3 Editing mode and the NSUndoManager instance	544
20.2.4 Registering undo actions	544
20.3 Wrapping Up	546

20.4 Summary	546
Problems	546
21 Copy and Paste	547
21.1 Pasteboards	547
21.1.1 System pasteboards	547
21.1.2 Creating pasteboards	547
21.1.3 Properties of a pasteboard	548
21.2 Pasteboard Items	548
21.2.1 Pasteboard items	549
21.2.2 Manipulating pasteboard items	549
21.3 The Editing Menu	551
21.3.1 The standard editing actions	551
21.3.2 The UIMenuController class	551
21.3.3 The role of the view controller	552
21.4 Putting it Together	553
21.4.1 The image view	553
21.4.2 The view controller	554
21.5 Summary	558
Problems	559
Appendices	561
A Saving and Restoring App State	563
B Invoking External Applications	567
C App Store Distribution	569
D Using XCode	571
D.1 XCode Shortcuts	571
D.2 Creating Custom Templates	571
D.2.1 Changing template macro definitions	573
D.3 Build-Based Configurations	574
D.4 Using Frameworks	577
E Unit Testing	581
E.1 Adding a Unit Test Target	581
E.2 Adapting to Foundation	582
E.3 The Model	584
E.4 Writing Unit Tests for the Employee Class	586
E.4.1 The setUp and tearDown methods	587
E.4.2 Testing for equality	588
E.4.3 Testing for nullity	588

E.5	Adding a Build Dependency	589
E.6	Running the Tests	589
F	Working with Interface Builder	591
F.1	National Debt Clock Application	591
F.1.1	Creating the project	591
F.1.2	Creating the view controller class	591
F.1.3	The application delegate class	594
F.1.4	Building the UI	595
F.2	Toolbar Application	609
F.2.1	Writing code	609
F.2.2	Building the UI	611
F.2.3	Putting it together	617
References and Bibliography		619
Index		621

PREFACE

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.
- iPhone SDK 3. Download from: <http://developer.apple.com/iphone>.
- 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

and the various methods available to you to manipulate them. After that, we address the subject of the editing menu which users use to issue editing commands. Finally, we put all the ideas behind copy and paste together and present a simple image editing application.

Appendix A In this appendix, you will learn how to use property lists for saving and restoring the application state. This will give the user the illusion that your application does not quit when he/she hits the Home button.

Appendix B Here, you will learn how to programmatically invoke iPhone applications from within your application. In addition, you will learn how to publish services that other iPhone applications can utilize.

Appendix C This appendix explains the major steps needed to submit your application to the App Store.

Appendix D In this appendix, we cover several topics related to using XCode. First, we show some useful shortcuts. Next, we talk about writing custom templates for your classes and after that we cover build configuration. Finally, we show you how to add references to other libraries (also known as frameworks).

Appendix E In this appendix, we show you how to add unit tests to your project. By adding unit testing support, you'll be able to write tests for your business logic. These tests will be added as a dependency on the building of your application. This will result in the tests being run before actually building your application. The appendix walks you through a step-by-step process for adding unit testing for a simple business model.

Appendix F In this appendix, we use Interface Builder to build a couple of iPhone applications. The techniques you learn from building these applications should prove to be useful in building similar iPhone applications.

1

Getting Started

This chapter serves as a quick introduction to the tools bundled with the SDK. It also shows you basic development steps that include coding, UI design, and debugging. You do not have to understand everything in this chapter as we will go over these concepts throughout the book. What you need to get from this chapter is a feeling of iPhone development using XCode.

We start with some basics of the XCode IDE in Section 1.1. Next, Section 1.2 talks about the UI design tool Interface Builder. After that, we show you how to use the built-in debugger in XCode in Section 1.3. Next, Section 1.4 shows you different sources of information for obtaining additional help. Finally, we summarize the chapter in Section 1.5.

1.1 SDK and IDE Basics

In this section, we walk you through the process of creating your first iPhone application. But first, you need to obtain the iPhone SDK and install it on your Mac.

1.1.1 *Obtaining and installing the SDK*

Obtaining and installing the iPhone SDK is easy; just follow these steps:

1. Get your iPhone developer Apple ID and password from:
<http://developer.apple.com/iphone/>
2. Download the latest iPhone SDK for iPhone OS from the site mentioned above.
3. Install the iPhone SDK on your Intel-based Mac.

Now, you're ready to create your first project – read on!

1.1.2 Creating a project

Locate XCode and launch it. You can use Spotlight to find it or you can navigate to /Developer/Applications/XCode. XCode is the central application for writing, designing, debugging, and deploying your iPhone applications. You will use it a lot, so go ahead and add it to the Dock.

From XCode, select File->New Project. You should see a window, similar to the one shown in Figure 1.1, asking you for the type of project you want to create. Choose the default and create a window-based application. This is the most generic type of iPhone project and the one that can be customized for different needs.

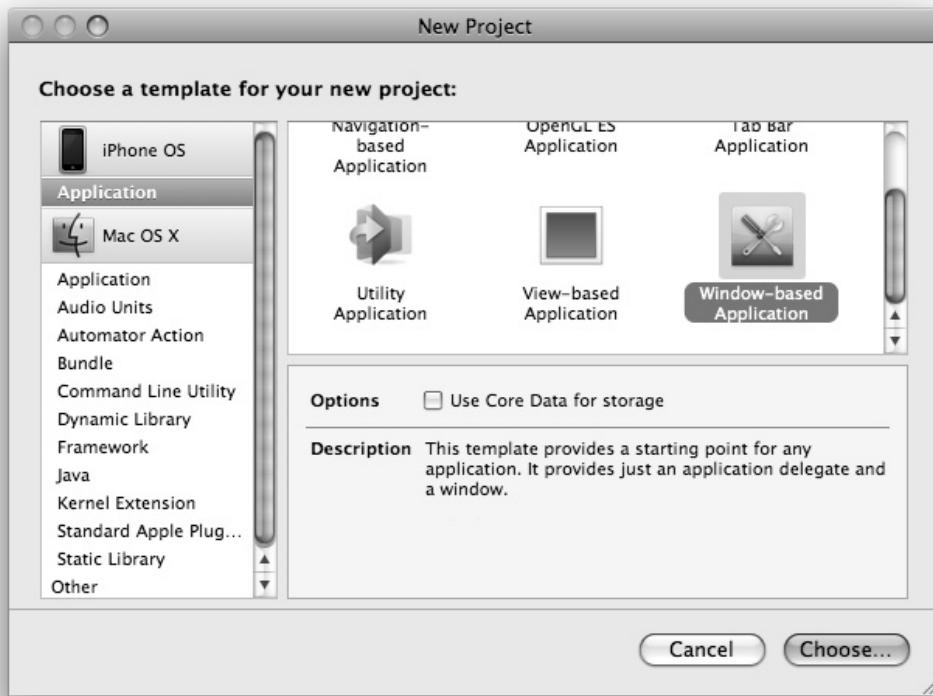


Figure 1.1 Choosing window-based application in the project creation process.

Click on Choose . . . and enter the name of your project (here, we're using My Project) and hit Save. A new directory is created with the name you entered, and several files are generated for you. You should now see the newly created iPhone project as in Figure 1.2.

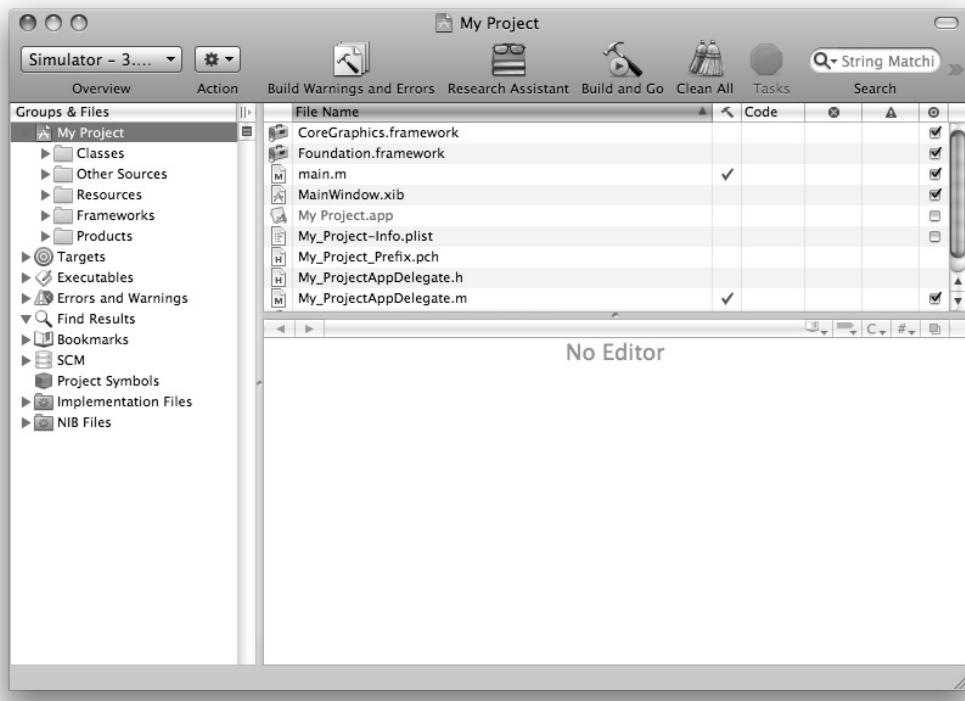


Figure 1.2 A newly created iPhone project in XCode.

1.1.3 Familiarizing yourself with the IDE

As you can see from Figure 1.2, the main window is divided into several areas. On the top, you will find the Toolbar (Figure 1.3). The Toolbar provides quick access to common tasks. It is fully configurable; you can add and remove tasks as you want. To customize the Toolbar, Control-click it and choose *Customize Toolbar*.... There, you can drag your favorite task on the Toolbar. Hit *Done* when you're finished. To remove an item, Control-click on it and choose *Remove Item*.



Figure 1.3 The XCode Toolbar.

On the left-hand side, you'll see the Groups & Files list (Figure 1.4).

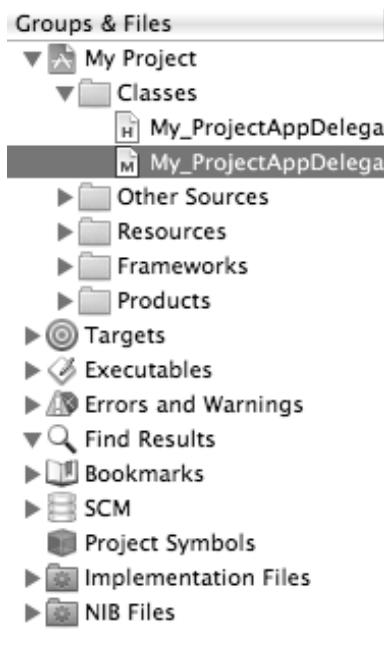


Figure 1.4 The Groups & Files list in XCode.

This list is used to organize the source code, frameworks, libraries, executables, and other types of files in your project.

The list shows several files and groups. Groups can contain other groups and files. You can delete a group as well as create a new one. The group indicated by the blue icon whose name is the same as the name you've chosen as the project name is a *static group*. Underneath it, you see all your headers, implementations, resources (images, audio files, etc.), and other related files. The folder-like yellow groups act conceptually as containers. You can have containers inside other containers and all files inside these containers live in the same directory on the disk. The hierarchy only helps you organize things. You have full freedom to organize your project's layout as you like. The compiler will pick up the resources, headers, and implementation files when it builds your application.

The other kind of groups that are listed below the project group are called *smart groups*. There are two types of smart groups: 1) built-in smart groups, and 2) custom smart groups. The content of the built-in smart groups cannot be customized. Examples of these groups include executables, bookmarks, errors/warnings, and targets. Customized smart groups are shown in purple, and two predefined groups are created for you when you create a new project.

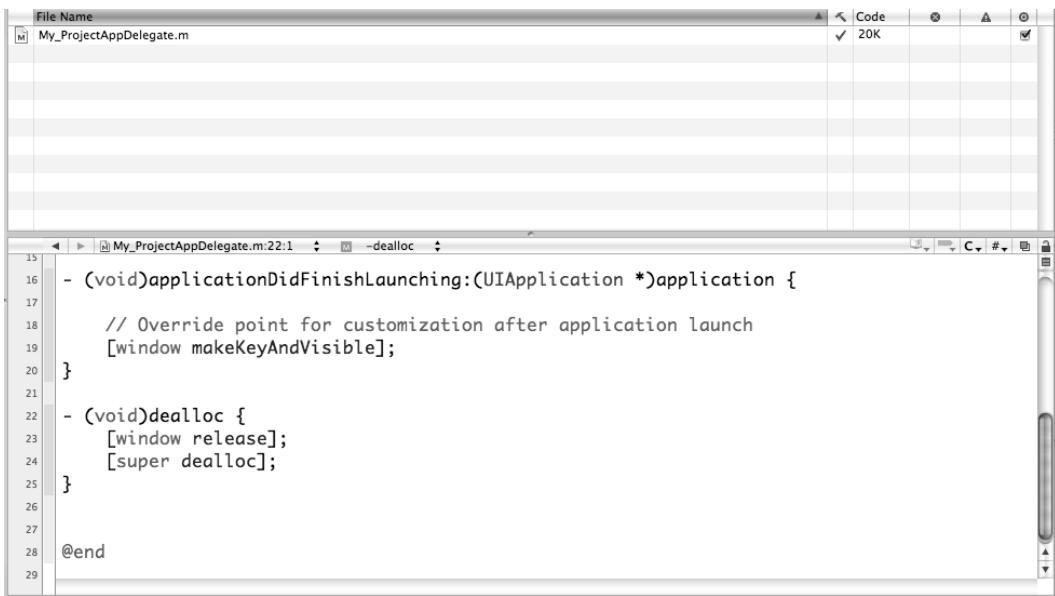


Figure 1.5 The Details view with the text editor view.

Figure 1.5 shows the Details view and the text editor beneath it.

Selecting an item in the Groups & Files list will result in its details being shown in the Details view. You can go to a full-editor window using Command-shift-E.

1.1.4 Looking closely at the generated code

Expand the Classes and Other Sources groups. You will notice several files that live underneath these two groups. Click on the main.m file and expand to a full-editor view.

The main.m file looks very similar to a C file with a main() function. As we will see later in this book, all that main() does is prepare for memory management and launch the application.

Click on the My_ProjectAppDelegate.h file under the Classes group. You will notice that the editor changes its content. This file contains the declaration of the application delegate class. Every application that runs on the iPhone OS has a delegate object that handles critical phases of its lifecycle.

Click on My_ProjectAppDelegate.m. This file with the .m extension is the counterpart of the previous .h file. In it, you see the actual implementation of the application delegate class. Two methods of this class are already implemented for you. The applicationDidFinishLaunching: method is one of those methods that handles a particular phase of the application lifecycle. The other

method, `dealloc`, is a method where memory used by this object is released. In iPhone OS, you manage the allocation and freeing of memory as there is no garbage collection. Memory management is crucial in iPhone development, and mastering it is very important. The first chapters are dedicated to teaching you exactly that – and much more.

The generated files and resources are adequate for starting the application. To launch the application, click on `Build` and `Go` in the Toolbar or press the `Command-Enter` key combination. You'll notice that the application starts in the Simulator and it only shows a white screen with the status bar on top. Not very useful, but it works!

1.2 Creating Interfaces

To be useful, an iPhone application needs to utilize the amazing set of UI elements available from the SDK. Our generated iPhone application contains a single UI element: a window.

All iPhone apps have windows (usually one.) A window is a specialized view that is used to host other views. A view is a rectangle piece of real-estate on the 320×480 iPhone screen. You can draw in a view, animate a view by flipping it, and you can receive multi-touch events on it. In iPhone development, most of your work goes towards creating views, managing their content, and animating their appearance and disappearance.

Views are arranged into a hierarchy that takes the shape of a tree. A tree has a root element and zero or more child elements. In iPhone OS, the window is the root element and it contains several child views. These child views can in turn contain other child views and so on and so forth.

To generate views and manage their hierarchy, you can use both Interface Builder (IB) and Objective-C code. IB is an application that comes with the SDK that allows you to graphically build your view and save it to a file. This file is then loaded at run-time and the views stored within it come to life on the iPhone screen.

As we mentioned before, you can also use Objective-C code to build the views and manage their hierarchy. Using code is preferred over using IB for the following reasons. First, as beginner, you need to understand all aspects of the views and their hierarchy. Using a graphical tool, although it simplifies the process, does hide important aspects of the process. Second, in advanced projects, your views' layouts are not static and change depending on the data. Only code will allow you to manage this situation. Finally, IB does not support every UI element all the time. Therefore, you will sometimes need to go in there and generate the views yourself.

The following section teaches you how to use IB. However, for the most part in this book, Objective-C code is used to illustrate the UI concepts. For extensive coverage of Interface Builder, please see Appendix F.

1.2.1 Interface Builder

The project has a basic window resource file. This file can be found under the Resources group. Expand the Resources group and locate the file `MainWindow.xib`. This file contains the main window of the application. This file is an `.xib` file that stores the serialized objects in the interface. When the project is built, this file is converted to the more optimized format `.nib` and loaded into memory when one or more of the UI components stored in it are requested.

Double-click on the `MainWindow.xib` file to launch IB. IB starts by opening four windows. The first window shows the main window stored in the file. The second window shows the document window listing the different objects stored in the file. The third window is the Library window containing all the UI objects that you can add to the file. The fourth and final window is the Inspector window with its four panes.

The Inspector window shows the attributes of the currently selected object. If you click on an object, the Inspector windows shows you its attributes distributed among four different panes. Each pane has several sections. You can change these attributes (such as color, position, and connections) and the changes will propagate to your project's user interface.

The main window of the application is white; let's change it to yellow. Click on the window object in the document window. In the Inspector window, make sure that the left-most pane is selected. In the View section of this pane, change the background color to yellow as shown in Figure 1.6.

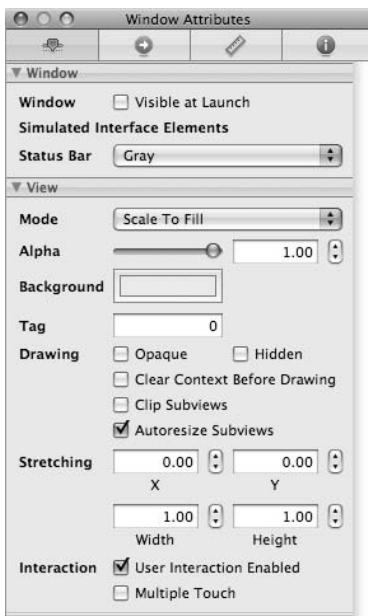


Figure 1.6 The attributes pane in the Inspector window of Interface Builder.

Go to XCode and run the application. Notice how the main window of the application has changed to yellow. It is important to keep the project open in XCode while working with IB. XCode and IB communicate well when both applications are open.

To build a user interface, you start with a view and add to it subviews of different types. You are encouraged to store separate views in separate .xib files. This is important as referencing one object in a file will result in loading all objects to main memory. Let's go ahead and add a label view to our window. This label will hold the static text "Hello iPhone."

A label is one of the many UI components available for you. These components are listed under several groups in the Library. Locate the Library window and click on Inputs & Values as shown in Figure 1.7.



Figure 1.7 The Library window of Interface Builder.

Click on the Label item and drag it onto the middle of the window. Expand the dimensions of the label as shown in Figure 1.8.

When the label is selected, the Inspector window changes to reflect the attributes of the label. Figure 1.9 shows a portion of the attributes of a label in the Inspector window. You can change these attributes and observe the effect they have on the object instantaneously.

The label's text is left justified; let's make it center. In the Layout item of the attributes, click on the icon indicating center. Notice how the label text becomes centered. The text of the label can be changed in the Text item. Change Label to Hello iPhone. Go to XCode and hit Build and Go. You will notice the window showing Hello iPhone in the middle.

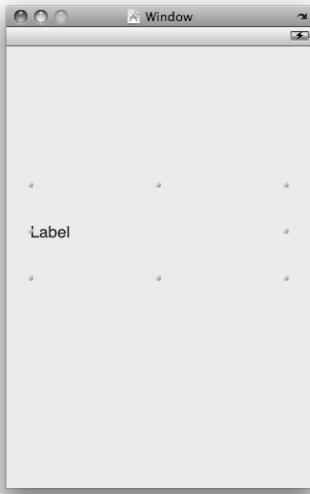


Figure 1.8 Adding a label view to a window in IB.

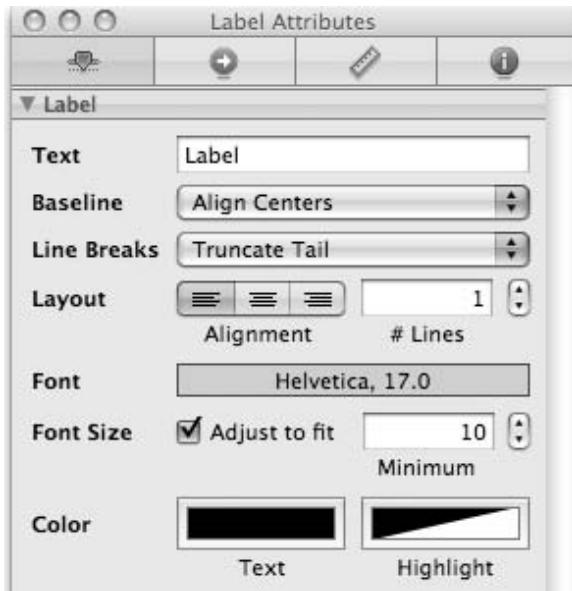


Figure 1.9 Attributes of a label in the Inspector window.

The text of the label is small, so let's make it bigger. Click on the **Text** item and choose a text size of 48 points. Go to XCode and hit **Build** and **Go**. Figure 1.10 shows a screenshot of the completed Hello iPhone application.



Figure 1.10 A screenshot of the completed Hello iPhone application.

Congratulations on your first successful iPhone application!

You deliver the product to the client and he is happy. However, he wants the application to have more interaction with the user. He asks you to revise the application by adding a button that the user can tap on to change the text displayed in the label.

Open the `MainWindow.xib` document if it is not already open. Locate the **Round Rect Button** item under **Items & Values** in the **Library** window. Drag and drop it under the label in the main window. Change the button's title by entering "Change" in the **Title** field found in the fourth section of the attributes window. The main window should look like the one shown in Figure 1.11.

Now that we have a button, we want to have a method (a function) in our code to get executed when the user touches the button. We can achieve that by adding a connection between the button's touch event and our method.



Figure 1.11 The main window after adding a new button.

Click on the button so that it becomes selected. Click on the second pane in the Inspector window. This pane shows the connections between an object and our code. The pane should look like the one in Figure 1.12.



Figure 1.12 The connections pane of our new button.

Now, we want to add a connection between the Touch Down event and a method we call buttonTapped. Let's first add this method in My_ProjectAppDelegate class.

In the `My_ProjectAppDelegate.h` file, add the following before `@end`.

```
- (IBAction)buttonTapped;
```

In the `My_ProjectAppDelegate.m` file, add the `buttonTapped` method body. The `My_ProjectAppDelegate.m` file should look something like the one in Listing 1.1.

Listing 1.1 The application delegate class after adding a new method.

```
#import "My_ProjectAppDelegate.h"
@implementation My_ProjectAppDelegate
@synthesize window;
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    // Override point for customization after application launch
    [window makeKeyAndVisible];
}

- (IBAction)buttonTapped{
    UILabel *label = (UILabel *)[window viewWithTag:55];
    if([label.text isEqualToString:@"Hello iPhone"])
        label.text = @"Hello World";
    else
        label.text = @"Hello iPhone";
}

- (void)dealloc {
    [window release];
    [super dealloc];
}
@end
```

The `buttonTapped` method simply obtains a reference to the label and changes its text to either “Hello World” or “Hello iPhone”. You don’t need to understand this code at this stage. All you need to understand is that the label on the screen is encapsulated by the `UILabel` class and it’s tagged with the number 55.

Now, let’s switch to IB and add a tag to the label so that it can be retrieved from the code. Click on the label and in the Inspector window, choose the first pane. In the second section, enter 55 for the Tag field (fourth item.)

We still need to perform one last step. We need to connect the touch event with the method we just created. Click on the button and choose the connections pane (second pane). Control-click or right-click on the circle on the right-hand side of Touch Down event and drag it on top of the `My_ProjectAppDelegate` object in the Document window and let go as shown in Figure 1.13.

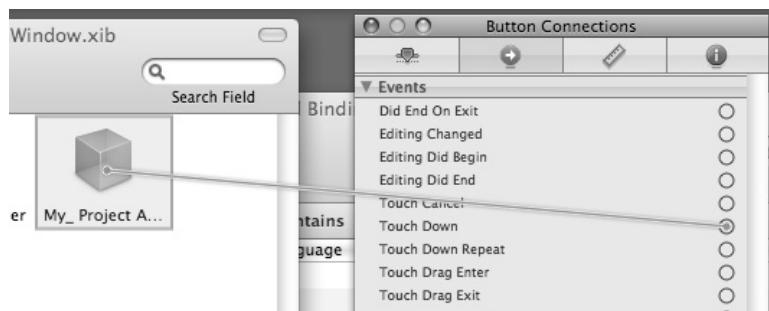


Figure 1.13 Making a connection between an event and a method in another object.

When you release the mouse, IB shows you potential methods (actions) that you can connect this event to. Right now we only have one action and that action is `buttonTapped`. Select that action and you'll notice that a connection has been made as shown in Figure 1.14.



Figure 1.14 A connection between a touch event and an action.

Now, switch to XCode and hit `Build` and `Go`. You'll notice that tapping on the button changes the text value of the label.

1.3 Using the Debugger

During the development of your applications, often things go wrong and the feature that you've just added is not functioning properly. At these moments, the built-in debugger becomes invaluable.

Let's introduce a bug into our code. Go to `My_ProjectAppDelegate.m` file and change the tag's value used to obtain the label from 55 to 54, then Build and Go. Now, tapping the button has no effect on the label's text.

First, you want to make sure that the `buttonTapped` method gets called. In XCode, click in the left margin of the first line in the `buttonTapped` method as shown in Figure 1.15. After you click there, a breakpoint (shown in blue) is added.

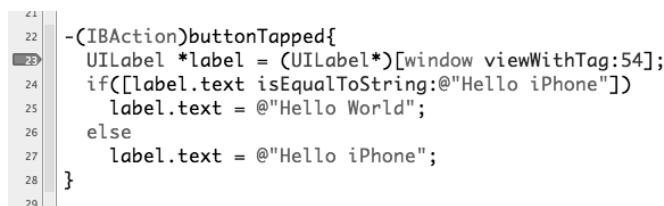


Figure 1.15 Adding a breakpoint in the `buttonTapped` method.

Click Build and Go to debug the application. When the application launches, tap on the button. You'll notice that the execution hits the breakpoint as shown in Figure 1.16. At least we know that we made our connection correctly.

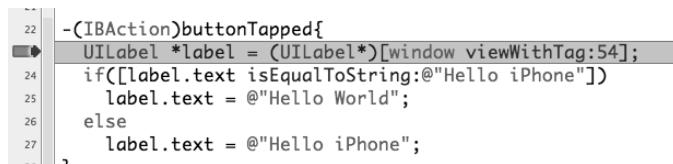


Figure 1.16 Hitting a breakpoint in the `buttonTapped` method.

Let's step over the statement that obtains the label from the window. Click on the Step Over button located beneath the Toolbar as shown in Figure 1.17.

After stepping over the statement, we need to inspect the value obtained. Hover the mouse over `label` in the statement just executed as shown in Figure 1.18. A tip appears showing its value. Notice that the value is `0x0`. In Objective-C, this value is called `nil` and means that no object is stored in this variable. After inspecting the tag value and going back-and-forth between XCode and IB, we find the problem, fix it, remove the breakpoint by clicking on it to turn it off, and hit Build and Go.



Figure 1.17 Step over a function or a method call button.

```
- (IBAction)buttonTapped{  
    UILabel *label = (UILabel*)[window viewWithTag:54];  
    if([label.text isEqualToString:@"Hello iPhone"])  
        label.text = @"Hello World";  
    else  
        label.text = @"Hello iPhone";  
}
```

Figure 1.18 Inspecting the value of the label after obtaining it from the window.

1.4 Getting More Information

There are plenty of sources for information on the SDK. These sources include the following:

- **Developer Documentation.** The best locally stored source of information is the Developer Documentation. In XCode, select Help->Documentation. The documentation window appears as shown in Figure 1.19. You can search using the search box on the left-hand corner for any defined type in the SDK. The documentation is hyper-linked and you can go back-and-forth between different pieces of information. It's easy to use and it will become your friend.
- **Developer Documentation from within XCode.** If you're in XCode and you need more information about something, Option-double-click it and the Developer Documentation opens with more information.
- **Other help from within XCode.** If you're in XCode and you need to get the declaration and possible implementation of a given token (e.g., class, tag, variable, etc.), Command-double-click it. If there are multiple pieces of information, or disambiguation is needed, a list of items to choose from will be shown.
- **iPhone Dev Center.** The center is located at <http://developer.apple.com/iphone/>. The iPhone Dev Center has a large collection of technical resources and sample code to help you master the latest iPhone technologies.
- **Apple's Fora.** You can start with the site at <https://devforums.apple.com/>.
- **The Web.** There is plenty of information on the web. Just enter a relevant query and let Google do its magic!

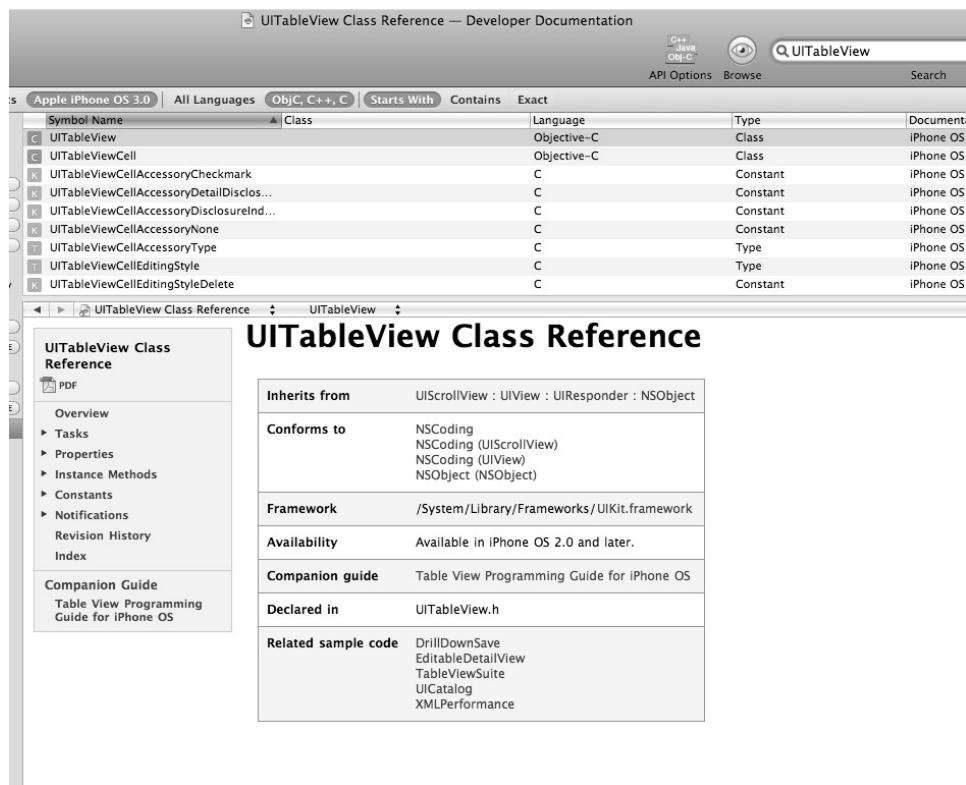


Figure 1.19 The Developer Documentation in XCode.

1.5 Summary

This chapter provided a gentle introduction to the world of iPhone development. We showed you in Section 1.1 how to download and install the iPhone SDK. After that, we iterated through the development of an iPhone application and showed you how to use Interface Builder to design user interfaces. Next, Section 1.3 discussed how to debug an iPhone application using the built-in visual debugger in XCode. You were also exposed to different sources for obtaining further help on the tools and the SDK in general in Section 1.4.

The rest of the book will detail all aspects of iPhone development. However, from now on, since we want to teach you everything you need, we will stop using Interface Builder and show you how to build your UI using code. This will help you gain a solid understanding of the process. You can, of course, mix and match with Interface Builder as you wish.

The next two chapters cover the Objective-C language and the coding environment that you will be working with: Cocoa. We hope you're as excited as we are!

Problems

- (1) Check out the `UILabel.h` header file and read about the `UILabel` class in the documentation.
- (2) What's an `IBOutlet` and `IBAction`? Use Command-double-click to see their definitions in the `UINibDeclarations.h` header file.
- (3) Explore the XCode IDE by reading the `XCode Workspace Guide` under the `Help` menu of the XCode application.
- (4) Explore Interface Builder by choosing `Interface Builder Help` under the `Help` menu of the Interface Builder application.

2

Objective-C and Cocoa

This chapter presents the main features of the Objective-C language under the Cocoa environment. Section 2.1 introduces the main concepts behind classes in Objective-C. In that section, you learn how to declare a new class, define it, and use it from within other classes. You also learn about important Cocoa classes and data types.

After that, in Section 2.2 you learn about memory management in the iPhone OS. You learn how to create new objects as well as how to deallocate them, and you also learn your responsibility when obtaining objects from Cocoa frameworks or other frameworks.

Section 2.3 introduces the topic of Objective-C protocols. There, you learn how to adopt protocols and how to declare new ones as well. Section 2.4 covers properties, an Objective-C language feature that allows you to access instance variables using the dot notation. The concept of categories is the subject of Section 2.5. These allow you to extend existing classes by adding new methods. Posing is another technique that is slightly different from categories. Posing allows you to replace a given class with one of its descendants. This is discussed in Section 2.6.

Exceptions and error handling are important features in any modern language. Section 2.7 covers both of these techniques and shows you the appropriate use of each feature. After covering exceptions and errors you are exposed to the concept of key-value coding (KVC) in Section 2.8. KVC is an important and widely used technique in Cocoa. KVC allows you to indirectly access object properties.

Next, you learn how to use multithreading in your iPhone application (Section 2.9). Cocoa makes it very easy to use multithreading and you will learn, using a step-by-step approach, how to make a task run in the background. After that, we cover the topic of notifications in Section 2.10. In Section 2.11, we discuss, in great length, the topic of the Objective-C runtime system. Finally, we provide a summary of this chapter in Section 2.12.

We have a lot to cover, so let's get started.

2.1 Classes

In object-oriented languages, an object encapsulates attributes and provides methods. These methods can be used by the outside world (i.e., other objects) to change the object's state as well as to interact with the object. All this can be achieved without opening the actual implementation of the object's behavior to the outside world.

In Objective-C, in order to create a new class, you first need to declare it using an *interface* and then define it using an *implementation*. The declaration and the definition are usually written in two separate files. The declaration part (described more fully in the following sections) is customarily done in a .h file having the same name as the class, while the implementation, which also has the same name as the class, is in a .m file. Both the declaration and the definition parts use compiler directives. A *compiler directive* is an instruction to the Objective-C compiler prefixed by the @ sign. The declaration is signaled to the compiler using the **@interface** directive, while the actual definition is signaled using the **@implementation** directive.

2.1.1 Class declaration

To declare a class, `MyClassName`, as a subclass of class `MyParentName`, you simply write:

```
@interface MyClassName : MyParentName{  
    // attribute declarations  
}  
    // method declarations  
@end
```

Here, we are telling the compiler that a new class type, `MyClassName`, is being declared. `MyClassName` is a subclass of `MyParentName` class. In addition, we list the definition of all instance variables between the curly brackets. The methods are declared between the end of the curly bracket and the **@end** compiler directive.

There are a few important aspects of the **@interface** declaration:

- The attributes declared between the curly brackets are *instance* variables. At runtime, every class has a unique *class* object and zero or more instances of the class. Every instance (object) of `MyClassName` has its own values for these attributes. The unique class object has no access to these instance variables.
- Methods declared can be either instance methods or class methods. An instance method is called by sending a *message* to an actual instance (i.e., an object) of the class. A class method does not require a class instance. You call a class method by sending a message to the unique class object. In Objective-C, every class has exactly one class object during the runtime of the program. An instance method is declared/defined by a “-” prefix, while a class method is declared/defined by a “+” prefix.

For example:

```
- (Address *) getAddress;
```

is an instance method, while

```
+ (id) getANewInstance;
```

is a class method.

- Objective-C does not support class variables. However, you can use the familiar **static** keyword in an implementation file of a given class. This will allow instance methods (i.e., those with a “-” prefix in their definition) to have access to the single value of this variable shared by all instances of that declared class. If you define a **static** variable inside a method, then that method is the *only* method that has access to that variable. If you put the definition of the **static** variable outside the class implementation, then all methods have access to that variable.

2.1.2 How do I use other declarations?

As a Cocoa developer, you will need to be able to use classes that other developers have written. In addition, if the declaration and the definition of your classes are in separate files, you will need to inform the compiler about the location of the class declaration in the implementation file.

If you use the name of a class without accessing its methods or instance variables, you can just use the **@class** directive. This gives the compiler enough information to successfully compile the code. Usually the **@class** directive is used in class declarations. For example, consider the following declaration:

```
@class Address;
@interface Person{
    Address *address;
}
@end
```

Here, we have a **Person** class declaration that uses the **Address** class. The compiler only needs to know that the **Address** is a class type. No details about the actual methods and attributes are needed since we just use the type.

If, on the other hand, you use the methods and/or the attributes of a given class, then you need to point the compiler to the location of the file that contains the declaration. There are two ways to do that: (1) using **#include**, and (2) using **#import**. **#include** and **#import** are almost identical, except that **#import** loads the given file only once during the compilation process. The **#import** directive is much simpler, fully supported by Apple, and produces potentially fewer problems. Bottom line: use **#import**.

2.1.3 Class definition

To actually define a class, you need to specify the actual implementation of the class/instance methods declared in the `@interface` part. To define the class, you write:

```
#import "MyClassName.h"  
@implementation MyClassName  
    // method definitions  
@end
```

Notice that we needed to import the declaration file. This import allowed us to skip repeating the parent's class name as well as the instance variables. Both can be deduced by the compiler so there is no need to repeat them.

2.1.4 Method invocation and definition

Method invocation in Objective-C addresses a problem that those of you who have used Java will be familiar with. In Java, a method is invoked using its name followed by a pair of left and right parentheses. If the method requires parameters, the values of these parameters are inserted inside the parentheses and separated by commas. For example, if `aPoint` is a Java object representing a point in 3D, `setLocation (float x, float y, float z)` can represent a method for changing the location of this point object. `aPoint.setLocation(3, 6, 9)` asks the `aPoint` object to change its location to (3, 6, 9). One problem with this notation is readability. If you come across such a statement written by another programmer, you cannot know for sure what these values represent. You have to go to the interface of this class and read about what each position in the parameters list represents.

Because Objective-C is an object-oriented language, it, too, provides *data encapsulation*. With data encapsulation, the outside world interacts with an object by sending *messages* to that object. To send an object (`aObject`) a message (`aMessage`) you use square brackets and write `[aObject aMessage]`. A message is composed of two parts: (1) keywords, and (2) parameters. Every message has at least one keyword. A keyword is an identifier followed by a colon.

Let's make these definitions concrete by writing the `setlocation` method invocation in Objective-C. In Objective-C, you write something like:

```
[aPoint setLocationX:3 andY:6 andZ:9];
```

Notice the improved readability of the invocation of the method. Just by looking at it, we know that 6 is used to change the y-coordinate. This message has three keywords: `setlocationX:`, `andY:`, and `andZ:`. The method is represented by `setLocationX:andY:andZ:`. This representation is called a *selector*. A selector is a unique name (within a class) of a method used by the runtime to locate the code implementing that method. The method is declared in the interface as:

```
- (void)setLocationX:(float) x andY:(float) y andZ:(float) z;
```

The statement [aPoint setLocationX:3 andY:6 andZ:9] as a whole is called a *message expression*. If this expression evaluates to an object, then it, too, can receive a message. Objective-C allows nested message invocation. For example, you can write:

```
[ [addressBook getEntryAtIndex:0] printYourself];
```

First, the message `getEntryAtIndex:0` is sent to the `addressBook` object. The method identified by the selector `getEntryAtIndex:` returns an object. This object is then sent a `printYourself` message.

It's worth noting that if a method has zero parameters, you should not use the ":" when the method is invoked. This notation can be difficult to deal with at first, but after a time it becomes natural.

Methods in Objective-C are always *public*. There is no such thing as a private method. Instance variables are defaulted to *protected*, a setting that works well for you most of the time.

2.1.5 Important types

We mentioned before that every class in a Cocoa application has a singleton class object. The type of this class object is `Class`. A null class pointer is of type `Nil`. `Nil` is basically `(Class) 0`. We also learned that a class can be instantiated. An instance of a class `A` is declared as:

```
A *anObject;
```

There is, however, a defined type in Cocoa that represents an arbitrary object. This type is named `id`. If `anObject` does not point to any object, its value is `nil`. `nil` is basically `(id) 0`.

`SEL` is a defined type that represents a selector. To obtain the `SEL` of a method, `aMethod:`, use the directive `@selector` as follows.

```
SEL mySelector = @selector(aMethod:);
```

If you want `mySelector` to point to a null selector, assign it `NULL`.

You can also obtain the `SEL` of a method from a string representation of its name. The function to use is `NSSelectorFromString()` which is declared as:

```
SEL NSSelectorFromString (NSString *aSelectorName);
```

`NSSelectorFromString` will always return a `SEL` named by a non-nil `aSelectorName` even if the selector is not found. If there is no selector with the name `aSelectorName`, a new selector is registered with this name and returned. If the parameter `aSelectorName` is `nil` or the function faces memory problems, it will return `NULL` (basically `(SEL) 0`).

2.1.6 Important Cocoa classes

There are several important Cocoa classes that you will often use in your iPhone application. This section discusses just the ones needed in this chapter. Other classes will be covered throughout this text.

- `NSObject`. This is the base class of most Cocoa classes. An object is not considered a Cocoa object if it is not an instance of `NSObject` or any class that inherits from `NSObject`. This class defines the runtime methods required for allocating and deallocating objects.
- `NSString`. This is the main class representing strings in Cocoa. Using this class, you can store an arbitrary text. However, once you store a value in an object of this type, you cannot change it. This kind of class is referred to as *immutable*. To be able to change a string's value (e.g., append text to it, etc.), you need the *mutable* string class `NSMutableString`. You can create a constant string using the "@" sign. For example, @"Plano" represents an `NSString` instance.
- `NSArray`. Instances of this class represents Cocoa array objects. The mutable version of this class is `NSMutableArray`. See Section 3.1 for more information on arrays in Cocoa.
- `NSSet`. Instances of this class represents Cocoa set objects. The mutable version is `NSMutableSet`. See Section 3.2 for more information on sets in Cocoa.

2.2 Memory Management

Modern computer languages employ *garbage collection*. A garbage collector is a runtime algorithm that scans the allocated objects in your program and reclaims (deallocates) objects that you have lost contact with. For example, if you have created an object and have stored its location in a variable pointer named `ptr` and later you set `ptr` to `nil`, the memory block allocated, and whose address was stored in `ptr`, is no longer accessible by your code. The garbage collector, at a time of its choosing, intervenes on your behalf and deallocates this memory so that future allocation requests can use it.

Cocoa under the iPhone OS does not employ a garbage collector. Instead, Cocoa applications must use *managed memory*. Applications running on this platform should clean up after themselves. Since iPhone applications run in a memory-constrained environment, you, as a developer, should pay extra attention to memory usage.

2.2.1 Creating and deallocating objects

You have learned in the previous section that `NSObject` is the root class in the Cocoa programming environment. `NSObject` defines the methods required for memory management and much more. One of the most important methods of `NSObject` is the `alloc` method. When you send an `alloc` message to a class object, the class object allocates memory for a new object instance of the class and sets its attributes to zero. For a class instance to start receiving messages, the `init` method

usually needs to be invoked. Every class implements at least one `init` method either explicitly or implicitly through the inheritance chain. If you override `init`, then you should call your parent's `init` first and then perform your initialization. This can be achieved using the `super` keyword. The keyword `super` makes the search for the method (here, `init`) start from the parent class rather than the class of the object, while the variable name `self` makes the search start from the class of the object where this statement is being executed. You can change the value of `self` at runtime, but you cannot change `super`. To change `super`, you have to change the parent class in the interface and then build your code.

We have talked about how a new object is born, but how can we know when we can get rid of it? The solution to this problem is simple: keep a counter per object. This counter tells us how many other objects are interested in this object. When an object wants to put a claim on our object, it increments this counter. When it wants to remove this claim, it decrements the counter.

This counter is maintained by the `NSObject` and is called the *retain count*. When you allocate the object, the retain count is set to 1. Any time another object wants to put a claim on this object, it sends it a `retain` message; thus increasing the retain count by 1. If the object wants to remove the claim, it sends it a `release` message, which in effect decrements the retain count by 1. When the retain count reaches 0, the object is deallocated by the system.

2.2.2 Preventing memory leaks

To keep your program from leaking memory, you need to release any object, whose memory you are responsible for, after it is no longer needed. You are mainly responsible for an object's memory in the following three scenarios:

- **You allocated the object using `alloc`.** If you allocated the object, you have to `release` it at the end.
- **The object is a result of a copy made by you.** If you create an object by copying it from another object, you are responsible for releasing it at the end.
- **The object was retained by you.** If you express your desire to keep a given object alive, you have to express your desire that the object should die when you are no longer in need of it.

We are left with one problem which can be illustrated by the following code.

```
// In one of your methods
// Ask an object to create a new object for you
NSMutableString *aString = [anObject giveMeANewString];
```

In the above code, you are asking `anObject` to give you a brand new object of type `NSMutableString`. The question is: who is responsible for releasing this new object when you are no longer in need of it?

One solution to this problem is to delay the release of the object. Basically, the `giveMeANewString` method creates a brand new `NSMutableString` object (e.g., using `alloc`) and puts that object in a pool for later release. When the time comes and you want to free up some memory, you release this pool and the pool will go over its content and send a `release` message to each and every object added to it.

The Foundation Framework provides the `NSAutoreleasePool` class for managing delayed releases. Every thread in your program needs to have at least one instance of this class.

You create an instance of the class as follows:

```
NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
```

This line will make `pool` the active autorelease pool for the code that follows. Any time your code or any of Cocoa's framework functions send an `autorelease` message to an object, a reference to that object is added to this pool. You can think of an autorelease pool as a list of entries. Each entry consists of a reference to an object (i.e., its address) and an integer counting the number of autorelease messages sent to this object on this pool.

To dispose of a pool, you send a `release` message to it, e.g., `[pool release]`. This will cause the pool to send `release` messages to every object it has a reference to. The number of `release` messages is equal to the number of `autorelease` messages sent to this object on this pool (a variable kept in the object's entry in the pool). Therefore, the retain count of every object will be reduced by the same number of delayed releases (i.e., autoreleases) it has received.

Autorelease pools can be nested. When you create a pool, this pool is pushed onto a stack. Any time an object receives an `autorelease` message, the runtime will send a reference to that object to the pool on top of the stack.

Having nested pools allows the developer to optimize memory usage. Let's assume, as an example, that `giveMeANewString` creates a large number of temporary objects in order to compute the return value. At the end of this method, these temporary objects are not needed. If you have only one autorelease pool in your application, these objects will linger until the end of the current run-loop and then get released.

To be able to reclaim the memory used by these temporary objects, you can create a new autorelease pool at the beginning of this method. All autoreleased objects generated by the method code (or calls made by the method) will go to this pool as it is on top of the pool stack. Before you return from this method, you `release` this local pool, thereby causing all these temporary objects to be released as well.

Listing 2.1 shows how the `giveMeANewString` method can be implemented. Here, we assume that producing the string is a rather involved process which requires extensive memory allocation of temporary objects.

Listing 2.1 Demonstration of local autorelease pools.

```
- (NSMutableString*) giveMeANewString{
    NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
```

```

NSMutableString *returnString = [[NSMutableString alloc] init];
// code that generates large amount of
// autoreleased objects.
.
.
.

// update the returnString with calculated data
[returnString appendString:computedData];
[pool release];
return [returnString autorelease];
}

```

All temporary objects created inside the method will be deallocated. The value returned is autoreleased and will be available to the caller as long as its immediate pool is not released.

If your class retains or allocates other objects, you need to make sure that these objects are released when your instance is released. The `dealloc` method is used for this purpose. It is called before the instance of an object is released. You should release any object that you are responsible for and propagate the deallocation up the inheritance chain by calling `[super dealloc]` as the very last statement in this method.

2.3 Protocols

A protocol is an important language feature in Objective-C. Protocols provide, among other things, the ability to realize multiple inheritance in a single-inheritance language.

Think of a protocol as an interface in the Java language. Just as classes in Java can implement multiple interfaces, so can classes in Objective-C *adopt* multiple protocols.

A protocol is just a list of methods. Each method in this list can be tagged as either required (`@required`, the default) or optional (`@optional`). If a class adopts a protocol, it must implement at least all required methods in that protocol. For example, to define a `Litigating` protocol, you would write something like this:

```

@protocol Litigating
- (int)sue:(id<Litigating>)someone;
- (int)getSuedBy:(id<Litigating>)someone;
@end

```

Any class can adopt this protocol by listing it, using angle brackets, in its declaration after the superclass name. For example,

```
@interface Citizen: Human <Litigating>
```

A class can adopt multiple protocols. For example, one could write:¹

¹In the USA, even non-citizens must serve in case of a draft.

```
@interface Citizen: Human <Litigating, MilitaryService, TransferFunds>
```

Two classes with different inheritance chains can implement the same protocol. For example,

```
@interface DemocraticCountry: Country<Litigating>
```

A democratic country does adopt the `Litigating` protocol; it can be sued and it can sue others. A dictatorship or a fascist country, on the other hand, does not adopt such a protocol.

It is also worth noting that a protocol can incorporate other protocols. For example:

```
@protocol LegalEntity <Taxable>
```

A class that adopts a protocol, must implement all required methods of that protocol as well as the required methods of protocols incorporated by that protocol (and so on recursively). Moreover, protocol methods are inherited by subclasses, i.e., a subclass conforms to a given protocol if its superclass also conforms to that protocol.

2.3.1 Protocol conformance

Suppose you want to model a system where citizens travel to different countries and can be potential candidates to be sued or to sue the host country. How can you, elegantly, test to see if a country can be sued? You cannot just send a message to the country instance and hope it will respond favorably.²

In Objective-C, protocols provide an elegant solution for this. You can test, at runtime, whether an object is an instance of a class that adopts a given protocol. You do that by sending that object a `conformsToProtocol:` message. For example, to test that a given country, `aCountry`, can be sued, you write:

```
if ([aCountry conformsToProtocol:@protocol(Litigating)]) {
    [aCountry getSuedBy:self];
} else
    [self letItGo];
```

The `conformsToProtocol:` method is defined in `NSObject` twice, once as a class method (with a “+” sign) and another as an instance method (with a “-” sign). Both are identical and are provided for convenience. For example, the class version is defined as:

```
+ (BOOL)conformsToProtocol:(Protocol *)aProtocol
```

It takes one argument: a protocol object. We can use `@protocol (protocol-name)` to get an instance of the protocol `protocol-name`. This instance is most of the time a unique instance during the lifetime of your program. However, it is safer to assume that it is not, and not cache the protocol object.

²In real life, this can be very dangerous!

`conformsToProtocol`: returns YES if the class of the receiving object adopts the protocol-name, and NO, otherwise. It is important to note that conformance is defined based on the declaration of the receiver's class, and not based on whether the methods of the protocols have actually been implemented. For example, if you have:

```
@interface DemocraticCountry: Country<Litigating>
@end

@implementation DemocraticCountry
@end
```

And you have:

```
DemocraticCountry *aCountry = [[DemocraticCountry alloc] init];
```

The statement:

```
[aCountry conformsToProtocol:@protocol(Litigating)]
```

will return YES (1). However, the statement:

```
[aCountry getSuedBy:self];
```

will result in an application crash.

2.4 Properties

A property is a neat feature of Objective-C that allows you to generate setter/getter methods for your instance variables. These setter and getter methods can be invoked without you even specifying them. To get/set the value of the instance variable, you use the dot notation. For example, if you have a defined `NSString*` property, `name`, in an object, `aObject`, you can write: `aObject.name = @"Plano"`. This statement is actually translated by the compiler to something like: `[aObject setName:@"Plano"]`. Note that the instance variable, `name`, is still a non-public variable, but it appears as if we are accessing the variable directly from the outside.

You use the `@property` directive in the class declaration in order to declare a property. To actually generate the getter and/or setter method(s), you use the `@synthesize` directive in the class definition (i.e., implementation). This feature of Objective-C allows you to request only getter methods for instance variables that are read-only.

2.4.1 Property declaration

Properties are declared in the methods' section (i.e., after the curly bracket) of the `@interface` part of your class. The format for property declaration is:

```
@property(property-attributess) property-type property-name;
```

The property attributes are used to influence how the compiler generates the getter/setter methods. You can use the following attributes:

- `nonatomic`. By using this attribute, you tell the compiler that it does not need to generate extra code for guaranteeing thread safety. If you do not specify `nonatomic`, the compiler will generate that extra code. If you know that the property will be accessed from a single thread, then specifying `nonatomic` can improve performance. Having an atomic accessor means that the setter/getter are thread-safe; it does not necessarily mean, however, that your code, as a whole, is correct. Having a code that is thread-safe involves more work from your side than guaranteeing the atomicity of a single operation such as a getter or a setter method. See Section 2.9 for more information on multithreading.
- `readonly`. This attribute tells the compiler that the property can be read but it cannot be set. The compiler will generate only a getter method. If you attempt to write code that assigns a value to the property via the dot notation, the compiler will generate a warning.
- `readwrite`. This is the default. Both a getter and a setter will be generated for you by the compiler when you use the `@synthesize` directive.
- `assign`. The value you use to set the property is directly assigned to the instance variable. This is the default.
- `copy`. You use this attribute when you want to store a copy of the object being assigned to your instance variable rather than the reference to that object. The value being assigned has to be an object that knows how to copy itself (i.e., implements the `NSCopying` protocol).
- `retain`. This specifies that you are interested in putting an ownership claim on this object. The compiler will invoke a `retain` on this object and assign it to the instance variable. If the caller later `released` this object, it does not get deallocated since you `retained` it. You need to `release` it, either when you are finished with it, or in the `dealloc` method of your object.
- `getter=getterName, setter=setterName`. By default, the name of the automatically generated setter of a property, `prob`, is `setProb`, and the getter is `prob`. You can change this naming convention of either the setter, the getter, or both.

After declaring the property, you have two choices: a) ask the compiler to generate the getter/setter methods by using the `@synthesize` directive, or b) implement the methods yourself by using the `@dynamic` directive.

Let's look at an example demonstrating these concepts. Consider the `Employee` class declared and defined in Listing 2.2.

Listing 2.2 The `Employee` class declaration and definition demonstrating Objective-C properties.

```
@interface Employee : NSObject{
    NSString          *name;
    NSString          *address;
    NSMutableArray    *achievements;
    BOOL              married;
    Employee          *manager;
```

```

    NSString          *_disability;
}

@property (nonatomic, copy) NSString* name;
@property (nonatomic, retain) Employee* manager;
@property (nonatomic, assign) NSString* address;
@property (nonatomic, copy) NSMutableArray* achievements;
@property (nonatomic, getter=isMarried) BOOL married;
@property (nonatomic, copy) NSString* disability;
@end

@implementation Employee
@synthesize name, address, manager, achievements, married,
        disability=_disability;
@end

```

The first property declaration:

```
@property (nonatomic, copy) NSString* name
```

can be realized by the compiler as follows:

```

- (NSString*) name{
    return name;
}
- (void) setName:(NSString*) aName{
    if(name != aName){
        [name release];
        name = [aName copy];
    }
}

```

The getter accessor returns a reference to the name instance variable. The setter accessor first checks to see if the new value for name is not the same as the current name value. If they are different, then the old object is released, and a copy (as instructed by the @property directive) of the aName is made and stored in the name instance variable. Note that in the dealloc method, you need to release name.

The second property declaration:

```
@property (nonatomic, retain) Employee* manager
```

can be realized by the compiler as follows:

```

- (Employee*) manager{
    return manager;
}
- (void) setManager:(Employee*) theManager{
    if(manager != theManager){
        [manager release];
        manager = [theManager retain];
    }
}

```

```
    }  
}
```

The setter first checks to see if `theManager` is not the same as the instance variable `manager`. If they are different objects, the old `manager` object is released and the `manager` instance variable is set to a retained `theManager`. Note that you need to release `manager` in the `dealloc` method.

The third property declaration:

```
@property (nonatomic, assign) NSString* address
```

can be realized by the compiler as follows:

```
- (NSString*) address{  
    return address;  
}  
  
- (void) setAddress:(NSString*) anAddress{  
    address = anAddress;  
}
```

Notice that, since the property directive is `assign`, the setter just stores the memory address of `anAddress` in the instance variable.

The fourth property declaration is:

```
@property (nonatomic, copy) NSMutableArray* achievements
```

When dealing with mutable collections such as `NSMutableArray`, the compiler-provided setter/getter might not be appropriate. Let us see a possible synthesis of the `achievements` property.

```
- (NSMutableArray*) achievements{  
    return achievements;  
}  
- (void) setAchievements:(NSMutableArray*) newAchievements{  
    if(achievements != newAchievements){  
        [achievements release];  
        achievements = [newAchievements copy];  
    }  
}
```

There are two problems with such a synthesis:

1. The caller of the getter will receive a reference to the actual `achievements` array. That means that the caller will be able to modify the state of the `Employee` instance. In some cases, you might not want such a behavior.

You might try to rewrite the getter yourself as:

```
- (NSArray*) achievements{  
    return achievements;  
}
```

This, however, will not solve the problem because the returned reference, although made to be an immutable array, is still an `NSMutableArray` and can be changed by the caller. One solution to this problem is to return an autoreleased copy of the collection as follows:

```
- (NSArray*) achievements{
    return [[achievements copy] autorelease];
}
```

This way, the caller will receive an immutable array. Note that, following the memory management convention, the caller is not responsible for deallocating the returned value; thus we **autorelease**d it before returning it. If it seems confusing to you, at present, please return to this discussion after reading Chapter 3.

2. The synthesized setter will assign an immutable copy to the mutable array instance variable. You will not be able to add/remove objects to/from this array. Therefore, you have to write the setter yourself. The following is a possible valid implementation:

```
- (void) setAchievements: (NSMutableArray*) newAchievements{
    if(achievements != newAchievements) {
        [achievements release];
        achievements = [newAchievements mutableCopy];
    }
}
```

Notice the use of the `mutableCopy` instead of the `copy`. Refer to Chapter 3 for further information on arrays and collections in general.

The fifth property:

```
@property (nonatomic, getter=isMarried) BOOL married
```

instructs the compiler to change the name of the getter accessor to `isMarried` instead of the conventional name `married`. The following is a possible implementation of the property:

```
- (BOOL) isMarried{
    return married;
}

- (void) setMarried: (BOOL) newMarried{
    married = newMarried;
}
```

The sixth property:

```
@property (nonatomic, copy) NSString* disability
```

has a synthesis directive as `@synthesize disability=_disability`. It will be synthesized exactly as we saw the synthesis of the first property, except that we tell the compiler to associate the `disability` property with the `_disability` instance variable.

A possible synthesis of this property is as follows:

```
- (NSString*) disability{
    return _disability;
}

- (void) setDisability:(NSString*)newDisability{
    if(_disability != newDisability){
        [_disability release];
        _disability = [newDisability copy];
    }
}
```

We have seen how we can realize the different types of property declarations. Of course, you will, for most of the time, rely on the compiler to generate the accessor methods and not write them yourself. In some special cases, such as mutable collections, and depending on your application's requirements, you may want to write some of these accessor methods yourself.

2.4.2 Circular references

You need to be extra careful when dealing with properties and retaining objects in general. The way you define properties has a direct impact on memory usage and the health of your application. If you are not careful, the memory footprint of your application can keep growing until the iPhone OS terminates your application.

In addition to being careful about releasing unused memory, you also need to make sure that your object design does not introduce *circular references*.

Circular references occur when two or more objects in a group hold references to other objects in the group such that the `dealloc` method of any of these objects will never be called.

To illustrate this concept, we present a contrived example based on the design pattern of *delegation*.

Delegation is one of the most widely used patterns in Cocoa. In delegation, an object can act as a helper to another object. It is sometimes used as a substitute to subclassing.

The delegation pattern can be employed in two different cases. In one case, an object may request help from its delegate to execute a specific task. In the other case, an object may be notified by its delegate of the occurrence of important events. In either case, the object and its delegate need to know about each other (i.e., hold pointers to each other).

Consider the `X` class shown below. An `X` instance holds a reference to its delegate. This reference is a *strong* reference in the sense that an `X` instance retains it. An instance of this class does the right thing and it releases its delegate in the `dealloc` method. It achieves that by relying on the behavior of the synthesized setter which does release an instance variable before retaining the assigned value. Since the assigned value is `nil`, and all messages sent to `nil` result in `nil`, no harm is done and we achieve our goal. This approach of releasing instance variables is found by many to be superior to releasing the instance variable directly and setting its value to `nil`.

```

@interface X : NSObject{
    id delegate;
}
@property(retain) id delegate;
- (void)hi;
@end

@implementation X
@synthesize delegate;

- (void)hi{
    [delegate hello];
}

- (void)dealloc{
    self.delegate = nil;
    [super dealloc];
}
@end

```

An instance of the class A, shown below, creates an instance of class X and retains it. It then sets the delegate of the X instance to **self**. This is a typical situation that arises frequently if you think of class X as a view and class A as another view that uses it. Or maybe X is a monitor of some external source and A is a controller that uses it.

The `dealloc` method does the right thing. It releases the X instance and propagates the deallocation to `super`.

```

@interface A : NSObject{
    X *myX;
}
@property(retain) X *myX;
@end

@implementation A
@synthesize myX;

- (id)init{
    if(self = [super init]){
        self.myX = [[[X alloc] init] autorelease];
        myX.delegate = self;
    }
    return self;
}

- (void)hello{
    NSLog(@"%@", @"Hello");
}

```

```
}
```



```
- (void) dealloc{
    self.myX = nil;
    [super dealloc];
}
```

```
@end
```

In the listing below, we create an instance of A, print its retain count, and then release it. One would expect that the A and X objects would be released and their respective dealloc methods would get called. But neither of these events occurs!

```
int main(int argc, char *argv[]) {
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    A *a = [[A alloc] init];
    NSLog(@"a's retain count is %d", a.retainCount);
    [a release];
    [pool release];
    return 0;
}
```

The X instance and whatever objects it has created and retained, and the A instance and whatever other objects it has created and retained, remain in memory. Of course, in the situation above, this memory will be reclaimed by the OS when the application terminates, but that's just the example. In real life, these will linger for a long time during the lifetime of the application. Worse, they can reoccur resulting in an ever-expanding memory footprint and eventual crashes of the application.

One solution to this problem is to have X's delegate be a *weak* reference. Just changing

```
@property(retain) id delegate;
```

to

```
@property(assign) id delegate;
```

will do the trick.

2.5 Categories

A category is an Objective-C feature that allows you to extend the capabilities of a given class. This feature works even if you do not have access to the source code of the class you are extending.

When you extend a given class through a category, the extension is inherited by all its subclasses. Of course, the additional methods defined by the category are only seen by your program.

To illustrate this powerful feature, let us extend the `NSObject` class by adding an instance method to it:

```

@interface NSObject (EnhancedObject)
- (NSComparisonResult) rankSelf:(NSObject*)anotherObject;
@end

@implementation NSObject (EnhancedObject)
- (NSComparisonResult) rankSelf:(NSObject*)anotherObject{
    if ([self retainCount] > [anotherObject retainCount]) {
        return NSOrderedDescending;
    }
    else if ([self retainCount] < [anotherObject retainCount]) {
        return NSOrderedAscending;
    }
    else return NSOrderedSame;
}
@end

```

To declare a category on an existing class such as `NSObject`, you add the name of the category in parentheses after the class name. The actual definition of the category follows a similar form. You define the category methods in the methods' section as you define regular methods.

The following illustrates the usage of this category. Since all objects are descendants of `NSObject`, all objects, in your application, will be able to rank themselves.

```

NSMutableString *string =
    [[NSMutableString alloc] initWithString:@"string"];
Employee *emp1 = [[Employee alloc] init];
[emp1 retain];
NSComparisonResult result = [emp1 rankSelf:string];

```

Here, we ask the `emp1` object of type `Employee` to rank itself with the `string` object of type `NSMutableString`. Neither the `Employee` class nor the `NSMutableString` class defines the `rankSelf:` method. The category `EnhancedObject` defined on `NSObject`, the ancestor of both, however, does define such a method. When `emp1` receives the message `rankSelf:`, the message is propagated up the inheritance chain to `NSObject`.

This feature is widely used in Cocoa. For example, the `UIStringDrawing.h` file defines a category `UIStringDrawing` (see Listing 2.3) on `NSString`; thus making every `NSString` object capable of drawing itself.

Listing 2.3 An example of a Cocoa category defined on `NSString` for the purpose of drawing.

```

@interface NSString (UIStringDrawing)
- (CGSize)drawAtPoint:(CGPoint)point withFont:(UIFont *)font;
- (CGSize)drawAtPoint:(CGPoint)point forWidth:(CGFloat)width
    withFont:(UIFont *)font
    lineBreakMode:(UILineBreakMode)lineBreakMode;
...
@end

```

2.6 Posing

Posing is part of the Objective-C language, but is not available on the device. You may want to look at Section 2.11 for alternatives to posing. Posing is covered here for completeness.

Posing is an Objective-C programming feature that allows you to swap one class, A, with another class, B. Swapping will result in all active instances that are subclasses of A, as well as all future instances of A or its subclasses, to use B instead of A. Therefore, after posing, all messages sent to A will, instead, be sent to B. This requires that B be a subclass of A. B can override existing methods, and add new methods, but it cannot add new instance variables.

Unlike categories, where the same method defined in the category replaces the one defined in the original class, a posing class that overrides one of its parent's methods can still call the overridden method using **super**. Posing is customarily used in testing scenarios.

The posing is achieved by a single call to the `NSObject`'s class method defined as:

```
+ (void)poseAsClass: (Class)aClass
```

For example,

```
[B poseAsClass: [A class]];
```

This should be done at the beginning of the program before any instance of A is created.

2.7 Exceptions and Errors

As a developer, even the simplest of your applications will some day face an unexpected event resulting in a change in the normal execution of your code. This event could simply be a division-by-zero, sending an undefined message to an object, or adding an element to an immutable collection. Regardless of the type of the error, your application needs to be aware of the possibility of its occurrence so that it can handle it gracefully when it does occur.

Cocoa divides these unexpected events into two categories: (1) those that are the developer's fault, and (2) those that are the user's fault. The problems that the developer is responsible for are called *exceptions*, while the problems that are user-specific are called *errors*. In Cocoa, exceptions are dealt with during the development of the application, and errors are used during the lifetime of the application. Cocoa frameworks use exceptions and errors. Therefore, as a Cocoa developer, you are expected to master both techniques.

2.7.1 Exceptions

Modern languages, such as Java and C++, provide language constructs for exception handling. Objective-C is no exception, for it too provides the same capabilities. To capture a possible exception, you enclose the problematic code with a `try` block. To process the actual exception, you use a

catch() block. If you want to execute some statements regardless of whether an exception occurred or not (e.g., releasing memory, etc.), you enclose these statements in a finally block.

But what is an exception and how it is signaled? An exception can be any Cocoa object. However, as a Cocoa developer, you should use `NSEException` or any subclass of it. An exception is signaled by being *thrown* or *raised*. Objective-C provides the `@throw` directive for throwing an exception and the `NSEException` class defines a `raise` instance method for raising an exception. Using the `@throw` directive, you can throw any Cocoa object, not just an instance of `NSEException`. However, using the `raise` method, you can only throw an `NSEException` object. Other than that, both techniques accomplish the same thing.

The structure of exception handling follows the following pattern:

```
@try {
    //statements that may cause an exception
}
@catch (NSEException *e) {
    //statements that handle an exception
    @throw; // optionally rethrowing the exception
}
@finally {
    //statements that should be executed regardless
    //of having an exception or not
}
```

You basically surround the potentially problematic code with a `@try` directive. To actually process the exception, you use an `@catch()` block. The `catch` block takes the exception object as its only parameter. As we mentioned above, the exception object does not have to be an instance of `NSEException`; any Cocoa object can be thrown/caught. For example, you can have code like the following, where an instance of `NSString` is being caught.

```
@catch(NSString *str) {
.
.
.
}
```

However, as we mentioned above, you should stick with `NSEException` or any of its subclasses.

Optionally, you can have a `finally` block where you put in it any code that is required to be executed regardless of the occurrence of an exception. This code usually releases memory and closes opened files.

You can optionally rethrow the exception to the next level on the call stack. You use the `@throw` directive to do that. You do not need to specify the exception object, however, as it is implied. Note that, if you rethrow an exception, the `@finally` block gets executed before actually throwing the exception to the lower level.

Exception example

Let's illustrate these concepts with a concrete example as shown below.

```
#import <Foundation/Foundation.h>
int main(int argc, char *argv[]) {
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    NSMutableArray *myArray = [[NSMutableArray alloc] initWithCapacity:0];
    [myArray addObject:@"an object"];
    [myArray replaceObjectAtIndex:1 withObject:@"another object"];
    [myArray release];
    [pool release];
    return 0;
}
```

The code above creates an array, then adds an element to it. After that, it attempts to replace that element with another object. If we run this code, an exception will occur and the program will be terminated with an error message similar to the following:

```
Exception Type: EXC_BREAKPOINT (SIGTRAP)
Exception Codes: 0x0000000000000002, 0x0000000000000000
Crashed Thread: 0
```

Application Specific Information:

```
*** Terminating app due to uncaught exception 'NSRangeException',
reason: '*** -[NSCFArray replaceObjectAtIndex:withObject:]:
index (1) beyond bounds (1)'
```

What has happened here is that we are using an invalid index (1) on an array of size 1. The method `replaceObjectAtIndex:withObject:` raised an exception upon seeing this invalid index. This method is declared as:

```
- (void)replaceObjectAtIndex:(NSUInteger)index withObject:(id)anObject
```

If you look at the documentation of this method, you will notice that the method can potentially raise two exceptions: (1) it raises an `NSRangeException` if `index` is beyond the end of the receiver, and (2) it raises an `NSInvalidArgumentException` if `anObject` is `nil`.

Let's rewrite the `main()` function adding an exception handler.

```
int main(int argc, char *argv[]) {
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    NSMutableArray *myArray = nil;
    @try {
        myArray = [[NSMutableArray alloc] initWithCapacity:0];
        [myArray addObject:@"an object"];
        [myArray replaceObjectAtIndex:1 withObject:@"another object"];
```

```

    }
    @catch (NSEException *e) {
        printf("Exception Name: %s. Reason: %s", [[e name] cString],
               [[e reason] cString] );
    }
    @finally {
        [myArray release];
        [pool release];
    }
    return 0;
}

```

We surrounded the problematic code with a `try` block. In catching the exception, we just print an error message. The `finally` block is important as we need to release the allocated memory. Instead of the application being terminated, it outputs the following useful message but, most importantly, exits gracefully.

```

Exception Name: NSRangeException.
Reason: *** - [NSCFArray replaceObjectAtIndex:withObject:]:
index (1) beyond bounds (1)

```

Creating exceptions

There are three important pieces of information that every instance of `NSEException` has:

1. `name`. A string that identifies the exception. This name has to be unique, relatively short, and never `nil`. You should never start the names of your exceptions with “NS”, but rather start names with something unique to your application and organization.
2. `reason`. This string attribute is also mandatory. It stores a human-readable explanation of the exception.
3. `userInfo`. This attribute is an optional dictionary (see Section 3.3). Using this dictionary, the code that generates the exception can communicate additional information to the exception handler.

If you are writing a method and you would like to communicate with the caller via exceptions, you need to be able to create exceptions and then throw them. To create an exception, you can use `NSEException`’s class method `exceptionWithName:reason:userInfo:` declared as:

```

+ (NSEException *)exceptionWithName:(NSString *)name
                           reason:(NSString *)reason
                         userInfo:(NSDictionary *)userInfo

```

This method returns an autoreleased `NSEException` object having the specified attributes. It returns `nil` if no such exception can be created.

In the following, we present an example for creating and throwing an exception.

```
- (void) myMethod: (NSString*) string{
    if(string == nil){
        NSEException *anException =
            [NSEException exceptionWithName:@"NSInvalidArgumentException"
                reason:@"Argument is nil"
                userInfo:nil];
        @throw anException; // OR [anException raise];
    }
    else{
        // proceed normally
    }
}
```

Nesting exceptions

Because an exception handler can optionally rethrow the exception (or a new one), exceptions can be nested. For example, consider the scenario where you have a method that adds a record to a database. This method calls another low-level method that handles the actual physical insertion of the record in a file. The following two listings show the database addRecord: and the insertRecord: methods.

```
- (void) addRecord: (Record*) record{
    @try {
        [file insertRecord:record];
    }
    @catch (NSEException * e) {
        // create a new exception, db,
        // name=MYDBException
        @throw db;
    }
    @finally {
        // close files, etc.
        // release memory
    }
}

- (void) insertRecord: (Record*) record{
    @try {
        // open the file
        // seek
        // insert record
    }
    @catch (NSEException * e) {
        // locally handle exception
        @throw;
    }
}
```

```

    }
    @finally {
        //close file
        // release memory
    }
}

```

Here, we see the nested exceptions. If an exception occurs while accessing the file, that exception is caught in the `insertRecord:` method, dealt with locally, and rethrown. The `addRecord:` method has an exception handler that catches the rethrown exception. It creates a new exception, named `MYDBException`, and throws it. This last exception is communicated to the caller of the `addRecord:` method. In case of a failure, the caller of `addRecord:` sees a meaningful *database* exception rather than the low-level *file* access exception. Note that nesting levels can be arbitrary.

2.7.2 Errors

As a C-programmer, you must be used to using error codes as a means to conveying errors to the caller. This approach is limited in that you can only convey a single piece of information (a number) to the caller.

Cocoa uses objects of type `NSError` (or subclasses of it) as the main mechanism to convey runtime errors to users.

A Cocoa method follows a pattern in conveying errors:

- The return value of a method is used to indicate failure or success. If the return value is of type `BOOL`, a `NO` indicates an error. If, on the other hand, the return value is of type `id`, a `nil` indicates a failure.
- As a secondary mechanism to further elaborate on the error, the user can pass a pointer to an `NSError` object as the last parameter of the method. If this parameter is not `NULL`, the method stores a new autoreleased `NSError` object using that pointer.

An `NSError` object stores three important attributes:

- `domain` – a string representing the error domain. Different frameworks, libraries, and even classes, have different error domains. Examples of error domains are `NSPOSIXErrorDomain` and `NSCocoaErrorDomain`. Applications can, and should, create their own unique error domains. If you are creating an error domain, make sure it is unique by prefixing the domain name with the name of the application and your organization's name.
- `code` – an integer error code that has meaning within the domain. Two `NSError` objects with the same error code but different domains are different.
- `userInfo` – a dictionary (see Section 3.3) containing objects related to the error.

Error example

Let's illustrate error handling in Cocoa. The following example deliberately causes an error. It handles the error by displaying the three attributes of the error described above.

```
NSError *myError = nil;
NSURL *myUrl = [NSURL URLWithString:@"http://fox.gov"];
NSString *str = [NSString stringWithContentsOfURL:myUrl
                                         encoding:NSUTF8StringEncoding
                                         error:&myError];
if(str == nil){
    printf("Domain: %s. Code: %d \n", [[myError domain] cString],
           [myError code]);
    NSDictionary *dic = [myError userInfo];
    printf("Dictionary: %s\n", [dic description]);
}
```

You do not necessarily need to know URL loading at this stage as we will go over it in detail later in this text. What you need to know is that we make a call to a Cocoa method to obtain an object (here, this object is the page as an `NSString` object). The method returns `nil` if there was an error, and allows the user to specify a pointer to an `NSError` object for further information on the error. We pass a pointer to an `NSError` object and make the call. Since the site `http://fox.gov` does not exist, the returned value of the method is `nil`, and the `NSError` object is created and autoreleased by the Cocoa method.

The output of this code snippet is the error domain, code, and the contents of the dictionary.

```
Domain: NSCocoaErrorDomain. Code: 260
Dictionary: {
    NSURL = http://fox.gov;
    NSUnderlyingError = Error Domain=NSURLLErrorDomain
        Code=-1003
        UserInfo=0x4183a0 "can't find host";
}
```

We notice that the domain is `NSCocoaErrorDomain` with code 260. The `userInfo` dictionary contains two entries: (1) the `NSURL` with value `http://fox.gov`, and (2) the `NSUnderlyingError` with value `Error Domain=NSURLLErrorDomain Code=-1003 UserInfo=0x4183a0 "can't find host"`.

Creating an `NSError` instance

We have seen how we can handle an error object that was created for us, but often, we are required to write methods that return an autoreleased error object to our clients. To create an `NSError` object, you can use one of the several class-instance methods available. For example,

the class method `errorWithDomain:code:userInfo:` returns an autoreleased error object. Another way for obtaining an error object is to allocate it using `alloc` and initialize it using `initWithDomain:code:userInfo::`. For example, assuming the last argument of your method, `error`, is of type `NSError**`, the following will create a new `NSError` object for the caller.

```
*error = [[[NSError alloc] initWithDomain:CompanyCustomDomain  
                                code:12 userInfo:dictionary] autorelease];
```

2.8 Key-value coding (KVC)

Up to now, we have seen two ways of accessing the instance variables in an object: either using accessor methods, or directly. Cocoa defines a third way that allows you to access the instance variables of a class indirectly. This technique is called key-value coding (KVC).

KVC is declared in the protocol `NSKeyValueCoding`. This protocol is implemented by `NSObject`, the root of all Cocoa objects. At the heart of this protocol, there are two basic methods that you use: (1) `setValue:forKey:` sets the value of a given key, and (2) `valueForKey:` retrieves the value of a given key.

The `valueForKey:` method is declared in the protocol as:

```
- (id)valueForKey:(NSString *)key
```

where `key` is an ASCII encoded string that starts with a lowercase letter and does not contain whitespace.

The `setValue:forKey` method is declared in the protocol as:

```
- (void)setValue:(id)value forKey:(NSString *)key
```

where `value` is a Cocoa object (i.e., a subclass from `NSObject`), and `key` is an instance of `NSString` with the same restrictions as stated above.

For KVC to work, you need to follow some Cocoa conventions in naming accessor methods. Given a key `xyz`, there should be an accessor named `xyz` or `isXyz` defined in your class in order to use the `valueForKey:` method. Similarly, to use the `setValue:forKey:` method, your class should define a setter named `setXyz:`.

Several keys can be dot-separated to form what is called a *key path*. The key path defines the sequence of object properties to traverse. For example, the key path `key1.key2.key3` says: obtain the object specified by `key1` from the receiver, then obtain the object specified by `key2` from the object you have just obtained from the receiver, and finally, obtain the object specified by `key3` from the last object you have obtained using `key2`.

To retrieve the value of a given key path, use the method `valueForKeyPath::` To set the value for a key path, use the `setValue:forKeyPath:` method.

2.8.1 An example illustrating KVC

Let's illustrate KVC through an example: consider the `Person` class declared and defined as follows:

```
@interface Person: NSObject{
    NSString *name;
    NSArray *allies;
    Person *lover;
}
@property NSString *name;
@property NSArray *allies;
@property Person *lover;
-(id)initWithName:(NSString*) theName;
@end

@implementation Person
@synthesize name, allies, lover;
-(id)initWithName:(NSString*) theName{
    if(self = [super init]){
        name = theName;
    }
    return self;
}
@end
```

In addition, consider the `Community` class declared and defined as follows:

```
@interface Community : NSObject{
    NSArray *population;
}
@property NSArray *population;
@end

@implementation Community
@synthesize population;
@end
```

The first thing you need to notice in this example is how the `initWithName:` method is implemented. First, notice how we invoke the `super`'s `init` method first and use the result as the value of the variable `self`. Second, notice that we assign the instance variable, `name`, directly. The reason we do that has nothing to do with our KVC example. It just shows that if you want the assignment to use the synthesized setter, you should use:

```
self.name = theName
```

The setter is `assign` (default), so we skip it and assign the instance variable directly. Be careful when you set instance variables inside your class. If you do not use `self`, you end up assigning the value rather than invoking the setter. Also, be careful when you implement the setter yourself. If, in

your setter, you set the instance variable using `self`, you end up with an infinite loop which results in a stack overflow and an application crash.

Let's use the above two classes to put KVC into action. Listing 2.4 shows the main function that demonstrates KVC.

Listing 2.4 Demonstration code for key-value coding (KVC).

```

int main(int argc, char *argv[]) {
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    Person *kate = [[Person alloc] initWithName:@"Kate"];
    Person *jack = [[Person alloc] initWithName:@"Jack"];
    Person *hurley = [[Person alloc] initWithName:@"Hurley"];
    Person *sawyer = [[Person alloc] initWithName:@"Sawyer"];
    Person *ben = [[Person alloc] initWithName:@"Ben"];
    Person *desmond = [[Person alloc] initWithName:@"Desmond"];
    Person *locke = [[Person alloc] initWithName:@"Locke"];
    Community *lost = [[Community alloc] init];
    [kate setValue:[NSArray arrayWithObjects:locke, jack, sawyer, nil]
        forKey:@"allies"];
    [hurley setValue:[NSArray arrayWithObjects:locke, nil]
        forKey:@"allies"];
    [sawyer setValue:[NSArray arrayWithObjects:locke, nil]
        forKey:@"allies"];
    [desmond setValue:[NSArray arrayWithObjects:jack, nil]
        forKey:@"allies"];
    [locke setValue:[NSArray arrayWithObjects:ben, nil]
        forKey:@"allies"];
    [jack setValue:[NSArray arrayWithObjects:ben, nil]
        forKey:@"allies"];
    [jack setValue:kate forKey:@"lover"];
    [kate setValue:sawyer forKey:@"lover"];
    [sawyer setValue:hurley forKey:@"lover"];
    [lost setValue:[NSArray arrayWithObjects: kate, jack, hurley,
        sawyer, ben, desmond,
        locke, nil] forKey:@"population"];
    NSArray *theArray = [lost valueForKeyPath:@"population"];
    theArray = [lost valueForKeyPath:@"population.name"];
    theArray = [lost valueForKeyPath:@"population.allies"];
    theArray = [lost valueForKeyPath:@"population.allies.allies"];
    theArray = [lost valueForKeyPath:@"population.allies.allies.name"];
    theArray = [lost valueForKeyPath:@"population.allies.name"];
    NSMutableSet *uniqueAllies = [NSMutableSet setWithCapacity:5];
    for(NSArray *a in theArray){
        if(![a isKindOfClass:[NSNull class]]){
            for(NSString *n in a){
                printf("%s ", [n cString]);
                [uniqueAllies addObject:n];
            }
        }
    }
}

```

```
    printf("\n");
}
}
NSString *luckyPerson =
    [jack valueForKeyPath:@"lover.lover.lover.name"];
[kate release];
[jack release];
[hurley release];
[sawyer release];
[ben release];
[desmond release];
[locke release];
[pool release];
return 0;
}
```

We first create and initialize seven `Person` instances and one `Community` instance. Next, we use KVC to set the `allies` array. KVC is used after that to set the `lover` attribute. Then we set the population of the lost `Community` instance with an array instance containing the seven `Person` instances.

Now, we would like to use KVC to retrieve values using keys and key paths. The line

```
[lost valueForKeyPath:@"population"];
```

retrieves the `population` array in the `lost` object. The key `population` is applied to the `lost` instance producing the array of `Person` instances returned to the caller. Figure 2.1 shows the result graphically.

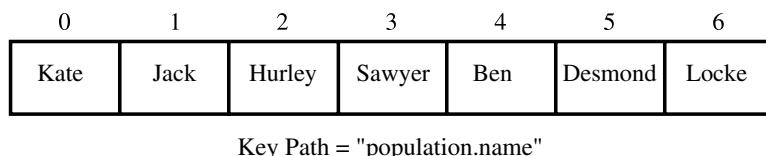
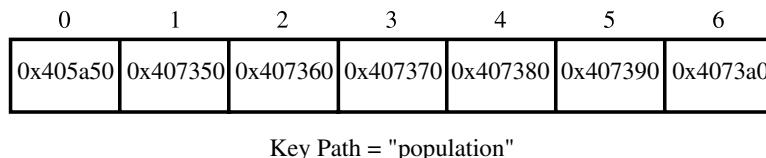


Figure 2.1 Using keys and key paths to retrieve the `population` array and an array of names of `population` from the `lost` instance.

Next, the line:

```
[lost valueForKeyPath:@"population.name"];
```

retrieves an array of names representing the population in the `lost` instance. This is a key path example. First, the key `population` is applied to the receiver, `lost`. This will produce an array of `Person` instances. Next, the key `name` is applied to each and every entry in this array. This will produce an instance of `NSString`. The array of `NSString` instances will be returned as the result. Figure 2.1 shows the result graphically.

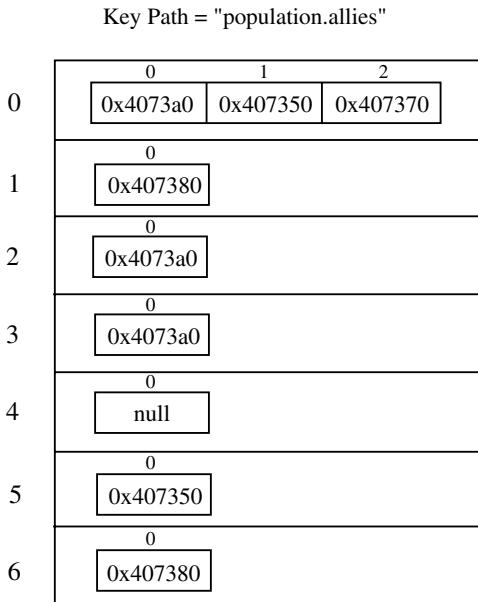


Figure 2.2 Graphical representation of the result obtained from applying the key path `population.allies` to the `lost` instance.

The line:

```
[lost valueForKeyPath:@"population.allies"];
```

is an interesting one. Let's follow it to come up with the result. First, the `population` key is applied to the receiver `lost`. This will produce an array of `Person` instances. Next, the key `allies` is applied to each and every `Person` instance in that array. This will produce an array of `Person` instances. So, now we have an array of an array of `Person` instances. This will be the result and will be returned to the caller. Figure 2.2 shows the result graphically.

The line:

```
[lost valueForKeyPath:@"population.allies.allies"];
```

goes even further. The subkey path `population.allies` produces the exact result as above, but now we apply another key, `allies`, to the result. This will produce an array of an array of an array of `Person` instances as shown in Figure 2.3.

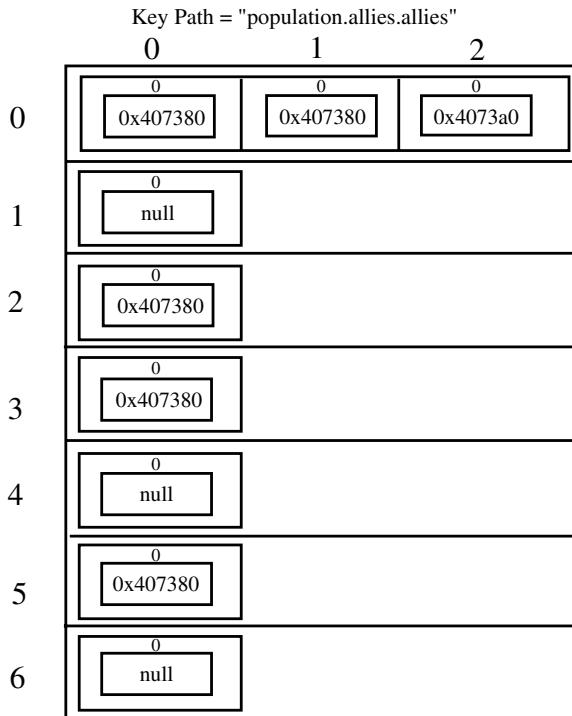


Figure 2.3 Graphical representation of the result from applying the key path population.allies.allies to the lost instance.

The line:

```
[lost  valueForKeyPath:@"population.allies.allies.name"];
```

does the same as above, except that it further applies the key name to every Person instance in the array of an array of an array of Person instances.

The code:

```
theArray = [lost valueForKeyPath:@"population.allies.name"];
NSMutableSet *uniqueAllies = [NSMutableSet setWithCapacity:5];
for(NSArray *a in theArray) {
    if (![a isKindOfClass:[NSNull class]]) {
        for(NSString *n in a) {
```

```

        printf("%s ", [n cString]);
        [uniqueAllies addObject:n];
    }
    printf("\n");
}
}

```

demonstrates the structure of the result from applying the key path `population.allies.name`. It enumerates all names, and produces a set of unique names. See Chapter 3 for more information on arrays and sets.

One thing you need to be aware of is the `nil` problem. Since some of the instance variables of objects can be `nil`, and collections in Cocoa cannot have `nil` entries, Cocoa uses the `NSNull` class to represent `nil` entries. In the above code, we just check to see if the entry is an instance of `NSNull`. If so, we skip it.

Some may confuse collections and key paths, thinking that a key path always results in a collection instance. But that is not true as these two concepts are orthogonal. The statement:

```
NSString *luckyPerson = [jack valueForKeyPath:@"lover.lover.lover.name"];
```

will result in an instance of `NSString` with the value @"Hurley".

2.9 Multithreading

Multithreading is an important subject in computing. In a single-core system, multithreading gives the user the illusion of concurrent processing. It allows the developer to have an application with a responsive user interface while performing time-consuming tasks in the background. In a multicore system, the importance of multithreading is highlighted even further. Developers want to design applications to utilize the multicore computers more efficiently. Even if the computer system is single-core, they still want to design the application to be user-centric and to have maximum flexibility.

Multithreading in Cocoa is very simple to achieve. All you have to do is to make sure that you design the multithreaded tasks³ to have minimal interaction with either the main thread or among the other threads. When threads interact with each other by using shared data structures, problems manifest themselves in the form of corrupted data or difficult-to-find bugs.

A simple approach for multithreading is the use of *operation objects*. You can use operation objects by either subclassing the `NSOperation` class or by using a concrete subclass of it called `NSInvocationOperation`. Using the latter approach makes transforming your code into a concurrent application even easier.

³A task is a piece of code that accomplishes a specific goal (e.g., find the square root of a number).

Let's assume that you have a method, possibly calling other methods, in a class, and you want to run this method in the background. Without multithreading, the structure of your code will look something like the following.

In one of your objects, you have, in one of the methods:

```
[myComputationallyIntensiveTaskObject compute:data];
```

In the class that actually does the job (i.e., the class of `myComputationallyIntensiveTaskObject`) which defines the `compute:` method, you have:

```
- (void) compute:(id)data{  
  
    // do some computationally intensive calculations on data  
    // store the either partial or final results  
    // in some data structure, ds, for others to use  
}
```

The `compute:` method operates on `data` and performs computationally intensive calculations. It either stores partial results in an instance variable for other threads to consume, or waits until it finishes the computation to present the final results for consumers. It all depends on the application.

Here are the steps you need to take in order to put the `compute:` method in the background, thus making the main thread responsive to the user while performing this task.

1. Create a launching method. Create a method in the class of `myComputationallyIntensiveTaskObject`. This method will be the one used by other objects if they choose to run the task in the background. Call it something meaningful such as `initiateCompute:` or `computeInBackground:`.
2. In `computeInBackground:`, create an operation queue. An operation queue is an object of type `NSOperationQueue` that holds operation objects. You do not necessarily have to create the operation queue here, as long as you have a queue created somewhere in the program.
3. Create an `NSInvocationOperation` object. This will be your operation object. You configure this object with enough information so that the new thread will know where to start executing.
4. Add the newly created operation object to the queue so that it starts running.
5. Since every thread requires its own autorelease pool, in the original `compute:` method, add a new autorelease pool at the beginning and `release` it at the end.
6. If the `compute:` method produces data to be used by other threads, synchronize access to this data using locks. Use locks to access this data in *all* places within your program that use (either read or write) this data.

And that's all! Let's apply these steps to our example and see how easy it is to use multithreading in Cocoa. Listing 2.5 shows the updated code.

Listing 2.5 A multithreaded application using operation objects.

```

// Changes to interface
@interface MyComputationallyIntensiveTask: NSObject{
    ...
    NSInvocationOperation *computeOp;
    NSOperationQueue      *operationQueue;
}

...
- (void) computeInBackground:(id)data;
- (BOOL) computationFinished;
- (DS*) computationResult;
@end

@implementation MyComputationallyIntensiveTask
...
// additional methods
- (void) computeInBackground:(id)data{
    operationQueue = [[NSOperationQueue alloc] init];
    computeOp = [[[NSInvocationOperation alloc]
                  initWithTarget:self
                  selector:@selector(compute:)
                  object:data] autorelease];
    [operationQueue addOperation: computeOp];
}

- (BOOL) computationFinished{
    @synchronized(ds){
        // if ds is complete return YES, else return NO
    }
}

- (DS*) computationResult{
    if([self computationFinished] == YES){
        return ds;
    }
    else
        return nil;
}

//changes to original method
- (void) compute:(id)data{
    NSAutoreleasePool * threadPool = [[NSAutoreleasePool alloc] init];

    // do some computationally intensive calculations
    // on data store the (either partial or final) results
    // in some data structure, ds, for others to you
    @synchronized(ds){
        // store result in ds
}

```

```
    }
    [threadPool release];
}

// Usage from another object
- (void)someOtherMethod{
    ...
    [myComputationallyIntensiveTaskObject computeInBackground:data];
    // be responsive to user GUI
    ...
    //If you need some results or all results
    if(myComputationallyIntensiveTaskObject computationFinished] == YES){
        result = [myComputationallyIntensiveTaskObject computationResult];
    }
}
@end
```

We added two instance variables in the class, one for the operation and the other for the operation queue. We also added three methods: the `computeInBackground:` for initiating background computation, the `computationFinished` to check if the final result is ready, and `computationResult` for retrieving the final result. This is the simplest inter-thread communication. Depending on your application requirements, you might opt for more sophisticated protocols. In the method that initiates the background thread, `computeInBackground:`, we start by allocating the operation queue. Next, we allocate the `NSInvocationOperation` and initialize it with the tasks object, main method, and the input data. The initialization method, `initWithTarget:selector:object:` is declared as:

```
- (id)initWithTarget:(id)target selector:(SEL)sel object:(id)arg
```

The `target` is the object defining the selector `sel`. The selector `sel` is the method that is invoked when the operation is run. You can pass at most one parameter object to the selector through the `arg` argument. Note that the selector has exactly one parameter. In the cases where you do not have a need to pass an argument, you can pass a `nil`.

After setting up the operation queue and creating and initializing the new operation object, we add the operation object to the queue so that it starts executing. This is done using the `addOperation:` method of the `NSInvocationOperation` object.

As we have mentioned before, autorelease pools are not shared across threads. Since our `compute:` method will be run in its own thread, we create and initialize an `NSAutoreleasePool` object at the beginning and release it at the end of the method. We keep the original `compute:` method intact.

Any time the shared data, `ds`, is accessed, we use a locking mechanism in order to guarantee data integrity. The shared data can be an instance variable of the object defining the method `compute:` or it can be in another object. Regardless of what shared data you have, if it is accessed from more than one thread, use a lock.

Locking is made easy with the `@synchronized()` directive. The `@synchronized()` directive is used to guarantee exclusive access to a block of code for only one thread. It takes one object as an argument. This object will act as the lock to that piece of code. It is not necessary that the data you are trying to protect is used as a lock. You can use `self`, another object, or even the `Class` object itself as the lock. It is important to note that if the sensitive data structure you are trying to protect is accessed from other parts of your program, the *same* locking object must be used. To enhance the concurrency of your program, delay access to the shared data till the end (i.e., when it needs to be written) and use different locking objects for different unrelated sections of your code.

2.10 Notifications

The delegate pattern allows an object to delegate a task to another object. Sometimes, this pattern is not adequate to the task. For example, suppose that several objects are interested in the result of a given object, `o`. When `o` completes its task, it needs to notify interested parties of the result so they can act on it. Object `o` can maintain an array of these parties and notify them when needed. However, this will require that the other objects know about `o` (its address), which gives rise to tight-coupling problems. In general, this approach is not adequate.

The iPhone runtime provides a centralized object called the *notification center* that acts as a switch-board between objects. The center relays messages from objects that produce events to other objects interested in these events. If an object is interested in a specific event, the object registers with the center for that event. If an object wants to broadcast an event, that object informs the center, and the center, in turn, notifies *all* objects who registered for that event.

The unit of communication between the objects and the center is referred to as a *notification*. `NSNotification` class encapsulates this concept. Every notification consists of three pieces of data:

- **Name.** A name is some text that identifies this notification. It can be set during initialization and read using the `name` method.
- **Object.** Each notification can have an object associated with it. This object can be set during initialization and retrieved using the `object` method.
- **Dictionary.** If additional information needs to be included in a notification, then a dictionary is used. The `aUserInfo` is used for that purpose. It can be set during initialization and retrieved afterwards using the `userInfo` method.

To post a notification, an object first obtains the default notification center and then sends it a `postNotificationName:object:userInfo:` message. To obtain the default notification center, send a `defaultCenter` class message to `NSNotificationCenter`.

The `postNotificationName:object:userInfo:` method is declared as follows:

```
- (void)postNotificationName: (NSString *)aName  
                      object: (id)anObject userInfo: (NSDictionary *)aUserInfo;
```

If your user info dictionary is not needed, you can use `postNotificationName:object:`, instead. This method simply calls `postNotificationName:object:userInfo:` with a nil `aUserInfo`. You can also post a notification with only a name using `postNotification:` method. This method simply passes nil for the second and third arguments.

Objects can express their interest in notifications by adding themselves as *observers*. An object can add as many observations as it needs. To add an object, `o`, as an observer, send `addObserver:selector:name:object:` to the default center. You must pass in the reference to `o` and a selector representing the method to be executed when the notification occurs. The last two parameters (`name` and `object`) define four possibilities. If you pass nil for both, object `o` will receive all notifications that occur in your application. If you specify a specific name and set the `object` parameter to nil, `o` will receive all notifications with `name` regardless of the sender. If you specify values for `name` and `object`, `o` will receive all notifications with `name` coming from the `object`. Finally, if you specify nil for `name` and a value for `object`, `o` will receive all notifications from that `object`. The method for adding an observer is declared as follows:

```
- (void) addObserver: (id) observer selector: (SEL) aSelector  
    name: (NSString *) aName object: (id) anObject;
```

The selector `aSelector` must represent a method that takes exactly one argument – the notification object (i.e., instance of `NSNotification`).

When an object posts a notification, the notification center goes through its table, determines the objects that need to receive the notification and invokes their respective selectors passing the notification. The order of notification is undefined. Once the notification is delivered to every object that needs it, control is returned to the object that posted that notification. In other words, posting a notification using this method is *synchronous*.

It's important to note that the notification center does not *retain* the observer. Therefore, you must remove an observer in its `dealloc` method; otherwise, the notification center will send a notification to a deallocated object and the application will crash. You can use `removeObserver:` passing in an object (the observer) as an argument to remove all entries related to that object. To remove some of observations and keep others, you use the `removeObserver:name:object:` method. The method is declared as follows:

```
- (void) removeObserver: (id) observer name: (NSString *) aName  
    object: (id) anObject;
```

You must pass in a value for `observer`. The `aName` and `anObject` are optional parameters.

2.11 The Objective-C Runtime

At the heart of object-oriented programming paradigm is the concept of a *class*. A class is a blueprint from which objects can be created. This blueprint specifies what instance variables (state) and what methods (behavior) are available to any object produced by this blueprint. In other words, a class is

an object factory: to get a brand-new object, whose instance variables are initialized to zeros, you ask its class to produce a new object.

Objects that are created using the same class share the same behavior (methods) but have their own copy of the instance variables. Class-level variables can be declared using the **static** keyword. These variables can be declared outside any method of the class which makes them accessible from any method in the class or they can be defined inside a given method which means they will be only accessible from within that method. In both cases, all instances (objects) of this class share the same static variable, and changes from one object to that variable are seen by all objects of this class.

Given a class, we can define a new class that inherits from this class but optionally adds new state/behavior. The original class is referred to as the *super-class* of the new class. Objective-C is a single-inheritance programming language; which means that a class can have at most one super-class.

The creation of new classes can be done at both compile-time and run-time. At compile-time, a new class is created using the **@interface** and **@implementation** compiler directives. The compiler generates the C-code that is responsible for bringing the class into existence at run-time. As you will see later in this section, you can use the runtime library to create a new class dynamically at run-time.

On the iPhone OS, a class is also an object. Since a class is an object, that means it needs a blueprint (a class) to create it. A class that is used to create class objects is referred to as a *metaclass*. The same way that any object is an instance of exactly one class, every class object is an instance of exactly one metaclass. Metaclasses are compiler generated and you rarely interact with them directly.

You access a given behavior (i.e., a method) of an object by sending it a *message*. A message is the name of the method and any arguments to that method. Methods are implemented using C-functions. The actual implementation of the method (i.e., the C-function) is, however, separate from the actual message. An object can, at run-time, change how it implements a given message. An object can even forward messages to other objects if it does not want to deal with these messages itself.

On the iPhone OS, the root class is `NSObject`. All objects must be instances of this class or subclasses of it. To have an instance of `NSObject` is really not that useful; you usually create new (or use existing) classes that inherit from `NSObject`. `NSObject` has no superclass.

2.11.1 Required header files

Before getting into the runtime system functions, you need to add the following include statements to any code that accesses these functions:

```
#import <objc/objc.h>
#import <objc/runtime.h>
#import <objc/message.h>
```

Furthermore, you need to target the device, not the simulator, in your build.

2.11.2 The `NSObject` class

The question is: what is an `NSObject`? If you examine the `NSObject.h` header file, you will notice that `NSObject` is declared as a class with one instance variable and a bunch of class and instance methods. In addition, the class adopts a protocol with the same name.

```
@interface NSObject <NSObject> {
    Class     isa;
}
// a bunch of class and instance methods
@end
```

The sole instance variable is called `isa` and it is of the type `Class`. This pointer points to the class used to generate the instance of the object. That means that every object, whether it is an instance object, a class object, or a metaclass object has a pointer to its class. Through this pointer, the runtime can find out what messages this object can respond to and the implementation of these methods.

The `Class` type is defined as follows:

```
typedef struct objc_class *Class;
```

It is basically a pointer to a C structure. The C structure is declared as follows:

```
struct objc_class {
    Class isa;

#if !__OBJC2__
    Class super_class         _OBJC2_UNAVAILABLE;
    const char *name          _OBJC2_UNAVAILABLE;
    long version              _OBJC2_UNAVAILABLE;
    long info                 _OBJC2_UNAVAILABLE;
    long instance_size        _OBJC2_UNAVAILABLE;
    struct objc_ivar_list *ivars_OBJC2_UNAVAILABLE;
    struct objc_method_list **methodLists_OBJC2_UNAVAILABLE;
    struct objc_cache *cache  _OBJC2_UNAVAILABLE;
    struct objc_protocol_list *protocols_OBJC2_UNAVAILABLE;
#endif

}_OBJC2_UNAVAILABLE;
```

The `OBJC2_UNAVAILABLE` availability macro indicates that the tagged variables are not available in the iPhone OS. They, however, provide insights into how the Objective-C class is structured.

As we saw in the `NSObject` class declaration, the first member variable in an Objective-C class is a pointer to another Objective-C class. The existence of this pointer in every instance, every class object, and every metaclass object, provides us with a linked-list data structure that the runtime can traverse.

In addition to the `isa` pointer, a class object has a `super_class` pointer to its superclass. Since the `NSObject` class is the root class, the `NSObject` class object has this pointer set to `nil`. The `NSObject` metaclass object is reached using the `isa` pointer of any instance, class object, or metaclass object including itself.

All classes, whether regular classes or metaclasses, have `NSObject` class as their root class. This also includes the `NSObject` metaclass. That means that if you traverse this `super_class` link from any instance object, any class object, or any metaclass object, you will reach `NSObject` class object and eventually `nil`.

2.11.3 Objective-C methods

At the time of allocating a new object of a given class, the class object representing that class provides information that guides the runtime in its memory allocation of that object's instance variables. Once the memory space has been reserved for the new object, all its instance variables are initialized to zeros. This excludes, of course, the `isa` instance variable.

The class object also plays a crucial role in providing the runtime with information on what kind of messages objects generated using it can receive. By the same token, the messages accepted by this class (i.e., class methods) are determined by its metaclass object.

Let's look at what happens when the following Objective-C statements is executed:

```
float value = [market stockValue:@"ALU"];
```

The compiler translates this statement into a C-function call similar to the following statement:

```
float value = ((float (*)(id, SEL, NSString*)) objc_msgSend)
    (market, @selector(stockValue:), @"ALU");
```

Here, the `objc_msgSend()` function is called with three arguments: 1) the receiver object, 2) the selector of the method, and 3) the sole argument to the method.

The `objc_msgSend()` function is declared as follows:

```
id objc_msgSend(id theReceiver, SEL theSelector, ...)
```

This is basically a function that takes at least two arguments and returns an object. Since this function is used by the compiler to translate any messaging statement, the compiler casts the function to the appropriate signature.

The `objc_msgSend()` function starts by obtaining a reference to the class object of `market`. This is, of course, the value of the `isa` pointer and it is located in the first few bytes of the memory pointed to by the pointer `market`. Once the class object has been determined, it is queried for the method corresponding to the selector `stockValue:`.

The class object maintains a table called *dispatch table*. Each entry in this table contains a selector and a pointer to a C-function implementing that selector.

If the class does not recognize this message, its superclass is queried, and so on. If the message is not recognized by any of the classes in the inheritance chain, the runtime sends the receiver a `doesNotRecognizeSelector:` message. This method is declared in `NSObject` as follows:

- `(void)doesNotRecognizeSelector: (SEL)aSelector`

This method must always result in an exception being thrown. The default behavior is to throw `NSInvalidArgumentException`. If you override this method, you must either raise this exception yourself or propagate the message to `super`.

The preceding paragraph highlights a powerful feature of Objective-C: dynamic binding. The name of the method (i.e., the message) and its actual implementation are not known until runtime. Not only that, but the receiver itself is also unknown until runtime.

A reference to the C implementation of the method is stored in a variable of type `IMP`. `IMP` is declared as follows:

```
typedef id (*IMP) (id, SEL, ...);
```

The preceding simply declares `IMP` to be a pointer to a function that takes two arguments and optionally zero or more additional arguments, and returns an object. These two arguments are passed in as `self` and `_cmd`, respectively.

To access the implementation of a given method, you can use the `NSObject` instance method `methodForSelector:` passing in the selector of the method. This method is declared as follows:

- `(IMP)methodForSelector: (SEL)aSelector`

Once you have the pointer to the implementation function, you can invoke the function directly as you do with any C function.

Let's look at an example. Suppose we have the following declaration and definition of a class, `RT1`:

```
@interface RT1 : NSObject  
- (float)valueForStock: (NSString*) stock onDay: (NSDate*) day;  
@end  
  
@implementation RT1  
- (float)valueForStock: (NSString*) stock onDay: (NSDate*) day{  
    return 33.5;  
}  
@end
```

To invoke the C implementation of the method `valueForStock:onDay:`, one first declares a function prototype as in the following statement:

```
typedef float(*StockFunc) (id, SEL, NSString*, NSDate*);
```

Notice, again, that the first two arguments are an object of type `id` representing the receiver of the message and the `SEL` value representing the method.

The following function creates a new instance of the RT1 class, obtains the implementation function and invokes it directly.

```
void illustration1() {
    RT1 *rt = [[RT1 alloc] init] autorelease];
    SEL selector = @selector(valueForStock:onDay:);
    StockFunc theFunc = (StockFunc)[rt methodForSelector:selector];
    NSLog(@"Stock value: %.2f",
          theFunc(rt, selector, @"ALU", [NSDate date]));
}
```

Calling implementations directly should be done with care. You need to have the justification for using such a technique and bypassing the message-forwarding mechanism. A good example of using this technique is if you have, say, thousands of objects, all of the same type, and you want to send each the same message. Using this technique will sharply speed up this task.

The Objective-C runtime defines the type `Method` as a representation of any method in a class. This type is declared as follows:

```
typedef struct objc_method *Method;
```

The `objc_method` structure is declared as follows:

```
struct objc_method {
    SEL      method_name;
    char    *method_types;
    IMP      method_imp;
}
```

As you might have guessed, a method has three components: 1) a name, 2) the types of its parameters and return value, and 3) the actual C-function implementing the method.

Here, we see that the name of the method is of type `SEL`, the parameters/return value types are encoded and stored in a C-string, and the actual C implementation of the method is a pointer to a function.

The `SEL` type is used to represent the name of the Objective-C method. In the Mac environment, it is represented as C string. You still need to use the `@selector` directive for managing selectors.

The encodings of the parameters' types are performed by the compiler. The directive `@encode` can be used to generate encodings of most types (including new classes).

There are specific encodings for the different known and unknown types. For example:

- **Object.** An object type is encoded as `@`.
- **Selector.** A `SEL` type is encoded as `:`.
- **Void.** A `void` type is encoded as `v`.
- **Class object.** A class object is encoded as `#`.

- **Integer.** An `int` type is encoded as `i`.
- **Boolean.** A `BOOL` type is encoded as `B`.
- **Character.** A `char` type is encoded as `c`.

You access the `Method` data using functions as illustrated, through examples, in the next section.

2.11.4 Examples

In this section, we present examples that are used to illustrate the main concepts behind the Objective-C runtime library.

Obtaining instance and class methods

Consider the following new class declaration and definition:

```
@interface RT2 : RT1
- (void)anInstanceMethod;
+ (void)aClassMethod;
@end

@implementation RT2
- (void)anInstanceMethod{ }
+ (void)aClassMethod{ }
@end
```

This class inherits from `RT1` and defines additional instance and class methods. It doesn't, however, override any method.

To obtain an instance method, you use the function `class_getInstanceMethod()` which is declared as follows:

```
Method class_getInstanceMethod(Class cls, SEL name)
```

The method takes the class object from which to start the search and the name of the method as a `SEL` argument.

Searching for the method starts from the specified class and goes up the inheritance chain until the method is found.

To retrieve a class method, you use `class_getClassMethod()` function. The following code shows how to retrieve three methods. First it retrieves an instance method defined by the class. Next, it retrieves a class method defined by the class. Finally, it retrieves an instance method defined by the superclass.

```
void illustration2() {
    Method method =
        class_getInstanceMethod([RT2 class], @selector(anInstanceMethod));
    methodLog(method);
    method =
        class_getClassMethod([RT2 class], @selector(aClassMethod));
    methodLog(method);
    method =
        class_getInstanceMethod([RT2 class], @selector(valueForStock:onDay:));
    methodLog(method);
}
```

Logging some of the method information is done using the following function:

```
void methodLog(Method method) {
    NSLog(@"%@", NSStringFromSelector(method_getName(method)));
    NSLog(@"%@", method_getImplementation(method));
}
```

To obtain a method's name (i.e., a SEL) from a Method variable, we use the function `method_getName()`. This SEL value is then converted into an `NSString` object using the `NSStringFromSelector()` function. To obtain the implementation (i.e., a pointer to the C function implementing this method), we use the `method_getImplementation()` function.

In RT2 above, had we overridden the method `valueForStock:onDay:` defined in its parent, the `class_getInstanceMethod()` would have produced the implementation of RT2 not that of RT1.

Querying response to messages

Sometimes, you have an object that you do not know its capabilities, but you would like to send it a message, nevertheless. You can test to see if an object responds to a selector by using the `respondsToSelector:` method.

When this method is invoked on a class object, it return YES if and only if that class (or one of its superclasses) implements a class method with that name. When invoked on an instance of a class, it returns YES if and only if an instance method is defined in the class (or one of its superclasses) representing that object.

The following code fragment shows how to use this method on the RT2 class.

```
void illustration3() {
    NSLog(@"Class method is %@ found in class RT2",
          [RT2 respondsToSelector:@selector(aClassMethod)] ? "" : "NOT");
    NSLog(@"Class method is %@ found in class RT2",
          [RT2 respondsToSelector:@selector(anInstanceMethod)] ? "" : "NOT");
    RT2 *r2 = [[[RT2 alloc] init] autorelease];
    NSLog(@"Instance method is %@ found in class RT2",
          r2 respondsToSelector:@selector(valueForStock:onDay:));
```

```
[r2 respondsToSelector:@selector(anInstanceMethod)] ?@"" :@"NOT") ;
NSLog(@"Instance method is %@ found in class RT2",
[r2 respondsToSelector:@selector(valueForStock:onDay:)] ?@"" :@"NOT") ;
}
```

To test whether the superclass implements a specific method, you can use the `instancesRespondToSelector:` class method on the superclass object.

Consider the following new class RT3:

```
@interface RT3 : RT2
-(void) test;
@end

@implementation RT3
-(void) test{
    if([RT2 instancesRespondToSelector:@selector(anInstanceMethod)]) {
        [super anInstanceMethod];
    }
    else{
        NSLog(@"Superclass does not implement anInstanceMethod.");
    }
}
@end
```

Here, we have the method checking whether the parent class RT2 implements a specific method. If the answer is yes, a message is sent to `super`. Otherwise, no message is sent to `super` and no exception is thrown.

Replacing existing implementation

Objective-C methods defined in the class implementation are translated into equivalent C-functions. For example, consider the following instance method:

```
- (NSString*) addToString: (NSString*) data{
    return [data stringByAppendingString:@"!"];
}
```

The compiler will translate this method into something similar to the following C-function:

```
NSString* addToString(id self, SEL _cmd, NSString* data){
    return [data stringByAppendingString:@"!"];
}
```

The function will receive a reference to the object (the receiver) and a selector of the method. The rest of the parameters follow.

If you want to replace the behavior of a message with another behavior, you can, at any time, replace the implementation of the method representing this message with a new implementation with the appropriate C-function signature.

Consider class `RT2`. Right now, the instance method `anInstanceMethod` does not do anything. Let's replace its implementation with a new, more useful, behavior as shown below:

```
void impNew(id self, SEL _cmd) {
    NSLog(@"My new implementation");
}
```

To replace the existing implementation with the above function, first obtain the `Method` value for this selector from the `RT2` class as follows:

```
Method method =
    class_getInstanceMethod([RT2 class], @selector(anInstanceMethod));
```

Here, we use the `class_getInstanceMethod()` function to obtain the method of the selector `anInstanceMethod`.

After obtaining the method, we set its implementation with our new function as follows:

```
method_setImplementation(method, (IMP)impNew);
```

The `method_setImplementation()` function takes as the first argument the `Method` value and as the second argument a function pointer.

Once the new implementation is set, all subsequent `anInstanceMethod` messages sent to instances of `RT2` will result in the execution of our C-function.

```
RT2 *rt2 = [[[RT2 alloc] init] autorelease];
[rt2 anInstanceMethod];
```

Patching methods

Sometimes, you face a situation where your application is using a given class in several places and you decide that you need to modify the behavior of some of its methods. Since you do not have access to its source code, you want somehow to patch these methods with your code. You want the flexibility of calling the original method before, after, or between your custom code.

Using the runtime system, achieving this goal is easy. We already know that a message and its implementation are two independent pieces. All we need to do is to simply swap the old and the new implementations and have the new implementation call the old one at the appropriate time(s).

You already know how to set the implementation of a method in a class, so the following code fragment, which swaps two implementations, should be familiar to you:

```
Method m1 = class_getInstanceMethod(aClass, original);
Method m2 = class_getInstanceMethod(aClass, new);
IMP imp1 = method_getImplementation(m1);
IMP imp2 = method_getImplementation(m2);
method_setImplementation(m1, imp2);
method_setImplementation(m2, imp1);
```

In the above code, the implementations of selectors `original` and `new` in class `aClass` are swapped.

Fortunately, there is a convenience function that does the swapping for us, atomically. This function is `method_exchangeImplementations()` which is declared as follows:

```
void method_exchangeImplementations(Method m1, Method m2)
```

Armed with this knowledge, we are ready to add a category on `NSObject` to equip every class with the ability to swap the implementations of two of its methods:

```
@interface NSObject (Patching)
+(void)swapMethod:(SEL)original withMethod:(SEL)new;
@end

@implementation NSObject (Patching)
+(void)swapMethod:(SEL)original withMethod:(SEL)new{
    method_exchangeImplementations(
        class_getInstanceMethod(self, original),
        class_getInstanceMethod(self, new)
    );
}
@end
```

Since the swapping method is a class method, `self` refers to the class object and it should be passed as the first argument to the `class_getInstanceMethod()` function.

Let's look at an example. Consider the following class:

```
@interface RT4 : NSObject
@end

@implementation RT4
-(void) originalMethod{
    NSLog(@"Inside originalMethod.");
}
@end
```

The `RT4` class has a single instance method that logs a message. We want to patch this method with another new method. We define a category on `RT4` as follows:

```
@implementation RT4 (CategoryOnMyClass)
```

```

- (void)anotherMethod{
    NSLog(@"Inside anotherMethod");
    [self anotherMethod];
}
@end

```

The method `anotherMethod` above looks weird. It's calling itself! However, if we swap its implementation and that of `originalMethod`, any call to `originalMethod` will effectively call `anotherMethod` and any call to `anotherMethod` will result in a call to `originalMethod`.

The following code fragment illustrates the concept:

```

RT4 *test = [[[RT4 alloc] init] autorelease];
NSLog(@"Before patching ...");
[test originalMethod];
[RT4 swapMethod:@selector(originalMethod)
    withMethod:@selector(anotherMethod)];
NSLog(@"After patching ...");
[test originalMethod];

```

Obtaining all methods defined by a class

If you want to get an array of all methods defined by a class and not by any of its superclasses, you can use the function `class_copyMethodList()`. This function returns an array of methods implemented by the class, and it is declared as follows:

```
Method * class_copyMethodList(Class cls, unsigned int *outCount)
```

The first argument is the class object and the second is a reference to an integer. If you want to get the instance methods, you pass in the class object. If, on the other hand, you want a list of all class methods, you need to pass in the metaclass object. This makes sense as the blueprint for the class (needed to obtain its methods) is its metaclass object. If `outCount` is not NULL, the number of elements in this array is returned. The returned array consists of pointers to `Method` type. You need to `free` the returned array when you are finished with it.

Let's illustrate through an example. Consider the following class:

```

@interface RT5 : NSObject
+(void)simpleS;
+(NSString*)complexS:(NSNumber*)aNumber
    andAString:(NSString*)aString;
-(void)simple;
-(NSString*)complex:(NSNumber*)aNumber
    andAString:(NSString*)aString;
@end

@implementation RT5

```

```
+ (void) simpleS{ }
+ (NSString*) complexS: (NSNumber*) aNumber
    andAString: (NSString*) aString{
    return @"Hi";
}
- (void) simple(){}
- (NSString*) complex: (NSNumber*) aNumber
    andAString: (NSString*) aString{
    return @"Hello";
}
@end
```

To list the class methods, we make a call to our `listAllMethods()` function as follows:

```
listAllMethods(object_getClass([RT5 class]));
```

Here, we are passing in the metaclass object of class RT5 as the sole argument. We obtain the metaclass object through the runtime function `object_getClass()` passing in the class object.

To list all instance methods, we pass in the class object as follows:

```
listAllMethods([RT5 class]);
```

The `listAllMethods()` function is shown below.

```
void    listAllMethods(Class class){
    unsigned int methodCount;
    Method *methods = class_copyMethodList(class, &methodCount);
    for(int i=0; i < methodCount; i++){
        char buffer[256];
        SEL      name = method_getName(methods[i]);
        NSLog(@"The method's name is %@", NSStringFromSelector(name));
        //OR
        //NSLog(@"The method's name is %s", name);
        char   *returnType = method_copyReturnType(methods[i]);
        NSLog(@"The return type is %s", returnType);
        free(returnType);
        // self, _cmd + any others
        unsigned int numberOfArguments =
            method_getNumberOfArguments(methods[i]);
        for(int j=0; j<numberOfArguments; j++){
            method_getArgumentType(methods[i], j, buffer, 256);
            NSLog(@"The type of argument %d is %s", j, buffer);
        }
    }
    free(methods);
}
```

The function above starts by obtaining the array of methods for the class object passed in as an argument. After obtaining the array of methods, the function iterates through this array logging specific attributes of each method. The function above logs the name of the method, the return type, and the type of each argument.

To obtain the return type of a method, you can use the `method_copyReturnType()` function declared as follows:

```
char *method_copyReturnType(Method m)
```

To obtain the type of a specific argument, you can use the `method_getArgumentType()` function declared as follows:

```
void method_getArgumentType(Method m, unsigned int index,
                            char *dst, size_t dst_len)
```

The function takes the method as the first argument, the index of the method argument in the second argument, a pointer to the buffer used to store the returned type in the third argument, and the size of the buffer in the fourth and final argument.

For example, here is an output related to one of the class methods.

```
The method's name is complexS:andAString:  
The return type is @  
The type of argument 0 is @  
The type of argument 1 is :  
The type of argument 2 is @  
The type of argument 3 is @
```

Notice that the first two arguments are the implicit arguments of every method.

Adding a new method

If you want to add a new method to a class, you can use the `class_addMethod()` function declared as follows:

```
BOOL class_addMethod(Class cls, SEL name, IMP imp, const char *types)
```

The first three parameters should be familiar to you. The last parameter is where you provide a C-string with the encoded return and argument types. The method `name` must not be implemented by the class `cls`. If it is declared in one of the superclasses of `cls`, it will be overridden.

Let's illustrate through an example. Consider a class `RT6` that defines no methods. Suppose we wanted to add a new instance method with the selector `newOne:withData:` whose signature is as follows:

```
- (NSString*) newOne: (BOOL)flag withData: (NSData*) data;
```

The C-function implementing this new method is shown below:

```
NSString* newOneImplementation(id self, SEL _cmd, BOOL flag, NSData* data) {
    NSLog(@"self: %@", _cmd, self, NSStringFromSelector(_cmd));
    NSLog(@"The flag is: %@ and the data is: %@", flag?@"YES":@"NO", data);
    return @"Done!";
}
```

To add the new method, we simply call the `class_addMethod()` function as shown below:

```
class_addMethod([RT6 class], @selector(newOne:WithData:),
                (IMP)newOneImplementation, "@@:B@");
```

We pass in the class object since it's an instance method we are adding. The name of the method is passed in the second argument. A pointer to our implementation is passed in the third argument. The fourth argument is a C-string with several encodings. We know that every method receives as the first two arguments an object encoded as @ and a selector encoded as :. The return type is `NSString*` and is encoded as @. The first and second arguments of our method are `BOOL` (encoded as B) and `NSData*` encoded as @. Notice that the return type is always listed first.

Once we have added the new method, we can call it as any Objective-C method. You will, however, get a compiler warning. The Objective-C compiler is smart, but it's not that smart!

```
RT6 *t = [[[RT6 alloc] init] autorelease];
NSLog(@"%@", [t newOne:YESWithData:[NSData data]]);
```

To add a class method, pass in `object_getClass([RT6 class])` as the first argument to the `class_addMethod()` function.

Sending a message to an object

We have already seen our friend `objc_msgSend()` function. If you find a need to use this function, you can utilize it as you please. For example, consider the following class:

```
@interface RT7 : NSObject
+(NSUInteger) lengthS:(NSString*)theString;
-(NSUInteger) length:(NSString*)theString;
@end

@implementation RT7
+(NSUInteger) lengthS:(NSString*)theString{
    return [theString length];
}
-(NSUInteger) length:(NSString*)theString{
    return [theString length];
}
@end
```

To call the instance method `length:`, you can write the following:

```
RT7 *rt = [[[RT7 alloc] init] autorelease];
NSUInteger value;
value = ((int(*)(id, SEL, NSString*))objc_msgSend) (
    rt, @selector(length:), @"hi");
```

Casting the `objc_msgSend()` function is optional. It only removes the compiler's warning.

To call the class method `lengths:`, you can write:

```
value = ((int(*)(id, SEL, NSString*))objc_msgSend) (
    [RT7 class], @selector(lengths:), @"hello");
```

Accessing instance variables

You can directly access instance variables of objects. To access an instance variable, use the function `object_getInstanceVariable()` function which is declared as follows:

```
Ivar
object_getInstanceVariable(id obj, const char *name, void **outValue);
```

The return value is of type `Ivar`, the runtime's type for instance variables. This return value represents the instance variable that you are accessing. You pass in the object whose instance you are retrieving in the first argument. The name of the instance variable is passed in as a C-string and the third argument is a pointer to `void*` where the value of the instance variable should be stored.

Consider the following class:

```
@interface RT8 : NSObject{
    NSNumber *val;
}
@property (nonatomic, assign) NSNumber *val;
@end

@implementation RT8
@synthesize val;
@end
```

Let's create a new instance and change the value of the instance variable as follows:

```
RT8 *rt8 = [[[RT8 alloc] init] autorelease];
rt8.val = [NSNumber numberWithInt:99];
```

To access the value of the instance variable, one can write something like the following statements:

```
void *outValue;
object_getInstanceVariable(rt8, "val", &outValue);
 NSLog(@"%@", [(NSNumber*) outValue intValue]);
```

Creating new classes dynamically

If your application requires the creation of new classes at runtime, you can use the support that the runtime provides to achieve your goal.

To create a new class, you start by creating it and its metaclass using the function `objc_allocateClassPair()`. This function is declared as follows:

```
Class objc_allocateClassPair(Class superclass, const char *name,
                           size_t extraBytes)
```

The first argument is the class object of the superclass. The second argument is the C-string name of the new class. The third and final argument specifies extra allocation bytes and should usually be zero.

After creating the new class, you can add instance variables and instance/class methods. After that, you register the class and its metaclass using the function `objc_registerClassPair()` passing in the return value of the call to `objc_allocateClassPair` function.

Let's illustrate this topic through a concrete example. Consider the following existing class:

```
@interface RT9 : NSObject{
    NSNumber *val;
}
@property(nonatomic, retain) NSNumber *val;
@end

@implementation RT9
@synthesize val;

-(id)init{
    if(self = [super init]){
        self.val = [NSNumber numberWithInt:99];
    }
    return self;
}

-(void)dealloc{
    NSLog(@"dealloc in super");
    self.val = nil;
    [super dealloc];
}
@end
```

RT9 is a simple class that we want to use as a superclass for a new class called MyAwesomeClass. To create the new class, we start by the following statement:

```
Class dynaClass =
objc_allocateClassPair([RT9 class], "MyAwesomeClass", 0);
```

After that, we add an instance variable using the function `class_addIvar` which is declared as follows:

```
BOOL class_addIvar(Class cls, const char *name, size_t size,
                    uint8_t alignment, const char *types)
```

The first argument is the class object. This class object cannot refer to a metaclass. The second argument is the C-string name of the new variable. The third argument is the size of the new instance variable. The fourth argument is the alignment of the storage. The fifth and final argument is the type encoding of the instance variable. The function returns YES if and only if the instance variable was successfully created.

To add an instance variable called `vertices` of type `NSArray*`, we write something like the following:

```
class_addIvar(dynaClass, "vertices", sizeof(id), log2(sizeof(id)), "@");
```

Next, let's add the following two methods: `many` and `dealloc` as follows:

```
class_addMethod(dynaClass, @selector(many),
                (IMP)manyImplementation, "@:@");
class_addMethod(dynaClass, @selector(dealloc),
                (IMP)deallocImplementation, "v@:");
```

Finally, we register the class and its metaclass as follows:

```
objc_registerClassPair(dynaClass);
```

The implementation of the `many` method is shown below:

```
NSNumber* manyImplementation(id self, SEL _cmd) {
    void *outValue1;
    void *outValue2;
    object_getInstanceVariable(self, "vertices", &outValue1);
    object_getInstanceVariable(self, "val", &outValue2);
    return [NSNumber numberWithInt:
        ((NSArray*)outValue1).count +
        [(NSNumber*)outValue2 intValue]];
}
```

Notice how we access the instance variable, `val`, inherited from the superclass.

The implementation of `dealloc` method is shown below:

```
void deallocImplementation(id self, SEL _cmd) {
    void *outValue;
    object_getInstanceVariable(self, "vertices", &outValue);
    [id outValue release];
    object_setInstanceVariable(self, "vertices", nil);
    struct objc_super obS;
```

```
    obS.super_class = [self superclass];
    obS.receiver = self;
    objc_msgSendSuper(&obS, @selector(dealloc));
}
```

Here, we retrieve the `NSArray` object and release it. We also propagate the `dealloc` call to `super` by sending a message to `super` using the function `objc_msgSendSuper()` which is declared as follows:

```
id objc_msgSendSuper(struct objc_super *super, SEL op, ...);
```

The first argument is the `objc_super` structure and the second is the selector. The `objc_super` structure is declared as follows:

```
struct objc_super {
    id receiver;
    Class super_class;
};
```

The following shows how we can use this new class:

```
//create an object of this class
id dynaObject = [[NSClassFromString(@"MyAwesomeClass") alloc] init];
// OR [dynaClass alloc]
//assign a value to an instance variable of this class
object_setInstanceVariable(dynaObject, "vertices",
    [[NSArray arrayWithObjects:@"Bart", @"lisa", nil] retain]);
//invoke a method on this class
NSNumber *numb = [dynaObject many];
NSLog(@"The returned number is %@", numb);
[dynaObject release];
```

Alternatives to executing methods

The `performSelector` method declared in the `NSObject` protocol allows you to send a message to an object. There are three versions of this method taking zero, one, or two arguments. These three methods are declared in `NSObject` protocol as follows:

- (**id**)`performSelector:(SEL)aSelector;`
- (**id**)`performSelector:(SEL)aSelector withObject:(id)object;`
- (**id**)`performSelector:(SEL)aSelector
 withObject:(id)object1 withObject:(id)object2;`

Consider the following class:

```
@interface Person : NSObject
- (void)play;
```

```

- (void)work;
- (void)eat:(NSString*)food;
- (void)cook:(NSString*)food1 withFood:(NSString*)food2;
- (float)difficultyForRecipe:(NSString*)recipe
    resources:(float)resources patience:(NSNumber*)patience;
@end

@implementation Person

- (void)play{
    NSLog(@"playing...");
}

- (void)work{
    NSLog(@"working...");
}

- (void)eat:(NSString*)food{
    NSLog(@"eating %@", food);
}

- (void)cook:(NSString*)food1 withFood:(NSString*)food2{
    NSLog(@"cooking %@ with %@", food1, food2);
}

- (float)difficultyForRecipe:(NSString*)str1 resources:(float)v1
    patience:(NSNumber*)t3{
    return 0.8;
}
@end

```

At runtime, one might vary the message sent to an object of type `Person` by varying the selector. Consider the following example:

```

Person *person = [[[Person alloc] init] autorelease];
strand([NSDate timeIntervalSinceReferenceDate]);
if(rand() % 2)
    [person performSelector:@selector(play)];
else
    [person performSelector:@selector(work)];

```

In the above code fragment, we create a new instance of `Person` and use a random number to determine which message to send to the object. This is part of the dynamic binding capabilities of Objective-C. If you find yourself needing to vary the message sent to an object during the runtime of your application, `performSelector` is your friend.

If you want to pass one or two objects to the method, you can use the other versions as in the following example:

```
[person performSelector:@selector(eat:) withObject:@"Banana"];
```

```
[person performSelector:@selector(cook:withFood:)
    withObject:@"Spaghetti" withObject:@"meat"] ;
```

When the return type is not an **id**, the arguments to the method are not objects, or you need to pass in more than two objects, you can resort to the **NSInvocation** class.

An **NSInvocation** object encapsulates an Objective-C message. It stores the selector, receiver, arguments, and return value. To create an instance of this class, you use the **invocationWithMethodSignature:** method declared as follows:

```
+ (NSInvocation*) invocationWithMethodSignature: (NSMethodSignature *) sig;
```

You pass in a method signature and you obtain an autoreleased **NSInvocation** object.

An **NSMethodSignature** instance is an object that stores the types for the return value and arguments for a method. To obtain a method's signature, you can use **NSObject**'s method **instanceMethodSignatureForSelector:** class method passing in the selector. Alternatively, you can use its class method **signatureWithObjCTypes:** passing in a C-string with encoded types. This method is declared as follows:

```
+ (NSMethodSignature *) signatureWithObjCTypes: (const char *) types;
```

After obtaining the **NSInvocation** object, you set the selector using its **setSelector:** method. Next, you set any of the arguments you want using **setArgument:atIndex:** method which is declared as follows:

```
- (void) setArgument: (void *) argumentLocation atIndex: (NSInteger) idx;
```

You start with index 2 as the first two indices are used by **self** and **_cmd**. You also pass in a reference to the argument location as we shall see shortly.

After that, you can set the target and send the object an **invoke** message or call **invokeWithTarget:** passing in the target. Either way, the message is sent, and control is returned to the next statement after the execution of the method representing the message finishes. You can retrieve the return value, if any, using **getReturnValue:** method passing in a buffer pointer. The buffer should be large enough to accommodate the return value. If you don't know the size of the return value, you can get that size from the signature object by sending it a **methodReturnLength** message.

The following illustrates how to call the selector **difficultyForRecipe:resources:patience:**.

```
NSMethodSignature *sig =
[Person instanceMethodSignatureForSelector:
 @selector(difficultyForRecipe:resources:patience:)];
NSInvocation *invocation =
[NSInvocation invocationWithMethodSignature: sig];
[invocation setSelector:
 @selector(difficultyForRecipe:resources:patience:)];
NSString *arg1 = @"Hi";
```

```

float      arg2 = 4.5;
NSNumber *arg3 = [NSNumber numberWithBool:YES];
[invocation setArgument:&arg1 atIndex:2];
[invocation setArgument:&arg2 atIndex:3];
[invocation setArgument:&arg3 atIndex:4];
[invocation invokeWithTarget:person];
float outValue;
[invocation getReturnValue:&outValue];
 NSLog(@"%@", @"return value is %.2f", outValue);

```

Forwarding messages to other objects

We mentioned before that when you send a message to an object and that object does not recognize that message, the runtime sends `doesNotRecognizeSelector:` message to that object. This invocation must result in raising an `NSInvalidArgumentException` exception. The runtime, does however, give the object an opportunity to recover before pursuing this track. The runtime creates an `NSInvocation` object representing this message and sends the object a `forwardInvocation:` message with that `NSInvocation` object as an argument. Objects can forward this invocation object to other objects. In essence, the object delegates the message.

To take advantage of this feature, you need to override the `forwardInvocation:` method as well as the `methodSignatureForSelector:` method.

Consider for example, the `RT10` class in Listing 2.6. An instance of this class maintains a list of objects that can be used to respond to messages it does not recognize.

Listing 2.6 A class that delegates messages to its friends.

```

@interface RT10 : NSObject{
    NSArray *myFriends;
}
@end

@implementation RT10

- (id)init{
    if(self = [super init]){
        RT5    *friend1 = [[[RT5 alloc] init] autorelease];
        RT7    *friend2 = [[[RT7 alloc] init] autorelease];
        myFriends = [[NSArray arrayWithObjects:friend1, friend2, nil] retain];
    }
    return self;
}

- (NSMethodSignature *)methodSignatureForSelector:(SEL)aSelector {
    NSMethodSignature *signature = nil;
    for(id friend in myFriends) {

```

```
    if(signature = [friend methodSignatureForSelector:aSelector]) {
        break;
    }
}
if(signature) {
    return signature;
}
else{
    return [super methodSignatureForSelector:aSelector];
}
}

- (void)forwardInvocation:(NSInvocation *)anInvocation{
for(id friend in myFriends){
    if([friend respondsToSelector:[anInvocation selector]]){
        return [anInvocation invokeWithTarget:friend];
    }
}
[super forwardInvocation:anInvocation];
}

- (void) dealloc{
[myFriends release];
[super dealloc];
}
@end
```

In the `init` method, we create and initialize two other objects and store them in an array. When a message is sent to `RT10` instance and the runtime cannot find a corresponding method for it, `methodSignatureForSelector:` gets called. This method simply iterates through the list of friend objects asking if any has a valid signature for that selector. If there is one object that has a valid signature, then that signature is returned. Otherwise, the message is propagated to `super`.

If there is a friend that has a valid signature for the selector, the `forwardInvocation:` method is called. This method iterates through the list, in the same order as above, and forwards the invocation by `invokeWithTarget:` passing in the first friend object that responds to the selector of the invocation object.

The following demonstrates message forwarding to other objects:

```
RT10 *rt10 = [[[RT10 alloc] init] autorelease];
NSLog(@"%@", @"Values: %@ and %d",
        [rt10 complex:[NSNumber numberWithFloat:33.5] andAString:@""],
        [rt10 length:@"k"]);
```

`RT10` instance is sent two messages that it can understand neither. However, it successfully produces a result in each case thanks to message delegation.

2.12 Summary

We have certainly covered a lot of ground in this chapter. In Section 2.1, we introduced the mechanism for declaring and defining classes. Then, we talked about how an object interacts with other objects by sending messages to them. In Section 2.2, we covered the topic of memory management. We illustrated how to allocate objects and how to initialize these objects. We discussed the concept of retain count and how every object maintains one such counter. We also covered the topic of autorelease pools and outlined the responsibilities that clients have with respect to releasing objects. In Section 2.3, we discussed the protocols feature of Objective-C. Protocols were shown to be a powerful feature that allows, among other things, the ability to realize multiple inheritance in a single-inheritance language. In Section 2.4, we discussed properties. A property is a feature of Objective-C that allows you to declaratively generate setter/getter accessor methods for instance variables. After that, we covered the topic of categories in Section 2.5. We showed how, using the category feature, you can extend the capabilities of existing classes without even having their source code. Posing was covered in Section 2.6. This facilitates the replacement of one class by another class that is a descendant of it, and it is mostly useful as a testing feature. Exceptions and errors were covered in Section 2.7. Exceptions are usually used by the developer for finding bugs, while errors are used in production code for conveying runtime errors due to the user's environment. In Section 2.8, we introduced the concept of key-value coding (KVC). KVC provides the ability to access object properties indirectly. KVC is widely used in Cocoa and we gave a lengthy treatment of the subject. Next, multithreading was discussed. In particular, we outlined a simple approach for multithreading using operation objects. After that, we covered the topic of notifications in Section 2.10. Finally, Section 2.11 discussed, in great length, the topic of the Objective-C runtime system.

Problems

- (1) Consider the following class declaration, definition, and usage:

```
@interface A
- (int) doSomething;
@end
@implementation A
- (int) doSomething{
    return 1;
}
@end
int main(int argc, char *argv[]){
    A *a = [[A alloc] init];
    int v = [a doSomething];
    [a release];
}
```

Study the above code and comment on the outcome of the `main()` function.

- (2) Consider the following class and its usage in the `main()` function. What is the last statement executed and why?

```
1 @interface B : NSObject{
2     NSString *myString;
3 }
4 @property(nonatomic) NSString * myString;
5 - (unichar)getFirstCharacter;
6 @end
7
8 @implementation B
9 @synthesize myString;
10 - (unichar)getFirstCharacter{
11     return [myString characterAtIndex:0];
12 }
13 @end
14
15 int main(int argc, char *argv[]){
16     NSAutoreleasePool * pool1 = [[NSAutoreleasePool alloc] init];
17     NSMutableString *str =
18         [NSMutableString stringWithString:@"Where am I?"];
19     B *b = [[B alloc] init];
20     b.myString = str;
21     [pool1 release];
22     unichar x = [b getFirstCharacter];
23     [b release];
24 }
```

- (3) The following code declares and defines a `Person` and a `Dog`, and then uses the two classes.

```
@interface Person: NSObject{}
- (void)bark;
@end

@implementation Person
- (void)bark{
    printf("Woof\n");
}
@end

@interface Dog : NSObject{}
- (void)bark;
- (void)bark:(NSString*)a;
@end

@implementation Dog
- (void)bark:(NSString*)a{
    printf("Woof\n");
}
```

```

- (void) bark{
    printf("Woof woof\n") ;
}

int main(int argc, char *argv[]) {
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    SEL sel = @selector(bark);
    SEL sel1 = @selector(bark:);
    Person *aPerson = [[Person alloc] init];
    Dog *aDog = [[Dog alloc] init];
    .
    .
    .
}

```

Answer the following questions:

- (a) What is the value of `equal` after the following statement?

```
BOOL equal = sel == sel1;
```

- (b) What happens when the following statement is executed?

```
[aPerson performSelector:sel];
```

- (c) What happens when the following two statements are executed?

```
[aDog bark];
[aDog bark:@""],
```

- (d) What is the result of the following statement?

```
[aPerson performSelector:NSSelectorFromString(@"bark:")];
```

- (e) What does the following statement do?

```
[aDog bark:];
```

- (4) Consider the following code. Describe the outcome of each line. What is the last line executed?

```

1  NSAutoreleasePool * pool1 = [[NSAutoreleasePool alloc] init];
2  NSMutableArray *arr;
3  arr = [NSMutableArray arrayWithCapacity:0];
4  NSAutoreleasePool * pool2 = [[NSAutoreleasePool alloc] init];
5  NSMutableString *str =
6      [NSMutableString stringWithString:@"Howdy!"];
7  [arr addObject:str];
8  [pool2 release];
9  int n = [arr count];
10 str = [arr objectAtIndex:0];

```

```
11     [arr release];
12     n = [str length];
13     [pool1 release];
```

- (5) The following function will cause an application crash. Why? Hint: a large percentage of iPhone application crashes have to do with illegal memory access.

```
1 void function() {
2     NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
3     NSString      *myString =
4         [[[NSString alloc] initWithString:@"Hello!"] autorelease];
5     @try {
6         [myString appendString:@"Hi!"];
7     }
8     @catch (NSEException * e) {
9         @throw;
10    }
11    @finally {
12        [pool release];
13    }
14 }
```

3

Collections

As a Cocoa developer, you are provided with many classes that can help you group several of your objects together in specific ways. This chapter discusses the main collection classes available to you.

Section 3.1 addresses the topic of arrays. You learn about immutable and mutable arrays, the different approaches used for copying arrays, and several sorting techniques. Section 3.2 covers the topic of sets. Sets are collections that do not impose ordering on the objects they contain. You learn about immutable and mutable sets as well as several interesting operations on sets. Section 3.3 discusses dictionaries. Dictionaries allow you to store objects and retrieve them using keys. As you saw in Section 2.7, dictionaries are widely used in Cocoa frameworks and understanding them is essential. Finally, we provide a summary in Section 3.4.

3.1 Arrays

You use `NSArray` and `NSMutableArray` if you would like to store/access your objects in an ordered way. `NSArray` is the immutable version of the array, allowing you to store your objects only once (during initialization). `NSMutableArray` is a subclass of `NSArray` that allows you to add/remove objects even after initialization of the collection.

To help illustrate the main concepts behind arrays, let us use the simple class `Person` shown in Listing 3.1.

Listing 3.1 The class `Person` used in the arrays examples.

```
#import <Foundation/Foundation.h>
@interface Person : NSObject{
    NSString *name;
    NSString *address;
}
@property(copy) NSString *name;
@property(copy) NSString *address;
-(id)initWithName:(NSString*) theName andAddress:(NSString*) theAddress;
```

```
- (id)init;
@end

@implementation Person
@synthesize name;
@synthesize address;
-(id)initWithName:(NSString*) theName andAddress:(NSString*) theAddress{
    self = [super init];
    if(self){
        self.name      = theName;
        self.address   = theAddress;
    }
    return self;
}
-(id)init{
    return [self initWithName:@"" andAddress:@""];
}
-(void)dealloc{
    [name      release];
    [address   release];
    [super     dealloc];
}
@end
```

Now that you have created the `Person` class, Listing 3.2 demonstrates how you can configure a static array using the `NSArray` class. We start by creating five instances of the class `Person`. Figure 3.1 shows the state of these five objects before being added to the array.

Listing 3.2 Creating a simple immutable array.

```
int main(int argc, char *argv[]){
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    Person  *a  = [[Person alloc] init];
    Person  *b  = [[Person alloc] init];
    Person  *c  = [[Person alloc] init];
    Person  *d  = [[Person alloc] init];
    Person  *e  = [[Person alloc] init];
    NSArray *arr1 = [NSArray arrayWithObjects: a,b,c,d,e,nil];
    [pool release];
    [a release];
    [b release];
    [c release];
    [d release];
    [e release];
    return 0;
}
```

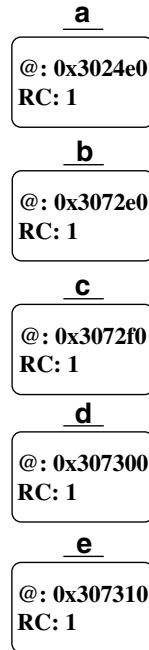


Figure 3.1 Five instances of `Person` before being added to an `NSArray` instance. “@” denotes an address, and “RC” denotes retain count.

There are several ways to create and initialize an `NSArray` instance. Here, we use the class method `arrayWithObjects:` and list the objects that we want to initialize the array with, in a comma-separated form. The final parameter must be `nil`, which means that an `NSArray` instance cannot have a `nil` element. Since the creation method used does not contain `alloc` or `new` in its name, and we do not use a `copy` method to obtain the new instance, this `NSArray` instance is not owned by us and we are not responsible for releasing it. Once the `NSArray` instance is initialized, you cannot remove/add elements from/to it. It remains static until it is deallocated.

One thing you need to be aware of is that if an object is added to a collection, its retain count is incremented by that collection. In our example, the five objects will each have a retain count of 2, right after the initialization of the `NSArray` instance as shown in Figure 3.2. Notice how the array just holds pointers to its elements.

Once we are finished with a collection, we can release it. When you release an instance of `NSArray`, that instance sends a `release` message to each of its elements (remember that collections retain their objects when the objects are added). Since we do not own `arr1`, just releasing the autorelease pool will release `arr1` and our five `Person` instances. We still have to send a `release` message to these five objects since we own them.

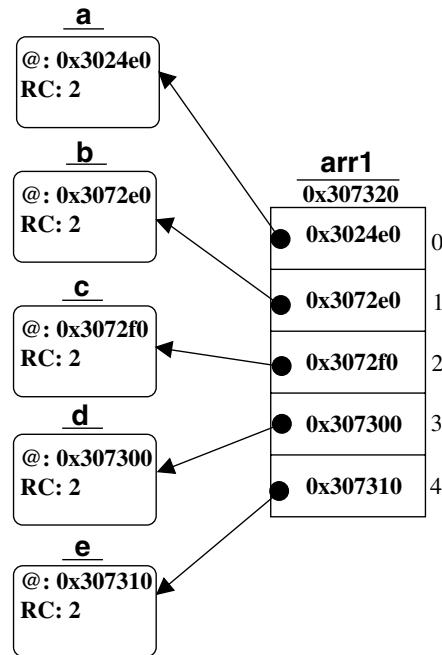


Figure 3.2 State of the five instances of `Person` after being added to an instance of `NSArray`. “@” denotes an address, and “RC” denotes retain count.

3.1.1 Immutable copy

Now that we know the basics of `NSArray`, let us look at the syntax and the semantics of making a copy of an `NSArray` instance. Listing 3.3 shows a sample code demonstrating this behavior. We create and add our five `Person` instances as we did before. After that, we ask `arr1` to make a copy of itself and we store that new copy into an `NSArray*` local variable.

Listing 3.3 Immutable copy of an `NSArray` instance.

```
int main(int argc, char *argv[]){
    NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
    Person *a = [[Person alloc] init];
    Person *b = [[Person alloc] init];
    Person *c = [[Person alloc] init];
    Person *d = [[Person alloc] init];
    Person *e = [[Person alloc] init];

    NSArray *arr1 = [NSArray arrayWithObjects: a,b,c,d,e,nil];
    NSArray *arr2 = [arr1 copy];
```

```
Person *aPerson = [arr1 objectAtIndex:0];
aPerson.name = @"Marge Simpson";
aPerson.address = @"Springfield";
// Result of the following line is:
// Person at 0 is: Name: Marge Simpson, Addr: Springfield
printf("Person at %d is: Name: %s, Addr: %s\n",
0,
[[[arr2 objectAtIndex:0] name]
cStringUsingEncoding:NSUTF8StringEncoding],
[[[arr2 objectAtIndex:0] address]
cStringUsingEncoding:NSUTF8StringEncoding]);
// Must release arr2 since we created it using copy.
[arr2 release];
// must release all objects
[a release];
[b release];
[c release];
[d release];
[e release];
[pool release];
return 0;
}
```

After making a copy of the array, we change the first element of the original array, `arr1`. Remember that `NSArray` and `NSMutableArray` are ordered collections. Each stored element has a specific location or index. To retrieve the first element, we use the `objectAtIndex:` method with the index 0.

After changing the first element in the original array, we inspect the first element in the copy, and we discover that that element was also changed. Why? The documented semantics of how an `NSArray` makes a copy of itself is as follows. First, `NSArray` makes a shallow copy of its elements. This means that only the pointers to these elements are copied. Second, the new instance of the `NSArray` is owned by the caller and is not autoreleased. Figure 3.3 shows the state of our five objects after making a copy of the `NSArray`.

What we notice is that we did not even obtain a new instance of `NSArray`. All that happened is: (1) `arr2` got a copy of the address of `arr1`, which is basically a simple assignment, (2) the `arr1` retain count was incremented by 1, and (3) the retain count of all five objects was incremented by 1. This behavior of immutable copy makes sense because the original array object is static and does not change.

Finally, even though `arr2` is just `arr1`, we did obtain it using a method that has `copy` in it. Therefore, we have to release it when we are finished with it.

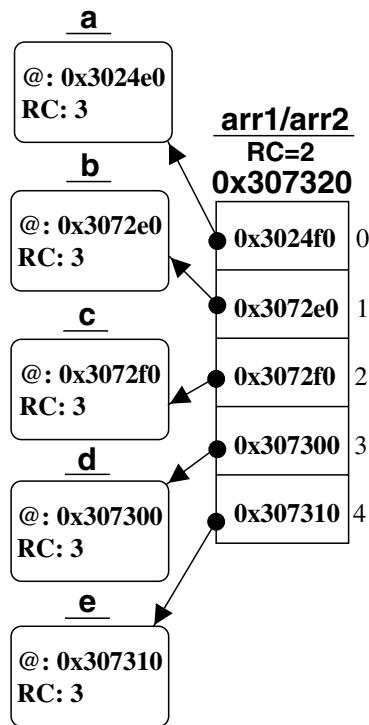


Figure 3.3 State of an NSArray and its immutable copy.

3.1.2 Mutable copy

Until now, we have been working exclusively with NSArray and its static behavior. NSMutableArray is a mutable version of this class, which means that the number of objects stored in it can grow and shrink during the lifetime of the program. As shown in Listing 3.4, we can obtain a mutable copy of an immutable source. However, instead of using `copy`, we use `mutableCopy`.

Listing 3.4 Illustration of how you can obtain a mutable copy of an immutable instance of NSArray.

```
int main(int argc, char *argv[]){
    NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
    Person *a = [[Person alloc] init];
    Person *b = [[Person alloc] init];
    Person *c = [[Person alloc] init];
    Person *d = [[Person alloc] init];
    Person *e = [[Person alloc] init];
    NSArray *arr1 = [NSArray arrayWithObjects: a,b,c,d,e,nil];
    NSMutableArray *arr2 = [arr1 mutableCopy];
    Person *f = [[Person alloc] init];
```

```

[arr2 addObject:f];
[arr2 removeObject:a];
[arr2 release];
[a release];
[b release];
[c release];
[d release];
[e release];
[f release];
[pool release];
return 0;
}

```

Having an `NSMutableArray` instance allows you to dynamically remove objects from, and add objects to, it. In the code example, we add a new object, `f`, and remove an existing object, `a`¹. Besides the change in the existing elements' positions within the array and their retain count, the retain count of `f` is incremented by 1 and that of `a` is decremented by 1. Figure 3.4 illustrates the state of the objects at this stage. Notice that, although the two arrays are now distinct, they still share pointers to the same elements.

3.1.3 Deep copy

Until now, we have been dealing with shallow copies. Shallow copying is the default behavior of `NSArray` and `NSMutableArray` regardless of the type of copy (i.e., whether the copy is mutable or immutable). However, sometimes you want to have a copy of an object that is independent of the original. Such a copy is referred to as a *deep copy*.

For an object to be able to make a clone of itself, its class has to implement the `NSCopying` protocol. The `NSCopying` protocol defines only one method: `copyWithZone:`. This method must be implemented by the adopting class. It should return an independent, functionally equivalent copy of an object whose instance variables have identical values of the object at the time of copying.

The following summarizes how copying is done.

1. Your class must be a descendant of `NSObject` and it must adopt the `NSCopying` protocol.
2. It must implement the `copyWithZone:` method. Unless the superclass is `NSObject`, a call to the super's `copyWithZone:` (with the same zone that you have received) should be the first statement in your implementation of `copyWithZone:`.
3. Inside `copyWithZone:`, you create a new instance of your class and initialize it with the same state that your instance is in. Depending on how deep a copy you want to achieve, you may want to propagate the copying to the instance variables themselves. It all depends on the requirements of your code.

¹`removeObject:` removes all occurrences of the object in the collection.

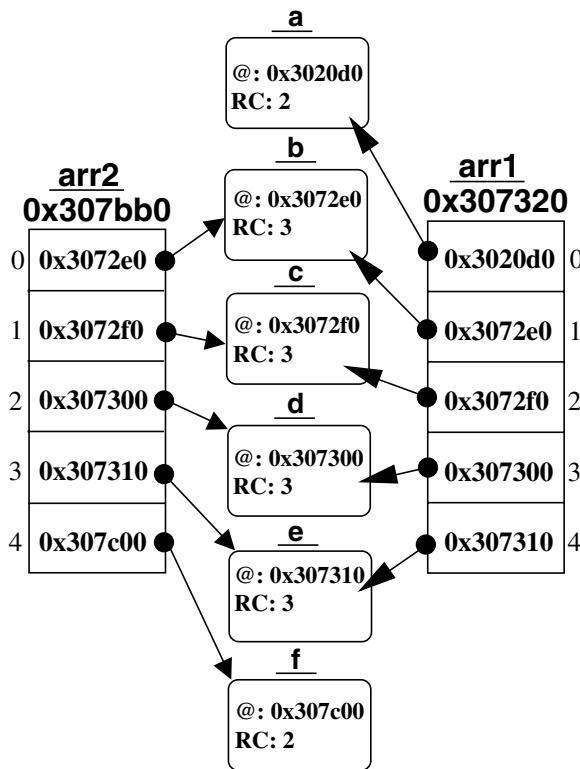


Figure 3.4 Illustration of a mutable copy of an immutable NSArray.

4. The `copyWithZone:` method returns the new copy instance to the caller. The caller owns that copy and is the one responsible for its eventual release.

These are the basic steps you can take in order to generate a new copy of the original object.

One question remains. How does sending a `copy` message to an instance end up in sending it a `copyWithZone:` message? The answer to this question is simple. The `NSObject` has a convenience `copy` method which calls `copyWithZone:` with a `nil` zone. Note that `NSObject` does not adopt the `NSCopying` protocol itself. Obviously, if none of the classes in the inheritance chain implement a `copyWithZone:` method, an exception (see Section 2.7.1) is raised. Therefore, it is important to understand that sending a `copy` message to an array object will always result in a shallow copy regardless of whether the objects it contains adopt the `NSCopying` protocol or not.

Listing 3.5 shows the updated `Person` class with the added `NSCopying` protocol adoption. You can easily notice that this class follows a deep copying approach. We generate a new instance of the object containing new instance variables and are not just copying pointers. The new instance

variables come from the property attribute “copy” used for both instance variables, name and address.

Listing 3.5 Enhanced Person class adopting the NSCopying protocol.

```
#import <Foundation/Foundation.h>

@interface Person : NSObject<NSCopying>{
    NSString *name;
    NSString *address;
}
@property(copy) NSString *name;
@property(copy) NSString *address;
-(id)initWithName:(NSString*) theName andAddress:(NSString*) theAddress;
-(id)init;
-(id)copyWithZone:(NSZone *)zone;
@end

@implementation Person
@synthesize name;
@synthesize address;
-(id)initWithName:(NSString*) theName andAddress:(NSString*) theAddress{
    self = [super init];
    if(self){
        self.name = theName;
        self.address = theAddress;
    }
    return self;
}
-(id)init{
    return [self initWithName:@"" andAddress:@""];
}
-(void)dealloc{
    [name release];
    [address release];
    [super dealloc];
}

// Implementing copyWithZone: declared in NSCopying
-(id)copyWithZone:(NSZone *)zone{
    Person *aPerson =
        [[[self class] allocWithZone: zone]
         initWithName:[self name] andAddress:[self address]];
    return aPerson;
}
@end
```

Listing 3.6 shows the demonstration code for acquiring a deep copy of an `NSArray` object. We use the same class method `arrayWithObjects:` that we used before to get a new instance of `NSArray`. The objects, however, are now copies of the original objects: a, b, c, d, and e.

Listing 3.6 Implementing a deep copy of an array of objects.

```
int main(int argc, char *argv[]){
    NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
    Person *a = [[Person alloc] init];
    Person *b = [[Person alloc] init];
    Person *c = [[Person alloc] init];
    Person *d = [[Person alloc] init];
    Person *e = [[Person alloc] init];
    NSArray *arr1 = [NSArray arrayWithObjects: a,b,c,d,e,nil];
    NSArray *arr2 = [NSArray arrayWithObjects:
        [[a copy] autorelease],
        [[b copy] autorelease],
        [[c copy] autorelease],
        [[d copy] autorelease],
        [[e copy] autorelease],
        nil
    ];
    Person *aPerson = [arr1 objectAtIndex:0];
    aPerson.name = @"Marge Simpson";
    aPerson.address = @"Springfield";
    // Result of the following line is:
    // Person at 0 is: Name: , Addr:
    printf("Person at %d is: Name: %s, Addr: %s\n",
        0, [[[arr2 objectAtIndex:0] name]
            cStringUsingEncoding:NSUTF8StringEncoding],
        [[arr2 objectAtIndex:0] address]
            cStringUsingEncoding:NSUTF8StringEncoding]);
    // must release all objects
    [a release];
    [b release];
    [c release];
    [d release];
    [e release];
    [pool release];
    return 0;
}
```

Since the `copy` message returns a new object that we own, we send an `autorelease` message to the `copy` object before adding it to the new array. At the end of creating and initializing the new array, the state of the objects is as depicted in Figure 3.5.

As the figure illustrates, the arrays are independent of each other. Every object involved is unique and has its own identity. If we change an element in `arr1`, no change occurs in `arr2`, and vice versa.

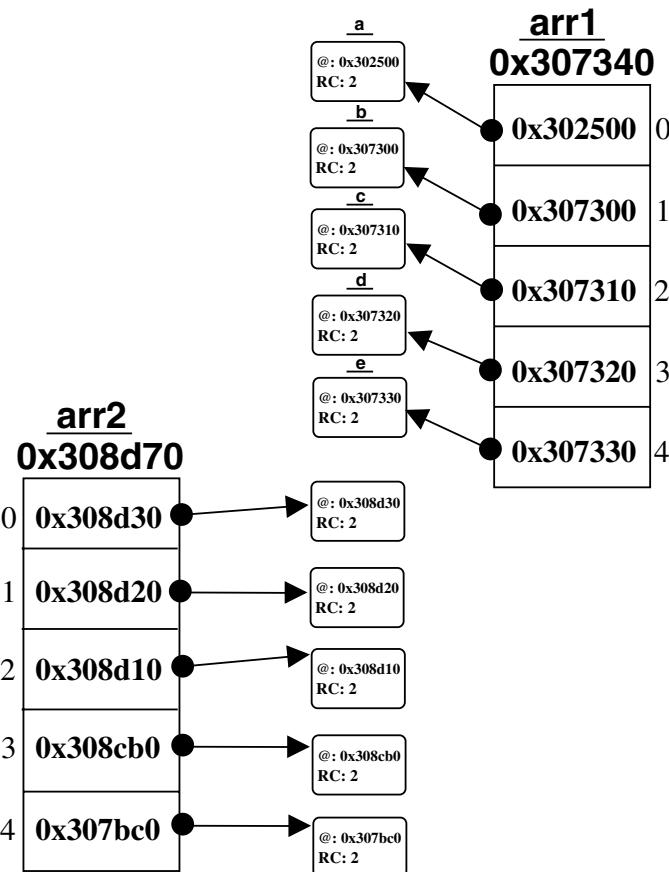


Figure 3.5 Illustration of the state of the objects involved in a deep copy of the contents of an array of objects.

This is illustrated in the code when we change the state of the object at index 0 in `arr1` and observe no change in `arr2` or in its contained objects.

To clean up, we only need to release the objects `a`, `b`, `c`, `d`, `e`, and `pool`. All other objects are autoreleased and will be released when we release the autorelease pool at the end.

3.1.4 Sorting an array

There are several approaches available to you for sorting an array. The two main options available are: a) write a function that finds the proper order of two objects, and b) add a method to your class that enables an instance to compare itself with another instance of the same class.

In Listing 3.7, we have updated the `Person` class as follows. First, we added a new instance variable called `personID` of type `NSInteger` (which is basically an `int`), and second, we added a new method `nameAscCompare:` which enables a `Person` object to compare itself with another `Person` instance.

Listing 3.7 The updated `Person` class with a sorting method.

```
#import <Foundation/Foundation.h>

@interface Person : NSObject{
    NSString      *name;
    NSString      *address;
    NSInteger     personID;
}

@property(copy) NSString  *name;
@property(copy) NSString  *address;
@property NSInteger personID;

-(id)initWithName:(NSString*) theName andAddress:(NSString*) theAddress
           andID:(NSInteger) theID;
-(id)init;
-(NSComparisonResult)nameAscCompare:(Person *)aPerson;
@end

@implementation Person
@synthesize name;
@synthesize address;
@synthesize personID;

-(id)initWithName:(NSString*) theName andAddress:(NSString*) theAddress
           andID:(NSInteger) theID{
    self = [super init];
    if(self){
        self.name = theName;
        self.address = theAddress;
        personID = theID;
    }
    return self;
}
-(id)init{
    return [self initWithName:@"" andAddress:@"" andID:0];
}
-(void)dealloc{
    [name release];
    [address release];
    [super dealloc];
}

-(NSComparisonResult)nameAscCompare:(Person *)aPerson{
```

```

    return [name caseInsensitiveCompare:[aPerson name]];
}
@end

```

Suppose you want to sort an array containing Person objects in an ascending order of the personID. NSArray provides an instance method called: sortedArrayUsingFunction:context:. This method is declared as follows:

```

- (NSArray *)sortedArrayUsingFunction:
    (NSInteger (^)(id, id, void *))comparator
    context:(void *)context

```

The first parameter is a pointer to a function that takes two arbitrary objects as the first two parameters and a (**void***) as the third parameter. It returns an NSInteger. The second parameter is a generic C-pointer so that your implementation, if it wishes to, can use it as a context. This second pointer is actually the third pointer used in each call made to your implementation of comparator.

Your implementation of the comparator function should return:

- NSOrderedAscending, if the first object is less than the second
- NSOrderedSame, if the two objects have the same ordering
- NSOrderedDescending, if the first object is greater than the second.

In Listing 3.8, we show the function intSort() that will be used as the comparator. The implementation of this function depends on the requirements of the application. Here, we just compare the personID of the two objects and return an appropriate comparison result.

Listing 3.8 Two different schemes for sorting an array.

```

NSInteger intSort(id p1, id p2, void *context) {
    int v1 = [(Person*)p1 personID];
    int v2 = [(Person*)p2 personID];
    if (v1 < v2)
        return NSOrderedAscending;
    else if (v1 > v2)
        return NSOrderedDescending;
    else
        return NSOrderedSame;
}

int main(int argc, char *argv[]) {
    NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
    Person *a = [[Person alloc]
                 initWithName:@"Kate Austen" andAddress:@"" andID:5];
    Person *b = [[Person alloc]
                 initWithName:@"Sayid Jarrah" andAddress:@"" andID:4];
    Person *c = [[Person alloc]

```

```
        initWithNibName:@"Sun Kwon" andAddress:@"" andID:1];
Person *d = [[Person alloc]
             initWithNibName:@"Hurley Reyes" andAddress:@"" andID:2];
Person *e = [[Person alloc]
             initWithNibName:@"Jack Shephard" andAddress:@"" andID:3];
NSArray *arr1 = [NSArray arrayWithObjects: a,b,c,d,e,nil];
NSArray *intSortedArray =
    [arr1 sortedArrayUsingFunction:intSort context:NULL];
NSArray *strSortedArray =
    [arr1 sortedArrayUsingSelector:@selector(nameAscCompare:)];
// must release all objects
[a release];
[b release];
[c release];
[d release];
[e release];
[pool release];
return 0;
}
```

In Listing 3.8, we send the following message to arr1:

```
sortedArrayUsingFunction:intSort context:NULL
```

and we store the new array reference in intSortedArray. Note that the new array is autoreleased and the objects in it are the same as objects as in the original array, arr1.

The second approach for sorting an array is through equipping the object with a way to compare itself with other siblings. Listing 3.7 shows the addition of the new method: nameAscCompare:. This method simply compares the value of the instance variable name with the other object's name instance variable. It uses the caseInsensitiveCompare: method to do the actual comparison.

In Listing 3.8, we show how we can sort the array using this method. We use the sortedArrayUsingSelector: method. Notice that no context is needed as a parameter since you have the **self** and class object pointers.

Figure 3.6 shows the state of the three array objects and their elements. Notice how the retain count of the array elements is now 4 (1 for each array and 1 for the alloc).

3.2 Sets

We saw in the previous section how we can store ordered objects in an array. Some scenarios, however, do not require object ordering, but are mostly concerned with maintaining unique objects and providing a fast verification mechanism on object membership.

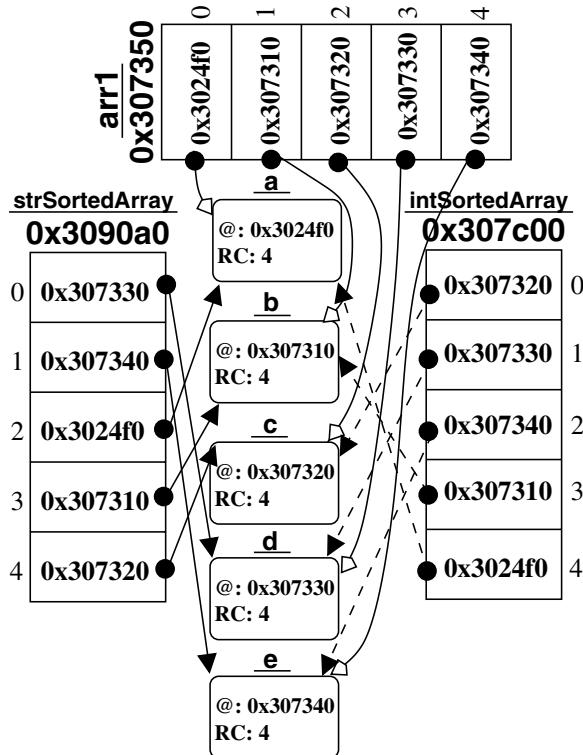


Figure 3.6 State of original array and two copies of it, sorted differently.

The set collection provides such a behavior. As in the array case, sets come in two flavors: (1) static sets represented by the `NSSet` class, and (2) dynamic or mutable sets represented by the `NSMutableSet` class.

3.2.1 Immutable sets

Listing 3.9 provides a sample code demonstrating the use of immutable sets.

To create an immutable set, you have to specify the members during the initialization phase. The method `initWithObjects:` does just that. This method is similar to the one in the `NSArray` class. The code below creates three sets.

Listing 3.9 Demonstration of immutable sets.

```
NSSet *favoritShows = [[NSSet alloc] initWithObjects:
    @"Everybody Loves Raymond",
    @"Lost",
```

```
        @"Nova",
        @"Late Show",
        @"Tom and Jerry",
        nil
    ];
NSSet *reallyFavoritShows = [[NSSet alloc] initWithObjects:
    @"Everybody Loves Raymond",
    @"Lost",
    nil
];
NSSet *hatedShows = [[NSSet alloc] initWithObjects:
    @"Heroes",
    @"60 minutes",
    @"The Tonight Show",
    @"Deal or no deal",
    nil
];
printf("Number of elements = %d\n", [favoritShows count]);

if( [favoritShows intersectsSet:hatedShows] == YES) {
    printf("makes no sense!\n");
}
if( [reallyFavoritShows isSubsetOfSet:favoritShows] == YES) {
    printf("makes sense!\n");
}

if( [reallyFavoritShows isEqualToSet:favoritShows] == YES) {
    printf("makes some sense!\n");
}

NSString *anyShow =[favoritShows anyObject];
if( [hatedShows containsObject:anyShow] == YES) {
    printf("makes no sense!\n");
}
```

To find the number of elements in a set, use the `count` instance method.

`NSSet` also provides methods that implement the mathematical operations defined on a set. For example, the code above demonstrates how you can find whether a set instance intersects (has common elements) with another set. The `intersectsSet:` method is declared as:

- (BOOL) intersectsSet: (NSSet *) otherSet

It returns YES if there is at least one common element shared by the receiver and `otherSet`, and NO, otherwise.

You can also test if a set instance is a subset of another set using the `isSubsetOfSet:` declared as:

- (BOOL) isSubsetOfSet: (NSSet *) otherSet

For this method to return YES, every element in the receiver must be present in otherSet.

If you want to see if all members of the receiver are present in another set and vice versa, use the method `isEqualToString:`. The method returns YES if and only if the number of elements in the receiver and the argument set is the same and every element available in the receiver is also found in the argument set. The method is declared as follows:

- (BOOL) isEqualToString:(NSSet *)otherSet

The method `anyObject` returns an arbitrary (not necessarily random) element in the set. The method `containsObject:` returns YES if a given element is present in a set and NO, otherwise. It is declared as:

- (BOOL) containsObject:(id)anObject

3.2.2 *Mutable sets*

Listing 3.10 is a continuation of Listing 3.9. Here, we continue our example and demonstrate the dynamic version of the set collection: `NSMutableSet`.

Listing 3.10 Demonstration of mutable sets.

```
NSMutableSet *dynamicSet = [[NSMutableSet alloc] initWithCapacity:2];
[dynamicSet addObject:@"Lost"];
[dynamicSet addObject:@"Nova"];
[dynamicSet addObject:@"Heroes"];
[dynamicSet addObject:@"Lost"];
[dynamicSet removeObject:@"Everybody Loves Raymond"];
[dynamicSet removeObject:@"Nova"];
printf("dynamicSet = %s\n", [[dynamicSet description] cString]);
[dynamicSet unionSet:reallyFavoritShows];
printf("dynamicSet = %s\n", [[dynamicSet description] cString]);
[dynamicSet minusSet:reallyFavoritShows];
printf("dynamicSet = %s\n", [[dynamicSet description] cString]);
```

To create a mutable set instance, you use `alloc` and set the initial capacity of the set. This initial capacity is not a limitation on the set size because it can grow and shrink dynamically. The statement `[[NSMutableSet alloc] initWithCapacity:2]` creates a new mutable set with an initial capacity of two elements.

To add an element to the set, use `addObject:`. As we saw in the array collection, the set does not copy the object you are adding, but it puts a claim on it by sending a `retain` message to it. If you add an element that is already in the set, the method has no effect on the set or the element. To remove an element from the set, use the `removeObject:` method. No side effect occurs if the element you are trying to remove is not found in the set.

After adding and removing objects from the set, we display the set using the `description:` method. The first `printf` statement produces:

```
dynamicSet = { (
    Heroes,
    Lost
) }
```

You can merge (make a union) of two sets using `unionSet`: declared as:

```
- (void)unionSet:(NSSet *)otherSet
```

The `unionSet`: adds every object in `otherSet` that is not a member of the receiver to the receiver. After the union operation, the `dynamicSet` is displayed as:

```
dynamicSet = { (
    Everybody Loves Raymond,
    Heroes,
    Lost
) }
```

The method `minusSet`: is declared as:

```
- (void)minusSet:(NSSet *)otherSet
```

It removes every member in `otherSet` from the receiver set. The contents of `dynamicSet` after executing the statement `[dynamicSet minusSet:reallyFavoritShows]` is:

```
dynamicSet = { (
    Heroes
) }
```

3.2.3 Additional important methods

To remove all elements of a set, you can use:

```
- (void)removeAllObjects
```

To remove all elements of a set and then add all the elements in another set to it, use:

```
- (void)setSet:(NSSet *)otherSet
```

If you have an array of elements and you would like to add all its elements to a set, use:

```
- (void)addObjectsFromArray:(NSArray *)anArray
```

To send every object in a set a message, use:

```
- (void)makeObjectsPerformSelector: (SEL)aSelector
```

The method specified by the selector `aSelector` must not take any arguments.

If you want to communicate with the members of the set using an object, you can use:

```
- (void)makeObjectsPerformSelector: (SEL)aSelector
    withObject: (id)anObject
```

This method will use a selector representing a method that takes exactly one argument of type `id`. In both methods above, the selector must not change the set instance itself.

3.3 Dictionaries

The immutable `NSDictionary` and its mutable subclass `NSMutableDictionary` give you the ability to store your objects and retrieve them using keys. Each entry of the dictionary consists of a key and a value. The key can be any object as long as it adopts the `NSCopying` protocol. Usually, instances of the `NSString` class are used as keys, but any class can be used.

In a dictionary, keys have to be unique. Keys and values cannot be `nil`. The framework, however, provides you with the class `NSNull` for storing null objects. When you add entries to the dictionary, the dictionary class makes a copy of the key and uses this copy as the key to store the value object. The storage follows a hash model, but the classes shield you from the implementation details. The value object is retained rather than copied.

As with the array collection classes, once the immutable dictionary is initialized, you cannot add or remove entries to/from it. You can get a mutable dictionary from an immutable one and vice versa. Listing 3.11 demonstrates working with dictionaries.

Listing 3.11 Working with dictionaries.

```
#import <Foundation/Foundation.h>

int main(int argc, char *argv[]) {
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    NSMutableArray *kArr = [NSMutableArray arrayWithObjects:
        @"1", @"2", @"3", @"4", nil];
    NSMutableArray *aArr = [NSMutableArray arrayWithObjects:@"2", nil];
    NSDictionary *guide =
        [NSDictionary dictionaryWithObjectsAndKeys:
            kArr, @"Kate", aArr, @"Ana-Lucia", nil];

    NSEnumerator *enumerator = [guide keyEnumerator];
    id key;
    while ((key = [enumerator nextObject])) {
        if ([[key substringToIndex:1] isEqualToString:@"K"]){
            [[guide objectForKey:key] addObject:@"5"];
        }
    }
}
```

```
        }
    }

NSMutableDictionary *dynaGuide = [guide mutableCopy];
for(key in dynaGuide) {
    if([key substringToIndex:1] isEqualToString:@"A"]){
        [[dynaGuide objectForKey:key] addObject:@"5"];
    }
}
NSArray *keys = [dynaGuide allKeys];
for(key in keys) {
    if([key substringToIndex:1] isEqualToString:@"A")){
        [dynaGuide removeObjectForKey:key];
    }
}
[dynaGuide release];
[pool release];
return 0;
}
```

In the code above, we create an immutable dictionary whose keys are strings and whose values are mutable arrays. The creation of the dictionary is achieved using the method `dictionaryWithObjectsAndKeys:`. The method takes a list of alternating values and keys that is null-terminated.

To access the values stored in a dictionary, you can use an enumerator of the keys. The method `keyEnumerator` returns such an enumerator from a dictionary object. The code uses the enumerator to check for all objects whose key starts with an “A”. For each such key, it updates the value stored in that entry. To retrieve the value of a given key, you use the `objectForKey:` method.

To generate a mutable copy of a dictionary, you use the `mutableCopy` method. This will create a new mutable dictionary initialized with the recipient dictionary’s elements. Since the method used has a “copy” in it, you own that object and you should release it when you’re done with it.

Another way for traversing the dictionary is the use of fast enumeration. The line `for(key in dynaGuide)` enumerates the keys in the dictionary `dynaGuide`.

You can add/remove entries to/from a mutable dictionary. To remove a given entry, you use the `removeObjectForKey:` method. You should not, however, do that while enumerating a dictionary. You should, instead, make a snapshot of the keys and then update the dictionary. To get an `NSArray` instance of all the keys, use `allKeys` method. Once you have that, you can enumerate the keys and update the dictionary as you wish.

3.3.1 Additional important methods

The method `isEqualToString:` returns YES if the receiver has the same number of entries, and for every key, the corresponding values in the two dictionaries are equal (i.e., `isEqual:` returns YES). The method is declared as follows:

- `(BOOL)isEqualToString: (NSDictionary *)otherDictionary`

The method `allValues` creates a new array with the values contained in the dictionary entries. The method is declared as follows:

- `(NSArray *)allValues`

The method `keysSortedByValueUsingSelector:` generates an array of keys ordered by sorting the values using comparator. The method is declared as follows:

- `(NSArray *)keysSortedByValueUsingSelector: (SEL)comparator`

The method `addEntriesFromDictionary:` adds the entries in `otherDictionary` to the receiver of the message. If the receiver already has an entry with the same key, that entry receives a `release` before being replaced. The method is declared as follows:

- `(void)addEntriesFromDictionary: (NSDictionary *)otherDictionary`

3.4 Summary

This chapter covered the topic of collections. Collections are Cocoa objects that act as containers to other Cocoa objects. We introduced three types of collections defined in the Foundation Framework. We first discussed the array collection in Section 3.1. Immutable arrays are instances of the `NSArray` class. `NSArray` allows for the creation of a static array that cannot be changed once initialized. The mutable version of `NSArray` is `NSMutableArray`. An instance of `NSMutableArray` can be modified by adding and removing elements during the lifetime of the program. The `NSArray` is more efficient than the `NSMutableArray` class. You should use instances of `NSArray` if the array is not required to change once initialized.

We discussed the concepts of shallow and deep copying. A shallow copy of an object is a new instance that shares the references (pointers) to other objects that the original object has. A deep copy, by contrast, propagates the copying to the referenced objects. Collections implement a shallow copy regardless of what kind of objects they hold. For a class to implement a deep copy, it needs to adopt the `NSCopying` protocol and implement the `copyWithZone:` method. To produce a deep copy of a collection, you need to iterate through the objects contained in that collection, sending a `copy` message to each object, `autorelease`ing each object, and adding it to the collection, in that order.

We also discussed sorting, and presented two schemes to accomplish that: (1) either using a function for comparing two instances, or (2) adding a method so that an instance can compare

itself with another. The first scheme is employed in the array instance method `sortedArrayUsingFunction:context:`, while the second scheme is employed in the array instance method `sortedArrayUsingSelector:`.

In Section 3.2, we covered the set collection. Immutable sets are instances of the `NSSet` class, while mutable sets are instances of `NSMutableSet`. We also presented several methods which implement mathematically inspired set operations.

In Section 3.3, we covered the dictionary collection. Dictionaries allow for the retrieval of objects using keys. Several examples were presented illustrating immutable and mutable dictionaries.

Problems

- (1) List all of the different ways that you can use to create an empty `NSArray` instance.
- (2) What's wrong with the following statement? Assume `array` property is declared as `retain`.

```
self.array = [ [NSArray alloc] initWithArray:[NSArray array]] ;
```

- (3) Write a method that returns a sorted array from an array of dictionaries. Base your sorting on the key `name`.
- (4) Study the header file `NSDictionary.h`.

4

Anatomy of an iPhone Application

This chapter discusses the basic steps needed to build a simple iPhone application. Section 4.1 demonstrates the basic structure of a simple iPhone application. Next, Section 4.2 shows the steps needed to write the application using XCode. Finally, Section 4.3 summarizes the chapter.

4.1 Hello World Application

This section demonstrates the basic structure of a simple iPhone application that simply displays the message `Hello World` to the user. Follow these steps to develop the application.

4.1.1 Create a `main.m` file

As in any C program, the execution of Objective-C applications starts from `main()`. You need to create the `main()` function in the `main.m` file as follows:

```
#import <UIKit/UIKit.h>

int main(int argc, char *argv[]) {
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    int retVal = UIApplicationMain(argc, argv, nil, @"HelloWorldAppDelegate");
    [pool release];
    return retVal;
}
```

The `main()` function starts by creating an autorelease pool and ends by releasing it. In between, it makes a call to the `UIApplicationMain()` function. `UIApplicationMain()` is declared as follows:

```
int UIApplicationMain(int argc, char *argv[], NSString *principalClassName,
                     NSString *delegateClassName)
```

This function takes four parameters. The first two parameters are the arguments passed in to the `main()` function. These parameters should be familiar to any C programmer. The third parameter is the name of the application class. If a `nil` is specified, the `UIApplication` class is used to instantiate the unique application object. The fourth and last parameter is the name of the application delegate class.

The `UIApplicationMain()` instantiates the application and the application delegate objects. After that, it sets the `delegate` property of the application object to the application delegate instance. The main run loop of the application is established. From this moment on, events, such as user touches, are queued by the system, and the application object dequeues these events and delivers them to the appropriate objects in your application (usually the main window.)

The `main.m` file is generated automatically when you create the project as we shall see shortly.

4.1.2 Create the application delegate class

The instance of the application delegate class will receive important messages from the application object during the lifetime of the application. The following is a typical application delegate class:

```
#import <UIKit/UIKit.h>

@class MyView;
@interface HelloWorldAppDelegate : NSObject <UIApplicationDelegate> {
    UIWindow      *window;
    MyView        *view;
}
@end
```

Notice that the application delegate class adopts the `UIApplicationDelegate` protocol. In addition, references to the user-interface objects that will be created and presented to the user are stored in instance variables. Most of the time, you will have one window object and several views attached to it. In the example above, the variable `window` stores a reference to the main window object and `view` is used to store a reference to a custom view of type `MyView`.

One of the most important methods of the `UIApplicationDelegate` protocol is the `applicationDidFinishLaunching:` method. This method is invoked by the application object to inform the delegate that the application has finished launching. You usually implement this method to initialize the application and create the user interface. The following is a listing of the implementation of the application delegate class. In the `applicationDidFinishLaunching:` method, we first create the main window of the application.

```
#import "HelloWorldAppDelegate.h"
#import "MyView.h"

@implementation HelloWorldAppDelegate

- (void)applicationDidFinishLaunching:(UIApplication *)application {
```

```
window= [[UIWindow alloc] initWithFrame:[UIScreen mainScreen] bounds]];
CGRect frame = [UIScreen mainScreen].applicationFrame;
view = [[MyView alloc] initWithFrame:frame];
view.message = @"Hello World!";
view.backgroundColor =[UIColor whiteColor];
>window addSubview:view];
>window makeKeyAndVisible];
}

- (void)dealloc {
[view release];
>window release];
[super dealloc];
}
@end
```

Windows are instances of the class `UIWindow`. `UIWindow` is a subclass of the `UIView` class. `UIView` is the base class of user-interface objects. It provides access to handling user gestures as well as drawings. Like any other object, a `UIWindow` instance is allocated and then initialized. The initializer (as we shall see in Chapter 5) specifies the frame that the window object will occupy. After that, an instance of the `MyView` class is created and initialized with the frame that it will occupy. After configuring the `MyView` instance and setting its background color, we add it as a subview to the `window` and make the `window` object key and visible.

The application delegate class is generated automatically for you when you create the project. You need, however, to customize it for your own needs.

4.1.3 Create the user interface subclasses

To receive the user events (e.g., the touches) and draw in the view, you need to create a subclass of `UIView` and override its event-handling and drawing methods. The declaration of the `MyView` class used in our `HelloWorld` application is shown below:

```
#import <UIKit/UIKit.h>

@interface MyView : UIView {
    NSString *message;
}
@property(nonatomic, retain) NSString *message;
@end
```

The implementation of the `MyView` class is shown below. This class overrides the event-handling method for ending-of-touches (we will cover the multitouch interface in the next chapter) and the `drawRect:` for drawing in the view area.

For drawing, we simply draw the contents of the `message` instance variable with a specific font. Whenever the user's finger is lifted from the screen, that event is stored in the application queue. The application object retrieves the event from the queue and sends it to the main window. The window searches its subviews for the view that should receive this event and delivers that event to it. In our example, since `MyView` instance spans the screen, all touch events will be delivered to it and the `touchesEnded:withEvent:` method will be invoked. You can put your code in this method in order to either update the state of the application or change its appearance or both.

The `dealloc` method releases memory owned by the view and propagates the deallocation process to `super`. Notice how the instance variable `message` is released by relying on the behavior of the synthesized setter. By assigning a `nil` value to the property, the synthesized setter first releases the memory and then sets the value of the instance variable to `nil`.

```
#import "MyView.h"

@implementation MyView
@synthesize message;

- (void)touchesEnded:(NSSet *)touches withEvent:(UIEvent *)event{
    if( [(UITouch *)[touches anyObject] tapCount] == 2){
        // handle a double-tap
    }
}

- (void)drawRect:(CGRect)rect{
    [message drawAtPoint:CGPointMake(60,180)
                  withFont:[UIFont systemFontOfSize:32]];
}

- (void)dealloc{
    self.message = nil;
    [super dealloc];
}
```

4.2 Building the Hello World Application

The following are the steps you need to take to realize the `HelloWorld` application.

1. **Create a new project in XCode.** In XCode, select `File->New Project` and select the Window-Based Application template (Figure 4.1.) Name the project `HelloWorld` and click `Save` as shown in Figure 4.2.
2. **Update the project for building the user interface programmatically.** You can create the user interface using either Interface Builder, programmaticaly, or both. Interface Builder accelerates the development process, but it also hides important concepts. If you are a beginner, we suggest that you build the user interface programmaticaly and do not rely on Interface Builder. This will

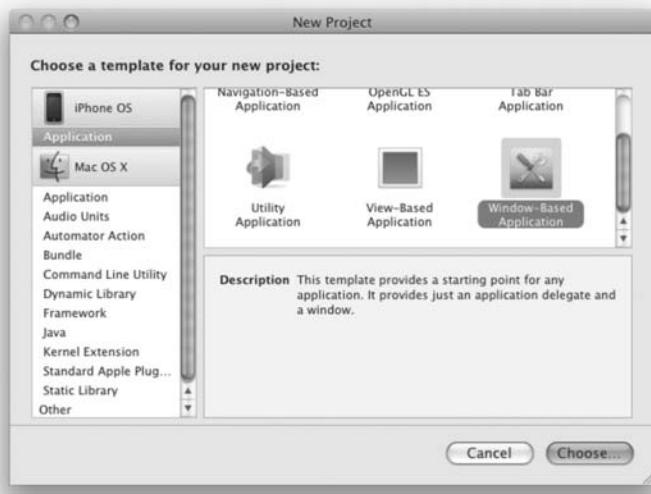


Figure 4.1 Choosing a template for a new project.

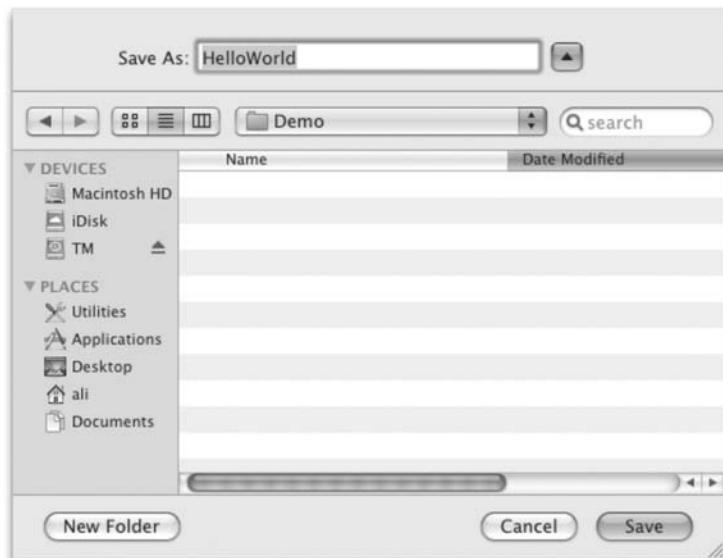


Figure 4.2 Naming a new project.



Figure 4.3 The Groups & Files window.

help you to understand what is going on. Once you have mastered this subject, you can use Interface Builder in your development.

The project template assumes that you are using Interface Builder, so you need to make some small changes to fully use the programmatic approach. Select the `Info.plist` file in the Groups & Files window (Figure 4.3) so that its content appears in the Editor. Right-click on "Main nib file base name" and select Cut. Right-click on the file `MainWindow.xib` in the Groups & Files window and select Delete. Click on Also Move to Trash.

Select the `main.m` file and change the `UIApplicationMain()` invocation by adding the name of the application delegate class to it as shown below:

```
int retVal=UIApplicationMain(argc,argv,nil,@"HelloWorldAppDelegate");
```

3. **Write your code.** Select the `HelloWorldAppDelegate.h` file and replace its content with the listing described in the previous section. Do the same for the `HelloWorldAppDelegate.m` file.
4. **Create a subclass of UIView.** Select File->New File and select the `UIView` subclass and hit Next (see Figure 4.4.) Name the file `MyView.m` and hit Finish (see Figure 4.5.) A subclass of `UIView` will be created for you. Change the contents of `MyView.h` and `MyView.m` with the listings shown in the previous section.

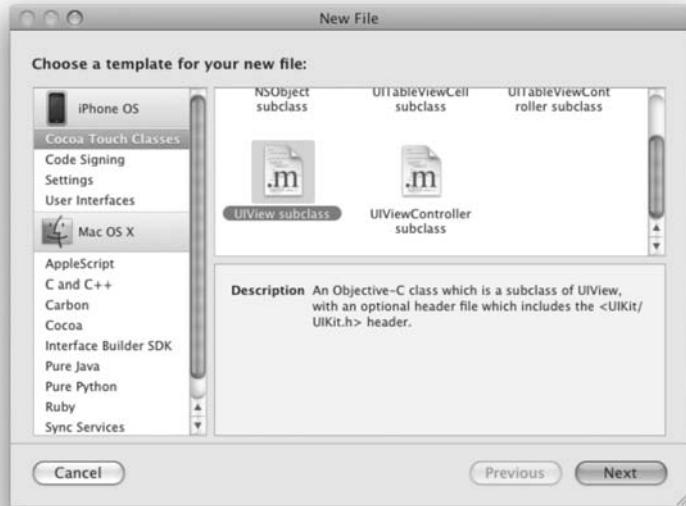


Figure 4.4 Choosing a template for a new file.

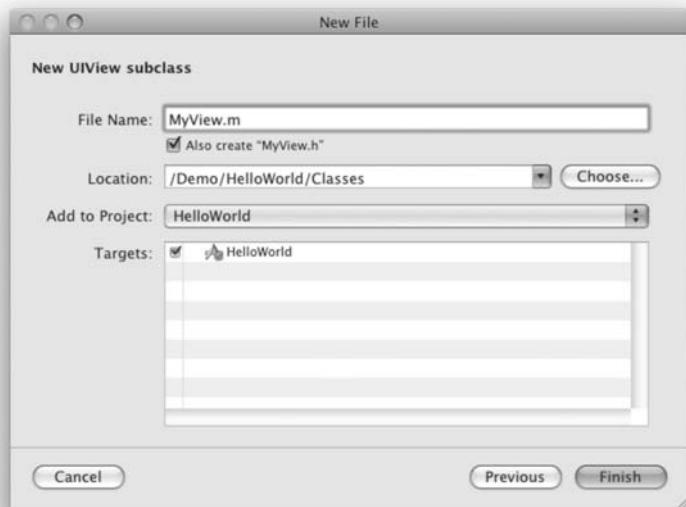


Figure 4.5 Naming the new UIView subclass.



Figure 4.6 The XCode Toolbar.



Figure 4.7 The HelloWorld application.

5. **Build and run the application.** Click on Build and Go (see Figure 4.6) to build and launch the application (see Figure 4.7).

The source code for this application can be found in the `HelloWorld` project available from the source downloads.

4.3 Summary

The execution of any iPhone application starts in the `main()` function. In this function, you create an autorelease pool to be used during the lifetime of the application. After that, the `UIApplicationMain()` is called passing in the application delegate class name as the last argument.

The application delegate class, a skeleton of which is produced automatically when you create a new project, creates a window, attaches additional views to it, and makes it key and visible. From that point on, the application runs an infinite loop looking for external events such as screen touches, external data, external devices, etc. When an event occurs, your application changes either its view hierarchy or the content of the current views, or both.

In the rest of the book, you will learn about views, data representation and manipulation, devices, and much more.

Problems

- (1) Locate the `UIApplication.h` header file and familiarize yourself with it.
- (2) Locate the `UIView.h` header file and familiarize yourself with it.

5

The View

This chapter explains the main concepts behind views. You learn about view geometry in Section 5.1. In Section 5.2, we cover the topic of view hierarchy. Next, Section 5.3 discusses, in great detail, the multitouch interface. In this section, you learn how to recognize multitouch gestures. After that, we discuss several animation techniques in Section 5.4. Next, Section 5.5 deals with how to use Quartz 2D functions for drawing inside a view. Finally, we summarize the chapter in Section 5.6.

5.1 View Geometry

This section covers the three geometric properties of the `UIView` class that you need to understand: `frame`, `bounds`, and `center`. Before explaining these properties, let's first look at some of the structures and functions used in specifying their values.

5.1.1 Useful geometric type definitions

The following types are used throughout the text:

- `CGFloat` represents a floating point number and is defined as:

```
typedef float CGFloat;
```

- `CGPoint` is a structure that represents a geometric point. It is defined as:

```
struct CGPoint {  
    CGFloat x;  
    CGFloat y;  
};  
typedef struct CGPoint CGPoint;
```

The `x` value represents the x-coordinate of the point and the `y` value represents its y-coordinate.

You will use `CGPoint` a lot. `CGPointMake()` is a convenient function defined to make a `CGPoint` from a pair of `x` and `y` values, and is defined as follows:

```
CGPoint CGPointMake (
    CGFloat x,
    CGFloat y
);
```

- `CGSize` is a structure used to represent width and height values. It is declared as follows:

```
struct CGSize {
    CGFloat width;
    CGFloat height;
};
typedef struct CGSize CGSize;
```

where `width` is the width value and `height` is the height value.

To make a `CGSize` structure from a width and a height, use the utility function `CGSizeMake()`, declared as follows:

```
CGSize CGSizeMake (
    CGFloat width,
    CGFloat height
);
```

- `CGRect` is used to represent the location and dimensions of a rectangle. It is declared as follows:

```
struct CGRect {
    CGPoint origin;
    CGSize size;
};
typedef struct CGRect CGRect;
```

The `origin` value represents the upper-left point of the rectangle, and `size` represents its dimensions (i.e., its width and height).

To make a `CGRect` structure, you can use the utility function `CGRectMake()` declared as follows:

```
CGRect CGRectMake (
    CGFloat x,
    CGFloat y,
    CGFloat width,
    CGFloat height
);
```

5.1.2 The UIScreen class

The `UIScreen` class is provided to you in order to obtain the dimensions of the device's screen. The device's screen is 320×480 points as shown in Figure 5.1.

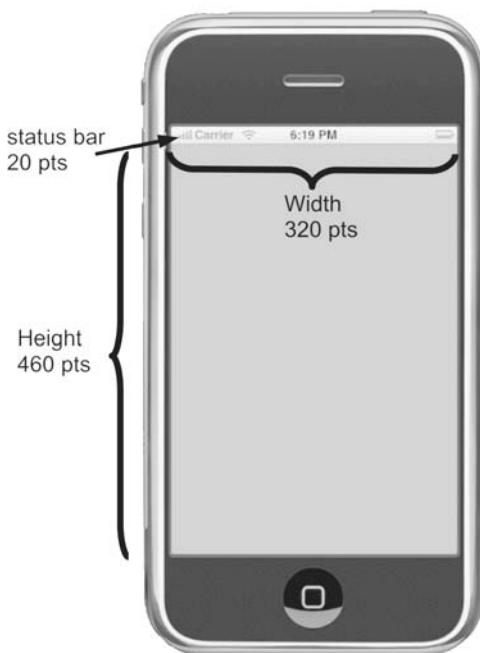


Figure 5.1 The dimensions of the device screen.

The status bar takes 20 points from the total height, leaving 460 points for the application. You can turn off the status bar using the following statement:

```
[UIApplication sharedApplication].statusBarHidden = YES;
```

You can retrieve the size of the device's screen as follows:

```
[[UIScreen mainScreen] bounds].size
```

In the above statement, we first obtain the singleton `UIScreen` instance and then obtain the size of its bounding rectangle.

The application window resides just below the status bar. To retrieve the application's frame, use the following statement:

```
CGRect frame = [[UIScreen mainScreen] applicationFrame]
```

If there is a status bar, the application's frame is 320×460 . Otherwise, it is equal to the screen's bounds.

5.1.3 The frame and center properties

The `UIView` class declares the `frame` property which is used to locate and dimension the `UIView` instance inside another `UIView` instance. The property is declared as follows:

```
@property(nonatomic) CGRect frame
```

You usually specify the frame of a view during the initialization phase. For example, the following creates a `UIView` instance whose origin is located at $(50, 100)$ in its superview's coordinates and whose width and height are 150 and 200, respectively.

```
CGRect frame = CGRectMake(50, 100, 150, 200);
aView = [[UIView alloc] initWithFrame:frame];
[window addSubview:aView];
```

Figure 5.2 shows the result of adding the above `UIView` instance to a full-screen window (minus the status bar).

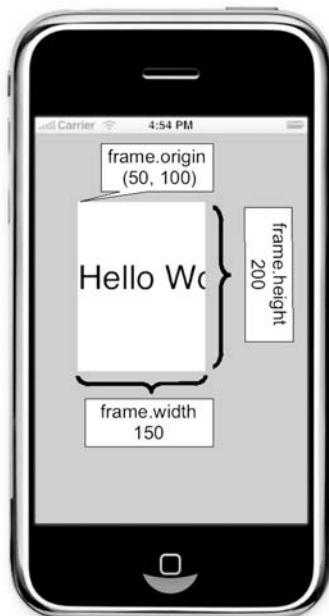


Figure 5.2 The `frame` geometric property for a subview of a main window.

The origin of this view is (50, 100) and its center is (125, 200), all in the parent view's (window) coordinates.

Changes to the `center` will result in changes to the origin of the frame. Similarly, changes to the origin or to the size of the frame will result in changes in the center. For the example above, if the x-coordinate of the `center` property is increased by 80 points, the frame's origin will be equal to (130, 100) which would result in the view being shifted as a whole a distance of 80 points to the right as shown in Figure 5.3.



Figure 5.3 Moving the view location by changing its `center` property.

5.1.4 The `bounds` property

The `bounds` property is used to specify the origin and size of the view in the view's own coordinate system. The property is declared as follows:

```
@property(nonatomic) CGRect bounds
```

When you initialize the view, the bound's origin is set to (0, 0) and its size is set to frame.size. Changes to the bounds.origin have no effect on the frame and the center properties. Changes to bounds.size, however, will result in a change in the frame and center properties.

As an example, consider Figure 5.2. The bound.origin is equal to (0, 0). The view draws a string's value as shown below:

```
- (void)drawRect: (CGRect)rect {  
    int x = 0;  
    int y = self.bounds.size.height/3;  
   [@"Hello World!"  
     drawAtPoint:CGPointMake(x,y)  
     withFont:[UIFont systemFontOfSize:40]];  
}
```

The x-axis of the point at which the string "Hello World!" is drawn is equal to 0. If we change the value of bounds.origin.x from 0 to 50, the string drawn will move 50 to the left as shown in Figure 5.4.



Figure 5.4 Changes to the bounds property's origin affect the content of the view not its dimension/location.

5.2 The View Hierarchy

Most of the time, you will have one main window for the application and several views and controls with different sizes and locations. The main window (an instance of `UIWindow` which is a subclass of `UIView`) will act as a root of a tree. When you want to add a view to the application, you add that view to the window or to an existing view. Eventually, you end up with a tree structure rooted at that window. Every view will have exactly one parent view called *superview*, and zero or more child views called *subviews*. To access the superview instance, use the property `superview` which is declared as follows:

```
@property(nonatomic, readonly) UIView *superview
```

To retrieve the children of a given view, use the property `subviews`, which is declared as follows:

```
@property(nonatomic, readonly, copy) NSArray *subviews
```

To add a view to an existing view, you allocate it, initialize it, configure it, and then add it as a subview. The following two statements create a view that occupies the full screen (minus the status bar).

```
CGRect frame = [UIScreen mainScreen].applicationFrame;
view1 = [[UIView alloc] initWithFrame:frame];
```

The initializer that is usually used is the `initWithFrame:` initializer.

To add a view as a subview, use the `addSubview:` method which is declared as follows:

```
- (void)addSubview:(UIView *)view
```

After invoking this method, the superview will retain the instance `view`.

To remove a view from the view hierarchy, you use the method `removeFromSuperview`. In addition to removing the view from the tree, this method will also release the view.

5.3 The Multitouch Interface

When the user touches the screen, they are requesting feedback from the application. Given that the application presents multiple views, subviews, and controls to the user at the same time, there is a need for the system to figure out which object is the intended recipient of the user's touches.

Every application has a single `UIApplication` object for handling users' touches. When the user touches the screen, the system packages the touches in an event object and puts that event object in the application's event queue. This event object is an instance of the class `UIEvent`.

The event object contains all the touches that are currently on the screen. Each finger on the screen has its own touch object, an instance of the class `UITouch`. As you will see later, each touch object can be in different phases, such as, has just touched the screen, moving, stationary, etc. Each time the user touches the screen, the event object and the touches objects get mutated to reflect the change.

The `UIApplication` unique instance picks up the event object from the queue and sends it to the key window object (an instance of `UIWindow` class). The window object, through a mechanism called *hit-testing*, figures out which subview should receive that event and dispatches the event to it. This object is referred to as the *first responder*. If that object is interested in handling the event, it does so and the event is considered as delivered. If, on the other hand, that object is not interested in handling the event, it passes it through a linked list of objects called the *responder chain*.

The responder chain of a given object starts from that object and ends in the application object. If any object on this chain accepts the event, then the event's propagation towards the application instance stops. If the application instance receives the event and does not know of a valid recipient of it, it throws that event away.

5.3.1 The `UITouch` class

Each finger touching the screen is encapsulated by an object of the `UITouch` class. The following are some of the important properties and methods of this class.

- `phase`. This property is used to retrieve the current phase of the touch. The property is declared as follows:

```
@property (nonatomic, readonly) UITouchPhase phase
```

There are several `UITouchPhase` values available including:

- `UITouchPhaseBegan` indicates that the finger touched the screen.
- `UITouchPhaseMoved` indicates that the finger moved on the screen.
- `UITouchPhaseStationary` indicates that the finger has not moved on the screen since the last event.
- `UITouchPhaseEnded` indicates that the finger has left the screen.
- `UITouchPhaseCancelled` indicates that the touch is being cancelled by the system.

- `timestamp`. The time when the touch changed its phase. The `UITouch` object keeps mutating during an event. This value refers to the last mutation.
- `tapCount`. The number of taps that the user made when he/she touched the screen. Successive tapping on the same place will result in a tap count greater than 1. The property is declared as follows:

```
@property (nonatomic, readonly) NSUInteger tapCount
```

- `locationInView::` This method returns the location of the touch in a given view. The method is declared as follows:

```
- (CGPoint)locationInView:(UIView *)view
```

The returned value is in the coordinate system of `view`. If you pass `nil`, the returned value is in the window's coordinate system.

- `previousLocationInView:`. The previous location of the touch in a given view can be retrieved using this method. The method is declared as follows:
 - `(CGPoint)previousLocationInView:(UIView *)view`

5.3.2 The UIEvent class

A multitouch sequence is captured by an object of the class `UIEvent`. The application will receive the same `UIEvent` object throughout its lifetime. This object will be mutated during the execution of the application. You can retrieve the timestamp of this event using the `timestamp` property. To retrieve the touches that this event represents, use the `allTouches` method which is declared as follows:

- `(NSSet *) allTouches`

5.3.3 The UIResponder class

User interface objects, such as instances of `UIView`, receiving touches are subclasses of the `UIResponder` class. To understand the multitouch interface, we need to understand the `UIResponder` class and its four main multitouch-handling methods.

The following are the main methods which subclasses of `UIResponder` class (such as `UIView` subclasses) need to override in order to handle gestures.

1. `touchesBegan:withEvent:`. This method is invoked to tell the responder object that one or more fingers have just touched the screen. The method is declared as follows:

- `(void)touchesBegan:(NSSet *)touches withEvent:(UIEvent *)event`

The first parameter is a set of `UITouch` objects that have just touched the screen. The second parameter is the event which these touches are associated with.

2. `touchesMoved:withEvent:`. This method is invoked to tell the responder object that one or more fingers have just moved on the screen. The method is declared as follows:

- `(void)touchesMoved:(NSSet *)touches withEvent:(UIEvent *)event`

The first parameter is a set of `UITouch` objects that have just moved on the screen. The second parameter is the event which these touches are associated with.

3. `touchesEnded:withEvent:`. This method is invoked to tell the responder object that one or more fingers have just been lifted from the screen. The method is declared as follows:

- `(void)touchesEnded:(NSSet *)touches withEvent:(UIEvent *)event`

The first parameter is a set of `UITouch` objects that have just been lifted from the screen. The second parameter is the event which these touches are associated with.

4. `touchesCancelled:withEvent:`. This method is invoked by the system to tell the responder object that the event has been cancelled. The method is declared as follows:

```
- (void)touchesCancelled:(NSSet *)touches withEvent:(UIEvent *)event
```

The first parameter is a set containing a single `UITouch` object whose phase is `UITouchPhaseCancel`. The second parameter is the event which has been cancelled.

It is best to understand the multitouch mechanism through a detailed example. Let's imagine three fingers, F1, F2, and F3, touching the screen, moving on the screen, and ending at various times. We will show the invocation of the responder's methods as a result of these fingers. For each invocation, we show the content of the `touches` set as well as the `allTouches` set of the event object.

The following assumes a starting condition just prior to Step 1 where no fingers are touching the screen.

1. Two fingers, F1 and F2, touched the screen.

`touchesBegan:withEvent:` is called.

`touches`: a set of two elements:

```
Touch T1 representing F1: <UITouch: 0x14a360> phase: Began  
Touch T2 representing F2: <UITouch: 0x14a0f0> phase: Began
```

`event: <UIEvent: 0x143ae0>`. The `allTouches` set:

```
T1: <UITouch: 0x14a360> phase: Began  
T2: <UITouch: 0x14a0f0> phase: Began
```

2. Fingers F1 and F2 moved.

`touchesMoved:withEvent:` is called.

`touches`: a set of two elements:

```
T1: <UITouch: 0x14a360> phase: Moved  
T2: <UITouch: 0x14a0f0> phase: Moved
```

`event: <UIEvent: 0x143ae0>`. The `allTouches` set:

```
T1: <UITouch: 0x14a360> phase: Moved  
T2: <UITouch: 0x14a0f0> phase: Moved
```

3. Finger F1 moved.

`touchesMoved:withEvent:` is called.

`touches`: a set of one element:

```
T1: <UITouch: 0x14a360> phase: Moved
```

`event: <UIEvent: 0x143ae0>`. The `allTouches` set:

```
T1: <UITouch: 0x14a360> phase: Moved  
T2: <UITouch: 0x14a0f0> phase: Stationary
```

4. Finger F2 moved.

touchesMoved:withEvent : is called.

touches: a set of one element:

T2: <UITouch: 0x14a0f0> phase: Moved

event: <UIEvent: 0x143ae0>. The allTouches set:

T1: <UITouch: 0x14a360> phase: Stationary
T2: <UITouch: 0x14a0f0> phase: Moved

5. Finger F3 touched the screen, Finger F2 moved.

touchesBegan:withEvent : is called.

touches: a set of one element:

T3: <UITouch: 0x145a10> phase: Began

event: <UIEvent: 0x143ae0>. The allTouches set:

T1: <UITouch: 0x14a360> phase: Stationary
T2: <UITouch: 0x14a0f0> phase: Moved
T3: <UITouch: 0x145a10> phase: Began

touchesMoved:withEvent : is called.

touches: a set of one element:

T2: <UITouch: 0x14a0f0> phase: Moved

event: <UIEvent: 0x143ae0>. The allTouches set:

T1: <UITouch: 0x14a360> phase: Stationary
T2: <UITouch: 0x14a0f0> phase: Moved
T3: <UITouch: 0x145a10> phase: Began

6. Fingers F2 and F3 moved.

touchesMoved:withEvent : is called.

touches: a set of two elements:

T2: <UITouch: 0x14a0f0> phase: Moved

T3: <UITouch: 0x145a10> phase: Moved

event: <UIEvent: 0x143ae0>. The allTouches set:

T1: <UITouch: 0x14a360> phase: Stationary
T2: <UITouch: 0x14a0f0> phase: Moved
T3: <UITouch: 0x145a10> phase: Moved

7. Finger F2 moved, Finger F3 lifted.

touchesMoved:withEvent : is called.

touches: a set of one element:

T2: <UITouch: 0x14a0f0> phase: Moved

```
event: <UIEvent: 0x143ae0>. The allTouches set:  
T1: <UITouch: 0x14a360> phase: Stationary  
T2: <UITouch: 0x14a0f0> phase: Moved  
T3: <UITouch: 0x145a10> phase: Ended
```

touchesEnded:withEvent : is called.
touches: a set of one element:

```
T3: <UITouch: 0x145a10> phase: Ended
```

```
event: <UIEvent: 0x143ae0>. The allTouches set:  
T1: <UITouch: 0x14a360> phase: Stationary  
T2: <UITouch: 0x14a0f0> phase: Moved  
T3: <UITouch: 0x145a10> phase: Ended
```

8. Finger F2 moved.

touchesMoved:withEvent : is called.
touches: a set of one element:

```
T2: <UITouch: 0x14a0f0> phase: Moved
```

```
event: <UIEvent: 0x143ae0>. The allTouches set:  
T1: <UITouch: 0x14a360> phase: Stationary  
T2: <UITouch: 0x14a0f0> phase: Moved
```

9. Finger F2 moved, Finger F1 lifted.

touchesMoved:withEvent : is called.
touches: a set of one element:

```
T2: <UITouch: 0x14a0f0> phase: Moved
```

```
event: <UIEvent: 0x143ae0>. The allTouches set:  
T1: <UITouch: 0x14a360> phase: Ended  
T2: <UITouch: 0x14a0f0> phase: Moved
```

touchesEnded:withEvent : is called.
touches: a set of one element:

```
T1: <UITouch: 0x14a360> phase: Ended
```

```
event: <UIEvent: 0x143ae0>. The allTouches set:  
T1: <UITouch: 0x14a360> phase: Ended  
T2: <UITouch: 0x14a0f0> phase: Moved
```

10. Finger F2 moved.

touchesMoved:withEvent : is called.
touches: a set of one element:

```

T2:      <UITouch: 0x14a0f0> phase: Moved
event: <UIEvent: 0x143ae0>. The allTouches set:
T2:      <UITouch: 0x14a0f0> phase: Moved

```

11. Finger F2 lifted.

`touchesEnded:withEvent:` is called.
`touches`: a set of one element:

```

T2:      <UITouch: 0x14a0f0> phase: Ended
event: <UIEvent: 0x143ae0>. The allTouches set:
T2:      <UITouch: 0x14a0f0> phase: Ended

```

Listing 5.1 shows a `UIView` subclass that overrides three responder methods and logs the touches and events for all three phases. Use this in an application to test your understanding of the multitouch interface.

Listing 5.1 A `UIView` subclass that overrides three responder methods and logs the touches and events for all three phases.

```

@interface ViewOne : UIView {}
@end

@implementation ViewOne

- (void)touchesBegan:(NSSet *)touches withEvent:(UIEvent *)event{
    for(UITouch *t in touches)
        NSLog(@"B: touch: %@", t);
    NSLog(@"B: event: %@", event);
}

- (void)touchesMoved:(NSSet *)touches withEvent:(UIEvent *)event{
    for(UITouch *t in touches)
        NSLog(@"M: touch: %@", t);
    NSLog(@"M: event: %@", event);
}

- (void)touchesEnded:(NSSet *)touches withEvent:(UIEvent *)event{
    for(UITouch *t in touches)
        NSLog(@"E: touch: %@", t);
    NSLog(@"E: event: %@", event);
}
@end

```

The complete application can be found in the `TheView1` project in the source downloads.

5.3.4 Handling a swipe

In this section, we demonstrate how you can intercept the phases of the user's touches in order to recognize a swipe gesture. The application that we are about to build will recognize a right/left swipe and present its speed (in points per second) in a view.

Listing 5.2 shows the declaration of the application delegate class. The `SwipeAppDelegate` application delegate uses the `SwipeDemoView` view as the main view for the application.

Listing 5.2 The declaration of the application delegate class `SwipeAppDelegate`.

```
#import <UIKit/UIKit.h>
#import "SwipeDemoView.h"

@interface SwipeAppDelegate : NSObject <UIApplicationDelegate> {
    UIWindow             *window;
    SwipeDemoView        *viewOne;
}
@property (nonatomic, retain) UIWindow *window;
@end
```

Listing 5.3 shows the implementation of the application delegate class. The `applicationDidFinishLaunching:` method creates an instance of the `SwipeDemoView` view class and enables it for multitouch by setting its `multipleTouchEnabled` property to YES. If you do not do that, the touches set in the four responder methods will always have a size of 1.

Listing 5.3 The implementation of the application delegate class `SwipeAppDelegate`.

```
#import "SwipeAppDelegate.h"

@implementation SwipeAppDelegate
@synthesize window;

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]];
    CGRect frame = [UIScreen mainScreen].applicationFrame;
    viewOne = [[SwipeDemoView alloc] initWithFrame:frame];
    viewOne.multipleTouchEnabled = YES;
    viewOne.backgroundColor = [UIColor whiteColor];
    [window addSubview:viewOne];
    [window makeKeyAndVisible];
}

- (void)dealloc {
    [viewOne release];
    [window release];
    [super dealloc];
}
@end
```

The view will keep track of the two touches' time and location. In addition, it uses a state variable to help in recognizing a swipe. If the view is in state S0, that means we haven't received any touch. If, however, it is in state S1, then that means that we have received exactly one touch and we are waiting for it to be lifted. Listing 5.4 shows the declaration of the `SwipeDemoView` view class. Notice that we have two instance variables for the location and two instance variables for the time. The time is specified in `NSTimeInterval` (`double`) which is measured in seconds.

Listing 5.4 The declaration of the `SwipeDemoView` view class.

```
#import <UIKit/UIKit.h>
typedef enum {
    S0,
    S1
} STATE;

@interface SwipeDemoView : UIView {
    CGPoint startLocation, endLocation;
    NSTimeInterval startTime, endTime;
    STATE state;
}
@end
```

Let's start analyzing the logic behind the recognition of a swipe gesture and displaying its speed. Listing 5.5 shows the `touchesBegan:withEvent :` method of the `UIResponder` class overridden by the `SwipeDemoView` class. What we would like to do in this method is to first make sure that we haven't received any touches before (i.e., we are in state S0). In addition, we would like to make sure that the number of touches in the `event` object and the number of elements in the `touches` object is the same and is equal to 1. After making sure that this condition holds, we record the start time and start location of the touch, and enter state S1.

Listing 5.5 The `touchesBegan:withEvent :` method used in the Swipe Determination application.

```
- (void)touchesBegan:(NSSet *)touches withEvent:(UIEvent *)event{
    int noTouchesInEvent = ((NSSet*)[event allTouches]).count;
    int noTouchesBegan = touches.count;
    NSLog(@"began %i, total %i", noTouchesBegan, noTouchesInEvent);
    if((state == S0) && (noTouchesBegan== 1) && (noTouchesInEvent==1)){
        startLocation = [(UITouch*)[touches anyObject] locationInView:self];
        startTime = [(UITouch*)[touches anyObject] timestamp];
        state = S1;
    }
    else{
        state = S0;
        [self setNeedsDisplay];
    }
}
```

Listing 5.6 shows the `touchesEnded:withEvent:` method. In this method, we make sure that we are in state `s1` (i.e., we started with one touch and it is being lifted). We also make sure that the touch is the last one leaving the screen. We achieve that by ensuring that the number of touches in the event is equal to that in `touches` and is equal to 1. Once we have these conditions met, we record the location and time of the touch, and display the result to the user.

Listing 5.6 The touchesEnded:withEvent: method used in the Swipe Determination application.

```
- (void)touchesEnded:(NSSet *)touches withEvent:(UIEvent *)event{
    int noTouchesInEvent = ((NSSet*)[event allTouches]).count;
    int noTouchesEnded = touches.count;
    NSLog(@"ended %i %i", touches.count, ((NSSet*)[event allTouches]).count);
    if( (state==S1) && (noTouchesEnded == 1) && (noTouchesInEvent==1)) {
        endLocation = [(UITouch*)[touches anyObject] locationInView:self];
        endTime      = [(UITouch*)[touches anyObject] timestamp];
        [self setNeedsDisplay];
    }
}
```

Listing 5.7 shows the remainder of the SwipeDemoView class definition.

Listing 5.7 The remainder of the SwipeDemoView class definition.

The `drawRect` : method presents to the user information about the swipe. If the state is `S0`, we clear the statistics from the previous swipe. If the state is `S1`, we check to see if the gesture was a swipe. The following statement checks to see whether: (1) the absolute difference in the y-coordinates of the beginning and ending touch is below or equal to the value `Y_TOLERANCE`, and (2) the absolute difference in the x-coordinates of the beginning and ending touch is above or equal to the value `X_TOLERANCE`.

```
if( (fabs(startLocation.y - endLocation.y) <= Y_TOLERANCE) &&  
    (fabs(startLocation.x - endLocation.x) >= X_TOLERANCE))
```

The tolerance values are defined as follows:

```
#define Y_TOLERANCE 20  
#define X_TOLERANCE 100
```

You can specify the values that best fit your application.

Once we have determined that it is a swipe, we determine the direction of the swipe using the following statement:

```
direction = (endLocation.x > startLocation.x) ? "right" : "left";
```

Finally, we determine the speed of the swipe using the following statement:

```
fabs(endLocation.x - startLocation.x) / (endTime-startTime)
```

The result is displayed to the user as shown in Figure 5.5.

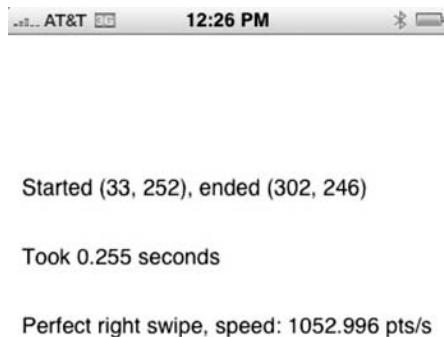


Figure 5.5 A screenshot of the Swipe Determination application showing a perfect right swipe.

It is worth noting that this gesture-recognition algorithm does not take into account the intermediate movements of the touch. For that, you need to override the `touchesMoved:withEvent:` method and make sure that the `Y_TOLERANCE` value is not violated.

The complete application can be found in the `Swipe` project in the source downloads.

5.3.5 More advanced gesture recognition

In this section, we provide yet another application that deals with multitouch gestures. This application recognizes the following gesture: two fingers touch the screen together or at most within 2 seconds. The fingers move either together or separately. At the end, the two fingers are lifted from the screen together at the same time. The application will display the following statistics: (1) what is the percentage of the time that the two fingers moved together, and (2) the average distance (in points) between the two fingers.

The application delegate is identical to the one you saw in the previous section. The only difference is the custom view class `ResponderDemoView`. Listing 5.8 shows the declaration of the view class. We define three states: (1) `s0`, the initial state, (2) `s1`, the state where we have received two touches within a reasonable time, and statistics can be collected, and (3) `s2`, where we have received only one touch and we are waiting for the second. We keep track of the current state in the instance variable `state`. The variables `movedTogether` and `movedSeparate` record the number of movements of the two fingers together and separately, respectively. The total distance between the

two fingers is accumulated in the `accDistance` variable. In addition, the first touch's information (in the case of a delayed second touch) is cached in the two variables `firstTouchLocInView` and `firstTouchTimeStamp`.

Listing 5.8 The declaration of the view class `ResponderDemoView`.

```
#import <UIKit/UIKit.h>

typedef enum {
    S0,
    S1,
    S2
} STATE;

@interface ResponderDemoView : UIView {
    STATE state;
    float movedTogether, movedSeparate;
    float accDistance;
    CGPoint firstTouchLocInView;
    NSTimeInterval firstTouchTimeStamp;
}
@end
```

Listing 5.9 shows the `touchesBegan:withEvent:` method for the advanced gesture tracking application.

Listing 5.9 The `touchesBegan:withEvent:` method for the advanced gesture tracking application.

```
- (void)touchesBegan:(NSSet *)touches withEvent:(UIEvent *)event{
    int noTouchesInEvent = ((NSSet*)[event allTouches]).count;
    int noTouchesBegan = touches.count;
    NSLog(@"began %i, total %i", noTouchesBegan, noTouchesInEvent);
    if((noTouchesBegan== 2) && (noTouchesInEvent==2)){
        NSArray *touchArray = [touches allObjects];
        state = S1;
        movedTogether = 1;
        movedSeparate = 0;
        accDistance =
            distance([touchArray objectAtIndex:0] locationInView:self],
                     [touchArray objectAtIndex:1] locationInView:self]);
    }
    else if((state!= S2)&& (noTouchesBegan== 1)&&(noTouchesInEvent==1)){
        state = S2; // S2 means we got the first touch
        UITouch *aTouch = (UITouch*)[touches anyObject];
        firstTouchTimeStamp = aTouch.timestamp;
        firstTouchLocInView = [aTouch locationInView:self];
    }
    else if((state == S2) && (noTouchesInEvent==2) ){
        UITouch *aTouch = (UITouch*)[touches anyObject];
```

```
if((aTouch.timestamp - firstTouchTimeStamp) <= MAX_ELAPSED_TIME) {
    // S1 means we got the second touch within reasonable time
    state = S1;
    movedTogether = 1;
    movedSeparate = 0;
    accDistance = distance([aTouch      locationInView:self],
                           firstTouchLocInView);
}
else {
    firstTouchTimeStamp = aTouch.timestamp;
    firstTouchLocInView = [aTouch locationInView:self];
}
else state = S0;
}
```

There are three major sections of this method. The first is checking to see if two simultaneous fingers have touched the screen. If that is the case, the method changes the state to `S1` and initializes the variables for collecting the statistics. The initial distance is also calculated and used to initialize the accumulated distance variable. The distance, in points, is calculated using the `distance()` function shown below.

```
float distance(CGPoint a, CGPoint b){
    return sqrt( pow((a.x - b.x), 2) + pow((a.y - b.y), 2));
}
```

If the user did not use two fingers together at the same time, we check to see if this is a single touch and it is the first touch that is received. If that is the case, we enter state `S2` (meaning that we have one touch and we are waiting for the second) and cache in the vital information about the touch.

If, on the other hand, we are in state `S2` and the `event` object has two touches, we check to see if the second touch is received within an acceptable time. The following statement checks to see if the difference in arrival time of the two touches is below a threshold:

```
if((aTouch.timestamp - firstTouchTimeStamp) <= MAX_ELAPSED_TIME)
```

If that is the case, we enter state `S1`; otherwise, the touch is considered the first touch and we wait for the next. The value for `MAX_ELAPSED_TIME` is defined to be equal to 2 seconds.

```
#define MAX_ELAPSED_TIME 2
```

Listing 5.10 shows the `touchesMoved:withEvent:` method. If the number of touches is two and we are in the state `S1` (collecting statistics), we increment the `movedTogether` counter and update the distance in `accDistance`. If, on the other hand, we receive just one movement, we increment the `movedSeparate` counter.

Listing 5.10 The touchesMoved:withEvent: method for the advanced gesture tracking application.

```
- (void)touchesMoved:(NSSet *)touches withEvent:(UIEvent *)event{
    NSLog(@"%@", touches.count,
           ((NSSet*)[event allTouches]).count);
    NSArray *allTouches = [touches allObjects];
    if((state == S1) && ([touches count] == 2) ){
        movedTogether++;
        accDistance +=
            distance([[allTouches objectAtIndex:0] locationInView:self],
                     [[allTouches objectAtIndex:1] locationInView:self]);
    }
    else if((state == S1) && ([touches count] == 1) ){
        movedSeperate++;
    }
}
```

Listing 5.11 shows the touchesEnded:withEvent: method. The method makes sure that the two fingers have been lifted at the same time and requests the display of the statistics by sending the view instance a `setNeedsDisplay` message. This will eventually trigger the invocation of the `drawRect:` method in Listing 5.13.

Listing 5.11 The touchesEnded:withEvent: method for the Advanced Gesture Tracking application.

```
- (void)touchesEnded:(NSSet *)touches withEvent:(UIEvent *)event{
    NSLog(@"%@", touches.count, ((NSSet*)[event allTouches]).count);
    if((state == S1) && ([touches count] == 2) ){
        NSLog(@"started together and ended together,"
              "moved together %.0f% "
              "of the time. AVG distance:%4.2f",
              (movedSeperate+movedTogether) ?
              100*(movedTogether/(movedTogether+movedSeperate)) : 100.0,
              movedTogether ? accDistance/movedTogether : 0.0);
        [self setNeedsDisplay];
    }
    state = S0;
}
```

If the system is canceling the event, we reset the variables as shown in Listing 5.12.

Listing 5.12 The overridden method touchesCancelled:withEvent: for the Advanced Gesture Tracking application.

```
- (void)touchesCancelled:(NSSet *)touches withEvent:(UIEvent *)event{
    state = S0;
    movedTogether = movedSeperate = 0;
    accDistance =0;
}
```

Listing 5.13 shows the remainder of the definition of the view class. The `initWithFrame:` initializer sets the statistics and state variables to their initial values. The `drawRect:` method, invoked when the view receives a `setNeedsDisplay` message, displays the percentage of the time that the two touches moved together and the average distance between them when they did move together.

Listing 5.13 The remainder of the implementation of the view class used in the Advanced Gesture Tracking application.

```
- (id) initWithFrame:(CGRect)frame {
    if (self = [super initWithFrame:frame]) {
        state = S0;
        movedTogether = movedSeparate = 0;
        accDistance = 0;
    }
    return self;
}

- (void) drawRect:(CGRect)rect {
    NSString *message =
    [NSString stringWithFormat:@"Moved together %.0f%% of the time.",
     (movedSeparate+movedTogether) ?
     100*(movedTogether/(movedTogether+movedSeparate)) : 100.0];
    [message drawAtPoint:CGPointMake(10,100)
        withFont:[UIFont systemFontOfSize:16]];
    message =
    [NSString stringWithFormat:@"Average distance:%4.2f.",
     movedTogether ? accDistance/movedTogether : 0.0];
    [message drawAtPoint:CGPointMake(10,150)
        withFont:[UIFont systemFontOfSize:16]];
}
```

Figure 5.6 shows a screenshot of the application.

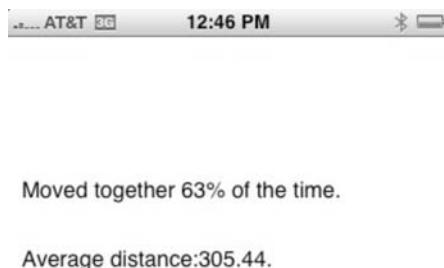


Figure 5.6 A screenshot of the Advanced Gesture Tracking application.

The complete application can be found in the ResponderDemo project in the source downloads.

5.4 Animation

Animation is a major feature of the iPhone OS. In this section, we discuss basic examples that achieve animation. These examples do not require knowledge of image processing. We first start by discussing how you can use the `UIView` class to animate properties of views. Next, we show how to animate a sliding view. After that, we discuss how you can animate the flipping of a view. Finally, we give an example that performs view transitioning.

5.4.1 Using the `UIView` class animation support

The geometric properties of a view can actually be animated with ease. The `UIView` class provides several class methods that can be used to perform simple animations such as moving a view instance to a new position or enlarging it.

To animate views' properties, you must do that between two `UIView` class calls: `beginAnimations:context:` and `commitAnimations`. Inside this animation block, you specify the characteristics of the animation (e.g., its length, timing function, etc.) and change the view's properties (e.g., its `center`) to the final value. When you commit the animation, the view's properties are animated to the new values.

Let's start by building an application that enables the user to move a view around the screen by double-tapping on the new position. The move of the view is animated by changing its `center`. We will create a new subclass of `UIView` named `AnimView`. `AnimView` adds as a subview another child view and waits for the user's tapping. When the user double-taps a location in an `AnimView` instance, the child view's `center` property is animated and changed to the location where the user double-tapped.

Listing 5.14 shows the application delegate class for the application. The `applicationDidFinishLaunching:` method creates a main window and adds to it an instance of the `AnimView` class. The `AnimView` instance occupies the full screen that is available to the user and has a gray background color.

Listing 5.14 The application delegate class for animating a view's `center` property.

```
#import <UIKit/UIKit.h>
#import "AnimView.h"

@interface AnimationApp1AppDelegate : NSObject <UIApplicationDelegate> {
    UIWindow *window;
}
@end

@implementation AnimationApp1AppDelegate
```

```
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window = [[UIWindow alloc]
              initWithFrame:[[UIScreen mainScreen] bounds]];
    CGRect frame = [UIScreen mainScreen].applicationFrame;
    AnimView *view = [[AnimView alloc] initWithFrame:frame];
    view.backgroundColor = [UIColor grayColor];
    [window addSubview:view];
    [view release];
    [window makeKeyAndVisible];
}

- (void)dealloc {
    [window release];
    [super dealloc];
}
@end
```

Listing 5.15 shows the AnimView class.

Listing 5.15 The AnimView class used in animating the center property of a child view.

```
#import <UIKit/UIKit.h>
#import <QuartzCore/QuartzCore.h>

@interface AnimView : UIView {
    UIView *childView;
}
@end

@implementation AnimView

- (id)initWithFrame:(CGRect)frame {
    if ([self initWithFrame:frame]) {
        childView = [[UIView alloc]
                    initWithFrame:CGRectMake(100, 150, 100, 150)];
        childView.backgroundColor = [UIColor whiteColor];
        [self addSubview:childView];
    }
    return self;
}

- (void)touchesEnded:(NSSet *)touches withEvent:(UIEvent *)event{
    if( [(UITouch*)[touches anyObject] tapCount] == 2){
        UITouch *touch = [touches anyObject];
        [UIView beginAnimations:nil context:NULL];
        [UIView setAnimationCurve:UIViewAnimationCurveEaseOut];
        [UIView setAnimationDuration:1];
        childView.center = [touch locationInView:self];
    }
}
```

```

        [UIView commitAnimations];
    }
}

- (void)dealloc {
    [childView release];
    [super dealloc];
}
@end

```

The class maintains a reference to a child view in the instance variable `childView`. The `initWithFrame:` initializer creates the child view instance, configures it with a white background color, and adds it as a subview.

The logic behind moving the child view to a new location is found in the `touchesEnded:withEvent:` method. The method first checks that we have a double-tap from the user. If that is the case, it starts the animation block by the following statement:

```
[UIView beginAnimations:nil context:NULL];
```

The class method is declared as follows:

```
+ (void)beginAnimations:(NSString *)animationID context:(void *)context
```

The two parameters of this method can be `NULL`. The `animationID` and `context` can be used to communicate with animation delegates. Our example does not use an animation delegate, so we pass `NULL` values.

After starting the animation block, the method sets the optional animation curve. The following statement overrides the default animation curve and sets it to `UIViewControllerAnimatedEaseOut`:

```
[UIView setAnimationCurve:UIViewControllerAnimatedEaseOut];
```

The `setAnimationCurve:` method is declared as follows:

```
+ (void)setAnimationCurve:(UIViewControllerAnimatedCurve)curve
```

The following are some of the curves available:

- `UIViewControllerAnimatedEaseInOut`. This curve specifies that the animation should be slow at the beginning and at the end. This curve is the default.
- `UIViewControllerAnimatedEaseIn`. This curve specifies that the animation should be slow at the beginning only.
- `UIViewControllerAnimatedEaseOut`. This curve specifies that the animation should be slow at the end only.
- `UIViewControllerAnimatedLinear`. This curve specifies that the animation should be constant throughout.

The duration of the animation is set using the method `setAnimationDuration:` which is declared as follows:

```
+ (void) setAnimationDuration: (NSTimeInterval) duration
```

The duration parameter is specified in seconds. The default is 0.2 seconds.

After the animation is set up, the method changes the properties of the views, which in our case is one property (`center`) and one view (`childView`), and commits the animation. The `center` property is changed in the following statement:

```
childView.center = [touch locationInView:self]
```

Using an animation delegate

Sometimes you want to receive a message when the animation ends. You can set a delegate to the animation using the method `setAnimationDelegate::`. Calls are made to two methods in this delegate: `animationDidStart:` and `animationDidStop:finished::`. These methods are defined by the category `CAAnimationDelegate` on `NSObject` in `CAAnimation.h`.

Let's update our animation application to change the color of the child view and animate its size. When the animation is finished, we revert back to the original size and color. The following is the updated `touchesEnded:withEvent::`.

```
- (void) touchesEnded: (NSSet *) touches withEvent: (UIEvent *) event{
    if( [(UITouch*) [touches anyObject] tapCount] == 2){
        childView.backgroundColor = [UIColor blueColor];
        [UIView beginAnimations:nil context:NULL];
        [UIView setAnimationCurve:UIViewAnimationCurveEaseOut];
        [UIView setAnimationDuration:0.5];
        [UIView setAnimationDelegate:self];
        childView.transform = CGAffineTransformMakeScale(1.5, 1.5);
        [UIView commitAnimations];
    }
}
```

In the code fragment above, on a double-tap, we change the color of the child view outside the animation block. This will result in an instantaneous color change rather than an animated change if it had been done inside the animation block. After that, the animation block is started, and the curve, duration, and delegate are set. To change the scale of the child view by increasing it by 50%, the method updates the `transform` property of the view. The property is declared as follows:

```
@property(nonatomic) CGAffineTransform transform
```

The `transform` is done using a 3×3 matrix that is used to rotate, scale, or translate the view. `CGAffineTransform` stores the first two columns of this matrix. The third column is always $[0, 0, 1]$. To scale the child view up by 50%, we use the following statement:

```
childView.transform = CGAffineTransformMakeScale(1.5, 1.5)
```

In the above statement, we obtain an affine transform for scaling 50% using the `CGAffineTransformMakeScale()` function, and set the value to the `transform` property.

After the animation ends, and the child view is enlarged 50%, a call is made to the method `animationDidStop:finished:` defined in the `AnimView` class as follows:

```
- (void)animationDidStop:(CAAnimation *)theAnimation finished:(BOOL)flag{
    childView.transform = CGAffineTransformIdentity;
    childView.backgroundColor = [UIColor whiteColor];
}
```

The method above changes the child view's background color to white and transforms (instantaneously) the dimensions to no scaling.

The complete application can be found in the `AnimationApp1` project in the source downloads.

5.4.2 Sliding view

Writing a sliding view is a simple task using the basic `UIView` animation functionality. The project `SlidingUpDownView`, available from the source downloads, shows a complete application demonstrating this idea.

Initially, you set the frame of the view that you want to slide down to something like the following:

```
self.slidingView =
[[[MyView alloc]
    initWithFrame:CGRectMake(0, -SLIDING_VIEW_HEIGHT, 320,
                           SLIDING_VIEW_HEIGHT)] autorelease];
```

In essence, the view is outside its parent's bounds, making it hidden from the user.

To bring the view by animating it sliding down, you change the frame (inside an animation block) to have a y-origin equal to 0. To slide it up, set the y-origin to a negative value of its height. The following shows a method that does just that. Refer to the project for further information.

```
- (void)slideView:(Direction)_direction{
    [UIView beginAnimations:nil context:nil];
    [UIView setAnimationDuration:0.75f];
    slidingView.frame =
    CGRectMake(0, _direction==DOWN?0:-SLIDING_VIEW_HEIGHT,
              320, SLIDING_VIEW_HEIGHT);
    [UIView commitAnimations];
}
```

5.4.3 Flip animation

Sometimes, you want the same view to flip from right to left or from left to right. This can be easily achieved using basic animation. The following method flips a view to the right. It sets the animation transition to flip from right for a given view. Caching is set to YES to improve performance; otherwise, a NO will result in the view being rendered for each frame – animation frame, that is.

```
- (void)right{
    [UIView beginAnimations:nil context:nil];
    [UIView setAnimationDuration:1.0];
    [UIView setAnimationTransition:UIViewAnimationTransitionFlipFromRight
        forView:self.view cache:YES];
    [UIView commitAnimations];
}
```

To flip to the left, use `UIViewAnimationTransitionFlipFromLeft` instead. Consult the `Flip-Animation` project, available from the source downloads, for a complete application demonstrating this feature.

5.4.4 Transition animation

The `UIView` class is actually a wrapper class that takes its event-handling capabilities from the `UIResponder` class, through the inheritance chain, and its animation capabilities from its unique `CALayer` instance variable. `layer`, an instance of `CALayer`, is the Core Animation object that encapsulates information about the animation that should be rendered to the display.

When you make changes to a `UIView` instance by, for example, adding and removing subviews, the changes happen instantaneously. To animate these changes, you create an animation object, configure it, and add it to the `layer` property. In this section, we show how you can animate the substitution of one view with another through transition animation. The application demonstrating this will create two subviews of the main window and add one of them to the window. When the user double-taps on the active view, the application will replace the view with the other inactive view and animate the change by moving the new view from right to left.

The animation is performed in the application delegate class. Listing 5.16 shows the declaration of the application delegate class. The class maintains two references to `AnimView` instances representing the two views. The `showOtherView:` method is used to animate the replacement of one view with the other.

Listing 5.16 The declaration of the application delegate class used in animating the transition of views.

```
#import <UIKit/UIKit.h>
@class AnimView;
@interface AnimationApp2AppDelegate : NSObject <UIApplicationDelegate> {
    UIWindow    *window;
    AnimView    *view1, *view2;
```

```

}
- (void)showOtherView:(UIView*) oldView;
@end

```

Listing 5.17 shows the implementation of the application delegate class. The `applicationDidFinishLaunching:` method creates the main window as well as two subviews. It adds one view to the window and makes the window key and visible.

Listing 5.17 The implementation of the application delegate class used in animating the transition of views.

```

#import <QuartzCore/QuartzCore.h>
#import "AnimationApp2AppDelegate.h"
#import "AnimView.h"

@implementation AnimationApp2AppDelegate
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window = [[UIWindow alloc]
              initWithFrame:[UIScreen mainScreen] bounds]];
    CGRect frame = [UIScreen mainScreen].applicationFrame;
    view1 = [[AnimView alloc] initWithFrame:frame];
    view1.message = @"View 1";
    view1.backgroundColor =[UIColor whiteColor];
    [window addSubview:view1];
    view2 = [[AnimView alloc] initWithFrame:frame];
    view2.message = @"View 2";
    view2.backgroundColor =[UIColor yellowColor];
    [window makeKeyAndVisible];
}
- (void)showOtherView:(UIView*) oldView{
    if(oldView == view1){
        [view1 removeFromSuperview];
        [window addSubview:view2];
    }
    else{
        [view2 removeFromSuperview];
        [window addSubview:view1];
    }
    CATransition *animation = [CATransition animation];
    [animation setType:kCATransitionMoveIn];
    [animation setSubtype:kCATransitionFromRight];
    [animation setDuration:0.5];
    [animation setTimingFunction:[CAMediaTimingFunction
                               functionWithName:kCAMediaTimingFunctionEaseInEaseOut]];
    [[window layer] addAnimation:animation forKey:@"mykey"];
}
- (void)dealloc {
    [view1 release];
    [view2 release];
}

```

```
[window release];
[super dealloc];
}
@end
```

When the current view asks the application delegate to switch to the other view, the `showOtherView:` is called with the reference to the active subview. The current view is removed from the window and the other view is added. To animate this change, we create an animation object and add it to the window's layer property.

Animation objects are instances of the class `CAAnimation`. The `CATransition` is a subclass of `CAAnimation` that makes it easy to animate transitions. We first obtain a new animation object by using the class method `animation`. Next, the type, duration, and timing of the animation are configured. The type of animation is move in from the right, and the duration chosen is 0.5 seconds. Also, an ease-in-ease-out timing function is used. To add the animation, we use the method `addAnimation:forKey:` which is declared as follows:

```
- (void)addAnimation:(CAAnimation *)anim forKey:(NSString *)key
```

The `anim` parameter is an instance of `CAAnimation` that represents the animation, and the key (can be `nil`) is to distinguish different animations on a given layer. Since the `anim` parameter is copied by the method, you need to invoke this method after you have configured the animation object.

Listing 5.18 shows the `AnimView` class. The class maintains a message instance variable whose content is drawn to the screen. This will serve as a distinguishing mark between the two transitioning views.

Listing 5.18 The `AnimView` class used in the transition views application.

```
#import <UIKit/UIKit.h>
#import <QuartzCore/QuartzCore.h>

@interface AnimView : UIView {
    NSString *message;
}

@property(nonatomic, copy) NSString *message;
@end

@implementation AnimView
@synthesize message;

- (void)touchesEnded:(NSSet *)touches withEvent:(UIEvent *)event{
    if( [(UITouch *)[touches anyObject] tapCount] == 2){
        [[UIApplication sharedApplication].delegate showOtherView:self];
    }
}

- (void)drawRect:(CGRect)rect{
```

```
[message drawAtPoint:CGPointMake(100,100)
           withFont:[UIFont systemFontOfSize:32]] ;
}
@end
```

The complete application can be found in the `AnimationApp2` project in the source downloads.

5.5 Drawing

The `drawRect:` method is an ideal place for drawing in a view. The view will set up the environment for you, making it easy to draw. You use Quartz 2D functions for drawing both simple and complex shapes. These functions require a graphics context as the first parameter. You can obtain a graphics context using the function `UIGraphicsGetCurrentContext()`.

Once you have a graphics context, you can use it to draw paths. A path is a collection of one or more shapes. Once you construct the path, you can stroke it, fill it, or both.

Listing 5.19 shows a `drawRect:` that draws several shapes. The result of this drawing is shown in Figure 5.7. After obtaining the graphics context, we set the line width of the path to 5 units (the default is 1). Then we signal a new path location using the function `CGContextMoveToPoint()`. The function `CGContextAddLineToPoint()` is used to add a line to the path starting from (50, 100) and ending at (200, 100). At this stage, we have only one shape (a straight line) in this path. To draw it, we use the `CGContextStrokePath()` function. This function will draw the path and clear the current path.

Listing 5.19 A `drawRect:` that draws several shapes.

```
- (void)drawRect:(CGRect)rect {
    CGContextRef context = UIGraphicsGetCurrentContext();
    CGContextSetLineWidth(context, 5.0);
    CGContextMoveToPoint(context, 50, 100);
    CGContextAddLineToPoint(context, 200, 100);
    CGContextStrokePath(context);
    CGContextAddEllipseInRect(context, CGRectMake(70.0, 170.0, 50.0, 50.0));
    CGContextStrokePath(context);
    CGContextAddEllipseInRect(context, CGRectMake(150.0, 170.0, 50.0, 50.0));
    CGContextFillPath(context);
    CGContextSetRGBStrokeColor(context, 0.0, 1.0, 0.0, 1.0);
    CGContextSetRGBFillColor(context, 0.0, 0.0, 1.0, 1.0);
    CGContextAddRect(context, CGRectMake(30.0, 30.0, 60.0, 60.0));
    CGContextFillPath(context);
    CGContextAddArc(context, 260, 90, 40, 0.0*M_PI/180, 270*M_PI/180, 1);
    CGContextAddLineToPoint(context, 280, 350);
    CGContextStrokePath(context);
    CGContextMoveToPoint(context, 130, 300);
    CGContextAddLineToPoint(context, 80, 400);
```

```
CGContextAddLineToPoint(context, 190, 400);
CGContextAddLineToPoint(context, 130, 300);
CGContextStrokePath(context);
}
```

To draw an ellipse, use the function `CGContextAddEllipseInRect()`. When you follow it up with the function call to `CGContextStrokePath()`, the ellipse is drawn. If you want to fill the ellipse, use the function `CGContextFillPath()`.

You can set the stroke color using the function `CGContextSetRGBStrokeColor()`. In this function, you specify the RGB components and the alpha (opacity level). Similarly, the fill color can be set using the function `CGContextSetRGBFillColor()`. Similar to lines and ellipses, you can draw rectangles, curves, arcs, etc.

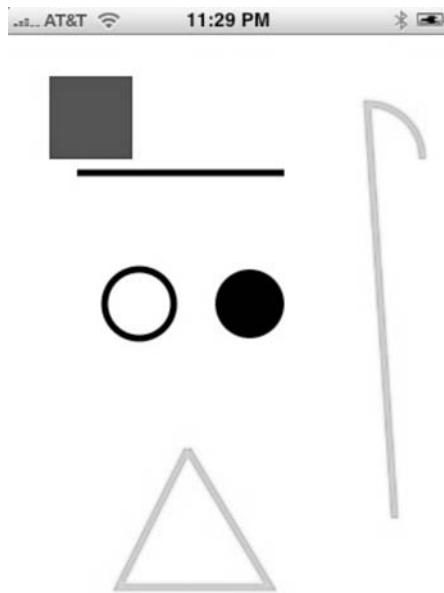


Figure 5.7 Drawing several shapes using Quartz 2D.

The complete application can be found in the `QuartzDemo` project in the source downloads.

5.6 Summary

This chapter explained the main concepts behind views. We covered the topic of view geometry in Section 5.1. In Section 5.2, we addressed the topic of view hierarchy. Next, Section 5.3 discussed, in great detail, the multitouch interface. In that section, you learned how to recognize multitouch gestures. After that, we discussed several animation techniques in Section 5.4. Finally, Section 5.5 dealt with how to use Quartz 2D functions for drawing inside a view.

Problems

- (1) What are the differences between the frame and the bounds of a view?
- (2) Study the `UIView` class by reading the documentation and the `UIView.h` header file.
- (3) Develop a subclass of `UIView` which recognizes a heart shape that is drawn with only two fingers.

6

Controls

Controls are graphical objects used by the user of the application to express their objective. For example, a slider control can be used by the user as a way to fine tune a specific value. A switch control, on the other hand, can be used to turn on/off an option. In this chapter, we present several important graphical controls that can be used in building attractive iPhone applications.

This chapter starts in Section 6.1 by covering the base class of all controls, `UIControl`, and the important *target-action* mechanism. After that, you learn about several important UI components such as text fields (Section 6.2), sliders (Section 6.3), switches (Section 6.4), buttons (Section 6.5), segmented controls (Section 6.6), page controls (Section 6.7), and date pickers (Section 6.8). We summarize the chapter in Section 6.9.

6.1 The Foundation of all Controls

Controls are subclasses of the `UIControl` class. The `UIControl` class's position in the class hierarchy is shown in Figure 6.1. The common behavior of controls is captured by this class. Therefore, understanding this class is essential to using its concrete subclasses such as `UITextField`, `UISlider`, `UIDatePicker`, etc.

6.1.1 *UIControl* attributes

As a superclass of controls, the `UIControl` class has several shared attributes that can be configured using accessor methods. These attributes include:

- `enabled`. This is a Boolean attribute that represents whether the control is enabled or not. The property is defined as:

```
@property(nonatomic, getter=isEnabled) BOOL enabled
```

If the value for `enabled` is `NO`, the user's touch events are ignored.

- `highlighted`. This Boolean value controls whether the control is highlighted or not. By default, the value is `NO`. When the user touches the control, the value of this attribute is `YES`,

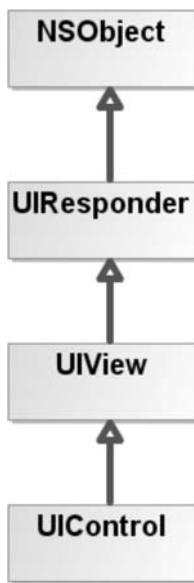


Figure 6.1 UIControl inheritance hierarchy.

and the control is highlighted. When the user's touch leaves the control, the value is NO, and the control is not highlighted. The property declaration of this attribute is:

```
@property(nonatomic, getter=isHighlighted) BOOL highlighted
```

- **selected**. This Boolean attribute indicates whether the control is selected or not. Most subclasses of UIControl do not use this. However, the UISwitch subclass might use it. The declaration of this property is as follows:

```
@property(nonatomic, getter=isSelected) BOOL selected
```

- **state**. This is a read-only attribute of type UIControlState. UIControlState is defined as an unsigned integer (NSUInteger). state is a bit-mask representing more than one state. Examples of defined states are UIControlStateHighlighted, UIControlStateDisabled, and UIControlStateNormal.

The property is defined as follows, but note that this attribute is read-only.

```
@property(nonatomic, readonly) UIControlState state
```

6.1.2 Target-action mechanism

UIControl and its subclasses use the target-action mechanism to inform interested parties when changes to the control object occur. Basically, an object, which is usually a controller, sends a

message to the control informing it that it is interested in monitoring some event related to the control. When such an event occurs, the control will inform the object (e.g., the controller).

An object registering itself using the target-action mechanism is required to include three pieces of information:

1. A pointer to the object (target) that should receive the message (usually itself).
2. The selector (action) representing the action method.
3. The control event it is interested in.

When the control receives the registration message, it stores this information in an internal dispatch table. Note that the same target can register for different events with different selectors. Moreover, different targets can register for the same event.

When the event (such as a change in the value of the control) occurs, the control sends itself the `sendActionsForControlEvents:` message. This method will then consult the internal dispatch table (the same table built incrementally as a result of the registration messages) to find all target-action entries for this event. The control then sends the singleton `UIApplication` instance a `sendAction:to:from:forEvent:` message for each such entry. The `UIApplication` instance is the one responsible for actually sending the action messages to the targets.

An object registers with a control using the following `UIControl` declared instance method:

```
- (void)addTarget:(id)target action:(SEL)action  
forControlEvents:(UIControlEvents)controlEvents
```

The `target` is usually the instance registering for this event (e.g., a controller). The `action` is a selector that identifies the action message of the target (i.e., the method that gets called by the `UIApplication` instance when the event occurs). The selector takes any of the following three forms:

```
- (void)action  
- (void)action:(id)sender  
- (void)action:(id)sender forEvent:(UIEvent *)event
```

The `controlEvents` is a bit-mask specifying the control events that trigger the sending of an action message to the target. There are several of these control events defined in `UIControl.h`. Some examples include:

- `UIControlEventValueChanged`. Used to indicate that the value of the control has changed, for example, the slider moved.
- `UIControlEventEditingDidBegin`. The control (e.g., `UITextField`) started editing.
- `UIControlEventEditingDidEnd`. A touch ending the editing of a field by leaving its bounds.
- `UIControlEventTouchDown`. A single tap touch inside the control's bounds.

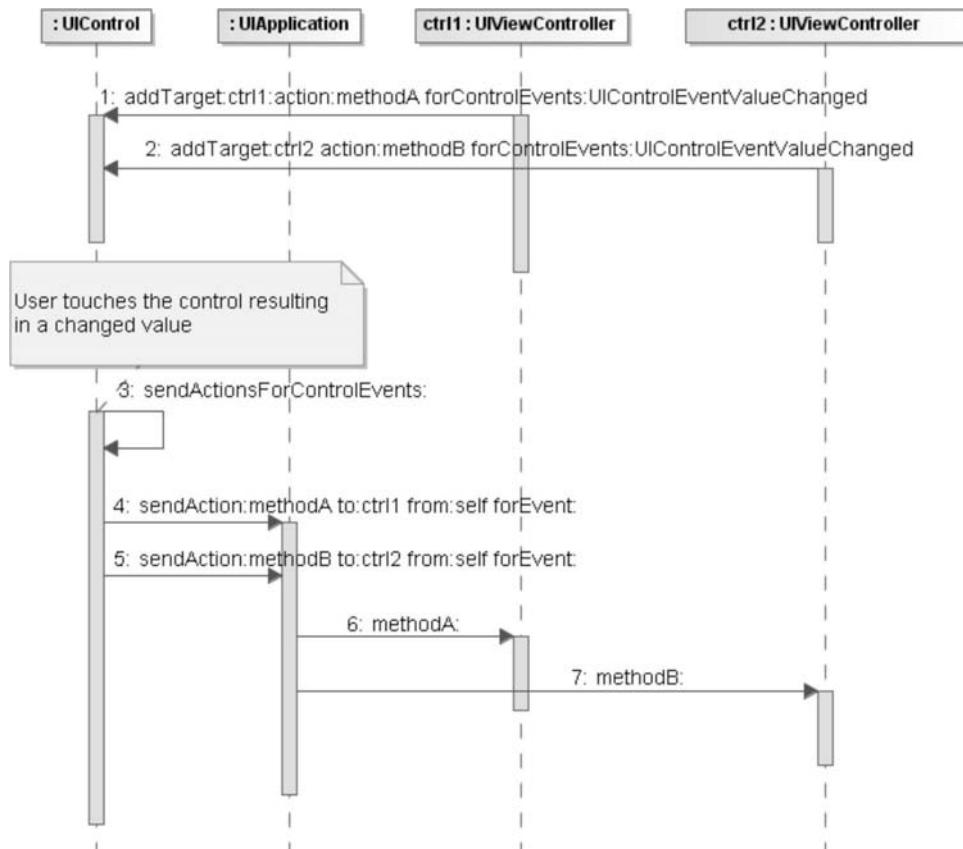


Figure 6.2 Sequence diagram illustrating the target-action mechanism. Two controllers, `ctrl1` and `ctrl2`, add themselves as targets for the control event `UIControlEventValueChanged`.

Figure 6.2 shows a sequence diagram for a target-action scenario. Here, we have two controllers, `ctrl1` and `ctrl2`, interested in the control event `UIControlEventValueChanged`. The diagram shows the role that the `UIApplication` singleton instance plays in delivering the action messages.

There are several other important methods available in the `UIControl` class that are related to the target-action mechanism.

- `removeTarget:action:forControlEvents:`: This method is used to remove a specific target and action entry from the dispatch table for particular control events. The method is declared as:


```
- (void)removeTarget: (id)target action: (SEL)action
forControlEvents: (UIControlEvents)controlEvents
```

- `allTargets`. This method returns all target objects related to a control object. The method is declared as:
 - `(NSSet *)allTargets`
- `allControlEvents`. This method returns all control events related to a control object. The method is declared as:
 - `(UIControlEvents)allControlEvents`
- `actionsForTarget:forControlEvents:`. This method return the actions associated with a specific target and a particular control event.
 - `(NSArray *)actionsForTarget: (id)target
forControlEvents: (UIControlEvents)controlEvent`

The return value is an `NSArray` of `NSString` objects of selector names. If there are no actions associated with the control events, the returned value is `nil`.

Now that we understand the `UIControl` class, let's look at some of its concrete implementations.

6.2 The Text Field

The `UITextField` class (see Figure 6.3) encapsulates a text editing control that allows the user to enter a small amount of information. This control provides an optional clear button on the right for clearing the text. `UITextField` uses the `UITextFieldDelegate` protocol for communicating with the delegate class (usually a controller). The `UITextField` itself adopts the `UITextInputTraits` protocol. This protocol must be implemented by any control which uses the keyboard. You create an instance of `UITextField` and add it to a view as a subview.



`UITextField`

Figure 6.3 A `UITextField` control.

There are several important properties of this control:

- `text`. Using this property, you can obtain and set the text displayed by the control. The property is declared as:

```
@property(nonatomic, copy) NSString *text
```

- `textAlignment`. This property is used to control the technique used to align the text inside the control. The property is declared as:

```
@property(nonatomic) NSTextAlignment textAlignment
```

The `textAlignment` can be set to one of the following values: `UITextAlignmentLeft` (the default), `UITextAlignmentCenter`, and `UITextAlignmentRight`.

- `textColor`. The color of the text inside the control. The property is declared as:

```
@property(nonatomic, retain) UIColor *textColor
```

Having a value of `nil` (the default) results in a text that is an opaque black.

- `background`. An image that represents the background of the control. The property is declared as:

```
@property(nonatomic, retain) UIImage *background
```

The default value is `nil`.

- `clearButtonMode`. This property manages the appearance of the clear button. The property is declared as:

```
@property(nonatomic) UITextFieldViewMode clearButtonMode
```

You can set its value to one of the following: `UITextFieldViewModeNever` (clear button never appears), `UITextFieldViewModeWhileEditing` (appears only when the user is editing text), `UITextFieldViewModeUnlessEditing` (appears only when the user is not editing text), and `UITextFieldViewModeAlways` (always appear).

- `borderStyle`. This property is used to set the border style of the control. It is declared as:

```
@property(nonatomic) UITextBorderStyle borderStyle
```

The value can be one of the following border style values: `UITextBorderStyleNone` (default), `UITextBorderStyleLine`, `UITextBorderStyleBezel`, and `UITextBorderStyleRoundedRect`.

- `delegate`. Use this property to assign the delegate of the control. The property declaration is as follows.

```
@property(nonatomic, assign) id<UITextFieldDelegate> delegate
```

If not `nil`, the control will send special messages to the delegate informing it of important editing changes, for example, the user tapping the return button on the keyboard. We will go over the `UITextFieldDelegate` protocol shortly.

- `disabledBackground`. If the value of this attribute is not `nil`, the `disabledBackground` value will be used as a background for the control when it is disabled. The property is declared as:

```
@property(nonatomic, retain) UIImage *disabledBackground
```

- `editing`. This is a read-only attribute indicating whether the control is in edit mode. The property is declared as:

```
@property(nonatomic, readonly, getter=isEditing) BOOL editing
```

- `font`. The value represents the font of the text. The property declaration is as follows:

```
@property(nonatomic, retain) UIFont *font
```

If this value is `nil` (the default), the font used is 12-point Helvetica plain.

- `placeholder`. The value is used to show in the text control if there is no text in the field. The declaration of the property is as follows:

```
@property(nonatomic, copy) NSString *placeholder
```

The default value is `nil` (i.e., no placeholder string). If not `nil`, the string is drawn in a 70% grey color.

6.2.1 Interacting with the keyboard

We mentioned above that the `UITextField` control conforms to the `UITextInputTraits` protocol. This protocol must be implemented by any control that wishes to interact with the user using the keyboard. The protocol defines several properties:

- `keyboardType`. This property controls the style of the keyboard associated with the text field. The property is declared as:

```
@property(nonatomic) UIKeyboardType keyboardType
```

There are several types of keyboard. Examples include:

- `UIKeyboardTypeDefault`. The default keyboard.
- `UIKeyboardTypeAlphabet`. Represents the standard alphanumeric (Qwerty) keyboard.
- `UIKeyboardTypeNumbersAndPunctuation`. A keyboard with numbers and punctuation.
- `UIKeyboardTypeURL`. A keyboard style that makes it easy to enter a URL.
- `UIKeyboardTypeNumberPad`. A numeric keyboard suitable for PIN entry.
- `UIKeyboardTypePhonePad`. A keyboard designed for entering phone numbers.
- `UIKeyboardTypeNamePhonePad`. A keyboard designed for entering a person's name or phone number.
- `UIKeyboardTypeEmailAddress`. A keyboard style for entering email addresses.

Figures 6.4 and 6.5 show some of the available keyboard styles.



UIKeyboardTypeDefault



UIKeyboardTypePhonePad

Figure 6.4 Two keyboard types: UIKeyboardTypeDefault and UIKeyboardTypePhonePad.

- `secureTextEntry`. This property is used to signal that the text entered should be hidden (e.g., each character replaced by a “*”). The property is declared as:

```
@property(nonatomic, getter=isSecureTextEntry) BOOL secureTextEntry
```

- `returnKeyType`. This property is used to define the title for the return key. The property is declared as:

```
@property(nonatomic) UIReturnKeyType returnKeyType
```

The attribute `returnKeyType` can hold any of the following values:
`UIReturnKeyDefault`, `UIReturnKeyGo`, `UIReturnKeyGoogle`,
`UIReturnKeyJoin`, `UIReturnKeyNext`, `UIReturnKeyRoute`,
`UIReturnKeySearch`, `UIReturnKeySend`, `UIReturnKeyYahoo`,
`UIReturnKeyDone`, and `UIReturnKeyEmergencyCall`.

- `keyboardAppearance`. This attribute is used to distinguish between text entry inside the application and text entry inside an alert panel. The property is declared as:

```
@property(nonatomic) UIKeyboardAppearance keyboardAppearance
```



UI KeyboardTypeEmailAddress



UI KeyboardTypeNumbersAndPunctuation

Figure 6.5 Two keyboard types: `UIKeyboardTypeEmailAddress` and `UIKeyboardTypeNumbersAndPunctuation`.

The value can be either `UIKeyboardAppearanceDefault` (default) or `UIKeyboardAppearanceAlert`.

- `enablesReturnKeyAutomatically`. If the value is YES, the keyboard's return key is disabled until the user enters some text. The default is NO. The property is declared as follows:

```
@property(nonatomic) BOOL enablesReturnKeyAutomatically
```

- `autocorrectionType`. This property is used to manage the auto-correction of the user's input. The property is declared as:

```
@property(nonatomic) UITextAutocorrectionType autocorrectionType
```

The property can take one of the following values:

`UITextAutocorrectionTypeDefault` (chooses the appropriate auto-correction)

`UITextAutocorrectionTypeNo` (no auto-correction)

`UITextAutocorrectionTypeYes` (auto-correction is enabled)

- `autocapitalizationType`. Determines when the shift key is automatically pressed to produce capital letters. The property is declared as:

```
@property(nonatomic) UITextAutocapitalizationType autocapitalizationType
```

The property can take one of the following values:

`UITextAutocapitalizationTypeNone` (do not automatically capitalize)
`UITextAutocapitalizationTypeWords` (capitalize the first character of every word)
`UITextAutocapitalizationTypeSentences` (capitalize the first character of each sentence)
`UITextAutocapitalizationTypeAllCharacters` (capitalize all characters automatically)

6.2.2 *The delegate*

We mentioned above that the control uses a delegate to communicate important editing events. The delegate protocol used is `UITextFieldDelegate`. It declares several optional methods.

- `textFieldShouldReturn:`. This delegate method is declared as follows:

```
- (BOOL)textFieldShouldReturn: (UITextField *)textField
```

It is called when the user presses the return key. Since this is a single-line text field, you can use this event as a signal to end editing of the text field and hiding the keyboard. The appearance of the keyboard and the first-responder status of the text field are linked together. If you want to show the keyboard so that the user starts editing a text field, just send the text field a `becomeFirstResponder` message. If you want to end editing and hide the keyboard, you need to remove the first responder status of the text field which will result in hiding the keyboard. To resign the text field as a first responder, just send it a `resignFirstResponder` message.

- `textFieldShouldClear:`. This method is called when the clear button is pressed. The method is declared as:

```
- (BOOL)textFieldShouldClear: (UITextField *)textField
```

If you return YES, the text field content is cleared; otherwise, it is not.

- `textFieldDidBeginEditing:`. This method is called when the text field begins as the first responder ready for user input. The method is declared as:

```
- (void)textFieldDidBeginEditing: (UITextField *)textField
```

- `textField:shouldChangeCharactersInRange:replacementString:`. This method is called asking the delegate's permission to change the specified text. The method is declared as:

```
- (BOOL)textField: (UITextField *)textField  
    shouldChangeCharactersInRange: (NSRange) range  
    replacementString: (NSString *)string
```

`range` is the range of characters to be replaced, and `string` is the replacement string.

- `textFieldDidEndEditing:`. This method is called after the text field ends editing. The method is declared as:
 - `(void)textFieldDidEndEditing: (UITextField *)textField`
- `textFieldShouldBeginEditing:`. This method is called asking permission from the delegate so that the text field can start editing. The method declaration is as follows:
 - `(BOOL)textFieldShouldBeginEditing: (UITextField *)textField`

Return YES to start editing; NO, otherwise.
- `textFieldDidBeginEditing:`. This method is called when the text field starts editing. The method declaration is as follows:
 - `(void)textFieldDidBeginEditing: (UITextField *)textField`

6.2.3 Creating and working with a UITextField

This section demonstrates how you can create a `UITextField` instance and add it to a view. Listing 6.1 shows how to create a text field instance, configure it, and attach it to the view.

Listing 6.1 Creating and configuring a `UITextField` instance as a subview.

```
CGRect rect = CGRectMake(10,10, 150, 30);
myTextField = [[UITextField alloc] initWithFrame:rect];
myTextField.textColor = [UIColor blackColor];
myTextField.font = [UIFont systemFontOfSize:17.0];
myTextField.placeholder = @"<enter text>";
myTextField.backgroundColor = [UIColor whiteColor];
myTextField.borderStyle = UITextBorderStyleBezel;
myTextField.keyboardType = UIKeyboardTypeDefault;
myTextField.returnKeyType = UIReturnKeyDone;
myTextField.clearButtonMode = UITextFieldViewModeAlways;
myTextField.delegate = self;
[theView addSubview:myTextField];
```

You usually create these controls in the `loadView` method of the view controller. Here, we make `self` (i.e., the view controller) the delegate. You have a choice of which of the optional delegate methods you want to implement. Here, we implement the `textFieldShouldReturn:` method shown in Listing 6.2.

Listing 6.2 Implementation of the `textFieldShouldReturn:` method for a `UITextField` instance.

```
- (BOOL)textFieldShouldReturn: (UITextField *)textField{
    if(myTextField == textField){
        if ([[myTextField text] isEqualToString:@"Hillary"]) == NO {
            [myTextField resignFirstResponder]; // hide KB
```

```
    return NO; // It's a text field, no need for new line
}
else return NO; // It's a text field, no need for new line
}
return NO; // It's a text field, no need for new line
}
```

In the code above, we first test to see if the `textField` is the instance `myTextField`. If yes, we check the text entered. If it is “Hillary”, we do not resign the first responder, and return `NO`. Otherwise, we send the text field control a `resignFirstResponder` message asking it to stop being the first responder. This will result in the disappearance of the keyboard. After that, we return `NO`. As we have mentioned above, the return value has no effect in a single-line text field.

6.3 Sliders

A `UISlider` control (see Figure 6.6) is that familiar horizontal control used to select a single value from a continuous range of values.



UISlider

Figure 6.6 A `UISlider` control.

The following are the essential properties needed to set up a slider.

- `value`. This attribute contains the current value indicated by the slider. The property is declared as:

```
@property(nonatomic) float value
```

You can read/write this value. If you set this value, the slider will redraw itself.

- `minimumValue`. Contains the minimum value of the slider control. The property is declared as:

```
@property(nonatomic) float minValue
```

- `maximumValue`. Contains the maximum value of the slider control. The property is declared as:

```
@property(nonatomic) float maxValue
```

- `continuous`. A Boolean attribute controlling how frequently the slider sends updates with its current value to the associated target-action. If the value is YES (the default), the slider continuously sends updates of its current value as the user drags the slider's thumb. If the value is NO, it sends it only once: when the user releases the slider's thumb.

```
@property(nonatomic, getter=isContinuous) BOOL continuous
```

Listing 6.3 shows how you can configure a slider instance and add it as a subview to a view.

Listing 6.3 Creating and configuring a `UISlider` instance.

```
CGRect rect = CGRectMake(10, 60, 200, 30);
mySlider = [[UISlider alloc] initWithFrame:rect];
[mySlider addTarget:self
               action:@selector(sliderValueChanged:)
             forControlEvents:UIControlEventValueChanged];
mySlider.backgroundColor = [UIColor clearColor];
mySlider.minimumValue = 0.0;
mySlider.maximumValue = 10.0;
mySlider.continuous = YES;
mySlider.value = 5.0;
[theView addSubview: mySlider];
```

The slider's range is from 0.0 to 10.0. It continuously sends updates to the action method `sliderValueChanged:` as the user changes its value.

To receive updates of the current value of the slider, we use the target-action mechanism. We add the action method `sliderValueChanged:` (shown in Listing 6.4) for the control event `UIControlEventValueChanged`.

Listing 6.4 The `sliderValueChanged:` action method.

```
- (void)sliderValueChanged: (id)sender{
    UISlider *slider = sender;
    if(mySlider == slider){
        printf("Value of slider is %f\n", [mySlider value]);
    }
}
```

6.4 Switches

A `UISwitch` (see Figure 6.7) is a control that allows you to present an on/off switch to the user. The `UISwitch` class defines a property `on` for retrieving and setting the current state of the switch. The property is declared as:

```
@property(nonatomic, getter=isChecked) BOOL on
```



Figure 6.7 A UISwitch control.

You can also use the method `setOn:animated:` which allows you to set the switch's state, optionally animating the change. The method is declared as:

```
- (void)setOn:(BOOL)on animated:(BOOL)animated
```

If `animated` is YES, the change in the state is animated.

As in any control, you can set up a target-action and associate it with an event. As a developer, you are mostly interested in the event when the user flips the switch. You can use the `UIControlEventValueChanged` event for this purpose. Listing 6.5 shows the creation and configuration of a `UISwitch` instance. Listing 6.6 shows the action method for the event `UIControlEventValueChanged`.

Listing 6.5 The creation and configuration of a `UISwitch` instance.

```
rect = CGRectMake(10, 90, 100, 30);
mySwitch = [[UISwitch alloc] initWithFrame:rect];
[mySwitch addTarget:self
               action:@selector(switchValueChanged:)
             forControlEvents:UIControlEventValueChanged];
mySwitch.backgroundColor = [UIColor clearColor];
[theView addSubview: mySwitch];
```

Listing 6.6 The action method for the `UISwitch` instance example.

```
- (void)switchValueChanged:(id)sender{
    UISwitch *aSwitch = sender;
    if(mySwitch == aSwitch) {
        if([mySwitch isOn] == YES) {
            printf("The switch is on\n");
        }
        else
            printf("The switch is off\n");
    }
}
```

6.5 Buttons

A `UIButton` class is a control that encapsulates the behavior of buttons. You create a button using the `UIButton` class method `buttonWithType:`. After that, you set up a target-action in order to handle the user taping on the button.

The following are some of the available button types:

- `UIButtonTypeRoundedRect`. This style is used to produce a rounded-rectangle button.
- `UIButtonTypeDetailDisclosure`. This style produces a detail disclosure button.
- `UIButtonTypeInfoLight`. This style produces an information button that has a light background.
- `UIButtonTypeInfoDark`. This style produces an information button that has a dark background.
- `UIButtonTypeContactAdd`. This style produces a contact add button.

Listing 6.7 shows the creation and configuration of a `UIButton` instance (see Figure 6.8).

Listing 6.7 The creation and configuration of a `UIButton` instance.

```
myButton =
    [ [UIButton buttonWithType:UIButtonTypeRoundedRect] retain];
myButton.frame = CGRectMake(40.0, 100.0, 100, 50);
[myButton setTitle:@"Click Me" forState:UIControlStateNormal];
[myButton addTarget:self
    action:@selector(buttonClicked:)
    forControlEvents:UIControlEventTouchUpInside];
[theView addSubview: myButton];
```

The listing above configures a target-action for the tapping event. Listing 6.8 shows the action method that handles the tapping on the button. As you notice, this is a basic mechanism inherited from `UIControl` and no new mechanism is introduced.

Listing 6.8 The action method for the `UIButton` instance example.

```
- (void)buttonClicked:(id)sender{
    UIButton *button = sender;
    if(myButton == sender){
        printf("The button was tapped\n");
    }
}
```

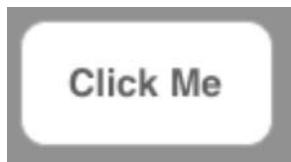


Figure 6.8 A button control example.

6.6 Segmented Controls

A segmented control is a horizontal control that manages a set of button-like items. Each item can be either a text string or an image. The user taps on an item within a segmented control and that item is selected by being highlighted.

To create a segmented control, you need to instantiate a `UISegmentedControl` object. After allocating an instance, you initialize the control with an array of items. The array of items can consist of objects of `NSString` or objects of `UIImage`. You can mix and match text and images in the same segmented control.

After the creation and initialization of the segmented control, you need to add a target-action for the control event `UIControlEventValueChanged`. The action method will be invoked when the selected item has changed. To retrieve the index of the selected item, use the property `selectedSegmentIndex` which is declared as:

```
@property(nonatomic) NSInteger selectedSegmentIndex
```

The default value for this property is `UISegmentedControlNoSegment`, indicating that no item is selected. If you set the property to this value, no item is selected (i.e., highlighted).

After that, you need to specify the frame for the segmented control which specifies the location and dimensions. Finally, the segmented control needs to be added to an existing view. Listing 6.9 shows the basic steps needed to display a functioning segmented control.

Listing 6.9 The creation and configuration of a `UISegmentedControl` instance.

```
NSArray *textOptionsArray = [NSArray arrayWithObjects:  
    @"Bart", @"Lisa", @"Maggie", nil];  
segmentedCtrl = [[UISegmentedControl alloc]  
    initWithItems:textOptionsArray];  
segmentedCtrl.frame = CGRectMake(20.0, 100.0, 280, 50);  
[segmentedCtrl addTarget:self  
    action:@selector(segmentChanged:)  
    forControlEvents:UIControlEventValueChanged];  
[theView addSubview:segmentedCtrl];
```

The control in the above listing has three items of text. The action invoked when the user taps on an item is `segmentChanged:` and this is shown in Listing 6.10.

Listing 6.10 The `segmentChanged:` action method invoked when the segmented control changes the selected item.

```
- (void)segmentChanged: (id)sender{
    if(segmentedCtrl == sender) {
        printf("The segment was changed to %d\n",
               [segmentedCtrl selectedSegmentIndex]) ;
    }
}
```

Figure 6.9 shows the text-based segmented control and Figure 6.10 shows it with the middle item selected.

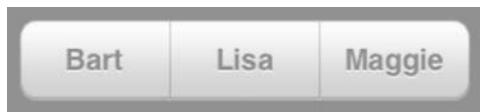


Figure 6.9 A segmented control of text items.

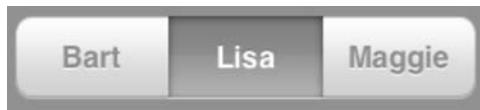


Figure 6.10 A segmented control of text items with a selected item.

To create an image-based segmented control, follow the same procedure except for the initialization phase. You can initialize the control by supplying an array of images as follows:

```
segmentedCtrl = [[UISegmentedControl alloc] initWithItems:
    [NSArray arrayWithObjects:
        [UIImage imageNamed:@"bart.png"],
        [UIImage imageNamed:@"lisa.png"],
        [UIImage imageNamed:@"maggie.png"],
        nil]];
```

Figures 6.11 shows the image-based segmented control, and Figure 6.12 shows it with the middle item selected.

In the previous examples, we accepted the default appearance of the segmented control. The property `segmentedControlStyle` allows you to select the style of the control. The property is declared as:

```
@property(nonatomic) UISegmentedControlStyle segmentedControlStyle
```



Figure 6.11 A segmented control of image items.

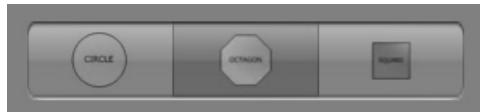


Figure 6.12 A segmented control of image items with a selected item.



Figure 6.13 A segmented control of image items with a style `UISegmentedControlStyleBordered`.



Figure 6.14 A segmented control of image items with a style `UISegmentedControlStyleBar`.

The available styles are:

- `UISegmentedControlStylePlain`. This is the default style which we have seen.
- `UISegmentedControlStyleBordered`. This is a bordered style. Figure 6.13 shows an example of this style.
- `UISegmentedControlStyleBar`. This is a toolbar style. Figure 6.14 shows an example of this style.

You can also dynamically change the items in a given segmented control. You can use `setTitle:forSegmentAtIndex:` to change a text item or `setImage:forSegmentAtIndex:` to change an item's image.

You can also add a new item to the control. If you would like to add a string item, use `insertSegmentWithTitle:atIndex:animated:` declared as:

```
- (void)insertSegmentWithTitle:(NSString *)title  
    atIndex:(NSUInteger)segment animated:(BOOL)animated
```

If you want to add an image item, use `insertSegmentWithImage:atIndex:animated:` declared as:

```
- (void)insertSegmentWithImage:(UIImage *)image  
    atIndex:(NSUInteger)segment animated:(BOOL)animated
```

You can also remove an item using `removeSegmentAtIndex:animated:` declared as:

```
- (void)removeSegmentAtIndex:(NSUInteger)segment  
    animated:(BOOL)animated
```

To remove all items, invoke `removeAllSegments`.

6.7 Page Controls

A page control (see Figure 6.15) presents the user with a set of horizontal dots representing pages. The current page is presented as a white dot. The user can go from the current page to the next or to the previous page.



Figure 6.15 A page control with 15 pages.

To present a page control to the user, allocate a new instance of `UIPageControl` and initialize it with the frame. After that, set the number of pages (maximum 20). To respond to the changes in the current page, add a target-action for the control event `UIControlEventValueChanged`. Finally, you add the page control to a view. Listing 6.11 shows the basic steps needed to present a page control to the user.

Listing 6.11 The creation and configuration of a `UIPageControl` instance.

```
pageCtrl = [[UIPageControl alloc]  
            initWithFrame:CGRectMake(20.0, 100.0, 280, 50)];  
[pageCtrl addTarget:self  
    action:@selector(pageChanged:)  
    forControlEvents:UIControlEventTouchUpInside];  
pageCtrl.numberOfPages = 15;  
[theView addSubview:pageCtrl];
```

The action method is shown below. To retrieve the current page, use the property `currentPage`.

```
- (void)pageChanged: (id) sender{
    if(pageCtrl == sender){
        printf("The page was changed to %d\n", [pageCtrl currentPage]);
    }
}
```

You can also change the current page programatically and update the visual page indicator by invoking `updateCurrentPageDisplay`.

6.8 Date Pickers

The `UIDatePicker` is a control that allows the user to select a time and a date using rotating wheels. Figure 6.16 shows four examples of a `UIDatePicker` instance.

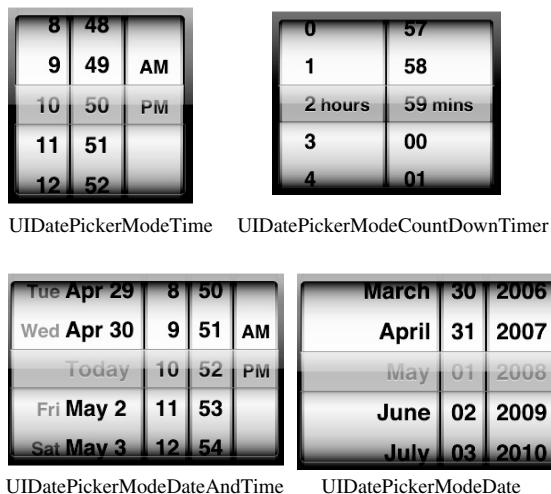


Figure 6.16 Four examples of `UIDatePicker`.

Here are several important properties and methods declared by this class.

- `calendar`. The calendar used in the `UIDatePicker` instance. The property is declared as:

```
@property(nonatomic, copy) NSCalendar *calendar
```

If this value is `nil`, then the user's current calendar is used.

- `date`. This property represents the date used in the display of the date picker.

```
@property(nonatomic, copy) NSDate *date
```

- `setDate:animated:`. This method is used to change the date. The method is declared as:

```
- (void)setDate:(NSDate *)date animated:(BOOL)animated
```

If `animated` is YES, the change is animated.

- `datePickerMode`. Using this property you can select the date picker mode. The property is defined as:

```
@property(nonatomic) UIDatePickerMode datePickerMode
```

The `UIDatePicker` instance can be configured (see Figure 6.16) to select a date; a time; a time and date; or to act as a countdown timer.

Listing 6.12 Shows how you can configure a date picker instance and add it as a subview to a view.

Listing 6.12 Creating and configuring a `UIDatePicker` instance.

```
myDatePicker = [[UIDatePicker alloc] initWithFrame:CGRectZero];
myDatePicker.autoresizingMask = UIViewAutoresizingFlexibleWidth;
myDatePicker.datePickerMode = UIDatePickerModeDate;
CGSize pickerSize = [myDatePicker sizeThatFits:CGSizeZero];
rect = CGRectMake(0,150, pickerSize.width, pickerSize.height);
myDatePicker.frame = rect;
[myDatePicker addTarget:self
                  action:@selector(datePickerChanged:)
            forControlEvents:UIControlEventValueChanged];
[theView addSubview: myDatePicker];
```

`UIDatePicker` instances differ from other controls in that they optimize their layout internally. You only need to specify the origin in the view; the size will be calculated automatically. The code above creates the instance, and sets up an action method for receiving value changes of the control. When the user rotates the wheel, the control will call the action method as soon as the wheel finishes rotating. Listing 6.13 shows the action method `datePickerChanged:` that is triggered when the value is changed.

Listing 6.13 Action method for date picker value change.

```
- (void)datePickerChanged:(id)sender{
    UIDatePicker *datePicker = sender;
    if(myDatePicker == datePicker) {
        printf("Value of picker is %s\n",
              [[[myDatePicker date] description] cString]);
    }
}
```

6.9 Summary

In this chapter, we covered the topic of controls in the iPhone OS. We started by presenting the base class of all controls, `UIControl`, and its main features. We then talked about the important target-action mechanisms used to communicate changes in the control to the clients. This chapter covered the text field, slider, switch, button, page control, segmented controls, and pickers.

Problems

- (1) Study the `UIControl.h` header file and the `UIControl` class in the documentation.
- (2) How many different forms are available for an action selector? Name them.

7

View Controllers

The model view controller (MVC) is a popular design pattern that is used in software construction to isolate the business logic from the graphical user interface. In MVC, a controller is used for the purpose of coordination between the model (where the business logic resides) and the view (where the user's interactions occur).

In this chapter, you learn about the available view controllers that are provided 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.

Section 7.1 provides a gentle introduction to view controllers by presenting a simple application with a single view controller. This application demonstrates important view controller concepts. In Section 7.2, we talk about tab bar controllers and how they can be used in the construction of radio interfaces. In Section 7.3, we talk about navigation controllers used primarily for presenting hierarchical information to the user. After that, Section 7.4 talks about modal view controllers and provides a detailed example showing their appropriate usage. Finally, we summarize the chapter in Section 7.5.

7.1 The Simplest View Controller

In this section, we demonstrate the simplest view controller. The application is composed of a view, a view controller, and a data model. The application simply displays a message that describes the orientation of the device. The view asks the controller for the message string, and the controller consults the device orientation and retrieves the appropriate text from the data model.

7.1.1 *The view controller*

Listing 7.1 shows the declaration of the view controller. The `UIViewController` is the base class for all view controllers. When creating a view controller, you either subclass this class or one of its subclasses. The data model is represented by three strings where each describes the orientation of the

device. The method `message` is used by the view instance to retrieve the appropriate text describing the orientation of the device.

Listing 7.1 The declaration of a simple view controller `CDAViewController` in file `CDAViewController.h`.

```
#import <UIKit/UIKit.h>
@interface CDAViewController : UIViewController {
    NSString *strPortraitNormal, *strPortraitUpSideDown, *strLandscape;
}
-(NSString*)message;
@end
```

In Listing 7.2, we show the implementation of the view controller `CDAViewController`.

Listing 7.2 The implementation of a simple view controller `CDAViewController` in file `CDAViewController.m`.

```
#import "CDAViewController.h"
#import "CDAUIView.h"

@implementation CDAViewController
- (id)initWithNibName:(NSString *)NibNameOrNil
    bundle:(NSBundle *)nibBundleOrNilOrNil {
    if ((self = [super initWithNibName:nibNameOrNilOrNil bundle:nibBundleOrNilOrNil]) {
        strPortraitNormal = @"Portrait";
        strPortraitUpSideDown = @"Portrait UpSideDown";
        strLandscape = @"Landscape";
    }
    return self;
}
- (void)loadView {
    CGRect rectFrame = [UIScreen mainScreen].applicationFrame;
    //Create the main view
    CDAUIView *theView = [[CDAUIView alloc] initWithFrame:rectFrame];
    theView.backgroundColor = [UIColor whiteColor];
    theView.myController = self;
    theView.autoresizingMask = UIViewAutoresizingFlexibleHeight |
        UIViewAutoresizingFlexibleWidth;
    self.view = theView;
    [theView autorelease];
}
- (BOOL)shouldAutorotateToInterfaceOrientation:
    (UIInterfaceOrientation)interfaceOrientation {
    return YES;
}
-(NSString*)message{
    switch (self.interfaceOrientation) {
        case UIInterfaceOrientationPortrait:
```

```

        return strPortraitNormal;
    case UIInterfaceOrientationPortraitUpsideDown:
        return strPortraitNormal;
    default:
        return strLandscape;
    }
}
@end

```

We override the initialization method `initWithNibName:bundle:` in order to initialize the data model. The three strings are set according to their purpose.

Since we are creating the view programmatically, we need to override the method `loadView`. Our method creates a view instance of the class `CDAUIView` (discussed later) and configures it to have flexible height and width. This is achieved by setting the `autoresizingMask` property with the appropriate value. Since the view needs a reference to the controller, we also set the property `myController` of our custom view with the view controller's instance.

The method `shouldAutorotateToInterfaceOrientation:` is also overridden. This method is called whenever the device's orientation changes. If you return `YES`, then the device orientation is changed; otherwise, no change in the device orientation occurs. Since our application requires that the orientation be changed, we return `YES`. The `message` method is the method used by the view to retrieve the text that needs to be displayed. The method simply queries the current orientation of the device and returns the appropriate string using the simple data model. The `UIViewController`'s property `interfaceOrientation` is used to retrieve the current orientation of the device. The property is declared as follows:

```
@property(nonatomic, readonly) UIInterfaceOrientation interfaceOrientation
```

There are four orientations of type `UIInterfaceOrientation`. These orientations are:

- `UIInterfaceOrientationPortrait` indicates that the iPhone is in portrait orientation where the home button is on the bottom.
- `UIInterfaceOrientationPortraitUpsideDown` indicates that the iPhone is in portrait orientation where the home button is on the top.
- `UIInterfaceOrientationLandscapeLeft` indicates that the iPhone is in landscape orientation where the home button is on the left.
- `UIInterfaceOrientationLandscapeRight` indicates that the iPhone is in landscape orientation where the home button is on the right.

7.1.2 The view

The view managed by the view controller is an instance of the class `CDAUIView` declared in Listing 7.3. The view has a property used to assign the view controller that is managing the view.

Listing 7.3 The declaration of the view CDAUIView in CDAUIView.h used to demonstrate the simplest view controller.

```
#import <UIKit/UIKit.h>
@class CDAViewController;
@interface CDAUIView : UIView {
    CDAViewController *myController;
}
@property(nonatomic, assign) CDAViewController* myController;
@end
```

Listing 7.4 shows the implementation of the view class. The class overrides the `drawRect:` method. The method simply asks the controller for a text message and draws that message on the view.

Listing 7.4 The implementation of the view CDAUIView in CDAUIView.m used to demonstrate the simplest view controller.

```
#import "CDAUIView.h"
@implementation CDAUIView
@synthesize myController;
- (void)drawRect:(CGRect)rect {
    [[myController message] drawAtPoint:CGPointMake(80, 30)
        withFont:[UIFont systemFontOfSize:50]];
}
@end
```

7.1.3 The application delegate

Listing 7.5 shows the declaration of the application delegate. It holds two instance variables: a window instance and a view controller instance.

Listing 7.5 The declaration of the application delegate CDAAppDelegate in CDAAppDelegate.h demonstrating the simplest view controller.

```
@class CDAViewController;
@interface CDAAppDelegate : NSObject {
    UIWindow          *window;
    CDAViewController *viewController;
}
@end
```

In Listing 7.6, we show the implementation of the application delegate class. As usual, we initialize the user interface objects in the method `applicationDidFinishLaunching:`. First, we create the application window. Next, the view controller instance is created and initialized using `initWithNibName:bundle:`. Since we are creating the controller programmaticaly, we pass `nil` for both parameters. The controller's view is then added to the window as a subview, and the window is made key and visible.

Listing 7.6 The implementation of the application delegate CDAAppDelegate in CDAAppDelegate.m demonstrating the simplest view controller.

```
#import "CDAAppDelegate.h"
#import "CDAViewController.h"
@implementation CDAAppDelegate
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]];
    viewController =
        [[CDAViewController alloc] initWithNibName:nil bundle:nil];
    [window addSubview:viewController.view];
    [window makeKeyAndVisible];
}
- (void)dealloc {
    [window release];
    [viewController release];
    [super dealloc];
}
@end
```

The `UIViewController` declares a `view` property as follows:

```
@property(nonatomic, retain) UIView *view
```

The `view` property is initially `nil`. When the property is accessed (as in the statement `viewController.view`), the controller checks to see if it is `nil`. If it is `nil`, it sends itself a `loadView` message. As we saw before, we create the view in the `loadView` method and set the property `view` with the instance created. Therefore, when the controller's `view` is eventually added to the window, our `CDAUIView` instance is actually added as a subview to the window.

Figures 7.1 and 7.2 show the application in portrait and landscape orientations, respectively.

7.1.4 Summary: creating a simple MVC application

Let's look at the major steps we have performed:

1. **Create a subclass of `UIViewController`.** Create the subclass and override the following methods:
 - (a) `initWithNibName:bundle:`. This is the initializer of the view controller. You can perform initialization of the data model and the controller instance.
 - (b) `loadView`. This method is used to load the view managed by the controller. You should create the view instance, configure it, and set its reference to the `view` property of the controller.



Figure 7.1 The application demonstrating the simplest view controller in portrait orientation.



Figure 7.2 The application demonstrating the simplest view controller in landscape orientation.

-
- (c) `shouldAutorotateToInterfaceOrientation`: If your application allows for the orientation to change, you should override this method and return YES for the acceptable orientations.
2. **Create a subclass of `UIView`.** If your application requires a specialized view, you should subclass the `UIView` class. Optionally, add a property for the controller so that the controller can set this property in order for the view to communicate with the controller concerning changes in the data model. Otherwise, the view can communicate with the application delegate.
 3. **Create an application delegate class.** In the `applicationDidFinishLaunching:` method, you should create the main window and the view controller, and add the `view` property of the view controller as a subview to the main window.

The complete application can be found in the CDA project in the source downloads.

7.2 Radio Interfaces

Often you need to design an application that has several functionalities or operates in parallel modes. The interface of such an application is sometimes referred to as a *radio interface*. Each functionality or mode will be managed by a view controller, and the set of these controllers defines the application. You can use a tab bar controller to manage several view controllers similar to the one you saw in the previous section. Each controller is represented by a button, and the set of buttons is available at the bottom of the screen on a tab bar managed by the tab bar controller. When the user taps a button, the view of the corresponding controller becomes the visible view, and the button changes to indicate that it is the active mode. Adding a tab bar to your application is simple: you simply create a tab bar controller, add the set of view controllers to it, and add its view to an existing view. In the next section, we present a simple application that demonstrates the basic steps needed in developing radio-based interface applications.

7.2.1 A detailed example

In this section, we create a simple application that utilizes a tab bar. The application screenshot is shown in Figure 7.3.

The application presents to the user a number of geometric shapes to select from. Each item is represented by a view controller that, when its item is selected, displays the name of the shape in its view.

The first step is writing the classes for the view controllers of each item. In this example, we use a single view controller class to represent every item. Each controller instance will be configured to output a different message. Note that it is usually the case that every item (or mode) has its own view controller class. The view controller class is `CDBViewController`, and it is declared in Listing 7.7.



Figure 7.3 A screenshot of a simple tab bar application.

Listing 7.7 The declaration of the view controller representing each item in the tab bar application.

```
#import <UIKit/UIKit.h>
@interface CDBViewController : UIViewController {
    NSString *message;
}
@property (nonatomic, retain) NSString *message;
- (id)initWithMessage:(NSString *)theMessage andImage:(UIImage*) image;
@end
```

The view controller uses a custom initializer, `initWithMessage:andImage:`, that initializes the view controller with the custom message that will be displayed when it becomes active, and an image used to represent its item in the item list on the tab bar.

The implementation of the view controller class is shown in Listing 7.8.

Listing 7.8 The implementation of the view controller used in the tab bar application.

```
#import "CDBViewController.h"
#import "CDBUIView.h"

@implementation CDBViewController
```

```

@synthesize message;
- (id)initWithMessage:(NSString *)theMessage andImage:(UIImage*) image {
    if (self = [super initWithNibName:nil bundle:nil]) {
        self.message = theMessage;
        self.tabBarItem.image = image;
    }
    return self;
}
- (void)loadView {
    CGRect rectFrame = [UIScreen mainScreen].applicationFrame;
    CDBUIView *theView = [[CDBUIView alloc] initWithFrame:rectFrame];
    theView.backgroundColor = [UIColor whiteColor];
    theView.myController = self;
    theView.autoresizingMask = UIViewAutoresizingFlexibleHeight |
                                UIViewAutoresizingFlexibleWidth;
    self.view = theView;
    [theView release];
}
@end

```

The initializer first calls the super's initializer, `initWithNibName:bundle:`. Since we are going to build our graphical interface programatically, we pass `nil` value for both parameters. The initializer then stores the custom message in the `message` property for later use by its managed view, and stores the image representing this controller in the `image` property of the `tabBarItem` property of the view controller instance.

The `tabBarItem` property is declared in the `UIViewController` class as follows:

```
@property(nonatomic, readonly, retain) UITabBarItem *tabBarItem
```

The value for this property is an object (possibly `nil`) of the class `UITabBarItem` representing the view controller on the tab bar. The `UITabBarItem` class is a subclass of `UIBarButtonItem`. It inherits from its superclass the `image` and `title` properties. The default value for the `image` is `nil`. However, the `title` value, if not set, is set to the value of the view controller's `title` property. The `UITabBarItem` class adds an additional property: `badgeValue` which is an instance of `NSString` and its value is shown inside a red oval to the right of the corresponding tab bar item. More on this later.

The controller, as usual, overrides the `loadView` method for setting up its managed view. This method is similar to what we saw in the previous section. The view class is a custom view class `CDBUIView` that we will see shortly. Since we plan to add the view controller to a tab bar controller, the view managed by the view controller needs to be able to resize so that it fits above the tab bar. Therefore, it is important to set the `autoresizingMask` property of the managed view as shown in the method.

The `CDBUIView` view class is declared in Listing 7.9. It simply maintains a `myController` property to hold a reference to its controller. This reference is needed so that the view can retrieve the proper message to be drawn in the view.

Listing 7.9 The view class declaration used in the tab bar application.

```
#import <UIKit/UIKit.h>
@class CDBViewController;
@interface CDBUIView : UIView {
    CDBViewController *myController;
}
@property(nonatomic, assign) CDBViewController* myController;
@end
```

The implementation of the CDBUIView class is shown in Listing 7.10. The class overrides the drawRect: method of its superclass to draw the message obtained from the controller.

Listing 7.10 The implementation of the view class used in the tab bar application.

```
#import "CDBUIView.h"
@implementation CDBUIView
@synthesize myController;
- (void)drawRect:(CGRect)rect {
    [[myController message] drawAtPoint:CGPointMake(80, 30)
                                         withFont:[UIFont systemFontOfSize:20]];
}
@end
```

Now that we have constructed the view controller and its required view class, we can use the application delegate to present the application window to the user. The application delegate class declaration is shown in Listing 7.11. In addition to maintaining a reference to the main window, it has six references to view controllers, all of type CDBViewController. These controllers will be added to a tab bar controller of type UITabBarController whose reference is in the instance variable tabBarController.

Listing 7.11 The application delegate class declaration used to present the main window in the tab bar application.

```
#import <UIKit/UIKit.h>
@class CDBViewController;
@interface CDBAppDelegate : NSObject {
    UIWindow          *window;
    CDBViewController *viewController1, *viewController2,
                      *viewController3, *viewController4,
                      *viewController5, *viewController6;
    UITabBarController *tabBarController;
}
@end
```

Listing 7.12 shows the implementation of the application delegate class.

Listing 7.12 The application delegate class implementation used to present the main window in the tab bar application.

```
#import "CDBAppDelegate.h"
#import "CDBViewController.h"
@implementation CDBAppDelegate

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]];
    viewController1 =
        [[CDBViewController alloc]
            initWithMessage:@"Triangle"
            andImage:[UIImage imageNamed:@"tri.png"]];
    viewController1.title = @"Tri";
    viewController2 =
        [[CDBViewController alloc]
            initWithMessage:@"Rectangle"
            andImage:[UIImage imageNamed:@"rect.png"]];
    viewController2.title = @"Rect";
    viewController3 =
        [[CDBViewController alloc]
            initWithMessage:@"Ellipse"
            andImage:[UIImage imageNamed:@"ellipse.png"]];
    viewController3.title = @"Elli";
    viewController4 =
        [[CDBViewController alloc]
            initWithMessage:@"Rectangle+Ellipse"
            andImage:[UIImage imageNamed:@"rect-elli.png"]];
    viewController4.title = @"R&E";
    viewController5 =
        [[CDBViewController alloc]
            initWithMessage:@"Rectangle+Triangle"
            andImage:[UIImage imageNamed:@"rect-tri.png"]];
    viewController5.title = @"R&T";
    viewController6 =
        [[CDBViewController alloc]
            initWithMessage:@"Rectangle+Rectangle"
            andImage:[UIImage imageNamed:@"two-tri.png"]];
    viewController6.title = @"R&R";
    tabBarController = [[UITabBarController alloc] init];
    tabBarController.viewControllers =
        [NSArray arrayWithObjects:
            viewController1, viewController2, viewController3,
            viewController4, viewController5, viewController6,
            nil];
    [window addSubview:tabBarController.view];
    [window makeKeyAndVisible];
}
```

```
- (void)dealloc {
    [window release];
    [viewController1 release];
    [viewController2 release];
    [viewController3 release];
    [viewController4 release];
    [viewController5 release];
    [viewController6 release];
    [tabBarController release];
    [super dealloc];
}
@end
```

The application delegate overrides the `applicationDidFinishLaunching:` method for setting up the main window. First, we create six instances of the `CDBViewController` view controller class. Each of these instances is initialized with the message that will be displayed in their view and the image that will be displayed as their representation on the tab bar. In addition, the view controller's title is set, which also has the side effect of setting the tab bar item's title to the same value.

The image files are stored in the application's bundle. Using the class method `imageNamed:`, we retrieve the image encapsulated by a `UIImage` class. See Chapter 10 for more information.

After creating the view controllers, we create the tab bar controller that will manage them. This class is of type `UITabBarController`. To add the view controllers, we set its `viewControllers` property. This property is declared as:

```
@property(nonatomic, copy) NSArray *viewControllers
```

Therefore, all we have to do is create an instance of `NSArray` with the six view controller instances as its elements and use it as the value for the `viewControllers` property.

Finally, we have to add the tab bar's view as a subview to the main window. When the window appears, the tab bar's view appears and it will consist of the tab bar (at the bottom) and the currently selected view controller's view above it. Initially, the first controller is selected.

The complete application can be found in the `CDB` project in the source downloads.

7.2.2 Some comments on tab bar controllers

There are several additional aspects of the tab bar controller that need to be highlighted.

- **The More List.** If there are more than five view controllers to be managed, the tab bar will show the first four controllers and an additional `More` item is added as the fifth controller.

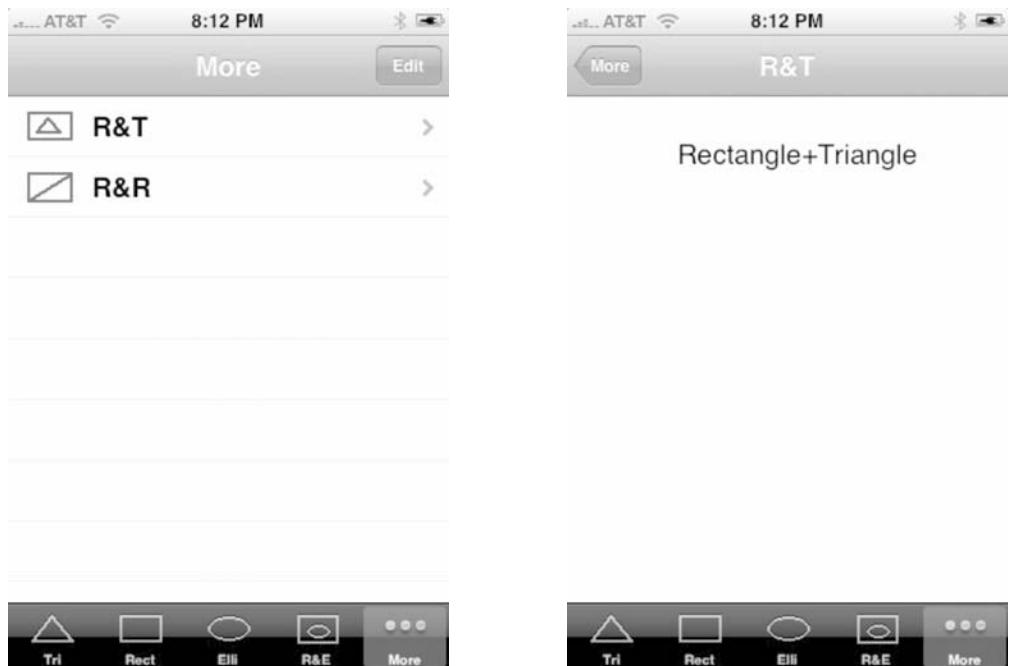


Figure 7.4 Showing the additional items on the tab bar by tapping on the More item.

Figure 7.5 Showing an item on the More list. Tapping on “More” shows the More list.

Tapping on the More item will present a list of the rest of the view controllers. Figure 7.4 shows how the view changes when the More item is tapped.

The user can then tap on any of the items to activate the corresponding view controller. Figure 7.5 shows what happens when the user taps on the R&T item. The user can tap on the More button to go back to the list of More items.

The More item is managed by a navigation controller which can be accessed using the tab bar controller’s property `moreNavigationController` which is declared as:

```
@property(nonatomic, readonly) UINavigationController  
*moreNavigationController
```

We will talk more about navigational controllers in the next section. For now, note that a navigational controller allows the application developer to present the user with hierarchical information in a natural way.

- **Badge.** Every item on the tab bar can have an optional value displayed in its upper-right corner surrounded by a red oval. The property that controls this is `badgeValue` which is declared as:

```
@property(nonatomic, copy) NSString *badgeValue
```



Figure 7.6 Showing a badge value for a view controller on a tab bar.

The default value for this property is `nil`. You can assign any string value to it, but usually it is a short message (e.g., a number). For example, to add a badge value to the third controller, we can write:

```
viewController3.tabBarItem.badgeValue = @"3";
```

Figure 7.6 shows the effect of this line on the appearance of the tab bar.

- **Selected Controller.** You can retrieve or change the selected controller by manipulating the `selectedViewController` property. The property is declared as:

```
@property(nonatomic,assign) UIViewController *selectedViewController
```

Note that if the “More” item is selected, the view controller for the “More” list is returned. Also note that you can change the selected view controller for the items that are displayed on the tab bar as well as the hidden view controllers. Starting with iPhone OS 3.0, writing something like the following no longer results in an `NSRangeException` exception:

```
tabBarController.selectedViewController = viewController5;
```

You can also retrieve/change the selected view controller using the `selectedIndex` property which is declared as:

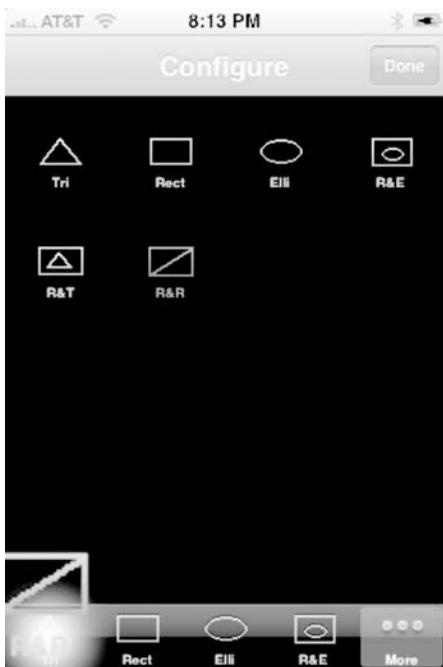


Figure 7.7 Rearranging the items on the tab bar by moving the R&R item to the first place.

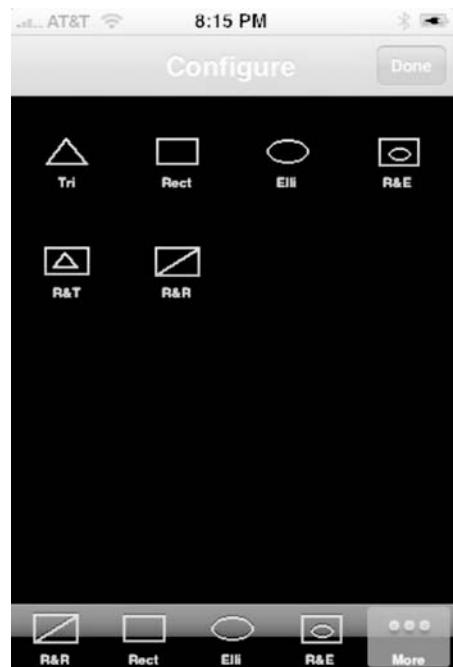


Figure 7.8 The state of the tab bar after moving the R&R item to the beginning, but while still being in editing mode.

```
@property(nonatomic) NSUInteger selectedIndex
```

where the index 0 (first controller selected) is the default value. The `selectedViewController` and `selectedIndex` properties are connected; changing one will result in a change to the other.

- **Customization.** If you have more than five items managed by the tab bar controller, you can give the user the ability to rearrange the position of these controllers. Since only the first four controllers will appear on the main screen, and the rest will be displayed in a table, the user may want to move some of the controllers in the table to the main window.

You can specify that a view controller can be customized by putting its reference in the `customizableViewControllers` array which is declared as follows:

```
@property(nonatomic, copy) NSArray *customizableViewControllers
```

To change the position of a specific controller, the user taps on the `More` list and then on the `Edit` button. They can then tap the image of that controller and drag it to its new position. Figure 7.7 shows R&R while it is in the process of being moved to the first position. Figure 7.8 shows the state just after the move.

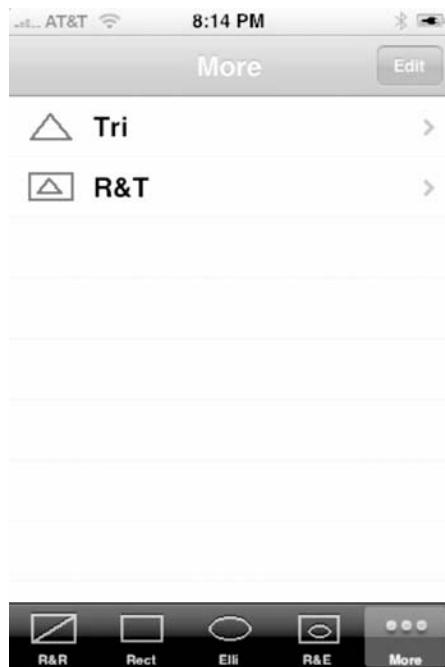


Figure 7.9 The state of the tab bar after moving the R&R item to the beginning and exiting the editing mode.

A controller that has lost its position (in our example, the Tri controller), will be moved to the table display as shown in Figure 7.9.

By default, when you set the `viewControllers` property, the same object references go to the `customizableViewControllers` property. That means that all view controllers are customizable. If you would like to pin down one or more view controllers, you need to change this property. For example, to make the only customizable view controllers to be the first, second, and fifth controllers, you can write something like the following:

```
tabBarController.customizableViewControllers =  
    [NSArray arrayWithObjects:viewController1, viewController2,  
                           viewController5, nil];
```

7.3 Navigation Controllers

Often, you would like to present hierarchical information to the user. The user starts at the top level of the information hierarchy. They then tap on a specific item, and the next level of the hierarchy is displayed. The process of drilling-down continues until the user reaches their desired level.

The class `UINavigationController` is provided for managing hierarchical views to the user. As we saw in the previous section, the controller rather manages view controllers and each view

controller manages the actual view for a given level. This class presents to the user a navigation bar and the view of the current level of hierarchy. In Section 9.8, you see how table views are ideal for such data presentation. In that section, we will use a navigation controller with table views to present hierachal information in a user-friendly manner. In this section, however, we would like to look at the basic mechanisms behind the `UINavigationController` class. We first present a detailed example showing the default behavior of this class and then discuss some of the customization options available to you.

7.3.1 A detailed example

This section presents a detailed example that utilizes a navigation controller. The application has three levels of hierarchy: Level I, Level II, and Level III. To keep the example simple and to the point, the user moves to the next level of hierarchy by just tapping on the view of the previous level. Also, all view controllers managed by the navigation controller are instances of the same class; it's the message displayed inside each view that distinguishes these levels of hierarchy. Figure 7.10 shows the first level of hierarchy.

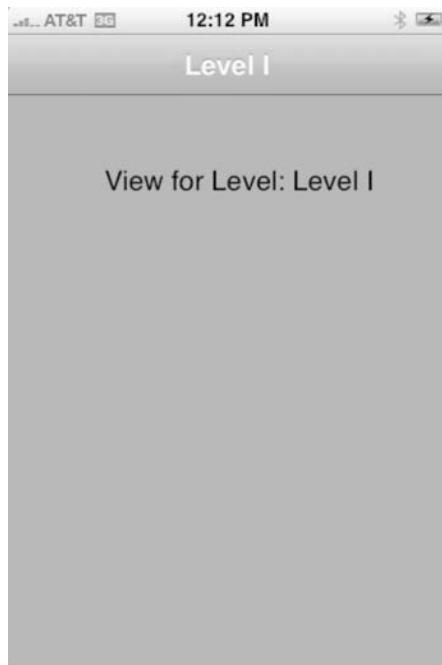


Figure 7.10 The navigation controller application showing the first level of hierarchy.

The figure shows the navigation bar and the view of the controller that is shown below it. The navigation bar has a title in the middle. By default, the title in the middle of the navigation bar is the same as the title property of the top most view controller. Figure 7.11 shows the application screenshot when the user taps on the view of the first level.

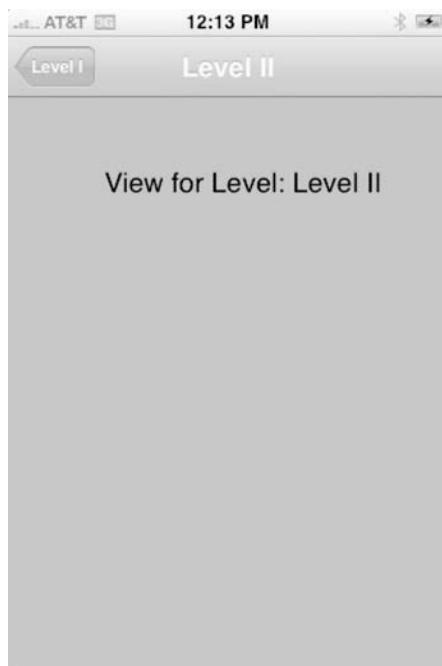


Figure 7.11 The navigation controller application showing the second level of hierarchy.

A new view appears that shows the second level of hierarchy. The second view appears by *pushing* a new view controller on the stack of navigation managed by the navigation controller. Notice that, by default, a back button appears on the left that has the title of the previous level. Tapping on the back button will result in the current view controller being *popped* from the stack and the view of the previous view controller appearing.

The view controller

Let's start by building the view controller classes whose instances will be pushed/popped on/off the navigation stack. To simplify things, we assume that all view controllers are instances of one view controller, `CDCViewController`. Listing 7.13 shows the declaration of this class. It declares the `showNextLevel` method used by the view to show the next level of the view hierarchy.

Listing 7.13 The declaration of the view controller used in the navigation controller example.

```
#define LEVELI @"Level I"
#define LEVELII @"Level II"
#define LEVELIII @"Level III"

@interface CDCViewController : UIViewController {
}
- (void)showNextLevel;
@end
```

Listing 7.14 shows the implementation of the view controller. The `showNextLevel` uses the application delegate to push the view controller of the next level on the stack of the navigation controller (which itself is managed by the application delegate). To retrieve a reference to the single application delegate, use the class method `sharedApplication` of the `UIApplication` class. The `loadView` method is similar to what we saw before. It uses the `CDCUIView` class for the view.

Listing 7.14 The implementation of the view controller used in the navigation controller example.

```
#import "CDCViewController.h"
#import "CDCUIView.h"

@implementation CDCViewController
- (void)showNextLevel{
    [[[UIApplication sharedApplication] delegate] showNextLevel:self.title];
}

- (void)loadView {
    CGRect rectFrame = [UIScreen mainScreen].applicationFrame;
    CDCUIView *theView = [[CDCUIView alloc] initWithFrame:rectFrame];
    theView.backgroundColor = [UIColor grayColor];
    theView.myController = self;
    theView.autoresizingMask = UIViewAutoresizingFlexibleHeight |
                                UIViewAutoresizingFlexibleWidth;
    self.view = theView;
    [theView release];
}
@end
```

The view

Listing 7.15 shows the declaration of the view class `CDCUIView` used by the view controller. The view has a reference to its controller in the property `myController`. We will see in Listing 7.16 how this reference is used in the method intercepting the user's tapping in order to navigate to the next level.

Listing 7.15 The declaration of the view class used in the navigation controller example.

```
@class CDCViewController;

@interface CDCUIView : UIView {
    CDCViewController *myController;
}
@property(nonatomic, assign) CDCViewController* myController;
@end
```

Listing 7.16 shows the implementation of the view class. As we mentioned before, to navigate to the next level, the user taps on the view. The method `touchesBegan:withEvent:` intercepts the tapping and invokes the controller's `showNextLevel` method which in turn invokes the application delegate `showNextLevel:` method. The `drawRect:` method is used to display a unique message in the view area that is specific to each of the three navigation levels.

Listing 7.16 The implementation of the view class used in the navigation controller example.

```
#import "CDCUIView.h"
#import "CDCViewController.h"

@implementation CDCUIView
@synthesize myController;

- (void)touchesBegan:(NSSet *)touches withEvent:(UIEvent *)event{
    [myController showNextLevel];
}

- (void)drawRect:(CGRect)rect {
    NSString *message;
    message =
        [NSString stringWithFormat:
            @"View for Level: %@", [myController title]];
    [message
        drawAtPoint:CGPointMake(70, 50)
        withFont:[UIFont systemFontOfSize:20]];
}
```

```
@end
```

The application delegate

Listing 7.17 shows the declaration of the application delegate class. It keeps track of the window and the three view controllers. In addition, it maintains a reference to the navigation controller. The application delegate also declares the method `showNextLevel:` that will be invoked by the view controller to go to the next level.

Listing 7.17 The declaration of the application delegate class of the navigation controller example.

```
@class CDCViewController;

@interface CDCAppDelegate : NSObject {
    UIWindow *window;
    CDCViewController *levelI, *levelII, *levelIII;
    UINavigationController *navController;
}
- (void)showNextLevel:(NSString*) level;
@end
```

Listing 7.18 shows the implementation of the application delegate class. The `applicationDidFinishLaunching:` method is used to initialize the application GUI. It starts by creating a window and then the view controller for the first level of hierarchy. After that the navigation controller is created and initialized. A navigation controller is an instance of the class `UINavigationController` which is a subclass of the `UIViewController` class. The instance of the navigation controller is initialized by the `initWithRootViewController:` method which is declared as follows:

- (**id**)`initWithRootViewController:(UIViewController *)rootViewController`

The initializer has a single parameter: the view controller instance that will become the first level (root) of the hierarchy. This controller is pushed on the (empty) stack without animation. After creating and initializing the navigation controller, we add its view as a subview to the window. This will result in having the navigation bar added below the status bar and the view of the root controller below it.

The `showNextLevel:` method takes as a parameter the current level's name. It pushes the second-level controller if the current level is the root and the third-level controller if it is the second level. To push a new view controller on the stack, you need to first create it and then use the `pushViewController:animated:` method to put it on the stack. This method is declared as follows:

- (**void**)`pushViewController:(UIViewController *)viewController animated:(BOOL)animated`

If `animated` is YES, the transition to the next level is animated. By default, when a view controller is pushed on the stack, the title of the current view controller becomes the title of the left button. The title in the middle will be changed to reflect the title of the newly pushed view controller. When the user taps on the left button, the current view controller is popped from the stack, the view of the previous controller replaces the view below the navigation bar, the title in the middle of the navigation bar is replaced with the title of the previous view controller, and the back button's title is changed accordingly. The method for popping the top view controller is `popViewControllerAnimated:` and it is declared as follows:

- (`UIViewController *`)`popViewControllerAnimated:(BOOL)animated`

If animated is YES, the popping is animated, otherwise it is not. Notice that the method also returns a reference to the popped view controller. It is worth noting that if there is only one view controller on the stack (root), the method will not be able to pop it, but will gracefully return without generating an exception.

Listing 7.18 The implementation of the application delegate class of the navigation controller example.

```
#import "CDCAppDelegate.h"
#import "CDCViewController.h"

@implementation CDCAppDelegate

- (void)showNextLevel:(NSString*) level{
    if([level isEqualToString:LEVELI]){
        levelII = [[CDCViewController alloc] initWithNibName:nil bundle:nil];
        levelII.title = LEVELII;
        [navController pushViewController:levelII animated:YES];
    }
    else if([level isEqualToString:LEVELII]){
        levelIII = [[CDCViewController alloc] initWithNibName:nil bundle:nil];
        levelIII.title = LEVELIII;
        [navController pushViewController:levelIII animated:YES];
    }
}

- (void)
applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]];
    levelI = [[CDCViewController alloc] initWithNibName:nil bundle:nil];
    levelI.title = LEVELI;
    navController =
        [[UINavigationController alloc] initWithRootViewController:levelI];
    [window addSubview:navController.view];
    [window makeKeyAndVisible];
}

- (void)dealloc {
    [window release];
    [levelI release];
    [levelII release];
    [levelIII release];
    [navController release];
    [super dealloc];
}
@end
```

The complete application can be found in the CDC project in the source downloads.

7.3.2 Customization

In the previous section, you learned the default behavior of navigation controllers. In this section, we look at ways to customize the appearance and behavior of navigation bars.

Navigation item

Every view controller is represented on the navigation bar by a navigation item. A navigation item is an instance of the `UINavigationItem` class. This class declares several properties that define the appearance of the view controller when it is pushed onto the stack or when another view controller is pushed on top of it (i.e., it becomes the immediate child controller). By default, when a view controller is pushed onto the stack, the title in the middle of the navigation bar becomes the same as the view controller's title. When another view controller is pushed onto the stack, the title for the back button becomes the title of the currently active view controller (the controller about to become a child). To change this behavior, you can access the navigation item of each view controller instance and set its various properties instead of them being taken from the default values. To obtain the instance of the navigation item, use the property `navigationItem` which is declared in the `UIViewController` class as follows:

```
@property(nonatomic, readonly, retain) UINavigationItem *navigationItem
```

The following list presents important properties of the navigation item.

- **The title.** To specify the title of the navigation bar when the view controller is the topmost on the stack, set the `title` property of its navigation item. The `title` property is declared as:

```
@property(nonatomic, copy) NSString *title
```

For example, to set the title of the navigation item for the view controller, `ctrl11`, change the `title` property as follows:

```
ctrl11.navigationItem.title = @"Nav Title 1";
```

Every time `ctrl11` is the topmost controller on the stack, the title of the navigation bar is "Nav Title 1".

- **The prompt.** There is an optional text that can be displayed above the navigation bar buttons. To take advantage of this option, set the `prompt` property of the navigation item which is declared as:

```
@property(nonatomic, copy) NSString *prompt
```

For example, the following code will result in the prompt in Figure 7.12.

```
ctrl11.navigationItem.prompt = @"The Prompt 1";
```

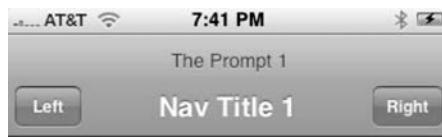


Figure 7.12 Customizing a navigation bar to show custom right/left buttons, prompt, and title.

- **Right/left buttons.** You can add a right and/or a left button to the navigation bar. To add a right button that will appear when the view controller becomes the topmost on the stack, set the property `rightBarButtonItem` which is declared as follows:

```
@property(nonatomic, retain) UIBarButtonItem *rightBarButtonItem
```

To add a left button to the navigation bar, set the `leftBarButtonItem` property which is declared as:

```
@property(nonatomic, retain) UIBarButtonItem *leftBarButtonItem
```

Note that this custom left button will replace the regular back button on the bar if one exists.

For example, to create a right button, you can write something like the following in the view controller's initializer:

```
UIBarButtonItem * rightButton =
    [ [UIBarButtonItem alloc]
        initWithTitle:@"Right"
        style:UIBarButtonItemStyleDone
        target:self
        action:@selector(rightButtonTapped:)];
self.navigationItem.rightBarButtonItem = rightButton;
[rightButton release];
```

In the above code, we are creating an instance of a `UIBarButtonItem` and initializing it with the title, the style, and the method that will be invoked when the button is tapped. You might want to review Section 6.1.2 and come back here for a better understanding of the target-action mechanism.

Figure 7.12 shows a navigation bar with right and left custom buttons. The right button is the one created by the code above, having a style of `UIBarButtonItemStyleDone`. The left button is created using the style `UIBarButtonItemStylePlain`. You do have another style that can be used: `UIBarButtonItemStyleBordered`.

- **Title view.** You have the option of displaying a view instead of the title of the navigation bar. To specify a view, set the `titleView` property which is declared as follows:

```
@property(nonatomic, retain) UIView *titleView
```

To demonstrate this, let's consider the view class `MyBarView` shown in Listing 7.19. This class simply implements a view that has a white background and draws a "Hello" text inside.

Listing 7.19 A custom view that will replace the title in a navigation bar.

```

@interface MyBarView : UIView {}
@end

@implementation MyBarView

- (id)initWithFrame:(CGRect)frame {
    if (self = [super initWithFrame:frame]) {
        self.backgroundColor = [UIColor whiteColor];
    }
    return self;
}

- (void)drawRect:(CGRect)rect {
   [@"Hello" drawAtPoint:CGPointMake(55, 5)
        withFont:[UIFont systemFontOfSize:20]];
}
@end

```

To replace the title text with a view (see Figure 7.13) for controller `ctrl1`, you write something like the following:

```

MyBarView *titleView = [[[MyBarView alloc]
    initWithFrame:CGRectMake(0, 0, 150, 30)] autorelease];
ctrl1.navigationItem.titleView = titleView;

```

**Figure 7.13** A navigation bar with custom view title.

- **Editing support.** Some subclasses of `UIViewController`, such as `UITableViewController`, support editing a view. When the view managed by a controllers can be edited, it is customary to have an “Edit” button on the right-hand side. When this “Edit” button is tapped by the user, the view is supposed to enter editing mode and the button’s title changed to “Done”. Once the user finishes their editing, they tap on the “Done” button and the view controller is supposed to save the changes made.

It turns out that such a mechanism is already built in, and using it requires little effort. First, the `UIViewController` class has a method to communicate that change in its editing mode. This method is `setEditing:animated:` which is declared as:

```

- (void)setEditing:(BOOL)editing animated:(BOOL)animated

```

Subclasses of `UIViewController` override this method in order to respond appropriately.

Furthermore, the `UIViewController` declares a property `editing` that can be set to change the editing mode of the view controller. This property is declared as:

```
@property(nonatomic, getter=isEditing) BOOL editing
```

When you change the value of this property, the `setEditing:animated:` is invoked with the corresponding change. Furthermore, when the user taps on the Edit/Done button, the property's value is changed accordingly.

To add an Edit/Done button to the right-hand side when `ctrl1` is the topmost view controller, you can write something like the following:

```
ctrl1.navigationItem.rightBarButtonItem = [ctrl1 editButtonItem];
ctrl1.editing = NO;
```

Notice how we have obtained the button using the view controller's instance method `editButtonItem` which is declared as:

```
- (UIBarButtonItem *)editButtonItem
```

Figures 7.14 and 7.15 show the Edit/Done buttons on a navigation bar, respectively.

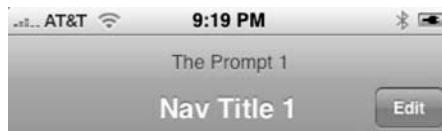


Figure 7.14 An Edit button on a navigation bar.

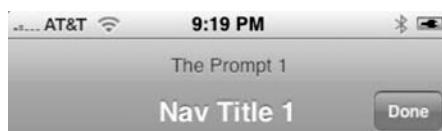


Figure 7.15 A Done button on a navigation bar.

7.4 Modal View Controllers

A modal view controller allows you to overlay another view controller on top of an existing one. When the modal view controller is presented to the user, it occupies the whole space below the status bar. Modal view controllers can appear animated from bottom to top (default behavior), flipped from right-to-left, or faded in.

Every view controller can present at most one modal view controller at a time. The `modalViewController` property holds the reference to the modal view controller. This property is declared as:

```
@property(nonatomic, readonly) UIViewController *modalViewController;
```

Likewise, the view controller, if presented as a modal view controller by another view controller, has a reference to its parent view controller using the `parentViewController` property which is declared as:

```
@property(nonatomic, readonly) UIViewController *parentViewController
```

To display a modal view controller, the view controller invokes the instance method `presentModalViewController:animated:` which is declared as:

```
- (void)  
presentModalViewController:(UIViewController *)modalViewController  
animated:(BOOL)animated
```

Without any configuration, the previous statement presents the controller from bottom to top. If you want to show the controller differently, you can set its `modalTransitionStyle` property to either `UIModalTransitionStyleFlipHorizontal` or `UIModalTransitionStyleCrossDissolve`. The style for the default behavior is denoted by `UIModalTransitionStyleCoverVertical`, but you do not need to set it as it is the default.

After the view of the modal view controller appears and the user finishes interacting with it, a mechanism (usually a button on the navigation bar) is used to dismiss the modal view controller. To dismiss the modal view controller, the parent view controller needs to invoke the method `dismissModalViewControllerAnimated:` which is declared as:

```
- (void)dismissModalViewControllerAnimated:(BOOL)animated
```

7.4.1 A detailed example

Let's illustrate modal view controllers using a detailed example. In the following, we build an application that first presents a view controller managed by a navigation controller. When the user taps on the view, another navigation controller is presented modally (Figure 7.16).

The modal controller has a “Dismiss” button on the navigation bar which, when tapped, will dismiss the modal controller and show the view of the hidden parent controller.

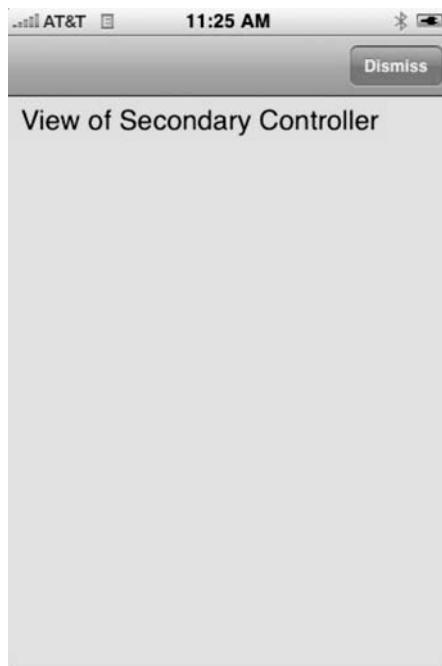


Figure 7.16 The view of the modal view controller and the navigation bar with the “Dismiss” button.

The parent view controller class is `MainViewController` which is declared in Listing 7.20.

Listing 7.20 The declaration of `MainViewController` that presents a modal view controller.

```
@class SecondaryViewController;

@interface MainViewController : UIViewController {
    SecondaryViewController *secondaryCtrl1;
    UINavigationController  *secondaryNavigationCtrl;
}
- (void) showModalController;
- (void) dismissModalController;
@end
```

The controller has a reference to the modal view controller as it will create it when the user taps on its view. A reference to the navigation controller which will also be created at that time is also maintained. As we will see shortly, the `showModalController` method will be invoked from its view and the `dismissModalController` is the action method of the “Dismiss” navigation bar button found on the modal controller. Listing 7.21 shows the implementation of the class.

Listing 7.21 The implementation of MainViewController that presents a modal view controller.

```
#import "MainViewController.h"
#import "SecondaryViewController.h"
#import "MainView.h"

@implementation MainViewController

- (void)loadView {
    CGRect rectFrame = [UIScreen mainScreen].applicationFrame;
    MainView *theView = [[MainView alloc] initWithFrame:rectFrame];
    theView.myController = self;
    theView.backgroundColor = [UIColor grayColor];
    theView.autoresizingMask = UIViewAutoresizingFlexibleHeight |
        UIViewAutoresizingFlexibleWidth;
    self.view = theView;
    [theView release];
}

- (void)showModalController{
    secondaryCtrl1 = [[SecondaryViewController alloc]
                      initWithNibName:nil
                      bundle:nil parent:self];
    secondaryNavigationCtrl = [[UINavigationController alloc]
                               initWithRootViewController:secondaryCtrl1];
    [self presentModalViewController:secondaryNavigationCtrl animated:YES];
}

- (void)dismissModalController {
    [secondaryCtrl1 release];
    [secondaryNavigationCtrl release];
    [self dismissModalViewControllerAnimated:YES];
}
@end
```

The `loadView` method is very similar to the `loadView` methods we have seen so far. The view created is of type `MainView` which we will see shortly. When the user taps on the view, the view invokes the `showModalController` method. This method creates the view controller of type `SecondaryViewController`, and then makes it the root controller of a new navigation controller. It will then display the navigation controller on top of itself and the navigation bar by invoking the `presentModalViewController:animated:` method animating the appearance from bottom to top. As we will see shortly, the `SecondaryViewController` adds a “Dismiss” button to the navigation bar and makes its target-action this controller instance and the `dismissModalController` method. The method simply deallocates the view and the navigation controllers, and invokes the `dismissModalViewControllerAnimated:` method animating the dismissal of the navigation controller from top to bottom.

The view class for the parent view controller is declared in Listing 7.22. It is similar to what we have seen so far. The implementation of this class is shown in Listing 7.23. The view overrides the touchesBegan:withEvent : method to ask the view controller to show the modal view controller.

Listing 7.22 The declaration of the MainView class used as the view for the controller presenting a modal view controller.

```
@class MainViewController;
@interface MainView : UIView {
    MainViewController *myController;
}
@property(nonatomic, assign) MainViewController* myController;
@end
```

Listing 7.23 The implementation of the MainView class used as the view for the controller presenting a modal view controller.

```
#import "MainView.h"
#import "MainViewController.h"

@implementation MainView
@synthesize myController;
- (void)touchesBegan:(NSSet *)touches withEvent:(UIEvent *)event{
    [myController showModalController];
}
@end
```

Listing 7.24 shows the declaration of the SecondaryViewController class. The initializer has a reference parameter to the parent view controller which will become the target of the “Dismiss” button.

Listing 7.24 The declaration of SecondaryViewController class.

```
@class MainViewController;

@interface SecondaryViewController : UIViewController {
}
- (id)initWithNibName:(NSString *)NibNameOrNil
    bundle:(NSBundle *)nibBundleOrNilOrNil
    parent:(MainViewController*) myParent;
@end
```

Listing 7.25 shows the implementation of the SecondaryViewController class. The initializer adds a “Dismiss” right button on the navigation bar.

Listing 7.25 The implementation of SecondaryViewController class.

```
#import "SecondaryViewController.h"
#import "SecondaryView.h"
#import "MainViewController.h"
```

```
@implementation SecondaryViewController

- (id)initWithNibName:(NSString *)NibNameOrNil
    bundle:(NSBundle *)nibBundleOrNilOrNil
    parent:(MainViewController*) myParent{
    if (self = [super initWithNibName:nibNameOrNilOrNil
        bundle:nibBundleOrNilOrNil]) {
        UIBarButtonItem *rightButton = [[UIBarButtonItem alloc]
            initWithTitle:@"Dismiss"
            style:UIBarButtonItemStyleDone
            target:myParent
            action:@selector(dismissModalController)];
        self.navigationItem.rightBarButtonItem = rightButton;
        [rightButton release];
    }
    return self;
}

- (void)loadView {
    CGRect rectFrame = [UIScreen mainScreen].applicationFrame;
    SecondaryView *theView =
        [[SecondaryView alloc] initWithFrame:rectFrame];
    theView.backgroundColor = [UIColor yellowColor];
    theView.autoresizingMask = UIViewAutoresizingFlexibleHeight |
        UIViewAutoresizingFlexibleWidth;
    self.view = theView;
    [theView release];
}

@end
```

Listing 7.26 shows the SecondaryView class used by the SecondaryViewController view controller.

Listing 7.26 The SecondaryView class.

```
@interface SecondaryView : UIView {
}

@implementation SecondaryView
- (void)drawRect:(CGRect)rect {
   [@"View of Secondary Controller"
        drawAtPoint:CGPointMake(10, 5)
        withFont:[UIFont systemFontOfSize:20]];
}
@end
```

To put all the previous pieces together, the application delegate class is shown in Listings 7.27 and 7.28. The application delegate has reference to the navigation controller and its lone view controller. It creates the navigation controller, initializes it with the view controller, and displays it to the user.

Listing 7.27 The declaration of the application delegate class for the modal view controller application.

```
@class MainViewController;

@interface CDEAppDelegate : NSObject <UIApplicationDelegate> {
    UIWindow *window;
    MainViewController *ctrl1;
    UINavigationController *navCtrl1;
}
@property (nonatomic, retain) UIWindow *window;
@end
```

Listing 7.28 The implementation of the application delegate class for the modal view controller application.

```
#import "CDEAppDelegate.h"
#import "MainViewController.h"

@implementation CDEAppDelegate
@synthesize window;

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]]];
    ctrl1 = [[MainViewController alloc] initWithNibName:nil bundle:nil];
    navCtrl1 = [[UINavigationController alloc]
                initWithRootViewController:ctrl1];
    [window addSubview: navCtrl1.view];
    [window makeKeyAndVisible];
}

- (void)dealloc {
    [window release];
    [ctrl1 release];
    [ navCtrl1 release];
    [super dealloc];
}
@end
```

The complete application can be found in the CDE project in the source downloads.

7.5 Summary

In this chapter, we covered the topic of view controllers. In Section 7.1, we provided a gentle introduction to view controllers by presenting a simple application with a single view controller. This application demonstrated important view controller concepts. In Section 7.2, we talked about tab bar controllers and how they can be used in the construction of radio interfaces. In Section 7.3, we talked about navigation controllers used primarily for presenting hierarchical information to the user. After that, Section 7.4 talked about modal view controllers and provided a detailed example showing their appropriate usage.

Problems

- (1) Study the `UIViewController.h` header file and the documentation on `UIViewController` class.
- (2) After reading the relevant chapters in this book, come back here and write an application that remembers the last tab before termination and selects that tab when it is launched for the next time.

8

Special-Purpose Views

This chapter presents several important subclasses of the `UIView` class. In Section 8.1, we discuss picker views and show how they can be used for item selection. In Section 8.2, we discuss progress views and also talk about activity indicator views. Next, Section 8.3 shows how to use scroll views in order to display large (greater than 320×480) views. Section 8.4 presents text views used in displaying multiline text. In Section 8.5 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 discussed in Section 8.6. In Section 8.7, we discuss several aspects of web views. Finally, we provide a summary in Section 8.8.

8.1 Picker View

The `UIPickerView` class can be used for giving the user a fancy way to select an item from a set of values. The class allows you to have multiple sets of values where each set is represented by a wheel (see Figure 8.1 for an example). The user spins the wheel in order to select a specific value from a given set. The values in a given set can be views (such as instances of `UILabel`, `UIImageView`, etc.) or strings.



Figure 8.1 An example of a picker view.

Each wheel is a graphical representation of a *component*. Components are numbered starting from 0. Each component contains *rows* (i.e., the set of values). Rows are also numbered starting from 0.

You can dynamically change the contents of any component. To force a change in the contents of a specific component, change the underlying data model (e.g., the array) representing the values of the component and call the `UIPickerView`'s method `reloadComponent:` passing in the component index. If you would like to change all the components, call the method `reloadAllComponents`.

8.1.1 The delegate

To use an instance of a `UIPickerView`, you need to set up a delegate for it. This delegate must adopt the protocol `UIPickerViewDelegate` and implement specific methods defined by this protocol.

To actually construct the view contents, the `UIPickerView` instance needs the value for each (component, row) pair. The delegate has to implement either a method which returns an `NSString` instance, or a `UIView` instance. The method which returns an `NSString` instance is declared as:

```
- (NSString *)pickerView:(UIPickerView *)pickerView  
    titleForRow:(NSInteger)row  
    forComponent:(NSInteger)component
```

where `pickerView` is the picker view requesting the title value, and `row` is the row number inside component.

The method which returns an instance of a `UIView` is declared as:

```
- (UIView *)pickerView:(UIPickerView *)pickerView  
    viewForRow:(NSInteger)row  
    forComponent:(NSInteger)component  
    reusingView:(UIView *)view
```

where `view` is a previously used view for this (component, row) pair. If this is adequate, you can just return this value. Otherwise, return a new view instance.

In addition, the delegate must implement the following two methods:

```
- (NSInteger)numberOfComponentsInPickerView:(UIPickerView *)pickerView
```

This method provides the number of components (wheels) that the picker view instance should construct.

```
- (NSInteger)pickerView:(UIPickerView *)pickerView  
    numberOfRowsInComponent:(NSInteger)component
```

This method provides the number of rows that the component contains.

In addition to these required methods, you can implement the following methods if you choose to:

- `pickerView:rowHeightForComponent:` is used to provide the view with the height (in points) of a given component. The method is declared as:

- (CGFloat)pickerView:(UIPickerView *)pickerView
rowHeightForComponent:(NSInteger)component
- pickerView:widthForComponent : is used to provide the view with the width (in points) of a given component. The method is declared as:
 - (CGFloat)pickerView:(UIPickerView *)pickerView
widthForComponent:(NSInteger)component
- pickerView:didSelectRow:inComponent : is used by the picker view to inform the delegate that a given row in a specific component was selected. The method is called once the wheel settles on a specific row. The method is declared as:
 - (**void**)pickerView:(UIPickerView *)pickerView
didSelectRow:(NSInteger)row
inComponent:(NSInteger)component

8.1.2 An example

Let's illustrate the concepts behind the `UIPickerView` class through a concrete example. We would like to construct a view in which the user chooses a street name and the direction on that street. The example utilizes two classes: the application delegate, `PVAppDelegate`, and the view controller, `PVVViewController`.

Listings 8.1 and 8.2 show the declaration and definition of the application delegate class, respectively.

Listing 8.1 The file `PVAppDelegate.h` declaring the application delegate.

```
#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>

@class PVViewController;

@interface PVAppDelegate : NSObject {
    UIWindow           *window;
    PVViewController   *viewController;
}
@end
```

The application delegate creates the view controller and initializes it with the array of street names.

Listing 8.2 The file `PVAppDelegate.m` defining the application delegate.

```
#import "PVAppDelegate.h"
#import "PVViewController.h"
```

```
@implementation PVAppDelegate

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window=[[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]];
    NSArray *arr = [NSArray arrayWithObjects:
                     @"Plano PKWY", @"Coit Road",
                     @"Preston Road", @"Legacy",
                     @"Independence", nil];
    viewController = [[PVViewController alloc] initWithStreetNames:arr];
    [window addSubview:viewController.view];
    [window makeKeyAndVisible];
}

- (void)dealloc {
    [window release];
    [viewController release];
    [super dealloc];
}
@end
```

Listings 8.3 and 8.4 show the view controller declaration and definition, respectively.

Listing 8.3 The file PVViewController.h declaring the view controller.

```
#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>

@interface PVViewController : UIViewController<UIPickerViewDelegate> {
    UIPickerView      *pickerView;
    NSArray          *streetNames;
    NSMutableArray   *directions;
}
-(id) initWithStreetNames:(NSArray*) streets;
@end
```

Listing 8.4 The file PVViewController.m defining the view controller.

```
#import "PVViewController.h"

@implementation PVViewController
-(id)initWithStreetNames:(NSArray*) streets{
    if (self = [super init]) {
        directions = [[NSMutableArray arrayWithObjects:@"East",@"West",nil]
                      retain];
```

```
    streetNames = [streets copy];
}
return self;
}
- (id)init{
    return [self initWithStreetNames:
               [NSArray arrayWithObjects:@"Street Name", nil]];
}
- (void)loadView {
//Create the main view
UIView *theView =
    [[UIView alloc] initWithFrame:[UIScreen mainScreen].applicationFrame];
theView.autoresizingMask =
    UIViewAutoresizingFlexibleHeight | UIViewAutoresizingFlexibleWidth;
// Create the picker view
pickerView = [[UIPickerView alloc] initWithFrame:CGRectMakeZero];
CGSize pickerSize = [pickerView sizeThatFits:CGSizeZero];
pickerView.frame= CGRectMake(0,0,pickerSize.width,pickerSize.height);
pickerView.autoresizingMask = UIViewAutoresizingFlexibleWidth;
pickerView.delegate = self;
pickerView.showsSelectionIndicator = YES;
[theView addSubview:pickerView];
self.view = theView;
}
- (void)dealloc {
[pickerView release];
[directions release];
[streetNames release];
[super dealloc];
}
// Delegate methods
- (void)pickerView:(UIPickerView *)pickerView
    didSelectRow:(NSInteger) row
    inComponent:(NSInteger) component{
NSString *street, *direction;
street =
    [streetNames objectAtIndex:[pickerView selectedRowInComponent:0]];
direction =
    [directions objectAtIndex:[pickerView selectedRowInComponent:1]];
if(component ==0){
    if( ([street isEqualToString:@"Coit Road"] == YES) ||
       ([street isEqualToString:@"Preston Road"] == YES) ||
       ([street isEqualToString:@"Independence"] == YES)){
        [directions removeAllObjects];
        [directions addObject:@"North"];
        [directions addObject:@"South"];
        [pickerView reloadComponent:1];
    }
}
```

```
    else{
        [directions removeAllObjects];
        [directions addObject:@"East"];
        [directions addObject:@"West"];
        [pickerView reloadComponent:1];
    }
    printf("Selected row in Component 0 is now %s.
           Selected row in Component 1 remains %s\n",
           [street cStringUsingEncoding:NSUTF8StringEncoding],
           [direction cStringUsingEncoding:NSUTF8StringEncoding]);
}
else{
    printf("Selected row in Component 1 is now %s.
           Selected row in Component 0 remains %s\n",
           [direction cStringUsingEncoding:NSUTF8StringEncoding],
           [street cStringUsingEncoding:NSUTF8StringEncoding]);
}
}
- (NSString *)pickerView:(UIPickerView *)pickerView
    titleForRow:(NSInteger)row
    forComponent:(NSInteger)component{
if (component == 0){
    return [streetNames objectAtIndex:row];
}
else{
    return [directions objectAtIndex:row];
}
}
- (CGFloat)pickerView:(UIPickerView *)pickerView
    widthForComponent:(NSInteger)component{
if (component == 0)
    return 200.0;
else
    return 100.0;
}
- (CGFloat)pickerView:(UIPickerView *)pickerView
    rowHeightForComponent:(NSInteger)component{
return 40.0;
}
- (NSInteger)pickerView:(UIPickerView *)pickerView
    numberOfRowsInComponent:(NSInteger)component{
if (component == 0){
    return [streetNames count];
}
else{
    return [directions count];
}
}
```

```
- (NSInteger)numberOfComponentsInPickerView: (UIPickerView *)pickerView{
    return 2;
}
@end
```

The controller uses two arrays as the underlying data model for the picker view. The `streetNames` array holds the names of the streets. The `directions` mutable array is a dynamic array that contains the directions available on the currently selected street. Initialization of the data model is done in the method `initWithStreetNames:`.

The creation of the picker view is done in the controller's `loadView` method. The `UIPickerView` object is special in that it calculates the optimal size of itself internally. Therefore, you should use `CGRectZero` in the initialization. To fit the view using the internally calculated frame, use the `UIPickerView` instance method `sizeThatFits:` and pass a `CGRectZero`.

Once you have the optimal width and height of the view, you should update the picker view's frame. To finish the setup, set the property `showsSelectionIndicator` to YES, make the controller the delegate, and add the picker view to the main view.

Since the second component, the street directions, is a function of the selected street, we need to change its underlying data model when the currently selected street changes. The method `pickerView:didSelectRow:inComponent:` is a delegate method that is called whenever the selected row of a component changes. This is a good place to put the logic that will change the data model of the street directions component.

The method starts by retrieving the two selected rows. To retrieve a selected value from a component, use the method `selectedRowInComponent:`. If the selected row is in the first component (the streets wheel), the method determines the street directions, and updates the second wheel. To update a component, you should update the data model (the array `directions`), and call the picker view's method `reloadComponent:` passing in the component number.

Figure 8.2 shows the application main window. The complete application can be found in the `Picker View 1` project available from the source downloads.

8.2 Progress Views

Progress views (see Figures 8.3 and 8.4) are visual indicators to the user showing that a task is being executed. If you can quantify the progress of a task, an instance of `UIProgressView` is used. If, on the other hand, you do not know how long the task will take, an instance of `UIActivityIndicator` is more suitable.

There is only one main attribute of a `UIProgressView` instance: `progress`. The property declaration of `progress` is as follows:

```
@property(nonatomic) float progress
```



Figure 8.2 A picker view allowing the user to choose a street name and a direction.



Figure 8.3 An example of a progress view.

The value taken by `progress` ranges from `0.0` to `1.0`. Whenever the `progress` value is changed, the view updates itself.

To make an instance of `UIActivityIndicatorView` start spinning, invoke the method `startAnimating`. To make it stop, send the message `stopAnimating`. If the Boolean attribute `hidesWhenStopped` is `YES` (the default), the activity indicator view hides itself when you send the `stopAnimating` message. There are several `UIActivityIndicatorViewStyle` values that you can use to set the `activityIndicatorViewStyle` property. Examples include: `UIActivityIndicatorViewStyleGray`, `UIActivityIndicatorViewStyleWhite`, and `UIActivityIndicatorViewStyleWhiteLarge`.

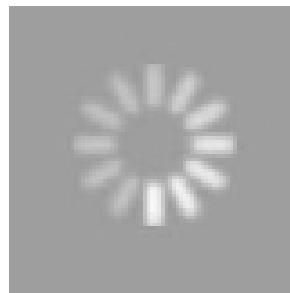


Figure 8.4 An example of a activity indicator view.

8.2.1 An example

Let's illustrate the concepts behind the two classes through a concrete example. The example utilizes two classes: the application delegate, `PVAppDelegate`, and the view controller, `PVViewController`.

Listings 8.5 and 8.6 show the declaration and definition of the application delegate class, respectively.

Listing 8.5 The file `PVAppDelegate.h` declaring the application delegate.

```
#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>
@class PVViewController;
@interface PVAppDelegate : NSObject {
    UIWindow          *window;
    PVViewController *viewController;
}
@end
```

Listing 8.6 The file `PVAppDelegate.m` defining the application delegate.

```
#import "PVAppDelegate.h"
#import "PVViewController.h"
@implementation PVAppDelegate
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]];
    viewController = [[PVViewController alloc] init];
    [window addSubview:viewController.view];
    [window makeKeyAndVisible];
}
- (void)dealloc {
    [window release];
}
```

```
    [viewController release];
    [super dealloc];
}
@end
```

Listings 8.7 and 8.8 show the declaration and definition of the view controller class. The main view, `theView`, houses two subviews: an instance of a `UIProgressView` and an instance of a `UIActivityIndicatorView`.

We first create the progress bar and set the initial progress to 0. After that, the activity indicator is created and the animation is started. Next, we create, for demonstration purposes, an instance of NSTimer. The timer is set up to invoke our method `updateProgress:` once every second.

Inside the `updateProgress:` method, we update the value for `progress`; thus advancing the indicator of the progress bar by 1/10. If the task is finished (i.e., 10 seconds have passed), we send a `stopAnimating` to the activity indicator and stop the timer.

Listing 8.7 The file PVViewController.h declaring the view controller.

```
#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>
@interface PVViewController : UIViewController {
    UIProgressView           *progressBar;
    UIActivityIndicatorView *activityIndicator;
}
@end
```

Listing 8.8 The file PVViewController.m defining the view controller.

```
#import "PVViewController.h"
@implementation PVViewController
- (void)loadView {
    //Create the main view
    UIView *theView =
        [[UIView alloc] initWithFrame:[UIScreen mainScreen].applicationFrame];
    theView.autoresizingMask = UIViewAutoresizingFlexibleHeight |
                                UIViewAutoresizingFlexibleWidth;
    [theView setBackgroundColor:[UIColor grayColor]];
    //Create the progress bar
    CGRect frame = CGRectMake(50.0, 100.0, 200, 40);
    progressBar = [[UIProgressView alloc] initWithFrame:frame];
    progressBar.progressViewStyle = UIProgressViewStyleDefault;
    progressBar.progress = 0.0;
    [theView addSubview:progressBar];
    //Create the activity indicator
    frame = CGRectMake(150.0, 200.0, 40, 40);
    activityIndicator =
        [[UIActivityIndicatorView alloc] initWithFrame:frame];
```

```

activityIndicator.activityIndicatorViewStyle =
    UIActivityIndicatorViewStyleWhite;
[activityIndicator startAnimating];
[theView addSubview:activityIndicator];
//Create a timer for demo purposes
[NSTimer scheduledTimerWithTimeInterval:1
    target:self
    selector:@selector(updateProgress:)
    userInfo:nil repeats:YES];
self.view = theView;
}
- (void)updateProgress:(NSTimer*)theTimer{
progressBar.progress += 0.1;
if(progressBar.progress >= 1.0){
    [theTimer invalidate];
    [activityIndicator stopAnimating];
}
}
- (void)dealloc {
    [progressBar release];
    [activityIndicator release];
    [super dealloc];
}
@end

```

Figure 8.5 shows a screenshot of the application. The complete application can be found in the *ProgressView* project available from the source downloads.

8.3 Scroll View

The `UIScrollView` class is used to display a view that is bigger than the screen dimensions. Usually, the scroll view takes the size of the full screen.

Let's illustrate the scroll view through an example. We would like to show a large picture on the screen. Since the size of this picture exceeds the screen dimensions, we need to use a scroll view to manage panning and zooming of the picture.

A `UIImageView` class is used to encapsulate an image in a view. We will create the image view and add it to a scroll view. The scroll view is used to set the `view` property of a view controller as shown below:

```

- (void)loadView {
UIImageView *imgView =
    [[[UIImageView alloc] initWithImage:
        [UIImage imageNamed:@"picture.jpg"]] autorelease];
imgView.tag = 100;

```



Figure 8.5 Providing visual clues to the user regarding the progress of a given task.

```
UIScrollView *scrollView = [[[UIScrollView alloc]
    initWithFrame:CGRectMake(0, 0, 320, 480)] autorelease];
scrollView.delegate = self;
scrollView.minimumZoomScale = 0.25;
scrollView.maximumZoomScale = 2;
scrollView.bounces = NO;
scrollView.showsHorizontalScrollIndicator = NO;
scrollView.showsVerticalScrollIndicator = NO;
scrollView.contentSize = imgView.frame.size;
scrollView.contentOffset =
    CGPointMake((imgView.frame.size.width-320)/2,
               (imgView.frame.size.height-480)/2);
[scrollView addSubview:imgView];
self.view = scrollView;
}
```

The code above shows the `loadView` method of the view controller. It starts by creating an image view initialized with an image. Next, the scroll view is created to fit the whole screen. The `minimumZoomScale` is used to control how small the image can be zoomed out relative to its size. The default

is 1.0 and we choose 0.25. The `maximumZoomScale` is used to specify how large the image can be zoomed in relative to its size. The default is 1.0 and we choose 2.0.

The `contentSize` property is used to specify the size of the content the scroll view is supposed to manage. We set that value to the size of the image.

The `contentOffset` specifies the offset point of the origin of the image to the origin of the scroll view. We want to center the image when the view appears, so we offset the image origin relative to the scroll view origin.

To accommodate zooming in/out, we must implement the delegate method `viewForZoomingInScrollView:` as shown below.

```
- (UIView *)viewForZoomingInScrollView:(UIScrollView *)scrollView {
    return [self.view viewWithTag:100];
}
```

It suffices to return the image view. Since it was tagged with a 100, we retrieve that from its parent view, the scroll view. The complete source code of this application can be found in the `ScrollView` project in the source downloads.

8.4 Text View

The class `UITextView` is a subclass of `UIScrollView` (which extends `UIView`). You can use this class to display multiline text with a given color, font, and text alignment (see Figure 8.6).

This is a text. This is only a text.

Figure 8.6 An example of a text view.

The following are the main properties of this class.

- `text`. The value of this property is the text displayed inside this view. The property is declared as:

```
@property(nonatomic, copy) NSString *text
```

- `font`. This represents the font of the text. Note that you can only have one font for the whole text. The property is declared as:

```
@property(nonatomic, retain) UIFont *font
```

- `textColor`. This represents the color of the text. As in the font's case, only one color can be used. The property is declared as:

```
@property(nonatomic, retain) UIColor *textColor
```

- `textAlignment`. The value dictates the alignment of the text in the view. The property is declared as:

```
@property(nonatomic) NSTextAlignment textAlignment
```

The alignment can be `left` (`UITextAlignmentLeft`), `right` (`UITextAlignmentRight`), or `center` (`UITextAlignmentCenter`). The default is left alignment.

- `editable`. This value determines whether the text can be edited or not. The property is declared as:

```
@property(nonatomic, getter=isEditable) BOOL editable
```

8.4.1 *The delegate*

The delegate of this class should adopt the `UITextViewDelegate` protocol. All methods in this protocol are optional. The delegate will receive messages related to the editing of the text. These message are the following:

- `textViewShouldBeginEditing:`. The delegate is queried whether the text view should begin editing. This is triggered by the user touching inside the text area. You return `YES`, if you want editing to begin, and `NO`, otherwise.
- `textViewDidBeginEditing:`. This is received immediately after editing starts, but before the text is actually changed.
- `textViewShouldEndEditing:`. This is received when the text view resigns as the first responder. You return `YES` to end editing, and `NO`, otherwise.
- `textViewDidEndEditing:`. This is received to inform the delegate that the text view has ended the editing.

8.4.2 *An example*

To illustrate the concepts behind the `UITextView` class, let's look at an example. We will create a multiline text area and allow the user to edit it. The user will be able to signal the end of the editing by pressing a Done button.

The example uses two classes: the application delegate shown in Listings 8.9 and 8.10, and the view controller shown in Listings 8.11 and 8.12.

Listing 8.9 The file `TVAppDelegate.h` declaring the application delegate.

```
#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>
@class TVViewController;
@interface TVAppDelegate : NSObject {
    UIWindow           *window;
    TVViewController   *viewController;
}
@end
```

Listing 8.10 The file `TVAppDelegate.m` defining the application delegate.

```
#import "TVAppDelegate.h"
#import "TVViewController.h"
@implementation TVAppDelegate
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[UIWindow alloc] initWithFrame: [[UIScreen mainScreen] bounds]];
    viewController = [[TVViewController alloc] init];
    [window addSubview:viewController.view];
    // make the window key and visible
    [window makeKeyAndVisible];
}
- (void)dealloc {
    [window release];
    [viewController release];
    [super dealloc];
}
@end
```

Inside the `loadView` method of the view controller, we allocate an instance of `UITextView`, initialize it with a size of (320, 200), and position it at (0, 50). The text color, font, and background color of the text area are then configured.

An initial text can be added to the view. Notice how the "\n" is used to form a new line. The return key type used is `UIReturnKeyTypeDefault`. The keyboard type is assigned a value of `UIKeyboardTypeDefault`.

After creating the text view area and adding it to the view, `theView`, the method continues and creates and configures a Done button. When pushed, the Done button will resign the text view instance as the first responder, thus hiding the keyboard.

Listing 8.11 The file TVViewController.h declaring the view controller.

```
#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>
@interface TVViewController : UIViewController <UITextViewDelegate>{
    UITextView *textView;
    UIButton    *doneButton;
}
@end
```

Listing 8.12 The file TVViewController.m defining the view controller.

```
#import "TVViewController.h"
@implementation TVViewController
- (void)loadView {
    //Create the main view
    UIView *theView =
        [ [UIView alloc] initWithFrame:[UIScreen mainScreen].applicationFrame];
    theView.autoresizingMask = UIViewAutoresizingFlexibleHeight |
        UIViewAutoresizingFlexibleWidth;
    CGRect frame = CGRectMake(0.0, 50.0, 320, 200.0);
    textView = [ [UITextView alloc] initWithFrame:frame];
    textView.textColor = [UIColor blackColor];
    textView.font = [UIFont fontWithName:@"Arial" size:20];
    textView.delegate = self;
    textView.backgroundColor = [UIColor whiteColor];
    textView.text = @"Dear Sir/Madam, \n I would like ";
    textView.returnKeyType = UIReturnKeyDefault;
    textView.keyboardType = UIKeyboardTypeDefault;
    [theView addSubview: textView];

    doneButton =
        [ [UIButton buttonWithType:UIButtonTypeRoundedRect] retain];
    doneButton.frame = CGRectMake(210.0, 5.0, 100, 40);
    [doneButton setTitle:@"Done" forState:UIControlStateNormal];
    [doneButton addTarget:self action:@selector(doneAction:)
        forControlEvents:UIControlEventTouchUpInside];
    doneButton.enabled = NO;
    [theView addSubview: doneButton];
    self.view = theView;
}
- (void)doneAction:(id)sender{
    [textView resignFirstResponder];
    doneButton.enabled = NO;
}
//UITextView delegate methods
- (BOOL)textViewShouldBeginEditing:(UITextView *)textView{
    printf("textViewShouldBeginEditing\n");
    return YES;
```

```

}
- (void)textViewDidBeginEditing:(UITextView *)textView{
    printf("textViewDidBeginEditing\n");
    doneButton.enabled = YES;
}
- (BOOL)textViewShouldEndEditing:(UITextView *)textView{
    printf("textViewShouldEndEditing\n");
    return YES;
}
- (void)textViewDidEndEditing:(UITextView *)textView{
    printf("textViewDidEndEditing\n");

}
- (void)dealloc {
    [textView release];
    [doneButton release];
    [super dealloc];
}
@end

```

As we mentioned earlier, all the delegate methods are optional. Of those, we implement four methods. When the editing of the text view starts, the method `textViewDidBeginEditing:` is called. In this method, we enable the `Done` button, thus allowing the user to quit editing when they have finished. The other three methods are for demo purposes and achieve the default behavior. Figure 8.7 shows a screenshot of the application.

8.5 Alert View

Alert views are used to display an alert message to the user. This alert message consists of a title, a brief message, and one or more buttons (see Figure 8.8).

The class used for an alert view is `UIAlertView` which is a subclass of `UIView`.

To initialize an alert view, you use the convenient initializer `initWithTitle:message:delegate:cancelButtonTitle:otherButtonTitles:` declared as:

```
- (id)initWithTitle:(NSString *)title message:(NSString *)message
            delegate:(id<UIAlertViewDelegate>)delegate
            cancelButtonTitle:(NSString *)cancelButtonTitle
            otherButtonTitles:(NSString *)otherButtonTitles, ...
```

The `title` is a string used as the title for the alert view. The `message` is a descriptive text providing more details about the purpose of the alert view. The `delegate` is an object that adopts the `UIAlertViewDelegate` that will receive messages from the `UIAlertView` instance. The `cancelButtonTitle` is the title of the cancel button used to dismiss the alert view. You need



Figure 8.7 Editing a multiline text area.



Figure 8.8 An example of an alert view.

at least one button in order for the user to have the ability to dismiss the alert view. You can add one or more other buttons in `otherButtonTitles` by listing their titles in a comma-separated nil-terminated list. After initializing the alert view instance, you send it a `show` message to make it appear. The following shows the basic steps described above:

```
UIAlertView *alert = [[UIAlertView alloc]
    initWithTitle:@"Host Unreachable"
    message:@"Please check the host address"]
```

```
delegate:self cancelButtonTitle:@"OK"
otherButtonTitles: nil];
[alert show];
```

The UIAlertViewDelegate has several declared methods. You mostly need the `alertView:-clickedButtonAtIndex:` method. This method will be invoked by the alert informing the delegate of the index of the button used to dismiss the alert view. The method is declared as:

- `(void)alertView: (UIAlertView *)alertView clickedButtonAtIndex: (NSInteger)buttonIndex`

where `alertView` is the instance of the alert view that originated the call, and `buttonIndex` is the index of the button used to dismiss the alert view. The index of the first button is 0. Our implementation for this example simply logs the index used to dismiss the alert view as shown below:

- `(void)alertView: (UIAlertView *)alertView clickedButtonAtIndex: (NSInteger)buttonIndex{
 NSLog(@"The index of the alert button clicked is %d", buttonIndex);
}`

In our example, the index logged will always be 0 as we have only one button. Figure 8.9 shows the alert view example.

As we mentioned above, you can have more than one button in an alert view. The following statement adds two buttons in addition to the cancel button.

```
UIAlertView *alert = [[UIAlertView alloc]
    initWithTitle:@"Disk Error"
    message:@"Error reading sector 18"
    delegate:self cancelButtonTitle:@"Abort"
    otherButtonTitles:@"Retry", @"Fail", nil];
```

The index of the “Abort” button remains 0. The indices of the “Retry” and “Fail” buttons are 1 and 2, respectively. Figure 8.10 shows the alert view with the three buttons.

The delegate defines the method `alertViewCancel:`. This method will be called when the user taps the home button of the iPhone. If the delegate does not implement this method, tapping of the cancel button is simulated and the alert view is dismissed. If you decide not to implement this delegate method, make sure that the cancel button is used for *cancellation*. If you use it to, say, make a phone call, then receiving a phone call while the alert view is showing will result in rejecting the call and dialing the number!



Figure 8.9 An alert view with one button.



Figure 8.10 An alert view with three buttons.

8.6 Action Sheet

Action sheets are similar to alert views in that they present a message to the user and one or more buttons. Action sheets, however, differ in how they look and in how they are presented to the user (see Figure 8.11).

To present an action sheet to the user, allocate a new instance of the class `UIActionSheet` and initialize it using the `initWithTitle:delegate:cancelButtonTitle:destructiveButtonTitle:otherButtonTitles:` initializer. The initializer is declared as:

```
- (id) initWithTitle: (NSString *) title
    delegate: (id <UIActionSheetDelegate>) delegate
    cancelButtonTitle: (NSString *) cancelButtonTitle
    destructiveButtonTitle: (NSString *) destructiveButtonTitle
    otherButtonTitles: (NSString *) otherButtonTitles, ...
```

The `title` is used to specify the title of the action sheet. You specify a delegate using the `delegate` parameter. A cancel button title is specified in the `cancelButtonTitle` parameter. A destructive button (shown in red) title is specified in `destructiveButtonTitle`. Additional buttons can be

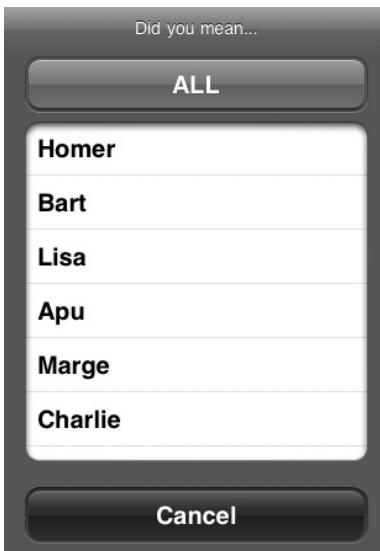


Figure 8.11 An example of an action sheet.

specified in a comma-separated nil-terminated list using the `otherButtonTitles` parameter. After the creation and initialization of the action sheet, you show it in a view using the `showInView:` method passing in the parent view instance. A simple action sheet is presented to the user as follows:

```
UIActionSheet *
actionSheet = [[UIActionSheet alloc]
    initWithTitle:@"Are you sure you want to erase all data?"
    delegate:self cancelButtonTitle:@"Cancel"
    destructiveButtonTitle:@"ERASE" otherButtonTitles:nil];
[actionSheet showInView:self.view];
```

Figure 8.12 shows the action sheet created by the above code.

The delegate `UIActionSheetDelegate` defines several optional methods. If you want to know which button was tapped by the user, you need to implement the method `actionSheet:clickedButtonAtIndex:`. The indices start at 0. In the example above, “Cancel” has an index of 0 and “ERASE” has an index of 1.

8.7 Web View

This section introduces the `UIWebView` class. `UIWebView` is a subclass of `UIView` that allows you to present rich content to the user. We begin by first showing a simple web view application.



Figure 8.12 An action sheet with two buttons.

8.7.1 A simple web view application

Let's start by looking at a simple application that utilizes a web view. The application will present an array of personal records in the form of an HTML table (see Figure 8.13).

Records Found:

Database

Name	Address	Phone
John Doe	1234 Fake st	(555) 555-1234
Jane Doe	4321 Fake st	(555) 555-7898

Figure 8.13 A screenshot of the simple web view application showing the data in the form of an HTML table.

Listing 8.13 shows the declaration of the application delegate class.

Listing 8.13 The declaration of the application delegate class used in the simple web view application.

```
#import <UIKit/UIKit.h>

@interface DWebViewAppDelegate : NSObject <UIApplicationDelegate> {
    UIWindow *window;
    NSArray *records;
}
@property (nonatomic, retain) UIWindow *window;
- (NSString*) allRecordsInHTML;
@end
```

The class keeps a reference to the records, to be presented in the form of a table, in the `records` `NSArray` instance. The `allRecordsInHTML` method is used by the application delegate to produce an HTML representation of the personal records found in the array as we shall see later.

Listing 8.14 shows the implementation of the application delegate class.

Listing 8.14 The implementation of the application delegate class used in the simple web view application.

```
#import "DWebViewAppDelegate.h"
#import "Person.h"

@implementation DWebViewAppDelegate
@synthesize window;

- (void)loadData{
    Person *a, *b;
    a = [[Person alloc] autorelease];
    a.name = @"John Doe";
    a.address = @"1234 Fake st";
    a.phone = @"(555) 555-1234";
    b = [[Person alloc] autorelease];
    b.name = @"Jane Doe";
    b.address = @"4321 Fake st";
    b.phone = @"(555) 555-7898";
    records = [NSArray arrayWithObjects:a, b, nil];
}

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    [self loadData];
    CGRect rectFrame = [UIScreen mainScreen].applicationFrame;
    window = [[UIWindow alloc] initWithFrame:rectFrame];
    UIWebView *webView =
        [[UIWebView alloc] initWithFrame:CGRectMake(0, 0, 320, 460)];
    webView.scalesPageToFit = YES;
    NSMutableString *html = [[NSMutableString alloc] initWithCapacity:200];
    [html appendString:
        @"<html>"
```

```
" <meta name=\"viewport\" content=\"width=320\"/>
" <body>
" <h4>
" Records Found:
" </h4>
" <table border=\"1\">
" <caption>Database</caption>
" <tr>
" <td>Name</td>
" <td>Address</td>
" <td>Phone</td>
" </tr>" ];
[html appendString:[self allRecordsInHTML]];
[html appendString:
@"</table>
" </body>
" </html>";
];
[webView loadHTMLString:html baseURL:nil];
>window addSubview:webView];
[webView release];
[html release];
>window makeKeyAndVisible];
}

- (NSString*) allRecordsInHTML{
    NSMutableString *myRecords =
        [[[NSMutableString alloc] initWithCapacity:200]autorelease];
    for (Person *p in records) {
        [myRecords appendString:[p html]];
    }
    return myRecords;
}

- (void)dealloc {
    [window release];
    [super dealloc];
}
@end
```

The `applicationDidFinishLaunching:` method builds the data model by invoking the method `loadData`. For demonstration purposes, two `Person` instances are initialized and added to the `records` array. After that, the `applicationDidFinishLaunching:` creates and initializes a `UIWebView` instance similar to other `UIView` subclasses. To make the content fit the screen and allow the user zooming in/out, the `scalesPageToFit` property should be set to YES.

To load a web view instance with HTML content for display, the application uses the `loadHTMLString:baseURL:` method. This method is declared as follows:

```
- (void)loadHTMLString: (NSString *)string baseURL: (NSURL *)baseURL
```

The first parameter is the HTML to be displayed and the second parameter is the base URL for the content. Our application builds the HTML content (as we shall see shortly) and uses `nil` as the base URL. The HTML content is composed of a static part and a dynamic part. The static part consists of the HTML tags and the formatting needed to display the HTML table. The dynamic part is the portion produced by concatenating the output of every personal record, as we shall see later. Listing 8.15 shows the HTML page that is finally loaded and visualized by the web view.

If you would like the have the text of the page appear with reasonable size, you should use the meta tag `viewport` and specify 320 for the width of the page content as shown below:

```
<meta name="viewport" content="width=320" />
```

The static part of the HTML also includes the table tag and the first row specifying the columns' headings.

Listing 8.15 The HTML page that is finally loaded and visualized by the web view for the simple web view application.

```
<html>
<meta name="viewport" content="width=320" />
<body>
    <h4> Records Found: </h4>
    <table border="6">
        <caption>Database</caption>
        <tr>
            <td>Name</td> <td>Address</td> <td>Phone</td>
        </tr>
        <tr>
            <td>John Doe</td> <td>1234 Fake st</td>
            <td>(555) 555-1234</td>
        </tr>
        <tr>
            <td>Jane Doe</td> <td>4321 Fake st</td>
            <td>(555) 555-7898</td>
        </tr>
    </table>
</body>
</html>
```

The dynamic part of the HTML page is produced in the `allRecordsInHTML` method. This method simply iterates over all the elements in the `records` array and appends each item's HTML content representation. Items in the `records` array are instances of the `Person` class shown in Listings 8.16 and 8.17.

Each `Person` instance contains references to the strings `name`, `address`, and `phone` of the individual represented. The `html` method is used to produce an HTML code for a row in the table with the values of these three strings as the columns.

Listing 8.16 The declaration of the `Person` class used in the simple web view application.

```
#import <Foundation/Foundation.h>

@interface Person : NSObject {
    NSString *name, *address, *phone;
}
@property(nonatomic, assign) NSString *name;
@property(nonatomic, assign) NSString *address;
@property(nonatomic, assign) NSString *phone;
- (NSString*)html;
@end
```

Listing 8.17 The implementation of the `Person` class used in the simple web view application.

```
#import "Person.h"
@implementation Person
@synthesize name, address, phone;
- (NSString*)html{
    NSMutableString *output =
        [[[NSMutableString alloc] initWithCapacity:50] autorelease];
    [output appendString:@"<tr> <td>"];
    [output appendString:name];
    [output appendString:@"</td> <td>"];
    [output appendString:address];
    [output appendString:@"</td> <td>"];
    [output appendString:phone];
    [output appendString:@"</td> </tr>"];
    return output;
}
@end
```

The complete application can be found in the `DWebView` project in the source downloads.

8.7.2 Viewing local files

In this section, you learn how to embed images stored in your `Home` directory in a web page and present the page to the user in a web view. Listings 8.18 and 8.19 show the application delegate class declaration and implementation, respectively. The application delegate simply creates a view controller of type `MyWebViewController` and adds its view as a subview to the main window.

Listing 8.18 The declaration of the application delegate class used in viewing images in a web view.

```
#import <UIKit/UIKit.h>

@class MyWebViewController;
@interface BWebViewAppDelegate : NSObject <UIApplicationDelegate> {
    UIWindow *window;
    MyWebViewController *ctrl;
}
@property (nonatomic, retain) UIWindow *window;
@end
```

Listing 8.19 The implementation of the application delegate class used in viewing images in a web view.

```
#import "BWebViewAppDelegate.h"
#import "MyWebViewController.h"

@implementation BWebViewAppDelegate
@synthesize window;

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window = [[UIWindow alloc]
              initWithFrame:[[UIScreen mainScreen] bounds]];
    ctrl = [[MyWebViewController alloc] initWithNibName:nil bundle:nil];
    [window addSubview:ctrl.view];
    [window makeKeyAndVisible];
}

- (void)dealloc {
    [ctrl release];
    [window release];
    [super dealloc];
}
@end
```

Listing 8.20 shows the declaration of the view controller used by the application delegate. The view controller maintains a reference to a `UIWebView` instance. In addition, the `produceImageReference:withType:` method, as we shall see shortly, is used internally to generate an `IMG` HTML tag for a given local image file.

Listing 8.20 The declaration of the view controller used by the application delegate of the application showing local image files in a web view.

```
#import <UIKit/UIKit.h>

@interface MyWebViewController : UIViewController {
    UIWebView *webView;
}
```

```
- (NSString*)produceImageReference:(NSString*) imgFileName
    withType:(NSString*) imgType;
@end
```

Listing 8.21 shows the implementation of the view controller class.

Listing 8.21 The implementation of the view controller used by the application delegate of the application showing local image files in a web view.

```
#import "MyWebViewController.h"

@implementation MyWebViewController

- (void)loadView {
    CGRect rectFrame = [UIScreen mainScreen].applicationFrame;
    UIView *view = [[UIView alloc] initWithFrame:rectFrame];
    view.autoresizingMask = UIViewAutoresizingFlexibleHeight |
                           UIViewAutoresizingFlexibleWidth;
    webView =
        [[UIWebView alloc] initWithFrame:CGRectMake(0, 0, 320, 460)];
    webView.scalesPageToFit = YES;

    NSMutableString *htmlContents =
        [[NSMutableString alloc] initWithCapacity:100];
    [htmlContents appendString:
     @"<meta name=\"viewport\" content=\"width=320\"/><html><body>"];
    [htmlContents appendString:@"<H2>Hurley</H2>"];
    [htmlContents
     appendString:[self produceImageReference:@"hurley" withType:@"jpg"]];
    [htmlContents appendString:@"<H1>Hugo</H1>"];
    [htmlContents
     appendString:[self produceImageReference:@"hurley" withType:@"jpg"]];
    [htmlContents appendString:@"<H3>Jorge Garcia</H3>"];
    [htmlContents
     appendString:[self produceImageReference:@"hurley" withType:@"jpg"]];
    [webView loadHTMLString:htmlContents baseURL:nil];
    [view addSubview:webView];
    self.view = view;
    [view release];
    [htmlContents release];
}

- (NSString*)produceImageReference:(NSString*) imgFileName
    withType:(NSString*) imgType{
    NSMutableString *returnString =
        [[[NSMutableString alloc] initWithCapacity:100] autorelease];
    NSString *filePath =
```

```

[[NSBundle mainBundle] pathForResource:imgFileName
                                 ofType:imgType];
if(filePath) {
    [returnString appendString:@"<IMG SRC=\"file://"];
    [returnString appendString:filePath];
    [returnString appendString:@"\" ALT=\"";
    [returnString appendString:imgFileName];
    [returnString appendString:@"\">"];
    return returnString;
}
else return @"";
}
- (void)dealloc {
    [webView release];
    [super dealloc];
}
@end

```

The `loadView` method starts by creating the GUI objects (as we have seen in the previous section). It then proceeds to produce the web page containing image references.

To embed an image in a web page, you can use an `IMG` element. The `IMG` element has two required attributes: (1) the `src`, which is a URL specifying the location of the image, and (2) the `alt`, defining a short description of the image.

In our example, the image is stored in the application bundle (see Figure 8.14 and Chapter 10).

To specify the URL of the local image, you simply use the `file` protocol with the full path of the image file. For example, the following HTML is dynamically generated on the device:

```

<IMG SRC="file:///var/mobile/Applications/
8884F8E2-E466-4500-8FFF-6263C99016DB/web view 2.app/
hurley.jpg" ALT="hurley"
>

```

You do not need to know how we obtained the path for the image as you will learn about that in Chapter 10. The `htmlContents` mutable string is incrementally constructed to contain the full web page source. For simplicity, we embed the same image three times with different headings. The full web page that is loaded on the device is shown in Listing 8.22.

Listing 8.22 The HTML page that is finally loaded and visualized by the web view for the web view application with a page containing embedded local images.

```

<meta name="viewport" content="width=320" />
<html>
  <body>
    <H2>Hurley</H2>
    <IMG SRC="file:///var/mobile/Applications/
8884F8E2-E466-4500-8FFF-6263C99016DB/web view 2.app/

```

```
hurley.jpg" ALT="hurley">
<H1>Hugo</H1>
<IMG SRC="file:///var/mobile/Applications/
8884F8E2-E466-4500-8FFF-6263C99016DB/web view 2.app/
hurley.jpg" ALT="hurley">
<H3>Jorge Garcia</H3>
<IMG SRC="file:///var/mobile/Applications/
8884F8E2-E466-4500-8FFF-6263C99016DB/web view 2.app/
hurley.jpg" ALT="hurley">
</body>
</html>
```

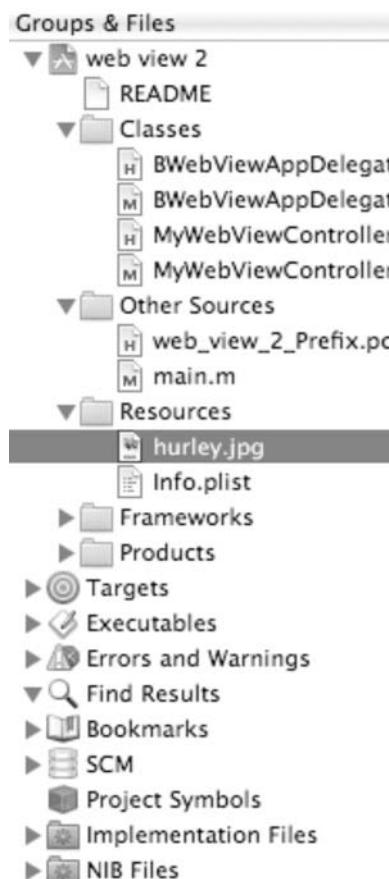


Figure 8.14 The Groups & Files content showing the `hurley.jpg` image in the Resources group.

Figure 8.15 shows a screenshot of the application showing local image files in a web view. The complete application can be found in the BWebView project in the source downloads.

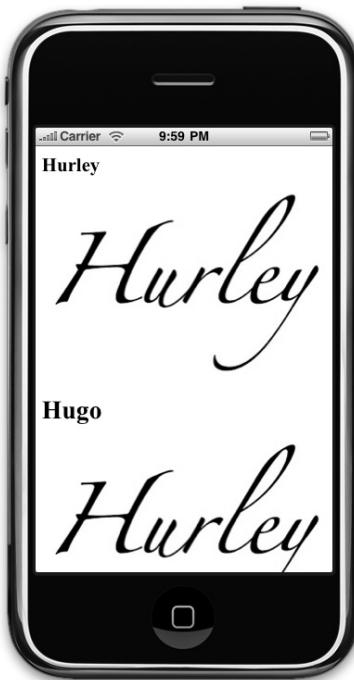


Figure 8.15 A screenshot of the application showing local image files in a web view.

8.7.3 Evaluating JavaScript

In this section, we would like to build an application that presents the user with a web page with a form and one text field (Figure 8.16).

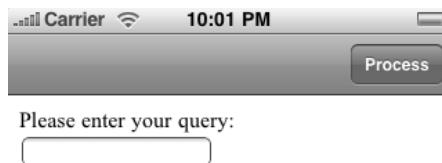


Figure 8.16 A screenshot of the application demonstrating the JavaScript–Objective-C interaction. An HTML form is provided to the user for inputting a search term.

The user enters text in the field and taps on the “Process” button on the navigation bar. If the text entered is “forbidden” (we will define the meaning of forbidden shortly), the application presents an alert view informing the user that they need to re-enter the text (Figure 8.17).



Figure 8.17 A screenshot of the application that demonstrates JavaScript execution from within Objective-C code. The screenshot shows an alert view when a forbidden query is used.

The text field is cleared and the user is given the opportunity to re-enter the text. If the text entered is not “forbidden”, the application will retrieve the text value of the field, and update the web page to have a link to a Google query of the word entered (Figure 8.18).

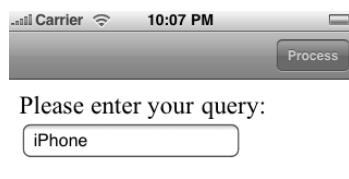


Figure 8.18 The application responding to a valid search term by updating the web page in the web view.



Figure 8.19 The search result of a valid search term viewed in the web view.

When the user taps on the generated link, the search result is displayed (Figure 8.19). That is what the application is supposed to do. Let's start constructing it.

Listing 8.23 shows the declaration of the application delegate. It maintains both a navigation controller and a view controller.

Listing 8.23 The declaration of the application delegate class used to demonstrate the execution of JavaScript code in a web view.

```
#import <UIKit/UIKit.h>

@class MyViewController;
@interface AWebViewDelegate : NSObject <UIApplicationDelegate> {
    UIWindow *window;
    MyViewController *ctrl;
    UINavigationController *navCtrl;
}
@property (nonatomic, retain) UIWindow *window;
@end
```

Listing 8.24 shows the implementation of the application delegate class. The `applicationDidFinishLaunching:` method creates a navigation controller, adds a `MyViewController` instance to it, and then adds the navigation controller's view as a subview to the main window.

Listing 8.24 The implementation of the application delegate class used to demonstrate the execution of JavaScript code in a web view.

```
#import "AWebViewDelegate.h"
#import "MyViewController.h"

@implementation AWebViewDelegate
@synthesize window;

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]];
    ctrl = [[MyViewController alloc] initWithNibName:nil bundle:nil];
    navCtrl =
        [[UINavigationController alloc] initWithRootViewController:ctrl];
    [window addSubview:navCtrl.view];
    [window makeKeyAndVisible];
}

- (void)dealloc {
    [ctrl release];
    [navCtrl release];
    [window release];
    [super dealloc];
}
@end
```

Listing 8.25 shows the declaration of the view controller class.

Listing 8.25 The declaration of the view controller class used in demonstrating evaluation of JavaScript code in a web view.

```
#import <UIKit/UIKit.h>

@interface MyViewController : UIViewController {
    UIWebView      *webView;
    UIBarButtonItem *rightButton;
}
@end
```

The controller maintains a reference to the web view instance and a right button implementing the “Process” navigation bar button.

Listing 8.26 shows the implementation of this class.

Listing 8.26 The implementation of the view controller class used in demonstrating evaluation of JavaScript code in a web view.

```
#import "MyViewController.h"
@implementation MyViewController
- (id)initWithNibName:(NSString *)NibNameOrNil
    bundle:(NSBundle *)nibBundleOrNilOrNil {
    if (self = [super initWithNibName:nibNameOrNil bundle:nibBundleOrNilOrNil]) {
        rightButton = [[UIBarButtonItem alloc]
            initWithTitle:@"Process"
            style:UIBarButtonItemStyleDone
            target:self
            action:@selector(processJavaScript)];
        self.navigationItem.rightBarButtonItem = rightButton;
        [rightButton release];
    }
    return self;
}
-(void)processJavaScript{
    NSString* var =
        [webView stringByEvaluatingJavaScriptFromString:@"getQuery()"];
    if([var isEqualToString:@"dissent"] == YES){
        UIAlertView *alert = [[UIAlertView alloc]
            initWithTitle:@"Forbidden!"
            message:@"Please enter a valid query."
            delegate:nil
            cancelButtonTitle:@"OK"
            otherButtonTitles:nil];
        [alert show];
        [webView stringByEvaluatingJavaScriptFromString:@"clearQuery()"];
        return;
    }
    NSMutableString *query=[[NSMutableString alloc] initWithCapacity:200];
    [query appendString:@"document.getElementById('anchor').href"
        "=\"http://www.google.com/search?q=\""];
    [query appendString:var];
    [query appendString:@"\";\""];
    NSMutableString *innerHTML =
        [[NSMutableString alloc] initWithCapacity:200];
    [innerHTML appendString:
        @"document.getElementById('anchor').innerHTML=\"Google \""];
    [innerHTML appendString:var];
    [innerHTML appendString:@"\";\""];
    [webView
        stringByEvaluatingJavaScriptFromString:@"loseFocusOfField()"];
    [webView stringByEvaluatingJavaScriptFromString:innerHTML];
    [webView stringByEvaluatingJavaScriptFromString:query];
    rightButton.enabled = NO;
    [query release];
}
```

```
[innerHTML release];
}
- (void)loadView {
    CGRect rectFrame = [UIScreen mainScreen].applicationFrame;
    UIView *view = [[UIView alloc] initWithFrame:rectFrame];
    view.autoresizingMask = UIViewAutoresizingFlexibleHeight |
                           UIViewAutoresizingFlexibleWidth;
    webView =
        [[UIWebView alloc] initWithFrame:CGRectMake(0, 0, 320, 460)];
    webView.scalesPageToFit = YES;
    [webView loadHTMLString:
     @"<html><head><title>Query Assistant</title>\n"
     "<meta name=\"viewport\" content=\"width=320\"/>"
     "<script>\n"
     "function getQuery() {\n"
     "return document.queryform.query.value; }"
     "function clearQuery() {\n"
     "return document.queryform.query.value=\\"\\\"; }"
     "function loseFocusOfField() {\n"
     "return document.queryform.query.blur(); }"
     "</script>\n"
     "</head><body>Please enter your query: "
     "<form name=\"queryform\">\n"
     "<input name=\"Query\" type=\"text\" "
     "value=\"\" id=\"query\" />\n"
     "<br/>\n"
     "<br/>\n"
     "<br/>\n"
     "<a id=\"anchor\" href=\"\"></a>\n"
     "</form></body></html>" baseURL:nil];
    [view addSubview:webView];
    self.view = view;
    [view release];
}
- (void)dealloc {
    [webView release];
    [rightButton release];
    [super dealloc];
}
@end
```

The `initWithNibName:bundle:` initializes the view controller's instance and adds a “Process” navigation button. The action method for this button is `processJavaScript` which we will cover shortly.

The `loadView` method creates and initializes a `UIWebView` instance and adds it to the main window. The web view is loaded with the `loadHTMLString` string. The HTML in this string is all static and is shown in Listing 8.27. The HTML contains a form with one text field. It also declares the following three functions:

- `getQuery()`: retrieves the text value of the field in the form.
- `clearQuery()`: clears the contents of the text field.
- `loseFocusOffField()`: makes the text field lose focus so that the keyboard disappears.

Listing 8.27 A static HTML specifying the main page for the application demonstrating the execution of JavaScript in a web view from within Objective-C code.

```
<html>
  <head>
    <title>Query Assistant</title>
    <meta name="viewport" content="width=320"/>
    <script>
      function getQuery() {
        return document.queryform.query.value;
      }
      function clearQuery() {
        return document.queryform.query.value="";
      }
      function loseFocusOffField() {
        return document.queryform.query.blur();
      }
    </script>
  </head>
  <body>Please enter your query:
    <form name="queryform">
      <input name="Query" type="text" value="" id="query" />
      <br/>
      <br/>
      <br/>
      <a id="anchor" href=""></a>
    </form>
  </body>
</html>
```

The `UIWebView` class allows you to evaluate JavaScript code on demand. To execute a JavaScript code, you use the `stringByEvaluatingJavaScriptFromString:` method. This method is declared as follows:

- (`NSString *`)`stringByEvaluatingJavaScriptFromString:` (`NSString *`)`script`;

The `script` parameter is an `NSString` instance containing the JavaScript code that you wish to execute. The result value of the executed JavaScript code, if any, is returned as an `NSString` object.

When the user taps on the “Process” navigation bar right button, the `processJavaScript` method is executed. In this method, we start by retrieving the text value of the field. The `getQuery()` JavaScript statement is executed and the result is returned to us. After retrieving the value, we check to see if it is equal to the text “`dissent`”. If that is the case, we show an alert view to the user (see Figure 8.17) and clear the text field by invoking the `clearQuery()` JavaScript function.

If the text value is valid, we update the web page by changing the `href` of the element whose ID is `anchor` to the Google search query. Below, we show the code generated for the search term “`iPhone`”:

```
document.getElementById('anchor').href=
    "http://www.google.com/search?q=iPhone";
```

We also update the `innerHTML` as shown in the example below:

```
document.getElementById('anchor').innerHTML="Google iPhone";
```

Both updates of the web page are then executed. In addition, we invoke the `loseFocusOffield()` JavaScript function in order to lose the keyboard.

The complete application can be found in the `AWebView` project in the source downloads.

8.7.4 The web view delegate

In this section, we build an application that intercepts the user’s web navigation activity. If the user taps on a link for a PDF file, the user is asked whether they want to download a copy for later use. We do not implement the actual downloading/storage management as this has been demonstrated in other chapters. What this section provides is an illustration of how you can intercept important changes to the web view instance due to the user’s interaction.

The `UIWebView` class has an important property, `delegate`, that allows you to intercept important calls. The `delegate` property is declared as follows:

```
@property(nonatomic,assign) id<UIWebViewDelegate> delegate
```

The `UIWebViewDelegate` protocol declares the following four optional methods:

1. `webView:shouldStartLoadWithRequest:navigationType:`: This method is invoked just before loading the content of the web page. The method is declared as follows:

```
- (BOOL)webView: (UIWebView *)webView
    shouldStartLoadWithRequest: (NSURLRequest *)request
    navigationType: (UIWebViewNavigationType)navigationType
```

You return `YES` if you want the web view to perform the loading of this request and `NO` otherwise. The first parameter is the web view instance. The second parameter is an instance of `NSURLRequest` representing the request, and the third is the navigation type that has led to loading the content.

The `NSURLRequest` class defines the `URL` method for obtaining an instance of the `NSURL` class. The `NSURL` class defines the `absoluteString` for obtaining an `NSString` instance representing the URL of the request. As you will see later, we will look into this string in order to decide whether to trigger actions or not.

There are several predefined navigation type values. The values are as follows:

- `UIWebViewNavigationTypeLinkClicked` indicates that the user tapped on a link on the page.
- `UIWebViewNavigationTypeFormSubmitted` indicates that the user submitted a form.
- `UIWebViewNavigationTypeBackForward` indicates that the user tapped on forward/backward button.
- `UIWebViewNavigationTypeReload` indicates that the user tapped on the reload button.
- `UIWebViewNavigationTypeFormResubmitted` indicates that the user resubmitted the form.
- `UIWebViewNavigationTypeOther` indicates some other navigation trigger.

This method will be implemented in our application. If the URL is a request to a PDF file, we ask the user if they want to download a copy of the file for later use.

2. `webViewDidStartLoad`: This method is used to communicate that the web view has started loading content. The method is declared as follows:

- `(void)webViewDidStartLoad: (UIWebView *)webView`

3. `webViewDidFinishLoad`: This method is used to communicate that the web view has finished loading the content. The method is declared as follows:

- `(void)webViewDidFinishLoad: (UIWebView *)webView`

4. `webView:didFailLoadWithError`: This method is used to communicate that the web view encountered an error in loading content. The method is declared as follows:

- `(void)webView: (UIWebView *)webView
didFailLoadWithError: (NSError *)error`

Listings 8.28 and 8.29 show the declaration and implementation, respectively, of the application delegate class. The delegate creates an instance of the `MyViewController` view controller and adds its view as a subview to the main window.

Listing 8.28 The declaration of the application delegate class of the application demonstrating interception of web view user interactions.

```
#import <UIKit/UIKit.h>
@class MyViewController;
@interface EWebViewAppDelegate : NSObject <UIApplicationDelegate> {
    UIWindow *window;
}
```

```
    MyViewController *ctrl;
}
@property (nonatomic, retain) UIWindow *window;
@end
```

Listing 8.29 The implementation of the application delegate class of the application demonstrating interception of web view user interactions.

```
#import "EWebViewAppDelegate.h"
#import "MyViewController.h"

@implementation EWebViewAppDelegate
@synthesize window;
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]];
    ctrl = [[MyViewController alloc] initWithNibName:nil bundle:nil];
    [window addSubview:ctrl.view];
    [window makeKeyAndVisible];
}
- (void)dealloc {
    [ctrl release];
    [window release];
    [super dealloc];
}
@end
```

Listings 8.30 and 8.31 show the declaration and implementation, respectively, of the view controller class. The class maintains a reference to the web view that is created in the `loadView` method. The web view is made to allow scaling and the `delegate` property is set to the view controller instance. The web view is made to start with the Google search page (Figure 8.20). The view controller only implements the `webView:shouldStartLoadWithRequest:navigationType:` method of the `UIWebViewDelegate` protocol.

The `webView:shouldStartLoadWithRequest:navigationType:` method first retrieves the URL string of the request. It checks to see if it is for a PDF file by using the `NSString`'s method `hasSuffix:`. If it is for a PDF file, an alert view is displayed to the user asking for the opportunity to download it into a local directory (Figure 8.22). The PDF file is always downloaded into the web view (see Figure 8.21).

Listing 8.30 The declaration of the view controller class used in the application demonstrating interception of web view user interactions.

```
#import <UIKit/UIKit.h>
@interface MyViewController : UIViewController<UIWebViewDelegate> {
    UIWebView      *webView;
    NSString       *url;
}
@end
```



Figure 8.20 A screenshot of the application allowing additional local caching of PDF files.



Figure 8.21 Result of a search operation in the application allowing additional local caching of PDF files.

Listing 8.31 The implementation of the view controller class used in the application demonstrating interception of web view user interactions.

```
#import "MyViewController.h"
@implementation MyViewController
- (void)loadView {
    CGRect rectFrame = [UIScreen mainScreen].applicationFrame;
    UIView *view = [[UIView alloc] initWithFrame:rectFrame];
    view.autoresizingMask = UIViewAutoresizingFlexibleHeight |
                           UIViewAutoresizingFlexibleWidth;
    webView = [[UIWebView alloc] initWithFrame:CGRectMake(0, 0, 320, 460)];
    webView.scalesPageToFit = YES;
    webView.delegate = self;
    [webView loadRequest:
     [NSURLRequest requestWithURL:
      [NSURL URLWithString:@"http://www.google.com"]]];
    [view addSubview:webView];
    self.view = view;
}
```

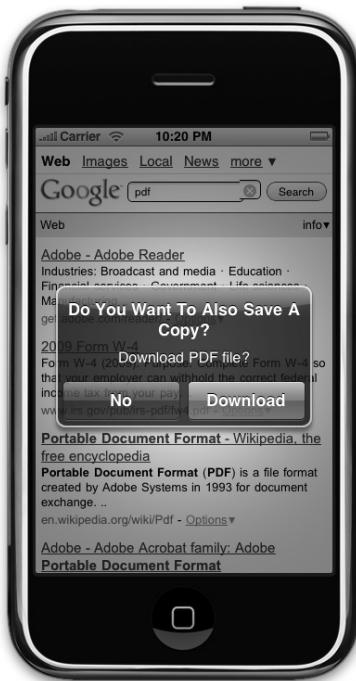


Figure 8.22 A screenshot of the application that allows additional downloading of PDF files.

```
[view release];
}
- (void)dealloc {
[webView release];
[super dealloc];
}
- (BOOL)webView:(UIWebView *)webView
shouldStartLoadWithRequest:(NSURLRequest *)request
navigationType:(UIWebViewNavigationType)navigationType{
url = [[request URL] absoluteString];
NSLog(url);
if([url hasSuffix:@".pdf"] == YES) {
UIAlertView *alert =
[[UIAlertView alloc]
initWithTitle:@"Do You Want To Also Save A Copy?"
message:@"Download PDF file?"
delegate:self
cancelButtonTitle:@"No"
otherButtonTitles:@"Download", nil] autorelease];
```

```
    [alert show];
}
return YES;
}
- (void)alertView:(UIAlertView *)alertView
clickedButtonAtIndex:(NSInteger)buttonIndex{
if(buttonIndex == 1){ //download?
NSLog(@"%@", @" ...", url);
}
}
@end
```

The complete application can be found in the EWebView project in the source downloads.

8.8 Summary

This chapter presented several important subclasses of the `UIView` class. In Section 8.1, we discussed picker views and showed how they can be used for item selection. In Section 8.2, we discussed progress views and also talked about activity indicator views. Next, Section 8.3 showed how to use scroll views in order to display large (greater than 320×480) views. Section 8.4 presented text views used in displaying multiline text. In Section 8.5 we showed how to use alert views for the display of alert messages to the user. Similar to alert views are action sheets which were discussed in Section 8.6. Finally, in Section 8.7, we discussed several aspects of web views.

Problems

- (1) Study the `UIWebView` class using its header file and the documentation.
- (2) After reading the relevant chapters from the text, come back to this chapter and implement the downloading part discussed in Section 8.7. Use a table view to present the downloaded files.
- (3) Construct a view that hosts a multi-line text area and a label underneath it. The label shows the number of characters entered inside the text area out of 255. The text area should not accept more than 255 characters.

9

Table View

A table view is an important and widely used graphical user interface object in the iPhone OS. Understanding table views is essential to writing iPhone applications. Fortunately, programming table views could not be any easier.

This chapter takes 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 in Section 9.1. After that, we present in Section 9.2 a simple table view application and discuss the mandatory methods you need to implement in order to populate and respond to the user's interaction with the table view.

In Section 9.3, we show how easy it is to add images to table rows. Section 9.4 introduces the concept of sections and provides a table view application that has sections with section headers and footers.

In Section 9.5, 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. In Section 9.6, we address the insertion of new rows in a table view. An application that presents a data entry view to the user and adds that new data to the table's rows is discussed. In Section 9.7, we continue our discussion of the editing mode and present an application for reordering table entries. The main concepts of reordering rows are presented.

Section 9.8 covers the mechanism for presenting hierarchical information to the user, and an application that uses table views to present three levels of hierarchy is discussed. In Section 9.9, we discuss grouped table views through an example. After that, we present the main concepts behind indexed table views in Section 9.10. In Section 9.11, we present a dynamic table view controller class. This class can be used to show cells with varying heights. In Section 9.12, we address the issue of turning the text color to white when a custom cell is selected. Finally, we summarize the chapter in Section 9.13.

9.1 Overview

To use a table view in your application, you need to create an instance of the class `UITableView`, configure it, and add it as a subview to another view. The `UITableView` class is a subclass of

`UIScrollView`; which itself is a subclass of `UIView`. The table view allows for only one column and zero or more rows. Each row in the table is represented by a cell. A cell is an instance of the class `UITableViewCell`. The cell comes with four different styles to choose from. In addition, you can access its `contentView` property which allows you to configure the cell any way you want.

The `UITableView` class relies on two external objects: one for providing the data that will be displayed, and the other for controlling the appearance of the table. The object supplying the data model must adopt the `UITableViewDataSource` protocol, while the object supplying the visual aspects of the table must adopt the `UITableViewDelegate` protocol.

The following sections show you how to create and configure a table view starting from a simple table and gradually adding more features.

9.2 The Simplest Table View Application

In this section, we present the simplest table view application. This application presents, in a tabular form, a list of characters from the Simpsons show. The application accepts all the default values for the table view. It does not implement any of the table's delegate methods as all of them are optional. It does, however, use the application delegate as the data source and implements the two required methods of the `UITableViewDataSource` protocol.

Listing 9.1 shows the declaration of the application delegate class `TVAppDelegate`. The application delegate manages the table view and acts as the data source. The complete source code can be found in the `TableView1` project which can be found in the source downloads.

As you have learned before, the class adopts the protocol by listing it after its superclass as follows: `NSObject<UITableViewDataSource>`. In addition to the `myTable` `UITableView` instance, we keep an array of strings representing the data model in `theSimpsons` instance of `NSArray`.

Listing 9.1 The application delegate declaration (`TVAppDelegate.h`) for a simple table view application.

```
#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>

@interface TVAppDelegate : NSObject<UITableViewDataSource> {
    UIWindow      *window;
    UITableView   *myTable;
    NSArray       *theSimpsons;
}
@end
```

Listing 9.2 shows the implementation of the `TVAppDelegate` class. The application delegate manages the table view and acts as the data source.

Inside the `applicationDidFinishLaunching:` method, we perform all the initialization needed. After creating the main window, we create the table view instance. To initialize the table view, we use the method `initWithFrame:style:`. The frame used in the initialization is the area of

the application frame as we want the table to occupy the whole area available to the application. The style used is `UITableViewStylePlain`. The style of the table must be specified during the initialization phase and cannot be changed later. If you bypass this initialization method and use the `UIView`'s `initWithFrame:` initializer, the `UITableViewStylePlain` style will be used by default. To make your code readable, you should always explicitly specify the table's style even if it's the default.

The other table style that is available to you is `UITableViewStyleGrouped`. You learn about the other style in Section 9.9.

After that, we populate the array `theSimpsons` with the names that will be displayed inside the table. Next, the data source of the table view is set to the application delegate instance. The `UITableView`'s property for the data source is `dataSource` and is declared as:

```
@property(nonatomic, assign) id <UITableViewDataSource> dataSource;
```

Notice that this property uses `assign` rather than `retain`. Finally, the table view is added to the main window and the main window is made key and visible.

Listing 9.2 The application delegate definition (`TVAppDelegate.m`) for a simple table view application.

```
#import <Foundation/Foundation.h>
#import <UIKit/UIKit.h>
#import "TVAppDelegate.h"

@implementation TVAppDelegate

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window = [[UIWindow alloc]
              initWithFrame:[[UIScreen mainScreen] bounds]] ;
    myTable = [[UITableView alloc]
               initWithFrame:[UIScreen mainScreen].applicationFrame
               style:UITableViewStylePlain];
    theSimpsons = [[NSArray arrayWithObjects:
                    @"Homer Jay Simpson",
                    @"Marjorie \"Marge\" Simpson",
                    @"Bartholomew \"Bart\" J. Simpson",
                    @"Lisa Marie Simpson",
                    @"Margaret \"Maggie\" Simpson",
                    @"Abraham J. Simpson",
                    @"Santa's Little Helper",
                    @"Ned Flanders",
                    @"Apu Nahasapeemapetilon",
                    @"Clancy Wiggum",
                    @"Charles Montgomery Burns",
                    nil] retain];
    myTable.dataSource = self;
    [window addSubview:myTable];
    [window makeKeyAndVisible];
}
```

```
}

- (NSInteger)tableView:(UITableView *)tableView
    numberOfRowsInSection:(NSInteger)section{
    return [theSimpsons count];
}

- (UITableViewCell *)
    tableView:(UITableView *)tableView
    cellForRowAtIndexPath:(NSIndexPath *)indexPath{
    UITableViewCell *cell =
        [tableView dequeueReusableCellWithIdentifier:@"simpsons"];
    if (cell == nil) {
        cell = [[[UITableViewCell alloc]
            initWithStyle:UITableViewCellStyleDefault
            reuseIdentifier:@"simpsons"] autorelease];
    }
    cell.textLabel.text = [theSimpsons objectAtIndex:indexPath.row];
    return cell;
}

- (void)dealloc {
    [window release];
    [myTable release];
    [theSimpsons release];
    [super dealloc];
}
@end
```

The two required methods of the `UITableViewDataSource` protocol are:

- `tableView:numberOfRowsInSection:`. By default, the table view will have one section. You still need to specify the number of rows in that section. This method of the data source is invoked asking for that number. The method is declared as:

```
- (NSInteger)tableView:(UITableView *)table
    numberOfRowsInSection:(NSInteger)section;
```

You are given two values: the table view instance, which allows you to have the same data source method for multiple table view instances, and the section number, which in this example is always 0 (and is ignored) as we choose to take the default.

- `tableView:cellForRowIndexPath:`. The table view invokes this method asking the data source for a table cell representing a specific row. The method is declared as:

```
- (UITableViewCell *)
    tableView:(UITableView *)tableView
    cellForRowAtIndexPath:(NSIndexPath *)indexPath;
```

In addition to the table view instance, you are given an instance of `NSIndexPath`. `NSIndexPath` is used in Cocoa as a class representing a series of indices. For example: 1.5.8.33 represents an index path. This class is extended by `UITableView` by declaring a category on it as shown in Listing 9.3.

Listing 9.3 Extending the `NSIndexPath` for use in `UITableView`.

```
@interface NSIndexPath (UITableView)
+ (NSIndexPath *)indexPathForRow: (NSUInteger) row
    inSection: (NSUInteger) section;
@property(nonatomic,readonly) NSUInteger section;
@property(nonatomic,readonly) NSUInteger row;
@end
```

The category adds two properties: `section` and `row`.

Given the `NSIndexPath` instance, you can determine the cell configuration you want to return. In returning a cell, you can either create one from scratch, and return it autoreleased, or return a cached cell that is already created. You are encouraged to reuse cells. After creating a cell, you should use the designated initializer `initWithStyle:reuseIdentifier:` which is declared as:

- (`id`)`initWithStyle:(UITableViewCellStyle)style`
`reuseIdentifier:(NSString *)reuseIdentifier`

The value for `style` can be one the following constants:

- `UITableViewCellStyleDefault`. This is the default cell style prior to iPhone OS 3.0. It gives you a cell with a text label that is left-aligned and an optional image view.
- `UITableViewCellStyleValue1`. This style will give you a cell with two labels; the one on the left uses black text and is left-aligned while the one on the right holds blue text that is right-aligned.
- `UITableViewCellStyleValue2`. A cell configured with this style has two text labels: the one on the left is right-aligned with blue color and the one on the right is left-aligned with black color. The font size of the label on the right is smaller than that of the label on the left side.
- `UITableViewCellStyleSubtitle`. A cell with this style has the two text labels stacked. The one on top is left-aligned with black color while the one below it is also left-aligned but with gray color and a smaller font.

In all cases above, the larger text label is accessed via the property `textLabel` and the smaller text label is accessed via the `detailTextLabel` property. Figure 9.1 shows the four available styles.

The `reuseIdentifier` is a string used to tag the cell so that it can be easily identified for reuse in the future. Our method creates a new cell in the following statement:

```
cell = [[[UITableViewCell alloc]
        initWithStyle:UITableViewCellStyleDefault
        reuseIdentifier:@"simpsons"] autorelease];
```



Figure 9.1 Available cell styles. The row styles from top to bottom are as follows: UITableViewCellStyleDefault, UITableViewCellStyleSubtitle, UITableViewCellStyleValue1, UITableViewCellStyleValue2.

We mentioned above that you should always reuse a cached cell as much as possible. To obtain a reused cell, use the `UITableView` instance method `dequeueReusableCellWithIdentifier:` which is declared as:

```
- (UITableViewCell *)  
    dequeueReusableCellWithIdentifier:(NSString *)identifier
```

The value for `identifier` is the same tag as used in creating the cell, which in our case is `@"simpsons"`. If there is an available cell, a pointer to it is returned. If, on the other hand, there are no available cells, a `nil` value is returned.

After having a `UITableViewCell` instance, we need to configure it with values appropriate to the section and row numbers. Since we are implementing a simple table view, we only set the `text` property of `textLabel` with the corresponding value from the `theSimpsons` array (which represents the data model) as shown in the following statement:

```
cell.textLabel.text = [theSimpsons objectAtIndex:indexPath.row];
```



Figure 9.2 A screenshot of a simple text-only table view application.

Figure 9.2 shows a screenshot of the application.

9.3 A Table View with both Images and Text

In the previous section, we showed how to create a table view displaying text items. As we have mentioned before, each cell can have an image displayed to the left. In Listing 9.4, we show the updated `tableView:cellForRowAtIndexPath:` method that configures the cells to have images.

Listing 9.4 The updated method `tableView:cellForRowAtIndexPath:` for adding an image to the left side of each cell.

```
- (UITableViewCell *)  
    tableView: (UITableView *)tableView  
    cellForRowAtIndexPath: (NSIndexPath *)indexPath{  
    UITableViewCell *cell =  
        [tableView dequeueReusableCellWithIdentifier:@"simpsons"] ;  
    if (cell == nil) {  
        cell = [[[UITableViewCell alloc]
```

```
initWithStyle:UITableViewCellStyleDefault  
reuseIdentifier:@"simpsons"] autorelease];  
}  
cell.textLabel.text = [theSimpsons objectAtIndex:indexPath.row];  
NSString *imageName =  
[NSString stringWithFormat:@"%d.png", indexPath.row];  
cell.imageView.image = [UIImage imageNamed:imageName];  
return cell;  
}
```

To set up an image for the cell, set the `image` of the cell's `imageView` property to a `UIImage` instance. The property `imageView` is declared as:

```
@property(nonatomic, readonly, retain) UIImageView *imageView
```

The default value is `nil`. The image view is created on demand.

The image for each row is loaded from the application's bundle (see Chapter 10) using the `imageNamed:` class method of `UIImage`. The image files stored are named according to the

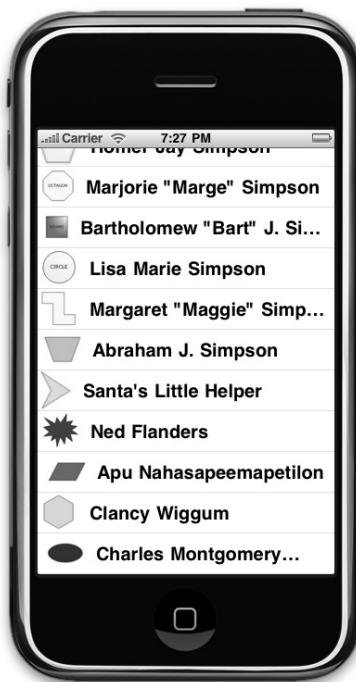


Figure 9.3 A table view with both images and text. For copyright reasons, the actual images of the characters are replaced by images of geometric shapes.

row index. For example, the image for the first row is 0.png. The `NSString` class method `stringWithFormat:` is used to obtain the name of the image to be used in the invocation of the `imageNamed:` method. Figure 9.3 shows a screenshot of the application.

9.4 A Table View with Section Headers and Footers

In the previous sections, we showed table views that had only one section. You can have a table with more than one section and have these sections presented with header and/or footer titles.

Let's modify our example so that it has a table with two sections. We need to have two arrays: one array, `theSimpsonsFamily`, holding names of the Simpsons' family, and `theSimpsonsOthers`, an array holding names of the others. We need to do the following modifications in order to have two sections.

First, modify the `numberOfSectionsInTableView:` method to return 2 for the number of sections.

Second, modify `tableView:numberOfRowsInSection:` as follows:

```
- (NSInteger)tableView:(UITableView *)tableView
    numberOfRowsInSection:(NSInteger)section{
    if(section == 0){
        return [theSimpsonsFamily count];
    }
    else{
        return [theSimpsonsOthers count];
    }
}
```

Third, if you would like a section header, add the following Data Source method:

```
- (NSString *)
tableView:(UITableView *)tableView
titleForHeaderInSection:(NSInteger)section{
if(section == 0){
    return @"The Simpsons Family";
}
else{
    return @"The Others";
}}
```

Fourth, if you would like a section footer, add the following Data Source method:

```
- (NSString *)
tableView:(UITableView *)tableView
titleForFooterInSection:(NSInteger)section{
if(section == 0){
```

```
    return @"End of Simpsons Family";
}
else{
    return @"End of The Others";
}
}
```

Finally, modify the `tableView:cellForRowAtIndexPath:` to return the appropriate cell as follows:

```
- (UITableViewCell *)tableView:(UITableView *)tableView cellForRowAtIndexPath:(NSIndexPath *)indexPath{
    UITableViewCell *cell =
        [tableView dequeueReusableCellWithIdentifier:@"simpsons"];
    if (cell == nil) {
        cell = [[[UITableViewCell alloc]
                  initWithStyle:UITableViewCellStyleDefault
                  reuseIdentifier:@"simpsons"] autorelease];
    }
    if(indexPath.section == 0){
        cell.textLabel.text =
            [theSimpsonsFamily objectAtIndex:indexPath.row];
    }
    else{
        cell.textLabel.text =
            [theSimpsonsOthers objectAtIndex:indexPath.row];
    }
    NSString *imageName =
        [NSString stringWithFormat:@"%d-%d.png",
         indexPath.row, indexPath.section];
    cell.imageView.image = [UIImage imageNamed:imageName];
    return cell;
}
```

Complete source code can be found in the `TableView2` project in the source downloads.

Figure 9.4 shows the table view with sections and section headers and footers. Notice how the headers and footers are always visible as you scroll through the table.

9.5 A Table View with the Ability to Delete Rows

The table view can be manipulated at runtime to enter an editing mode. In editing mode, you can delete, insert, and reorder rows. In this section, we will look at a table view application that allows the user to delete rows. The application uses a button that, when tapped, will make the table view instance enter the editing mode. The user will then tap on the delete button and confirm deletion.



Figure 9.4 A table view with sections and section headers and footers.

The data source of the table view will receive a message asking for confirmation of the deletion. If the data source approves such deletion, the data model, represented by a mutable array, will be updated by the removal of the corresponding element, and the table view instance is instructed to delete the row, optionally animating the deletion. These are the basic steps taken. In the following, we elaborate more on how we can achieve that.

Listing 9.5 shows the declaration of the application delegate TVAppDelegate. The application delegate manages the table view and acts as its data source. The source code can be found in the TableView3 project in the source downloads.

The application delegate will create and configure the table view and act as its data source. Notice that we have a mutable array, `theSimpsons`, that will capture our data mode. A button, `editButton`, is used in the switching between editing and non-editing modes.

Listing 9.5 The declaration (`TVAppDelegate.h`) of the application delegate for a table view application with the ability to delete rows.

```
#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>
@interface TVAppDelegate : NSObject <UITableViewDataSource> {
```

```
UIWindow           *window;
UITableView        *myTable;
NSMutableArray     *theSimpsons;
UIButton          *editButton;
}
@end
```

In Listing 9.6 we show the definition of the application delegate.

Listing 9.6 The definition of the application delegate of a table view application with the ability to delete rows.

```
#import <Foundation/Foundation.h>
#import <UIKit/UIKit.h>
#import "TVAppDelegate.h"

@implementation TVAppDelegate

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window = [[UIWindow alloc]
              initWithFrame:[[UIScreen mainScreen] bounds]];
    editButton = [[UIButton
                  buttonWithType:UIButtonTypeRoundedRect] retain];
    editButton.frame = CGRectMake(105.0, 25.0, 100, 40);
    [editButton setTitle:@"Edit" forState:UIControlStateNormal];
    [editButton addTarget:self action:@selector(editAction:)
                  forControlEvents:UIControlEventTouchUpInside];
    [window addSubview:editButton];

    CGRect frame = CGRectMake(0, 70, 320, 420);
    myTable = [[UITableView alloc]
               initWithFrame:frame
               style:UITableViewStylePlain];
    theSimpsons = [[NSMutableArray
                    arrayWithObjects:@"Homer Jay Simpson",
                    @"Marjorie \"Marge\" Simpson",
                    @"Bartholomew \"Bart\" J. Simpson",
                    @"Lisa Marie Simpson",
                    @"Margaret \"Maggie\" Simpson",
                    @"Abraham J. Simpson",
                    @"Santa's Little Helper",
                    @"Ned Flanders",
                    @"Apu Nahasapeemapetilon",
                    @"Clancy Wiggum",
                    @"Charles Montgomery Burns",
                    nil] retain];
    myTable.dataSource = self;
    [window addSubview:myTable];
}
```

```
[window makeKeyAndVisible];
}

- (void)editAction:(id)sender{
    if(sender == editButton){
        if([editButton.currentTitle isEqualToString:@"Edit"] == YES){
            [editButton setTitle:@"Done" forState:UIControlStateNormal];
            [myTable setEditing:YES animated:YES];
        }
        else {
            [editButton setTitle:@"Edit" forState:UIControlStateNormal];
            [myTable setEditing:NO animated:YES];
        }
    }
}

- (NSInteger)tableView:(UITableView *)tableView
    numberOfRowsInSection:(NSInteger)section{
    return [theSimpsons count];
}

- (void)
    tableView:(UITableView *)tableView
    commitEditingStyle:(UITableViewCellEditingStyle)editingStyle
    forRowAtIndexPath:(NSIndexPath *)indexPath{

    if(editingStyle == UITableViewCellEditingStyleDelete){
        [theSimpsons removeObjectAtIndex:indexPath.row];
        [myTable
            deleteRowsAtIndexPaths:[NSArray arrayWithObject:indexPath]
            withRowAnimation:UITableViewRowAnimationFade];
    }
}

- (UITableViewCell *)
    tableView:(UITableView *)tableView
    cellForRowAtIndexPath:(NSIndexPath *)indexPath{
    UITableViewCell *cell =
        [tableView dequeueReusableCellWithIdentifier:@"simpsons"];
    if(cell == nil) {
        cell = [[[UITableViewCell alloc]
            initWithStyle:UITableViewCellStyleDefault
            reuseIdentifier:@"simpsons"] autorelease];
    }
    cell.textLabel.text = [theSimpsons objectAtIndex:indexPath.row];
    return cell;
}
```

```
- (void)dealloc {
    [window release];
    [myTable release];
    [theSimpsons release];
    [editButton release];
    [super dealloc];
}
@end
```

We first create the edit button (see Section 6.5) that will trigger the switching between the two modes. The logic that will flip between editing and non-editing modes of the table view can be found in the action method `editAction:`. To make the table view enter editing mode, you invoke the method `setEditing:animated:` which is declared as:

```
- (void)setEditing:(BOOL)editing animated:(BOOL)animated
```

If `editing` is equal to YES, then the table view enters the editing mode. Set `animate` to YES to animate the change in mode. Once the table view instance receives this message, it sends it to every visible row (cell).

In editing mode, each row can allow either deletion or insertion. If a row is in delete editing mode, it will be marked by a circled red minus sign (“–”) icon to the left. If a row is in insert editing mode (addressed in Section 9.6), it will be marked by a circled green plus sign (“+”) icon to the left. The question remains: how does the table view know which mode to enter? The answer is simple: an optional method in the delegate, `tableView:editingStyleForRowAtIndexPath:` is used to provide the editing style for a specific cell. This method is declared as:

```
- (UITableViewCellEditingStyle)
    tableView:(UITableView *)tableView
    editingStyleForRowAtIndexPath:(NSIndexPath *)indexPath
```

If the table view is in editing mode, it has a delegate, and if that delegate implements this method, then this method is called for every visible row, asking it for the editing style of that row. The value returned can be either `UITableViewCellEditingStyleDelete` or `UITableViewCellEditingStyleInsert`. If there is no delegate assigned (as is the case in our example) or the delegate does not implement this method, the `UITableViewCellEditingStyleDelete` style is assumed.

Whenever the user taps on the button, the `editAction:` method is invoked. The method first checks the current mode by examining the button’s title. If the title is “Edit”, the button title is changed to “Done” and the table view is asked to enter editing mode with animation. Otherwise, the button title is changed to “Edit” and the table view is asked to stop editing with animation. Figure 9.5 shows the application in non-editing mode and Figure 9.6 shows it in editing mode (deletion).

When the user taps on the “–” icon, a “Delete” confirmation button appears to the right. If the user taps on that button, the table view sends a `tableView:commitEditingStyle:forRowAtIndexPath:` message to the data source. This method is declared as:

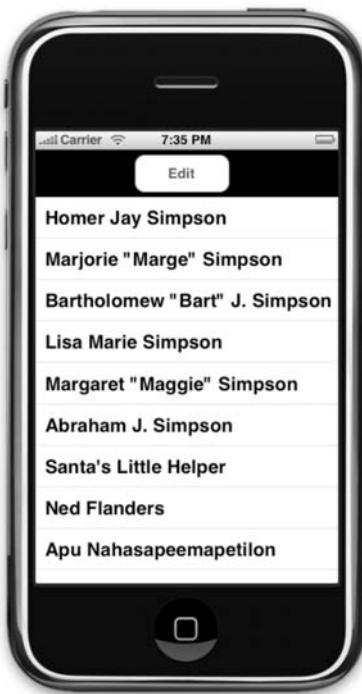


Figure 9.5 A table view that allows editing. Editing can be initiated using an Edit button.

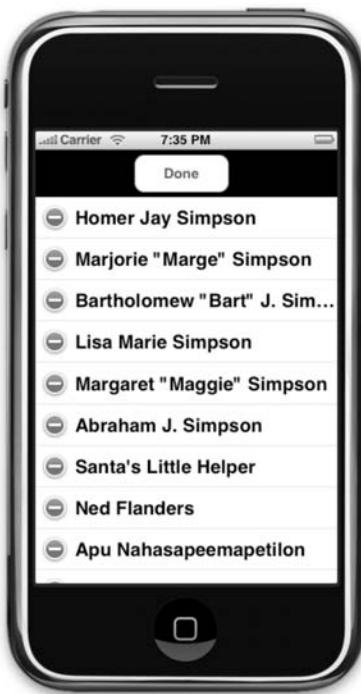


Figure 9.6 A table view in editing mode. The default editing mode is deletion.

```
- (void)


```

The `tableView` is the table view instance asking for editing confirmation. The `editingStyle` is the style that the row is in (either deletion or insertion) and `indexPath` is the object holding the section and row numbers of the affected cell.

If the row should be deleted, the above method should update its data model, by deleting the data for that row, and invoke the table view's `deleteRowsAtIndexPaths:withRowAnimation:` method. The method is declared as:

```
- (void)deleteRowsAtIndexPaths: (NSArray *)indexPaths
withRowAnimation: (UITableViewRowAnimation)animation
```

`indexPaths` is an `NSArray` instance holding the instances of `NSIndexPath` for the rows that will be deleted. The `animation` value can be one of the following:

- `UITableViewRowAnimationFade` specifies that the deleted row should fade out of the table view.
- `UITableViewRowAnimationRight` specifies that the deleted row should slide out to the right.
- `UITableViewRowAnimationLeft` specifies that the deleted row should slide out to the left.
- `UITableViewRowAnimationTop` specifies that the deleted row should slide out toward the top.
- `UITableViewRowAnimationBottom` specifies that the deleted row should slide out toward the bottom.

Figures 9.7 and 9.8 show the table view with the delete confirmation button and after a row has been deleted (while still in editing mode), respectively. Figure 9.9 shows the table view after exiting the editing mode and successfully deleting the `Lisa` row.

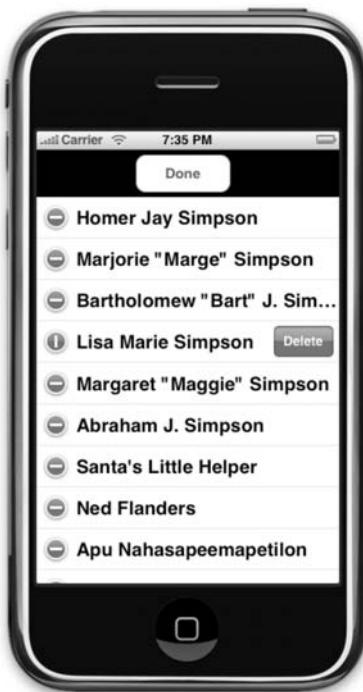


Figure 9.7 A table view row with delete confirmation.

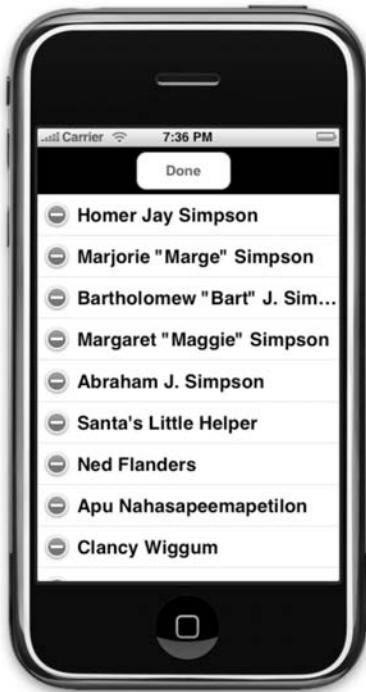


Figure 9.8 A table view after the deletion of a row while still in editing mode.

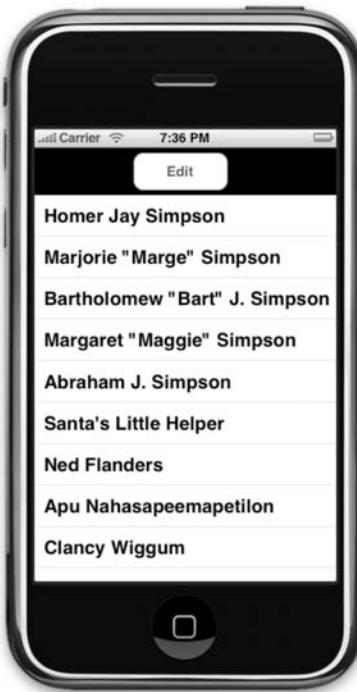


Figure 9.9 A table view after exiting the editing mode and successfully deleting a row.

9.6 A Table View with the Ability to Insert Rows

In the previous section, we saw how we can configure the table view to enter editing mode and manage deletion of rows. In this section, we will address insertion of new rows. Listing 9.7 shows the declaration of the application delegate of the demonstration application. The delegate allows for insertion of new table entries and acts as both the data source and the delegate of the table view. Complete source code can be found in TableView4 project in the source downloads.

The application delegate will create a new table view, an editing button, and a data entry view. It will also act as both the data source and the delegate of the table view.

Listing 9.7 The application delegate TVAppDelegate class declaration in file TVAppDelegate.h.

```
#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>

@interface TVAppDelegate :  
    NSObject <UITableViewDelegate, UITableViewDataSource,  
    UITextFieldDelegate> {
```

```
UIWindow           *window;
UITableView        *myTable;
NSMutableArray     *theSimpsons;
UIButton          *editButton;
UIView             *inputACharacterView;
UITextField        *characterTextField;
}
- (void)insertCharacter;
@end
```

Listing 9.8 shows the `applicationDidFinishLaunching:` method for our application delegate. First, the method creates and configures an edit button. After that, the table view is created and configured. As we saw in the previous section, when the user taps the edit button, the table view will enter the editing mode. The action method for the button is identical to the one you saw in the previous section. Figure 9.10 shows the starting window of the application.

Listing 9.8 The `applicationDidFinishLaunching:` method for the application delegate managing a table view with an insertion option.

```
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window = [[UIWindow alloc]
              initWithFrame:[UIScreen mainScreen] bounds]];
    editButton = [[UIButton buttonWithType:UIButtonTypeRoundedRect] retain];
    editButton.frame = CGRectMake(105.0, 25.0, 100, 40);
    [editButton setTitle:@"Edit" forState:UIControlStateNormal];
    [editButton addTarget:self action:@selector(editAction:)
                  forControlEvents:UIControlEventTouchUpInside];
    [window addSubview:editButton];

    CGRect frame = CGRectMake(0, 70, 320, 420);
    myTable = [[UITableView alloc]
               initWithFrame:frame
               style:UITableViewStylePlain];
    theSimpsons = [[NSMutableArray alloc]
                  arrayWithObjects:
                  @"Homer Jay Simpson",
                  @"Marjorie \"Marge\" Simpson",
                  @"Bartholomew \"Bart\" J. Simpson",
                  @"Lisa Marie Simpson",
                  @"Margaret \"Maggie\" Simpson",
                  @"Abraham J. Simpson",
                  @"Santa's Little Helper",
                  @"Ned Flanders",
                  @"Apu Nahasapeemapetilon",
                  @"Clancy Wiggum",
                  @"Charles Montgomery Burns",
                  nil] retain];
    myTable.delegate = self;
```

```

myTable.dataSource = self;
[window addSubview:myTable];
inputACharacterView = nil;
>window makeKeyAndVisible];
}

```

The application delegate defines the `tableView:editingStyleForRowAtIndexPath:` method needed to override the default (delete) editing style. The method simply returns `UITableViewCellStyleInsert` as shown below.

```

- (UITableViewCellEditingStyle)
    tableView: (UITableView *)tableView
    editingStyleForRowAtIndexPath: (NSIndexPath *)indexPath{
    return UITableViewCellStyleInsert;
}

```

Figure 9.11 shows the application's screenshot after entering the insert editing style.



Figure 9.10 A table view that allows insertion of rows.



Figure 9.11 A table view after entering editing mode for insertion.

Listing 9.9 shows the `tableView:cellForRowAtIndexPath:` method. If the image cannot be found, a generic image is used. This will allow the newly added row to have an image.

Listing 9.9 The data source method producing cells with text and images.

```
- (UITableViewCell *)  
    tableView: (UITableView *)tableView  
    cellForRowAtIndexPath: (NSIndexPath *)indexPath{  
    UITableViewCell *cell =  
        [tableView dequeueReusableCellWithIdentifier:@"simpsons"] ;  
    if (cell == nil) {  
        cell = [[UITableViewCell alloc]  
            initWithStyle:UITableViewCellStyleDefault  
            reuseIdentifier:@"simpsons"] autorelease] ;  
    }  
  
    cell.textLabel.text = [theSimpsons objectAtIndex:indexPath.row] ;  
    NSString *imageName =  
        [NSString stringWithFormat:@"%d.png", indexPath.row] ;  
    cell.imageView.image = [UIImage imageNamed:imageName] ;  
    if (cell.imageView.image == nil){  
        cell.imageView.image = [UIImage imageNamed:@"unknown-person.gif"] ;  
    }  
    return cell;  
}
```

The following listing shows the `tableView:commitEditingStyle:forRowAtIndexPath:` method. The method simply invokes the `insertCharacter` method that will actually present a data entry view to the user.

```
- (void)tableView: (UITableView *)tableView  
    commitEditingStyle: (UITableViewCellEditingStyle)editingStyle  
    forRowAtIndexPath: (NSIndexPath *)indexPath{  
    if (editingStyle == UITableViewCellStyleInsert){  
        [self insertCharacter];  
    }  
}
```

Listing 9.10 shows the `insertCharacter` method.

Listing 9.10 The `insertCharacter` method that will present a data entry view to the user.

```
- (void)insertCharacter{  
    inputACharacterView =  
        [[UIView alloc]  
            initWithFrame:[UIScreen mainScreen].applicationFrame]  
            autorelease] ;  
    inputACharacterView.backgroundColor = [UIColor lightGrayColor];  
    UIButton *cancelButton =
```

```

    [UIButton buttonWithType:UIButtonTypeRoundedRect];
cancelButton.frame = CGRectMake(105.0, 25.0, 100, 40);
[cancelButton setTitle:@"Cancel" forState:UIControlStateNormal];
[cancelButton addTarget:self action:@selector(cancelAction:)
    forControlEvents:UIControlEventTouchUpInside];
[inputACharacterView addSubview: cancelButton];
UILabel *label = [[UILabel alloc]
    initWithFrame:CGRectMake(10,100, 70, 30)] autorelease;
label.backgroundColor = [UIColor clearColor];
label.text = @"Name:";
[inputACharacterView addSubview: label];
characterTextField =
    [[UITextField alloc] initWithFrame:CGRectMake(80,100, 220, 30)];
characterTextField.textColor = [UIColor blackColor];
characterTextField.font = [UIFont systemFontOfSize:17.0];
characterTextField.placeholder = @"<enter a new character>";
characterTextField.backgroundColor = [UIColor clearColor];
characterTextField.borderStyle = UITextBorderStyleRoundedRect;
characterTextField.keyboardType = UIKeyboardTypeDefault;
characterTextField.returnKeyType = UIReturnKeyDone;
characterTextField.clearButtonMode = UITextFieldViewModeAlways;
characterTextField.enablesReturnKeyAutomatically = YES;
characterTextField.delegate = self;
[inputACharacterView addSubview: characterTextField];
>window addSubview:inputACharacterView];
}

```

The method creates a view and adds several controls to it. A “Cancel” button is added to the view for canceling the data entry. In addition, a `UILabel` instance is added with the value “Name:” as a label to a text field. The text field is where the user enters a new name to be added to the table view. Figures 9.12 and 9.13 show the data entry view.

The action for the cancel button is `cancelAction:` which is defined as follows:

```

- (void)cancelAction:(id)sender{
    [inputACharacterView removeFromSuperview];
    inputACharacterView = nil;
}

```

It simply removes the data entry view `inputACharacterView` from its superview, `window`, and sets the `inputACharacterView` to `nil`. Notice that the `removeFromSuperview` method does release the receiver.

The text field delegate method `textFieldShouldReturn:` is invoked, as you have learned in previous chapters, when the user taps the “Done” button on the keyboard. Inside this method, we add the name entered in the text field to the data model (`theSimpsons` mutable array) and ask the table to reload its data by sending a `reloadData` to the table view instance. After that, we remove the data entry view as we did above when we handled the data entry cancellation event.



Figure 9.12 The data entry view for adding a new entry to a table view before appearance of the keyboard.



Figure 9.13 The data entry view for adding a new entry to a table view after appearance of the keyboard.

```
- (BOOL)textFieldShouldReturn:(UITextField *)textField{
    [theSimpsons addObject:textField.text];
    [myTable reloadData];
    [inputACharacterView removeFromSuperview];
    inputACharacterView = nil;
    return YES;
}
```

Figure 9.14 shows the application after adding a new row.

9.7 Reordering Table Rows

A table view can be configured to allow reordering of its rows when it enters the editing mode. By default, reordering is not enabled. To enable reordering, the data source needs to implement the method `tableView:moveRowAtIndexPath:toIndexPath:`. Once this method is defined,



Figure 9.14 A table view after the addition of a new row at the bottom.

a reordering icon appears on the right side of each row when the table view is in editing mode. To disable reordering of specific rows, the data source needs to implement the method `tableView:canMoveRowAtIndexPath:` and exclude specific rows.

In the following, we give a detailed example of a table view reordering application. Listing 9.11 shows the application delegate that also acts as the data source. The complete source code can be found in the `TableView5` project in the source downloads.

Notice that the data model, `theSimpsons`, is a mutable array because we need to change the order of the rows dynamically.

Listing 9.11 The file `TVAppDelegate.h` declaring the application delegate for the rows reordering application.

```
#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>
@interface TVAppDelegate : NSObject <UITableViewDataSource> {
    UIWindow      *window;
    UITableView   *myTable;
    NSMutableArray *theSimpsons;
```

```
    UIButton *editButton;
}
@end
```

In Listing 9.12, we show the implementation of the application delegate.

Listing 9.12 The file `TVAppDelegate.m` implementing the application delegate for the rows reordering application.

```
#import <Foundation/Foundation.h>
#import <UIKit/UIKit.h>
#import "TVAppDelegate.h"

@implementation TVAppDelegate

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window = [[UIWindow alloc]
               initWithFrame:[UIScreen mainScreen] bounds]] ;
    editButton =
        [[UIButton buttonWithType:UIButtonTypeRoundedRect] retain];
    editButton.frame = CGRectMake(105.0, 25.0, 100, 40);
    [editButton setTitle:@"Edit" forState:UIControlStateNormal];
    [editButton addTarget:self action:@selector(editAction:)
                      forControlEvents:UIControlEventTouchUpInside];
    [window addSubview:editButton];

    CGRect frame = CGRectMake(0, 70, 320, 420);
    myTable = [[UITableView alloc]
               initWithFrame:frame style:UITableViewStylePlain];
    theSimpsons = [[NSMutableArray alloc]
                   arrayWithObjects:
                     @"Homer Jay Simpson",
                     @"Marjorie \"Marge\" Simpson",
                     @"Bartholomew \"Bart\" J. Simpson",
                     @"Lisa Marie Simpson",
                     @"Margaret \"Maggie\" Simpson",
                     @"Abraham J. Simpson",
                     @"Santa's Little Helper",
                     @"Ned Flanders",
                     @"Apu Nahasapeemapetilon",
                     @"Clancy Wiggum",
                     @"Charles Montgomery Burns",
                     nil] retain];
    myTable.dataSource = self;
    [window addSubview:myTable];
    [window makeKeyAndVisible];
}

- (void)editAction:(id)sender{
```

```
if(sender == editButton){
    if([editButton.currentTitle isEqualToString:@"Edit"] == YES) {
        [editButton setTitle:@"Done" forState:UIControlStateNormal];
        [myTable setEditing:YES animated:YES];
    }
    else {
        [editButton setTitle:@"Edit" forState:UIControlStateNormal];
        [myTable setEditing:NO animated:YES];
    }
}

- (NSInteger)
    tableView:(UITableView *)tableView
    numberOfRowsInSection:(NSInteger)section{
    return [theSimpsons count];
}

- (BOOL)
    tableView:(UITableView *)tableView
    canMoveRowAtIndexPath:(NSIndexPath *)indexPath{
    NSString *string =
    [theSimpsons objectAtIndex:indexPath.row];
    if([string isEqualToString:@"Bartholomew \\"Bart\\" J. Simpson"]){
        return NO;
    }
    if([string isEqualToString:@"Santa's Little Helper"]){
        return NO;
    }
    return YES;
}

- (void)
    tableView:(UITableView *)tableView
    moveRowAtIndexPath:(NSIndexPath *)fromIndexPath
    toIndexPath:(NSIndexPath *)toIndexPath{
    NSString *str= [[theSimpsons objectAtIndex:fromIndexPath.row] retain];
    [theSimpsons removeObjectAtIndex:fromIndexPath.row];
    [theSimpsons insertObject:str atIndex:toIndexPath.row];
    [str release];
}

- (UITableViewCell *)
    tableView:(UITableView *)tableView
    cellForRowAtIndexPath:(NSIndexPath *)indexPath{
    UITableViewCell *cell =
    [tableView dequeueReusableCellWithIdentifier:@"simpsons"];
    if (cell == nil) {
```

```
cell = [[[UITableViewCell alloc]
           initWithStyle:UITableViewCellStyleDefault
           reuseIdentifier:@"simpsons"] autorelease];
}
cell.textLabel.text = [theSimpsons objectAtIndex:indexPath.row];
return cell;
}

- (void)dealloc {
[window release];
[myTable release];
[theSimpsons release];
[editButton release];
[super dealloc];
}
@end
```

The method `applicationDidFinishLaunching:` is similar to what we have seen before. It creates the table view and an edit button. In addition, the data model is populated with the values.

The `tableView:canMoveRowAtIndexPath:` method is defined to allow the reordering of all rows except two: Bart and Santa's Little Helper. To disable reordering for a given row, the method needs to return NO.

If the user moves a row to a new position, the method

`tableView:moveRowAtIndexPath:toIndexPath:` is called. This method is declared as:

```
- (void)
    tableView:(UITableView *)tableView
    moveRowAtIndexPath:(NSIndexPath *)fromIndexPath
    toIndexPath:(NSIndexPath *)toIndexPath
```

The `fromIndexPath` is the current index path of the row and `toIndexPath` is the new index path. In our case, to move a name from one location in the array to a new location, we first retain the object at the current location in the statement:

```
NSString *str =
[[theSimpsons objectAtIndex:fromIndexPath.row] retain];
```

This is important as we are going to remove the object from the array, and this will result in releasing it. The statement that removes the object at the current row is as follows:

```
[theSimpsons removeObjectAtIndex:fromIndexPath.row];
```

After removing the object, we need to insert it at the new location as follows:

```
[theSimpsons insertObject:str atIndex:toIndexPath.row];
```

After that, we need to release the object, `str`.



Figure 9.15 A table view with reordering controls shown while a row is being moved to a new location.

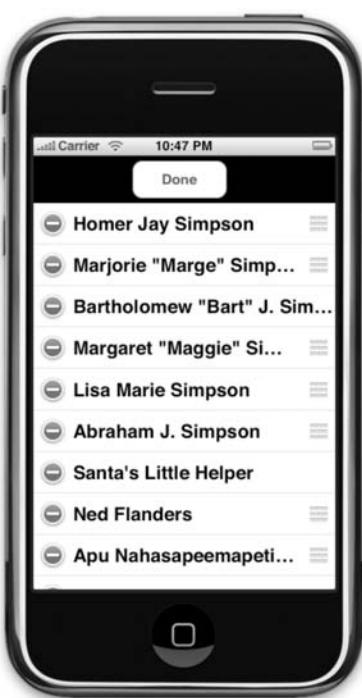


Figure 9.16 The table view after a row has been moved to a new location.

The method `tableView:canMoveRowAtIndexPath:` returns NO for the rows of Bart and Santa's Little Helper. It returns YES for all other rows. Figure 9.15 shows the table view while a row is being moved to a new location. Figure 9.16 shows the table view after a row has been moved to a new location.

9.8 Presenting Hierarchical Information

Table views are ideal for presenting hierarchical information. In interacting with hierarchical information, the user starts at the top level and drills down to the next level of the hierarchy. The user repeats this process until they reach the desired level. For example, consider a user looking at a list of names of TV shows (Figure 9.17). Tapping on a show name, the user will be presented with another table view holding the names of the show characters (Figure 9.18). Tapping on a show character, the user will be presented with a simple view with information about that character (Figure 9.19). The user can use the navigational buttons to go back to the previous levels of hierarchy or even edit the



Figure 9.17 A table view application for displaying information about TV shows. The figure shows the top level.



Figure 9.18 The second level of the table view hierarchy. The level shows the names of major characters of a specific TV show (*Lost*). Notice that the back button takes the user to the previous level of hierarchy.

data of the current level. Figures 9.17, 9.18, and 9.19 show screenshots of the user drilling down to information about a specific character for a specific TV show.

There are two main classes that help you present hierarchical information to the user: (1) table view controller, and (2) navigational controller. In previous chapters, we saw how to configure and use a navigational controller. A table view controller, `UITableViewController` is a subclass of `UIViewController` that creates and manages a `UITableView` instance. You allocate a table view controller and initialize it using the `initWithStyle:` method. The table view instance created by the controller can be accessed using its property `tableView`. In addition to creating the table view and initializing it, the controller acts as both the data source and the delegate of that table view. Therefore, you need to implement the table view's delegate and data source method in your subclass of that table view controller.



Figure 9.19 The last level of hierarchy in the TV shows application. The back button takes the user to the show that this character is part of.

There are four major steps that you need to perform in order to create a working application that will present hierarchical information in the form of hierarchical table views. In the following, we present these major steps. After presenting these steps, we provide a detailed example.

1. **Create a subclass of `UITableViewController` for every level of the hierarchy.** Each subclass of these controllers should override the `initWithStyle:` method to configure its title and the back button title displayed in the navigation bar.
2. **Choose an object that will create the navigation controller.** Allocate and initialize the `UITableViewController` subclass that is the top of the hierarchy and push it onto the navigation controller as the root view controller. The object that will create these UI objects is usually the application delegate, and the work is done in its `applicationDidFinishLaunching:` method.
3. **Choose a global object that is accessible from each of the table view controllers.** Inside this object, provide methods to retrieve/set the data model. The application delegate is usually preferred to be such an object.

4. **Inside each table view controller, override the `tableView:didSelectRowAtIndexPath:` method.** Inside this method, you should: (1) store the selected row information with a global object (usually the application delegate), and (2) create an instance of the controller for the next level and push it onto the navigation controller (obtained from the global object such as the application delegate). The object that will keep track of the selected row at each level should have a separate variable for each level, for example, `level1IndexPath`, `level2IndexPath`, etc. Required and optional methods for the table view data source and delegate should be implemented in each table view controller subclass.

9.8.1 Detailed example

Let's illustrate the creation of a hierarchical table view application using the TV Shows example shown in Figures 9.17, 9.18, and 9.19. The TV Shows application has three levels of hierarchy. The first level presents the user with a table containing names of TV shows. The second level presents the user with a list of names of major characters for a given TV show. The third, and final, level of the hierarchy presents the user with a view showing the name and a picture of a given character.

Clearly, we need two `UITableViewController` subclasses for the first two levels, and one `UIViewController` for the third and last level. The first table view controller subclass is called `ShowTableViewController` and it manages the table view that lists the TV shows (i.e., the first level). The declaration of the controller is shown in Listing 9.13. The controller represents the first level of hierarchy showing the list of TV shows. Complete source can be found in the `TableView6` project in the source downloads.

Listing 9.13 The `ShowTableViewController` declared in `ShowTableViewController.h`.

```
#import <UIKit/UIKit.h>
@interface ShowTableViewController : UITableViewController {
}
@end
```

The implementation of the `ShowTableViewController` class is shown in Listing 9.14. The controller manages the first level of hierarchy in the TV Shows application.

Listing 9.14 The definition of the `ShowTableViewController` in the `ShowTableViewController.m` file.

```
#import "ShowTableViewController.h"
#import "ShowCharactersTableViewController.h"
#import "TVAppDelegate.h"
@implementation ShowTableViewController
- (id)initWithStyle:(UITableViewStyle)style {
    if (self = [super initWithStyle:style]) {
        self.title = @"TV Shows";
        self.navigationItem.backBarButtonItem.title = @"Shows";
    }
}
```

```

    return self;
}
- (NSInteger)tableView:(UITableView *)tableView
    numberOfRowsInSection:(NSInteger)section{
    TVAppDelegate *delegate =
        [[UIApplication sharedApplication] delegate];
    return [delegate numberOfShows];
}
- (UITableViewCell *)tableView:(UITableView *)tableView
    cellForRowAtIndexPath:(NSIndexPath *)indexPath {
    static NSString *MyIdentifier = @"Show";
    UITableViewCell *cell =
        [tableView dequeueReusableCellWithIdentifier:MyIdentifier];
    if (cell == nil) {
        cell = [[[UITableViewCell alloc]
            initWithStyle:UITableViewCellStyleDefault
            reuseIdentifier:MyIdentifier] autorelease];
    }
    TVAppDelegate *delegate =
        [[UIApplication sharedApplication] delegate];
    cell.textLabel.text = [delegate showNameAtIndex:indexPath.row];
    cell.accessoryType = UITableViewCellAccessoryDisclosureIndicator;
    return cell;
}
- (void)tableView:(UITableView *)tableView
    didSelectRowAtIndexPath:(NSIndexPath *)indexPath{
    TVAppDelegate *delegate =
        [[UIApplication sharedApplication] delegate];
    delegate.selectedShow = indexPath;
    ShowCharactersTableViewController
        *showCharactersController =
        [[[ShowCharactersTableViewController alloc]
            initWithStyle:UITableViewStylePlain] autorelease];
    [[delegate navigationController]
        pushViewController:showCharactersController animated:YES];
}
@end

```

The `initWithStyle:` method sets the title of the controller to "TV Shows". This title will be used by the navigation controller to display in the middle of the navigation bar when the first level of hierarchy is presented to the user. The back button title is also set in this method. The value used is "Shows". When the user taps on a specific show, the next level of hierarchy, showing the list of characters of that show, will be presented, and the back button title will be this value (i.e., "Shows").

The data source methods needed are implemented in the controller. We have the `tableView:-numberOfRowsInSection:` method which obtains a reference to the application delegate and asks it to retrieve the number of shows. We will talk more about the data model shortly. The required data

source method `tableView:cellForRowAtIndexPath:` is also implemented in the controller. To configure the cell, we ask the delegate for the show name using its method `showNameAtIndex:`. In addition, to indicate that the cell has children, the `accessoryType` property is set to `UITableViewCellAccessoryDisclosureIndicator`.

The `tableView:didSelectRowAtIndexPath:` method is where we move the user to the next level of hierarchy. First, we need to store the index path of the selected row in a location accessible by next level controller. We achieve this by setting the application delegate property `selectedShow` with the `indexPath` value passed to the method. Next, we create an instance of the next level controller and push it onto the stack of the navigation controller.

The second level controller is an instance of the class `ShowCharactersTableViewController`. Listing 9.15 shows the declaration of the controller.

Listing 9.15 The `ShowCharactersTableViewController` declared in the `ShowCharactersTableViewController.h` file. The class manages the second level of hierarchy in the TV Shows application.

```
#import <UIKit/UIKit.h>
@interface ShowCharactersTableViewController : UITableViewController {}
@end
```

The implementation of the controller is shown in Listing 9.16. As we did for the previous controller, we override the `initWithStyle:` method to update the controller's title and the title for the back button. The application delegate is asked for the show name using the method `showNameAtIndex:`. The index used in this method is the global value `selectedShow.row` managed by the application delegate which was stored in the `tableView:didSelectRowAtIndexPath:` method of the root table view controller.

Listing 9.16 The definition of the `ShowCharactersTableViewController` in the file `ShowCharactersTableViewController.m`.

```
#import "ShowCharactersTableViewController.h"
#import "TVAppDelegate.h"
#import "CharacterViewController.h"
@implementation ShowCharactersTableViewController
- (id) initWithStyle: (UITableViewStyle) style {
    if (self = [super initWithStyle:style]) {
        TVAppDelegate *delegate =
            [[UIApplication sharedApplication] delegate];
        self.title =
            [delegate showNameAtIndex:delegate.selectedShow.row];
        self.navigationItem.backBarButtonItem.title =
            [delegate showNameAtIndex:delegate.selectedShow.row];
    }
    return self;
}
- (NSInteger)tableView: (UITableView *)tableView
    numberOfRowsInSection: (NSInteger)section{
    TVAppDelegate *delegate =
```

```

        [ [UIApplication sharedApplication] delegate];
    return [delegate
        numberOfRowsInSectionForShowAtIndex:delegate.selectedShow.row];
}
- (void)tableView:(UITableView *)tableView
    didSelectRowAtIndexPath:(NSIndexPath *)indexPath{
TVAppDelegate *delegate =
    [ [UIApplication sharedApplication] delegate];
delegate.selectedCharacter = indexPath;
CharacterViewController *characterController =
    [[CharacterViewController alloc] init];
[[delegate navigationController]
    pushViewController:characterController animated:YES];
[characterController release];
}
- (UITableViewCell *)
    tableView:(UITableView *)tableView
    cellForRowAtIndexPath:(NSIndexPath *)indexPath {
static NSString *MyIdentifier = @"Character";
UITableViewCell *cell =
    [tableView dequeueReusableCellWithIdentifier:MyIdentifier];
if (cell == nil) {
    cell = [[[UITableViewCell alloc]
        initWithStyle:UITableViewCellStyleDefault
        reuseIdentifier:MyIdentifier] autorelease];
}
TVAppDelegate *delegate =
    [ [UIApplication sharedApplication] delegate];
cell.textLabel.text =
    [delegate characterNameForShowIndex:delegate.selectedShow.row
        atIndex:indexPath.row];
cell.accessoryType = UITableViewCellAccessoryDisclosureIndicator;
return cell;
}
@end

```

The method `tableView:didSelectRowAtIndexPath:` is used to push a third controller onto the navigation controller. This view controller is the leaf controller `CharacterViewController`. Before pushing it onto the stack, we store the index path of the selected row in the delegate `selectedCharacter` property.

The `CharacterViewController` is declared in Listing 9.17 and is implemented in Listing 9.18.

Listing 9.17 The declaration of the `CharacterViewController` in file `CharacterViewController.h`. This controller manages the leaf view in the TV Shows application.

```

#import <UIKit/UIKit.h>
@interface CharacterViewController : UIViewController {
    UILabel      *nameLabel;

```

```
    UIView *theView;
}
@end
```

The `init` method is overridden and the title is set to the character name. The character name is retrieved from the application delegate using the method `characterNameForShowIndexAtIndex:`. The index of the show is `selectedShow.row` and the index of the character is `selectedCharacter.row`.

The `loadView` method is where we present more information about the character. To simplify things, we only use a `UILabel` instance for the name and a `UIImageView` for the picture of the character. You should be familiar with these UI objects from previous chapters by now.

Listing 9.18 The implementation of the `CharacterViewController` in file `CharacterViewController.m`.

```
#import "CharacterViewController.h"
#import "TVAppDelegate.h"
@implementation CharacterViewController
- (id)init{
    if (self = [super init]) {
        TVAppDelegate *delegate =
            [[UIApplication sharedApplication] delegate];
        self.title =
            [delegate characterNameForShowIndex:delegate.selectedShow.row
                                         atIndex:delegate.selectedCharacter.row];
    }
    return self;
}
- (void)loadView {
    TVAppDelegate *delegate =
        [[UIApplication sharedApplication] delegate];
    theView = [[UIView alloc]
               initWithFrame:[UIScreen mainScreen].applicationFrame];
    theView.autoresizingMask =
        UIViewAutoresizingFlexibleHeight |
        UIViewAutoresizingFlexibleWidth;
    theView.backgroundColor = [UIColor whiteColor];

    CGRect labelFrame = CGRectMake(80, 10, 190, 50);
    nameLabel = [[UILabel alloc] initWithFrame:labelFrame];
    nameLabel.font = [UIFont systemFontOfSize:25.0];
    nameLabel.textColor = [UIColor blackColor];
    nameLabel.backgroundColor = [UIColor clearColor];
    nameLabel.textAlignment = NSTextAlignmentLeft;
    nameLabel.lineBreakMode = UILineBreakModeWordWrap;
    NSString *theName =
        [delegate
```

```

        characterNameForShowIndex:delegate.selectedShow.row
        atIndex:delegate.selectedCharacter.row];
nameLabel.text =
    [NSString stringWithFormat:@"%@", @"Name", theName];
[theView addSubview: nameLabel];
UIImageView *imgView = [[UIImageView alloc]
    initWithImage:[UIImage imageNamed:
        [NSString stringWithFormat:@"%@.png", theName]]];
imgView.frame = CGRectMake(30, 70, 250, 300);
[theView addSubview:imgView];
[imgView release];
self.view = theView;
}
- (void)dealloc {
[nameLabel release];
[theView release];
[super dealloc];
}
@end

```

Listing 9.19 shows the declaration of the application delegate. The delegate maintains the two properties for storing the indices of the first and second levels in `selectedShow` and `selectedCharacter`, respectively. The three view controllers access the data model for the hierarchical information through the following four application delegate methods:

```

- (NSInteger)numberOfShows;
- (NSString*)showNameAtIndex:(NSInteger) index;
- (NSInteger)numberOfCharactersForShowAtIndex:(NSInteger) index;
- (NSString*)characterNameForShowIndex:(NSInteger) showIndex
   AtIndex:(NSInteger) index;

```

We have seen how these methods are used in the presentation.

Listing 9.19 The declaration of the application delegate for the TV Shows application.

```

#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>

@interface TVAppDelegate : NSObject {
    UIWindow           *window;
    UINavigationController *navigationController;
    NSIndexPath       *selectedShow;
    NSIndexPath       *selectedCharacter;
    NSArray           *theShows;
}
@property(nonatomic, retain) NSIndexPath *selectedShow;
@property(nonatomic, retain) NSIndexPath *selectedCharacter;
@property(nonatomic, retain)

```

```
UINavigationController *navigationController;  
  
- (NSInteger)numberOfShows;  
- (NSString*)showNameAtIndex: (NSInteger) index;  
- (NSInteger)numberOfCharactersForShowAtIndex: (NSInteger) index;  
- (NSString*)characterNameForShowIndex: (NSInteger)  
    showIndexAtIndex: (NSInteger) index;  
@end
```

The implementation of the application delegate is shown in Listing 9.20. The first thing we do in the `applicationDidFinishLaunching:` method is prepare the data mode. The data model is represented by an array of dictionaries. Each dictionary represents a TV show and has two entries. The first entry is name of that show and the second is an array of characters for that show. After initializing the data model, we create the navigation controller and push the first level table view controller onto it. The methods called by the controllers to retrieve specific information about our data model are straightforward.

Listing 9.20 The implementation of the application delegate for the TV Shows application.

```
#import <Foundation/Foundation.h>  
#import <UIKit/UIKit.h>  
#import "TVAppDelegate.h"  
#import "ShowTableViewController.h"  
@implementation TVAppDelegate  
@synthesize selectedShow;  
@synthesize selectedCharacter;  
@synthesize navigationController;  
- (void)applicationDidFinishLaunching: (UIApplication *)application {  
    [self prepareDataModel];  
    window = [[UIWindow alloc]  
        initWithFrame: [[UIScreen mainScreen] bounds]];  
    ShowTableViewController *showViewController =  
        [[ShowTableViewController alloc]  
            initWithStyle:UITableViewStylePlain];  
    navigationController = [[UINavigationController alloc]  
        initWithRootViewController: showViewController];  
    [showViewController release];  
    [window addSubview: [navigationController view]];  
    [window makeKeyAndVisible];  
}  
- (void)prepareDataModel{  
    NSDictionary *dic1 =  
        [NSDictionary dictionaryWithObjectsAndKeys:  
            @"Seinfeld",  
            @"Name",  
            [NSArray arrayWithObjects:  
                @"Jerry", @"George", @"Elaine", @"Kramer",  
                @"Newman", @"Frank", @"Susan",
```

```

        @"Peterman", @"Bania", nil],
        @"Characters",
        nil
    ];
NSDictionary *dic2 =
[NSDictionary dictionaryWithObjectsAndKeys:
    @"Lost",
    @"Name",
    [NSArray arrayWithObjects:
        @"Kate", @"Sayid", @"Sun", @"Hurley",
        @"Boone", @"Claire", @"Jin", @"Locke",
        @"Charlie", @"Eko", @"Ben", nil],
        @"Characters",
        nil
    ];
theShows = [ [NSArray arrayWithObjects:dic1, dic2, nil] retain];
}
-(NSInteger)numberOfShows{
    return [theShows count];
}
-(NSString*)showNameAtIndex:(NSInteger) index{
    return [[theShows objectAtIndex:index] valueForKey:@"Name"];
}
-(NSInteger)numberOfCharactersForShowAtIndex:(NSInteger) index{
    return [[[theShows objectAtIndex:index]
        valueForKey:@"Characters"] count];
}
-(NSString*)characterNameForShowIndex:(NSInteger) showIndex
    atIndex:(NSInteger) index{
    return [[[theShows objectAtIndex:showIndex]
        valueForKey:@"Characters"] objectAtIndex:index];
}
-(void)dealloc {
    [window release];
    [navigationController release];
    [theShows release];
    [super dealloc];
}
@end

```

9.9 Grouped Table Views

Until now, we have been dealing with the plain table view style. There is another style referred to as the *grouped* style that one can use to configure the table view. A grouped table view is generally used as the final level of hierarchy for presenting information about a specific item selected in the penultimate level.

The configuration process of a grouped table view follows a similar approach to what we have seen so far. What you need to know is that the rows of each section are grouped together. An optional header title is used to name that group. Other than that, everything is pretty much the same.

Let's illustrate that through an example. Consider an application that presents to the user a list of favorite TV shows sorted according to their classification: comedy, political, and drama. Listing 9.21 shows the declaration of the application delegate of the demonstration application. The complete source code can be found in the `TableView7` project in the source downloads.

Listing 9.21 The declaration of the application delegate demonstrating the use of grouped table views.

```
#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>

@interface TVAppDelegate : NSObject <UITableViewDataSource> {
    UIWindow          *window;
    UITableView       *myTable;
    NSArray           *comedyShows, *politicalShows, *dramaShows;
}
@end
```

The data model is represented in the three `NSArray` instances: `comedyShows`, `politicalShows`, and `dramaShows`. Each array will hold the shows for the corresponding section.

The implementation of the application delegate is shown in Listing 9.22. In the `applicationDidFinishLaunching:` method, we create the table view instance as we saw before. Instead of using the plain style, we use the `UITableViewStyleGrouped` style. The three arrays are then populated with the data.

We saw in Section 9.4 how to configure sections and headers. There are no differences between plain and grouped styles with respect to the implementation of the configuration methods.

Listing 9.22 The implementation of the application delegate for the grouped table view application.

```
#import <Foundation/Foundation.h>
#import <UIKit/UIKit.h>
#import "TVAppDelegate.h"

@implementation TVAppDelegate
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window = [[UIWindow alloc]
              initWithFrame:[[UIScreen mainScreen] bounds]];
    myTable = [[UITableView alloc]
               initWithFrame:[UIScreen mainScreen].applicationFrame
               style:UITableViewStyleGrouped];
    comedyShows = [[NSArray arrayWithObjects:
                    @"Seinfeld", @"Everybody Loves Raymond", nil] retain];
    politicalShows = [[NSArray arrayWithObjects:
                       @"60 Minutes", @"Meet The Press", nil] retain];
}
```

```
dramaShows = [[NSArray arrayWithObjects:@"Lost", nil] retain];

myTable.dataSource = self;
[window addSubview:myTable];
[window makeKeyAndVisible];
}

- (NSInteger) numberOfSectionsInTableView: (UITableView *)tableView {
    return 3;
}

- (NSInteger)
    tableView: (UITableView *)tableView
    numberOfRowsInSection: (NSInteger)section{
switch (section) {
    case 0:
        return [comedyShows count];
        break;
    case 1:
        return [politicalShows count];
        break;
    case 2:
        return [dramaShows count];
        break;
}
return 0;
}

- (UITableViewCell *)
    tableView: (UITableView *)tableView
    cellForRowAtIndexPath: (NSIndexPath *)indexPath{
UITableViewCell *cell =
    [tableView dequeueReusableCellWithIdentifier:@"shows"];
if (cell == nil) {
    cell = [[[UITableViewCell alloc]
              initWithStyle:UITableViewCellStyleDefault
              reuseIdentifier:@"shows"] autorelease];
}
switch (indexPath.section) {
    case 0:
        cell.textLabel.text = [comedyShows objectAtIndex:indexPath.row];
        break;
    case 1:
        cell.textLabel.text =
            [politicalShows objectAtIndex:indexPath.row];
        break;
    case 2:
        cell.textLabel.text = [dramaShows objectAtIndex:indexPath.row];
}
```

```
        break;
    }
    return cell;
}

- (NSString *)
    tableView:(UITableView *)tableView
    titleForHeaderInSection:(NSInteger)section {
    NSString *title = nil;
    switch (section) {
        case 0:
            title = @"Comedy Shows";
            break;
        case 1:
            title = @"Political Shows";
            break;
        case 2:
            title = @"Drama Shows";
            break;
        default:
            break;
    }
    return title;
}

- (void)dealloc {
    [window release];
    [myTable release];
    [comedyShows release];
    [politicalShows release];
    [dramaShows release];
    [super dealloc];
}
@end
```

Figure 9.20 shows the grouped table view application.

9.10 Indexed Table Views

Sometimes you present a large amount of data to the user. To save the user's time when they are looking for a specific row, you can add an index to the table view. This index is displayed on the right-hand side of the table. When the user taps on a specific index value, the table view will scroll to the corresponding section.

In this section, we provide a demonstration application for indexed views. The application presents five sections where each section corresponds to a US political party. Inside each section, we list some of the candidates for the office of president. Each section has an index represented by the first

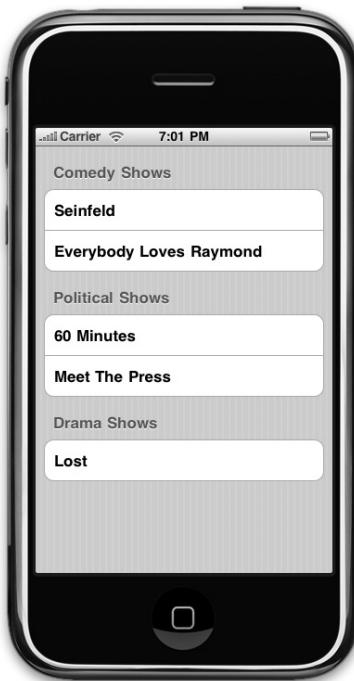


Figure 9.20 A grouped table view application.

letter of its name. Tapping on the letter makes the table view scroll (if necessary) to the corresponding party.

Listing 9.23 shows the declaration of the application delegate demonstrating indexed table views. Five NSArray instances are used to represent the data model. The source code can be found in the TableView8 project in the source downloads.

Listing 9.23 The declaration of the application delegate demonstrating the indexed table view.

```
#import <UIKit/UIKit.h>
#import <Foundation/Foundation.h>
@interface TVAppDelegate:NSObject<UITableViewDataSource> {
    UIWindow          *window;
    UITableView       *myTable;
    NSArray           *democratic, *republican, *independent,
                      *libertarian, *socialist;
}
@end
```

Listing 9.24 shows the implementation of the application delegate for the indexed table view application.

Listing 9.24 The implementation of the application delegate demonstrating the indexed table view.

```
#import <Foundation/Foundation.h>
#import <UIKit/UIKit.h>
#import "TVAppDelegate.h"
@implementation TVAppDelegate
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window = [[UIWindow alloc]
              initWithFrame:[[UIScreen mainScreen] bounds]];
    myTable = [[UITableView alloc]
               initWithFrame:[UIScreen mainScreen].applicationFrame
               style:UITableViewStylePlain];
    democratic = [[NSArray arrayWithObjects:
                   @"Barack Obama", @"Joe Biden",
                   @"Hillary Clinton",
                   @"Christopher Dodd", @"John Edwards",
                   @"Maurice Robert \"Mike\" Gravel",
                   @"Dennis Kucinich", nil] retain];
    republican = [[NSArray arrayWithObjects:
                   @"Ron Paul", @"John McCain",
                   @"Mike Huckabee", @"Mitt Romney", nil] retain];
    independent = [[NSArray arrayWithObjects:
                   @"Ralph Nader", nil] retain];
    libertarian = [[NSArray arrayWithObjects:@"Bob Barr", nil] retain];
    socialist = [[NSArray arrayWithObjects:@"Brian Moore", nil] retain];
    myTable.dataSource = self;
    [window addSubview:myTable];
    [window makeKeyAndVisible];
}
- (NSInteger) numberOfSectionsInTableView:(UITableView *)tableView {
    return 5;
}
- (NSInteger)
    tableView:(UITableView *)tableView
    numberOfRowsInSection:(NSInteger)section{
    switch (section) {
        case 0:
            return [democratic count];
        case 1:
            return [independent count];
        case 2:
            return [libertarian count];
        case 3:
            return [republican count];
    }
}
```

```
    case 4:
        return [socialist count];
    }
    return 0;
}

- (UITableViewCell *)tableView:(UITableView *)tableView
    cellForRowAtIndexPath:(NSIndexPath *)indexPath{
    UITableViewCell *cell =
    [tableView dequeueReusableCellWithIdentifier:@"shows"];
    if (cell == nil) {
        cell = [[[UITableViewCell alloc]
                  initWithStyle:UITableViewCellStyleDefault
                  reuseIdentifier:@"shows"] autorelease];
    }
    switch (indexPath.section) {
        case 0:
            cell.textLabel.text = [democratic objectAtIndex:indexPath.row];
            break;
        case 1:
            cell.textLabel.text = [independent objectAtIndex:indexPath.row];
            break;
        case 2:
            cell.textLabel.text = [libertarian objectAtIndex:indexPath.row];
            break;
        case 3:
            cell.textLabel.text = [republican objectAtIndex:indexPath.row];
            break;
        case 4:
            cell.textLabel.text = [socialist objectAtIndex:indexPath.row];
            break;
    }
    return cell;
}
- (NSString *)
    tableView:(UITableView *)tableView
    titleForHeaderInSection:(NSInteger)section {
    NSString *title = nil;
    switch (section) {
        case 0:
            title = @"Democratic";
            break;
        case 1:
            title = @"Independent";
            break;
        case 2:
            title = @"Libertarian";
```

```
        break;
    case 3:
        title = @"Republican";
        break;
    case 4:
        title = @"Socialist Party USA";
        break;
    }
    return title;
}

- (NSArray*)sectionIndexTitlesForTableView: (UITableView *)tableView {
    return [NSArray arrayWithObjects:@"D", @"I", @"L", @"R", @"S", nil];
}
- (NSInteger)
    tableView: (UITableView *)tableView
    sectionForSectionIndexTitle: (NSString *)title
    atIndex: (NSInteger) index {
    return index;
}

- (void)dealloc {
    [window release];
    [myTable release];
    [democratic release];
    [republican release];
    [independent release];
    [libertarian release];
    [socialist release];
    [super dealloc];
}
@end
```

As we did before in the previous examples, the table view is created and configured, and the data model is populated with the candidates' names.

The method `tableView:titleForHeaderInSection:` was encountered in previous sections. It returns the headers for the table view's sections.

The method `sectionIndexTitlesForTableView:` is invoked by the table view asking the data source for an array of `NSString` instances. This array of strings will form the index list on the right-hand side of the table view. The method is declared as follows:

```
- (NSArray *)sectionIndexTitlesForTableView: (UITableView *)tableView
```

Note that the number of elements in this array does not necessarily have to be equal to the number of sections in the table view. In our example, the index list is: D, I, L, R, S. Each letter represents one political party. Note, again, that we did not have to have an index letter for every section.

The method `tableView:sectionForSectionIndexTitle:atIndex:` is invoked asking the data source for the section index corresponding to the section index title and section title index. The declaration of the method is given by:

```
- (NSInteger)
    tableView:(UITableView *)tableView
    sectionForSectionIndexTitle:(NSString *)title
    atIndex:(NSInteger)index
```

This method is invoked when the user taps on a given index letter. Since the index of the index letter and the section index are the same, we simply return the index value passed to us. For example, if the user taps on the `S` index letter, the method is invoked with `title` equal to `S` and `index` equal to 4. Since `S` corresponds to the `Socialist Party USA` section, which has index 4, we simply return the `index` value passed to us. If you choose not to have a one-to-one correspondence between the index letters and the sections, you will have to do some extra work in order to return the section index.

Figure 9.21 shows the indexed table view application. Figure 9.22 shows the table view after the user taps on the `S` index letter. The table view scrolls up, making the corresponding section visible.

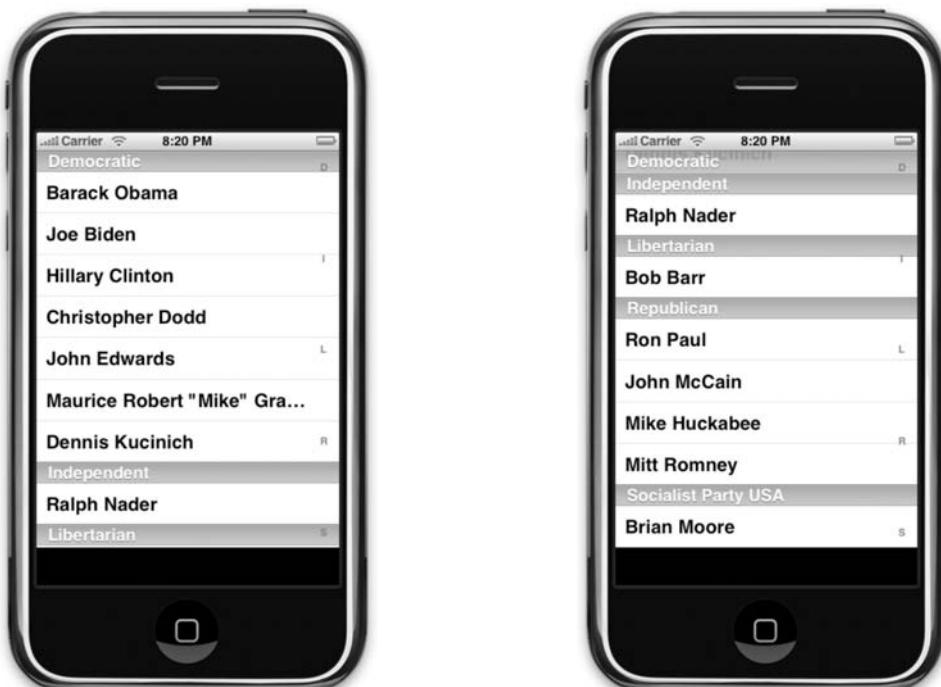


Figure 9.21 A indexed table view application.

Figure 9.22 A indexed table view application after tapping on an index.

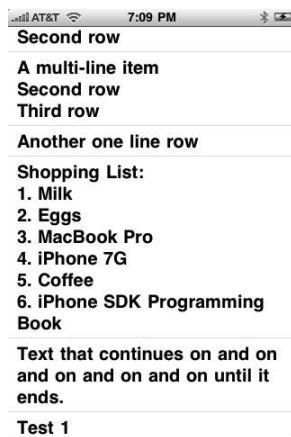


Figure 9.23 A screenshot of the dynamic table view application to be developed in this section.

9.11 Dynamic Table Views

Often, you want to present information with variable height depending on the data model (see Figure 9.23). One time, a cell has a height of 50 points because the underlying data model for this cell has two lines of text. Another time, its height is 150 containing six lines of text.

In this section, we will extend the `UITableViewController` class with the new `DynamicTableViewController` class. This class will manage the sizing of table cells for us.

Listing 9.25 shows the interface of our class. The complete source code can be found in the `DynamicTableView` project in the source downloads.

Listing 9.25 The interface of the `DynamicTableViewController` class.

```
@interface DynamicTableViewController : UITableViewController {
    NSArray *data;
    UIFont *textFont;
}
@property (nonatomic, retain) UIFont *textFont;
@property (nonatomic, retain) NSArray *data;
-(CGFloat) minHeightForText:(NSString*)_text;
-(id) initWithData:(NSArray*)_data;
@end
```

To use this class, you create a new object and initialize it using the `initWithData:` initializer. The parameter you pass in is an `NSArray` instance that holds the data you want to present. The `DynamicTableViewController` invokes the method `description` on the corresponding object in this array when it wants to show it in the cell. How this `description` method is defined is up to the

user of this class. If the object is an `NSString` instance, then the `description` method (overridden by `NSString` class) simply returns the textual representation of the string instance.

The class also has a `textFont` property. This property can be set to be the font of the text of each cell. If not set, a default font will be used. This will keep our class simple. If you want, you can modify this class to provide variable font for cells.

The `initWithData:` method (shown below) simply invokes the `initWithStyle:` initializer of the `UITableViewController` class and retains the data.

```
- (id) initWithData: (NSArray*) _data{
    if( self = [super initWithStyle:UITableViewStylePlain] ) {
        self.data = _data;
    }
    return self;
}
```

At the heart of this class is the `minHeightForText:` method. This method computes the minimum height that a given text needs in order to be presented. It relies on the following method declared in the category `UIStringDrawing` on `NSString`:

```
- (CGSize) sizeWithFont: (UIFont *) font
    constrainedToSize: (CGSize) size
    lineBreakMode: (UILineBreakMode) lineBreakMode;
```

This `NSString` method computes the minimum width and height that a text needs to render, given a specific font, line break mode, and maximum size. The method finds the size by wrapping the text according to the parameters values and its content (e.g., "\n"). If the height of only one line exceeds that height specified in `size`, the method may return a height bigger than the one specified in `size`.

The trick that we use in the `minHeightForText:` method is to restrict the width of `size` to a value of 300 while having a very large value for `height`. This way, the `NSString` method will compute the height for all rows contained in the text. We also check for the `font` property in case the caller hasn't set it. We use a bold system font of size 16 as a default value.

```
- (CGFloat) minHeightForText: (NSString*) _text{
    if( !textFont ) {
        self.textFont = [UIFont boldSystemFontOfSize:16];
    }
    return [_text
        sizeWithFont:textFont
        constrainedToSize:CGSizeMake(LABEL_WIDTH, 999999)
        lineBreakMode:LABEL_LINE_BREAK_MODE].height;
}
```

To specify the height of a each cell, we implement the `tableView:heightForRowAtIndexPath:` delegate method as shown below:

```
- (CGFloat)tableView:(UITableView *)tableView
    heightForRowAtIndexPath:(NSIndexPath *)indexPath{
    return [self minHeightForText:
        [[data objectAtIndex:indexPath.row] description]] + 2*Y_ANCHOR;
}
```

The method simply uses the value from `minHeightForText`: and adds the values of the top and bottom margins.

Each of our cells will host a `UILabel`. The label will be added as a subview to the cell. To add a subview to a cell, you need to add that view using the `addSubview:` method of the cell's `contentView`. The `tableView:cellForRowAtIndexPath:` method is shown in Listing 9.26.

The method creates a new cell when a reusable cell cannot be found. It then configures and adds a `UILabel` to that cell. To make the label multi-line, we assign 0 to the `numberOfLines` property. This in effect will make the label accept any number of lines. Since we want to access the label from a reused cell, we tag the label.

The cell is reconfigured each time (whether it has just been created or is dequeued). The configuration only pertains to the label. We retrieve the label view by sending the `viewWithTag:` message to the cell's `contentView`. Once it is retrieved, we adjust its frame to the proper computed value and set its text. Notice the use of the horizontal and the vertical anchors of the label.

Listing 9.26 The `cellForRowAtIndexPath:` method for the dynamic table view controller.

```
- (UITableViewCell *)
    tableView:(UITableView *)tableView
    cellForRowAtIndexPath:(NSIndexPath *)indexPath {
    NSString *textValue = [[data objectAtIndex:indexPath.row] description];
    static NSString *cellID = @"My Awesome Cell";
    UILabel *label;
    UITableViewCell *cell =
        [tableView dequeueReusableCellWithIdentifier:cellID];
    if (cell == nil) {
        cell = [[[UITableViewCell alloc]
            initWithFrame:CGRectZero]
            initWithStyle:UITableViewCellStyleDefault
            reuseIdentifier:cellID] autorelease];
        label =
            [[[UILabel alloc] initWithFrame:CGRectMake(0, 0, 100, 100)]
            autorelease];
        label.numberOfLines = 0;
        label.lineBreakMode = LABEL_LINE_BREAK_MODE;
        label.tag = 1234;
        label.font = textFont;
        [cell.contentView addSubview:label];
    }
    label = (UILabel*)[cell.contentView viewWithTag:1234];
    label.frame = CGRectMake(X_ANCHOR, Y_ANCHOR, LABEL_WIDTH,
        [self minHeightForText:textValue]);
```

```

label.text = textView;
return cell;
}

```

That's pretty much the `DynamicTableViewController` class. Listing 9.27 shows the use of this controller. As you can see, the controller takes care of almost everything. We just give it a list of items to display.

Listing 9.27 The use of `DynamicTableViewController` class.

```

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[UIWindow alloc] initWithFrame:[UIScreen mainScreen].bounds];
    self.ctrl = [[DynamicTableViewController alloc]
        initWithData:[NSArray arrayWithObjects:
            @"A single line item",
            @"A multi-line item \nSecond row",
            @"A multi-line item \nSecond row\nThird row",
            @"Another one line row",
            @"Shopping List:\n1. Milk\n2. Eggs\n3. MacBook Pro\n4."
                "iPhone 7G\n5. Coffee\n6. iPhone SDK Programming Book",
            @"Text that continues on and on and on and"
                "on and on until it ends.",
            @"Test 1\nTest 2\nTest 3\nTest 4\nTest 5\nTest 6",
            @"Line 1\nLine 2\nLine 3\nLine 4",
            nil]] autorelease];
    ctrl.textFont = [UIFont boldSystemFontOfSize:20];
    [window addSubview:ctrl.view];
    [window makeKeyAndVisible];
}

```

9.12 Whitening Text in Custom Cells

By now, you must have noticed that text in a cell turns white when that cell is selected. By turning the text's color to white, the user is able to see the text more clearly on the blue background. If the text remains black (or worse, blue), the user will have a hard time reading the text.

You can rely on this behavior as long as you stick to using any of the four cell styles covered in Section 9.2. If you customize the cell by adding subviews to its `contentView`, you need to handle whitening any text yourself.

There are two methods that are involved in this process:

- `setSelected:animated:`. This method animates between regular and selected state and is declared as follows:
 - `(void)setSelected:(BOOL)selected animated:(BOOL)animated;`

- `setHighlighted:animated:`: This method animates between regular and highlighted state and is declared as follows:

```
- (void)setHighlighted:(BOOL)highlighted animated:(BOOL)animated;
```

One approach to solving this problem is to subclass `UITableViewCell`, override these two methods, and change the text colors according to the highlighting/selection state. This approach requires subclassing of all cell types in the application. If you add a new cell, you'll need to add custom code that goes through all the subviews of that cell type changing the color of the text.

In this section, we present one approach that solves this problem in a centralized fashion. The basic idea is to *patch* these two methods with custom code. When the cell is asked to highlight or enter selection state, our code records the colors of the text, turns all text to white and forwards the call to the original highlighting/selecting code. When the cell is asked to stop being highlighted/selected, our code retrieves the original colors of the text and forwards the call to the original code.

At the start of the application, we make a call to `swapMethod:withMethod:`, which was developed in Section 2.11, to swap the two methods as shown below:

```
[UITableViewCell swapMethod:@selector(setHighlighted:animated:)
    withMethod:@selector(newSetHighlighted:animated:)] ;

[UITableViewCell swapMethod:@selector(setSelected:animated:)
    withMethod:@selector(newSetSelected:animated:)] ;
```

The `newSetHighlighted:animated:` is shown in Listing 9.28. The method uses a static mutable dictionary, `textColors`. This dictionary holds the text color of any subview of `contentView` that responds to the selector `text`.

At the start of this method, it checks to see if there is a need to process the text in the cell. If the method is asked to change to a state that it is already in, or the selection style of the cell is `UITableViewCellSelectionStyleNone`, the method simply calls itself (which results in calling the original method) and returns. Otherwise, the method continues and checks if the data structure holding the text colors has been created. If not, it creates it.

If the cell needs highlighting, the method calls the method `turnAllToWhite:` passing the `contentView` as an argument. Otherwise, it calls the method `turnAllToOriginal:` passing the `contentView` as an argument. In either case, it always forwards the message to the original method by calling itself.

Listing 9.28 A method used to patch the `setHighlighted:animated:` method in order to manage text color according to the highlighting state of the cell.

```
- (void)newSetHighlighted:(BOOL)highlighted animated:(BOOL)animated {
    if (highlighted == [self isHighlighted] || ([self selectionStyle] == UITableViewCellSelectionStyleNone)) {
```

```

    [self newSetHighlighted:highlighted animated:animated];
    return;
}
if(!textColors) {
    textColors = [[NSMutableDictionary dictionary] retain];
}
if(highlighted == YES){
    [self turnAllToWhite:self.contentView];
}
else{
    [self turnAllToOriginal:self.contentView];
}
[self newSetHighlighted:highlighted animated:animated];
}

```

Listing 9.29 shows the `turnAllToWhite:` method. The method checks to see if the view responds to the `text` selector. If yes, it looks in the dictionary to see if the view has its color already stored. The key used to store the text color for a view is the view's hash value.

If the view is not in the dictionary, its text color is stored in the dictionary with the view's hash as a key. After that, the text color is set to white.

In all cases, the method calls itself for each subview of the view argument.

Listing 9.29 A method that turns the text color of all subviews of a given view to white.

```

- (void)turnAllToWhite: (UIView*)theView{
    if([theView respondsToSelector:@selector(text)]) {
        id existing =
            [textColors
                objectForKey:[NSString stringWithFormat:@"%x", theView.hash]];
        if(!existing) {
            [textColors
                setObject:[((UILabel*)theView) textColor]
                forKey:[NSString stringWithFormat:@"%x", theView.hash]];
            [((UILabel*)theView) setTextColor:[UIColor whiteColor]];
        }
    }
    for(UIView *view in theView.subviews){
        [self turnAllToWhite:view];
    }
}

```

Listing 9.30 shows the `turnAllToOriginal:` method that turns all text to its original color. If the color is stored in the dictionary, the color is retrieved and used to set the text color of the view. After that, the color is removed from the dictionary. As in the previous method, all subviews are handled the same way through a recursive call.

Listing 9.30 A method that turns the text color of all subviews of a given view to their original color.

```
- (void)turnAllToOriginal:(UIView*)theView{
    if([theView respondsToSelector:@selector(text)]) {
        id color =
            [textColors
                objectForKey:[NSString stringWithFormat:@"%@",theView.hash]];
        if(color) {
            [(UILabel*)theView] setTextColor:color;
            [textColors removeObjectForKey:
                [NSString stringWithFormat:@"%@", theView.hash]];
        }
    }
    for(UIView *view in theView.subviews) {
        [self turnAllToOriginal:view];
    }
}
```

Similar to what we have done to `setHighlighted:animated:`, the `setSelected:animated:` is patched with the method shown in Listing 9.31.

Listing 9.31 A method used to patch the `setSelected:animated:` method in order to manage text color according to the selection state of the cell.

```
- (void)newSetSelected:(BOOL)selected animated:(BOOL)animated {
    if(selected == [self isSelected] ||
       ([self selectionStyle] == UITableViewCellStyleNone)) {
        [self newSetSelected:selected animated:animated];
        return;
    }
    if (!textColors) {
        textColors = [[NSMutableDictionary dictionary] retain];
    }
    if(selected == NO) {
        [self turnAllToOriginal:self.contentView];
    }
    else{
        [self turnAllToWhite:self.contentView];
    }
    [self newSetSelected:selected animated:animated];
}
```

Listing 9.32 shows a data source method that builds a custom cell with three `UILabel` subviews each with a different color.

Listing 9.32 A method that builds a custom cell with three `UILabel` subviews each with a different color.

```
- (UITableViewCell *)
tableView:(UITableView *)tableView
```

```
cellForRowAtIndexPath: (NSIndexPath *) indexPath{
UITableCell *cell =
[tableView dequeueReusableCellWithIdentifier:@"cell"];
UILabel *label1, *label2, *label3;
if (cell == nil) {
    cell = [[[UITableViewCell alloc]
        initWithStyle:UITableViewCellStyleDefault
        reuseIdentifier:@"cell"] autorelease];
label1 = [[[UILabel alloc]
        initWithFrame:CGRectMake(0, 0, 320, 60)] autorelease];
label1.textColor = [UIColor redColor];
label1.font = [UIFont boldSystemFontOfSize:22];
label1.tag = 20;
label2 = [[[UILabel alloc]
        initWithFrame:CGRectMake(30, 25, 150, 40)] autorelease];
label2.textColor = [UIColor greenColor];
label2.font = [UIFont boldSystemFontOfSize:12];
label2.tag = 21;
label2.backgroundColor = [UIColor clearColor];
label3 = [[[UILabel alloc]
        initWithFrame:CGRectMake(10, 15, 100, 30)] autorelease];
label3.textColor = [UIColor orangeColor];
label3.font = [UIFont boldSystemFontOfSize:7];
label3.tag = 22;
label3.backgroundColor = [UIColor clearColor];
[label2 addSubview:label3];
[label1 addSubview:label2];
[cell.contentView addSubview:label1];
cell.selectionStyle = UITableViewCellStyleBlue;
}
label1 = (UILabel*)[cell.contentView viewWithTag:20];
label2 = (UILabel*)[cell.contentView viewWithTag:21];
label3 = (UILabel*)[cell.contentView viewWithTag:22];
label1.text = [NSString stringWithFormat:
    @"This is the grandfather #%-d", indexPath.row+1];
label2.text = [NSString stringWithFormat:
    @"This is the father #%-d", indexPath.row+1];
label3.text = [NSString stringWithFormat:
    @"This is the child #%-d", indexPath.row+1];
return cell;
}
```

Figure 9.24 shows a screenshot of the application that uses the methods developed in this section. The complete source code that is presented in this section can be found in the `TableViewWhiten` project.



Figure 9.24 Turning the color of all text to white upon selection.

9.13 Summary

This chapter took you through a step-by-step journey to the world of table views. We started by presenting an overview of the main concepts behind table views in Section 9.1. After that, we presented, in Section 9.2, a simple table view application and discussed the mandatory methods you need to implement in order to populate and respond to users' interactions with the table view.

In Section 9.3, we showed how easy it is to add images to table rows. Section 9.4 introduced the concept of sections and provided a table view application that has sections with section headers and footers.

In Section 9.5, we introduced the concept of editing a table view. An application that allows the user to delete rows was presented, and the main ideas were clarified. In Section 9.6, we addressed the insertion of new rows in a table view. An application was discussed that presents a data entry view to the user and adds that new data to the table's rows. In Section 9.7, we continued our discussions of the editing mode and presented an application for reordering table entries. The main concepts of reordering rows were presented.

In Section 9.8, we discussed the mechanism for presenting hierarchical information to the user. An application that uses table views to present three levels of hierarchy was discussed. In Section 9.9, we discussed grouped table views through an example. After that, we presented the main concepts behind indexed table views in Section 9.10. In Section 9.11, we presented a dynamic table view controller class. This class was used to adjust each cell's height depending on the number of lines of the corresponding item in the data model. Finally, in Section 9.12, we addressed the issue of turning the text color to white when a custom cell is selected.

Problems

- (1) Investigate the UITableView class further by reading the UITableView.h header file and the relevant documentation.
- (2) Create a table view that has 10 rows where each row is a web view displaying the contents of a given URL. Each row's height is 50 pts.
- (3) Modify the whitening strategy described in Section 9.12 to bypass whitening if the default behavior suffices.

10

File Management

This chapter covers the topic of file management. Here, you learn how to use both high- and low-level techniques for storing/retrieving data to/from files. To perform high-level operations on files/directories you use instances of the `NSFileManager` class. `NSFileHandle` class is used in this chapter to demonstrate low-level file access.

Section 10.1 covers the `Home` directory of the application. Next, Section 10.2 shows how to enumerate the contents of a given directory using the high-level methods of `NSFileManager`. In that section, you learn more about the structure of the `Home` directory and where you can store files. After that, you learn in Section 10.3 how to create and delete directories. Next, Section 10.4 covers the creation of files. Section 10.5 deals with the topic of file and directory attributes, and you learn how to retrieve and set specific file/directory attributes. In Section 10.6, we demonstrate the use of application bundles and low-level file access. Finally, we summarize the chapter in Section 10.7.

10.1 The Home Directory

The application and its data are contained within a single directory called the `Home` directory. Your application can only access this directory and its contents. The absolute path of the home directory on the simulator is different from that on the actual device. However, the organization and content are identical.

To access the absolute path of the `Home` directory, you can use the function `NSHomeDirectory()` which is declared as follows:

```
NSString * NSHomeDirectory (void);
```

This function returns an `NSString` object holding the absolute path. As an example, the following is a home directory on the simulator:

```
/Users/ali/Library/  
Application Support/iPhone Simulator/User/Applications/  
F9CC3A49-997D-4523-9AFA-B553B5AE41EA
```

On the device, it is:

```
/var/mobile/Applications/F1C43BD0-1AB4-494B-B462-5A7315813D1A
```

In the next section, you will see the structure of the Home directory and where you can store files.

10.2 Enumerating a Directory

In this section, you learn how to enumerate (recursively) the contents of a given directory. Listing 10.1 shows the `main()` function for enumerating the contents of the Home directory.

Listing 10.1 A `main()` function listing the contents of the Home directory.

```
#import <Foundation/Foundation.h>

int main(int argc, char *argv[]) {
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    NSLog(@"Absolute path for Home Directory: %@", NSHomeDirectory());
    NSFileManager *fileManager = [NSFileManager defaultManager];
    NSDirectoryEnumerator *dirEnumerator =
        [fileManager enumeratorAtPath: NSHomeDirectory()];
    NSString *currPath;
    while (currPath = [dirEnumerator nextObject]) {
        NSLog(@"Found %@", currPath);
    }
    [pool release];
    return 0;
}
```

The function starts by logging the absolute path of the Home directory. The log output on the simulator is:

```
Absolute path for Home Directory: /Users/ali/Library/
Application Support/iPhone Simulator/User/Applications/
F9CC3A49-997D-4523-9AFA-B553B5AE41EA
```

On the device, it is:

```
Absolute path for Home Directory: /var/mobile/Applications/
F1C43BD0-1AB4-494B-B462-5A7315813D1A
```

After that, it obtains a default `NSFileManager` instance for the file system using the class method `defaultManager`. Using this instance, we can make our high-level calls manipulating files and directories inside the Home directory.

Finding all the files and directories inside a given directory is simple. You use the `enumeratorAtPath:` method declared as follows:

```
- (NSDirectoryEnumerator *) enumeratorAtPath: (NSString *)path
```

You pass the path of the directory that you would like to enumerate the contents of, and receive an instance of the `NSDirectoryEnumerator` class. Each object in the directory enumerator is the full path of an item inside the directory used in obtaining the enumerator. The paths are all relative to this directory. You can iterate over this instance, skip subdirectories, and even access file and directory attributes.

As a subclass of `NSEnumerator`, you use `nextObject` to retrieve objects. The `main()` function simply retrieves all objects and logs them. The log generated on the simulator is shown below. Note that the logging timestamps are removed to save space.

```
Found Documents
Found FileMgmt5.app
Found FileMgmt5.app/FileMgmt5
Found FileMgmt5.app/Info.plist
Found FileMgmt5.app/PkgInfo
Found Library
Found Library/Preferences
Found Library/Preferences/.GlobalPreferences.plist
Found Library/Preferences/com.apple.PeoplePicker.plist
Found tmp
```

The `Documents` directory is available to you for storing application data. The `tmp` directory is used for temporary files. The other two directories `AppName.app` (e.g., `FileMgmt5.app`) and `Library` should not be manipulated by file system calls. You can create directories inside the `Home`, `tmp`, and `Documents`. You can assume that all the contents of the `Home` directory will be backed up by iTunes except for the `tmp` directory.

The `NSDirectoryEnumerator` does have several convenience methods that you can use:

- `directoryAttributes`. You use this method to return a dictionary of the attributes of the directory you are enumerating. We will talk about file and directory attributes later in this chapter.
- `fileAttributes`. This method provides a dictionary of attributes for the current object of enumeration. This method works for both files and subdirectories. We will talk about file and directory attributes later in this chapter.
- `skipDescendents`. During enumeration, if you are not interested in the contents of a given subdirectory, you can skip it altogether by calling this method.

10.3 Creating and Deleting a Directory

This section demonstrates creating and deleting subdirectories in the Home directory. Listing 10.2 shows the `main()` function.

Listing 10.2 A `main()` function demonstrating creation and deletion of directories.

```
#import <Foundation/Foundation.h>

int main(int argc, char *argv[]) {
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    NSError *error;
    NSFileManager *fileManager = [NSFileManager defaultManager];
    NSString *newDirPath =
        [NSHomeDirectory() stringByAppendingPathComponent:@"tmp/directory"];
    BOOL success =
        [fileManager createDirectoryAtPath:newDirPath attributes:nil];
    if(success == YES){
        NSLog(@"Directory %@ created successfully!", newDirPath);
        success = [fileManager removeItemAtPath:newDirPath error:&error];
        if(success == YES){
            NSLog(@"Directory %@ deleted successfully!", newDirPath);
        }
        else{
            NSLog(@"Error deleting directory %@. %@", newDirPath, [error localizedDescription]);
            return -1;
        }
    }
    else{
        NSLog(@"Error creating directory %@.", newDirPath);
        return -1;
    }
    [pool release];
    return 0;
}
```

To create a directory, you use the `createDirectoryAtPath:attributes:` instance method of the `NSFileManager`. This method is declared as follows:

```
- (BOOL)createDirectoryAtPath:(NSString *)path
                      attributes:(NSDictionary *)attributes
```

The method takes as input parameters the path of the directory to be created and the attributes of that directory. We will tackle attributes in a later section. To create a directory with default attributes, you need to pass a `nil` value for the second parameter. If the directory was created successfully, the method returns a YES; otherwise, it returns a NO.

Once the directory is successfully created, we remove it. The method for removing a file or a directory is `removeItemAtPath:error:` which is declared as follows:

```
- (BOOL)removeItemAtPath:(NSString *)path error:(NSError **)error
```

It takes the path for the item (a directory, file, or link) to be removed, and a reference to an `NSError` object. You can pass `NULL` in the second parameter if you are not interested in knowing what may have caused the failure (i.e., a return of `NO`).

The log output generated on the simulator is:

```
Directory /Users/ali/Library/Application Support/
iPhone Simulator/User/Applications/
BCE1C2BE-FAF0-47C2-A689-C20F630604E2/
tmp/directory created successfully!
Directory /Users/ali/Library/Application Support/
iPhone Simulator/User/Applications/
BCE1C2BE-FAF0-47C2-A689-C20F630604E2/
tmp/directory deleted successfully!
```

The log output generated on the device is:

```
Directory /var/mobile/Applications/
2E723F14-B89B-450B-81BF-6385EFF76D05/
tmp/directory created successfully!
Directory /var/mobile/Applications/
2E723F14-B89B-450B-81BF-6385EFF76D05/
tmp/directory deleted successfully!
```

10.4 Creating Files

In this section, we demonstrate the creation of files in the application's `Home` directory. To make things interesting, we load a web page from the Internet using the `http` protocol and store that `html` file in `tmp`. After that, we use a web view to load the `html` from the `tmp` directory and present it to the user. As you will see, these tasks can be easily achieved using the rich APIs available.

Listing 10.3 shows the declaration of the application delegate class used in our example. The class is similar to what you have seen previously in Chapter 7.

Listing 10.3 The declaration of the application delegate class used in the file creation and local file viewing example.

```
#import <UIKit/UIKit.h>

@class MainViewController;
@interface FileAppDelegate : NSObject <UIApplicationDelegate> {
```

```
UIWindow *window;
MainViewController *mainCtrl;
}
@property (nonatomic, retain) UIWindow *window;
@end
```

The implementation of the application delegate is shown in Listing 10.4. The delegate simply uses the MainViewController as a subview of the main window.

Listing 10.4 The implementation of the application delegate class used in the file creation and local file viewing example.

```
#import "FileAppDelegate.h"
#import "MainViewController.h"

@implementation FileAppDelegate
@synthesize window;

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]];
    mainCtrl = [[MainViewController alloc] initWithNibName:nil bundle:nil];
    [window addSubview:mainCtrl.view];
    [window makeKeyAndVisible];
}

- (void)dealloc {
    [window release];
    [mainCtrl release];
    [super dealloc];
}
@end
```

The MainViewController class is declared in Listing 10.5. It has a reference to the UIWebView instance which will be used to visualize the contents of the local file in tmp. In addition, it declares two methods for the creation and visualization of the html file in tmp.

Listing 10.5 The declaration of the MainViewController class used in the file creation and local file viewing example.

```
#import <UIKit/UIKit.h>

@interface MainViewController : UIViewController {
    UIWebView *webView;
}
- (void) createAFileInTMP;
- (void) loadWebViewWithFileInTMP;
@end
```

Listing 10.6 shows the implementation of the `MainViewController` class. The `loadView` method simply creates the web view object and makes it able to respond to zooming gestures. The web view object is made as the view managed by the controller; thus it will be added as the subview to the main window.

The `viewDidLoad` method is invoked once the view has been loaded. It creates the file by invoking the `createAFileInTMP` method and after that it loads the web view with the downloaded file by invoking the `loadWebViewWithFileInTMP` method.

Listing 10.6 The implementation of the MainViewController class used in the file creation and local file viewing example.

```
path:@"/textedition/index.html"];  
NSData *data = [[NSData alloc] initWithContentsOfURL:theURL];  
BOOL fileCreationSuccess =  
[fileManager createFileAtPath:fileName contents:data attributes:nil];  
if(fileCreationSuccess == NO){  
    NSLog(@"Failed to create the html file");  
}  
[theURL release];  
[data release];  
}  
  
- (void)dealloc {  
    [webView release];  
    [super dealloc];  
}  
@end
```

The `createAFileInTMP` method first builds an `NSURL` object pointing to the URL `http://www.csmonitor.com/textedition/index.html`. It then creates an `NSData` object having the contents of the `index.html` file downloaded from the server. To actually create the file on the local file system, we use the `createFileAtPath:contents:attributes:` method which is declared as follows:

```
- (BOOL) createFileAtPath:(NSString *)path contents:(NSData *)data  
    attributes:(NSDictionary *)attr
```

It takes the path of the file as the first parameter, the data in the second, and the attributes in the third. Here, we use the default attributes and pass a `nil`. The path used is the absolute path of the Home directory with the `tmp/file.html` appended at the end. If there was a problem in creating the file, the return value is `NO`; otherwise, it is `YES`.

The `loadWebViewWithFileInTMP` method loads the local `html` file and presents it using the web view. It starts by creating an `NSData` object and loading it with the contents of the local file using the `NSFileManager`'s instance method `contentsAtPath:`. After that, we simply load the web view object with the contents of the `NSData` object.

Figure 10.1 shows a screenshot of the file creation and web visualization example. The complete application can be found in the `FileMgmt` project in the source downloads.

10.5 Retrieving and Changing Attributes

Until now, we have been specifying `nil` for the dictionary attributes of files and directories. You can, however, specify a dictionary which provides attributes that are different from the default. Moreover, you can alter the attributes of a file system object after it has been created.



Figure 10.1 A snapshot of the file creation and web visualization example.

In the following, we give an example showing how you can retrieve/set the attributes of a file. Listing 10.7 shows the `main()` function of the program.

Listing 10.7 An example showing how to retrieve/set the attributes of a file.

```
#import <Foundation/Foundation.h>

int main(int argc, char *argv[]) {
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    BOOL success;
    NSFileManager *fileManager = [NSFileManager defaultManager];
    NSString *filePath =
        [NSSearchPathDirectory(NSHomeDirectory) stringByAppendingPathComponent:@"tmp/file.txt"];
    NSData *data = [@"Hello! This is a line."
                    dataUsingEncoding:NSUTF8StringEncoding];
```

```
success =
    [fileManager createFileAtPath:filePath contents:data attributes:nil];
if(success == NO){
    NSLog(@"Error creating file");
    return -1;
}
NSDictionary *attributes =
    [fileManager fileAttributesAtPath:filePath traverseLink:NO];
if(attributes){
    NSNumber *fSize = [attributes objectForKey:NSFileSize];
    NSLog(@"File size is %qi", [fSize longLongValue]);
}
NSDictionary *newAttributes;
NSError *error;
newAttributes =
    [NSDictionary dictionaryWithObject:[NSNumber numberWithBool:YES]
        forKey:NSUTF8StringEncodingHidden];
success = [fileManager setAttributes:newAttributes
        ofItemAtPath:filePath error:&error];
if(success == NO){
    NSLog(@"Error setting attributes of file. Error: %@", [error localizedDescription]);
    return -1;
}
attributes =
    [fileManager fileAttributesAtPath:filePath traverseLink:NO];
[pool release];
return 0;
}
```

It starts by creating `file.txt` file in `tmp` with a one-line text stored in it. We first obtain an `NSData` object from a string by using the `NSString`'s instance method `dataUsingEncoding:` with `utf-8` encoding. After that, we create the file on the file system using the `createFileAtPath:contents:attributes:` method which we have seen before. We use the default attributes in creating the file.

10.5.1 Retrieving attributes

After creating the file using the default attributes, we would like to retrieve the file's attributes to see what are the keys available and what are the values for these keys. To retrieve the attributes of a file, we use the `NSFileManager`'s instance method `fileAttributesAtPath:traverseLink:` which is declared as follows:

```
- (NSDictionary *)fileAttributesAtPath:(NSString *)path
    traverseLink:(BOOL)flag
```

You pass the path of the file in the first parameter. If the path points to a symbolic link, you can then specify YES to traverse the link or NO to return the attributes of the link itself. The method returns an NSDictionary instance if successful, or nil if not. The attributes variable is used to hold on to the returned value. If attributes is not nil, we log the value of one attribute: the file's size in bytes. The key in obtaining this value is NSFileSize. The log output and the (dumped) contents of the attributes object on the simulator just after retrieving the attributes of the file are shown in the following log.

```
2008-08-01 08:12:06.996 FileMgmt4[394:20b] File size is 22
(gdb) po attributes
{
    NSFileCreationDate = 2008-08-01 08:11:49 -0500;
    NSFileExtensionHidden = 0;
    NSFileGroupOwnerAccountID = 20;
    NSFileGroupOwnerAccountName = staff;
    NSFileHFSCreatorCode = 0;
    NSFileHFSTypeCode = 0;
    NSFileModificationDate = 2008-08-01 08:11:49 -0500;
    NSFileOwnerAccountID = 501;
    NSFileOwnerAccountName = ali;
    NSFilePosixPermissions = 420;
    NSFileReferenceCount = 1;
    NSFileSize = 22;
    NSFileSystemFileName = 2436813;
    NSFileSystemNumber = 234881026;
    NSFileType = NSFileTypeRegular;
}
```

10.5.2 *Changing attributes*

To change one or more attributes of a file or a directory, you can use the `setAttributes:ofItemAtPath:error:` NSFileManager's method which is declared as follows:

```
- (BOOL) setAttributes:(NSDictionary *)attributes
                 ofItemAtPath:(NSString *)path error:(NSError **)error;
```

In the first parameter, you pass a dictionary with one or more of the item's attributes that you wish to set. You pass the path of the item in the second parameter and a reference to an NSError object in the third.

The following are the attribute keys related to files and directories that are available to you:

- `NSFileBusy`. Use this key to specify whether the file is busy or not. The value is `NSNumber` with a Boolean value.

- `NSFileCreationDate`. Use this key to set the creation date of the file/directory. The value for this key is an `NSDate` object.
- `NSFileExtensionHidden`. Use this key to specify whether the file extension is hidden or not. The value is `NSNumber` with a Boolean value. The example below shows how to set this attribute.
- `NSFileGroupOwnerAccountID`. Use this key to specify the file's group ID. The value is specified in an `NSNumber` object containing an `unsigned long` value.
- `NSFileGroupOwnerAccountName`. Use this key to specify the name of the group that the file owner belongs to. The value of this key is an `NSString` object.
- `NSFileHFSCreatorCode`. Use this key to specify the file's HFS creator code. The value is specified in an `NSNumber` object containing an `unsigned long` value.
- `NSFileHFSTypeCode`. Use this key to specify the file's HFS type code. The value is specified in an `NSNumber` object containing an `unsigned long` value.
- `NSFileImmutable`. Use this key to specify whether the file is mutable or not. The value is `NSNumber` with a Boolean value.
- `NSFileModificationDate`. Use this key to specify the date of the last modification of the file. The value for this key is an `NSDate` object.
- `NSFileOwnerAccountID`. Use this key to specify the account ID of the file's owner. The value is specified in an `NSNumber` object containing an `unsigned long` value.
- `NSFileOwnerAccountName`. Use this key to specify the name of the file's owner. The value of this key is an `NSString` object.
- `NSFilePosixPermissions`. Use this key to specify the POSIX permissions of the file. The value is specified in an `NSNumber` object containing an `unsigned long` value.

After changing the `NSFileExtensionHidden` to YES, the `attributes` object on the simulator is as follows:

```
(gdb) po attributes
{
    NSFileCreationDate = 2008-08-01 08:11:49 -0500;
    NSFileExtensionHidden = 1;
    NSFileGroupOwnerAccountID = 20;
    NSFileGroupOwnerAccountName = staff;
    NSFileHFSCreatorCode = 0;
    NSFileHFSTypeCode = 0;
    NSFileModificationDate = 2008-08-01 08:11:49 -0500;
    NSFileOwnerAccountID = 501;
    NSFileOwnerAccountName = ali;
    NSFilePosixPermissions = 420;
    NSFileReferenceCount = 1;
    NSFileSize = 22;
```

```
    NSFileSystemFileNumber = 2436813;  
    NSFileSystemNumber = 234881026;  
    NSFileType = NSFileTypeRegular;  
}
```

The attributes object on the device is a little bit different. We notice several changes such as the `NSFileGroupOwnerAccountName` and `NSfileOwnerAccountId`. Although the `NSFileExtensionHidden` was successfully changed by the API call, the `NSFileExtensionHidden` key does not appear at all in the attributes object. This serves as a reminder to always test your code on the actual device. The following are all the attributes of the file available to you on the device:

```
2008-08-01 08:17:39.982 FileMgmt4[164:20b] File size is 22
(gdb) po attributes
{
    NSFileGroupOwnerAccountID = 501;
    NSFileGroupOwnerAccountName = mobile;
    NSFileModificationDate = 2008-08-01 08:17:35 -0500;
    NSFileOwnerAccountID = 501;
    NSFileOwnerAccountName = mobile;
    NSFilePosixPermissions = 420;
    NSFileReferenceCount = 1;
    NSFileSize = 22;
    NSFileSystemFileName = 87161;
    NSFileSystemNumber = 234881026;
    NSFileType = NSFileTypeRegular;
}
```

10.6 Working with Resources and Low-level File Access

This section demonstrates the use of bundles (accessing files stored at the time that the application was packaged) and low-level file access (seeking and updating a file).

Listing 10.8 shows the `main()` function demonstrating loading a file from a bundle and modifying it by inserting text.

Listing 10.8 The main() function demonstrating loading a file from a bundle and modifying it by writing text.

```
NSData *fileData = [NSData dataWithContentsOfFile:filePath];
if (fileData) {
    NSString *newFilePath = [NSHomeDirectory()
        stringByAppendingPathComponent:@"Documents/fileNew.txt"];
    success = [fileManager createFileAtPath:newFilePath
        contents:fileData attributes:nil];
    if(success == NO){
        NSLog(@"Error creating file");
        return -1;
    }
    NSFileHandle *fileHandle =
        [NSFileHandle fileHandleForUpdatingAtPath:newFilePath];
    if(fileHandle){
        [fileHandle seekToFileOffset:11];
        NSData *appendedData =
            [@" modified " dataUsingEncoding:NSUTF8StringEncoding];
        [fileHandle writeData:appendedData];
        [fileHandle closeFile];
    }
    else{
        NSLog(@"Error modifying the file");
        return -1;
    }
}
else{
    NSLog(@"Could not load file from the app bundle");
    return -1;
}
[pool release];
return 0;
}
```

Our application stores a text file in the application bundle as shown in the XCode's Groups and Files screenshot in Figure 10.2. You can store data files anywhere you want, but usually you store them in the Resources group as shown in Figure 10.2.

We have previously seen that, inside the Home directory of every application, there is an `xxx.app` directory (where `xxx` stands for the name of the application). Inside this directory go the data files.

To help in locating the data files inside the bundle, an instance method of the class `NSBundle` can be used to search for a specific file with a specific extension, and return the absolute path of that resource. This method is declared as follows:

```
- (NSString *)pathForResource:(NSString *)name ofType:(NSString *)ext;
```

In the first parameter, you pass in the path of the resource file that you want to locate, and in the second its extension. You can pass an empty string or even `nil` for the extension if your file's name is unique in the bundle. The reason this works is because the search algorithm returns the first

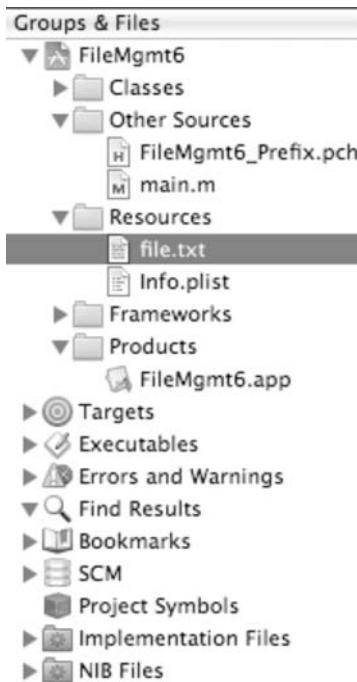


Figure 10.2 XCode's Groups and Files screenshot.

occurrence of a file with the exact name if the `ext` parameter is `nil` or empty. The location of the `file.txt` in the bundle (value of `filePath` in `main()` function) is:

```
/var/mobile/Applications/5ABEB448-7634-4AE8-9833-FC846A81B418/  
FileMgmt6.app/file.txt
```

Remember what we have mentioned before, that you should not change items in the `.app` directory as it will affect code signing. Therefore, to modify a file in the bundle, you need to copy it to a different directory and change it there.

After locating the file in the bundle and storing its absolute path in `filePath`, we load its contents into an `NSData` object using the `dataWithContentsOfFile:` method. Next, the file `Documents/fileNew.txt` is created containing the contents of the bundled file.

The original file contains a single line: `This is the contents of a file.` We would like to modify the copied file by replacing the text "contents" with the text "modified". We would like to perform this task by using low-level file operations involving seeking, rather than loading the whole file into memory, changing it, and storing it back to disk.

To perform low-level file operations, you need to obtain an `NSFileHandle` instance. This class encapsulates the low-level mechanism for accessing files. The nature of operations that you would like to perform on the file determines the method you use to obtain the `NSFileHandle` instance. The following are the three `NSFileHandle` class methods available to you:

- **Reading.** To obtain the instance for read-only access, use the class method `fileHandleForReadingAtPath:` which is declared as follows:
+ `(id)fileHandleForReadingAtPath:(NSString *)path`
- **Writing.** To obtain the instance for write-only access, use the class method `fileHandleForWritingAtPath:` which is declared as follows:
+ `(id)fileHandleForWritingAtPath:(NSString *)path`
- **Reading/writing.** To obtain the instance for update access, use the class method `fileHandleForUpdatingAtPath:` which is declared as follows:
+ `(id)fileHandleForUpdatingAtPath:(NSString *)path`

When you obtain the instance using one of the three methods above, the file's pointer is set to the beginning of the file.

In our example, we open the file for updating. Since we know the location of the text that needs to be inserted, we use the seek operation on the `NSFileHandle` instance. To seek a file, use the `seekToFileOffset:` method which is declared as follows:

- `(void)seekToFileOffset:(unsigned long long)offset`

The location to seek to in our example is 11. After seeking to that location, we write the "modified" text in the file by using the `writeData:` method. This method is declared as follows:

- `(void)writeData:(NSData *)data`

After finishing the update on the file, we close the `NSFileHandle` object by using the method `closeFile`.

10.7 Summary

This chapter covered the topic of file management. You learned how to use both high- and low-level techniques for storing/retrieving data to/from files. To perform high-level operations on files/directories, you used instances of the `NSFileManager` class. The `NSFileHandle` class was used in this chapter to demonstrate low-level file access.

In Section 10.1, we talked about the `Home` directory of the application. Next, Section 10.2 showed how to enumerate the contents of a given directory using the high-level methods of `NSFileManager`. In that section, you learned more about the structure of the `Home` directory and where you can store

files. After that, you learned in Section 10.3 how to create and delete directories. Next, Section 10.4 covered the creation of files. Section 10.5 covered the topic of file and directory attributes. You also learned how to retrieve and set specific file/directory attributes in that section. In Section 10.6 we demonstrated the use of application bundles and low-level file access.

Problems

- (1) Your app uses a database file to store data. You ship the app with a sample database file stored in the bundle. When your app first runs, it checks to see if the database file is available in a directory called `Database` in the `Home` directory. If it is not, the file is copied there and made available for modification. Write a method that implements the logic behind this.
- (2) Read about the `NSFileManager` class in the documentation and in the `NSFileManager.h` header file.

11

Working with Databases

This chapter covers the basics of the SQLite database engine that is available to you using the iPhone SDK. SQLite is different from the other databases that you may be familiar with. Databases such as Oracle and Sybase are server-based databases. In server-based databases, a server runs the database engine and serves the queries of clients running on other machines. SQLite is an embedded database in the sense that there is no server running, and the database engine is linked to your application. SQLite is 100% free to use.

This chapter is not an introduction to databases and it assumes that you know the basics of the Structured Query Language (SQL). You should know that a database is composed of a set of *tables* and each table has a name that uniquely identifies that table in the database. Each table consists of one or more *columns* and each column has a name that uniquely identifies it within that table. A row is a vector of values for each column in a given table. A row is often referred to as a *record*.

This chapter is organized as follows. Section 11.1 describes basic SQL statements and their implementation using SQLite function calls. In Section 11.2, we discuss the handling of result sets generated by SQL statements. In Section 11.3, we address the topic of prepared statements. In Section 11.4, we talk about extensions to the SQLite API through the use of user-defined functions. In Sections 11.5 and 11.6 we present, respectively, a detailed example for storing and retrieving BLOBs to/from the database. Finally, we summarize the chapter in Section 11.7.

11.1 Basic Database Operations

In this section, we talk about some of the basic SQL statements and how we can realize them in SQLite. We present a simple program that creates a database with one table. This table stores records of stock purchases. Each record stores the stock identifier (represented by the stock symbol), the purchase price, the number of shares bought, and the date of purchase.

To use SQLite in your application, you need to add the `libsqLite3.0.dylib` library to your target as explained in Section D.4. In addition, you need to add the following `#import` statement:

```
#import "/usr/include/sqlite3.h"
```

Listing 11.1 shows the `main()` function. The function creates a database (if one does not exist), adds a new table, and populates the table with some records.

Listing 11.1 The `main()` function demonstrating basic SQL statements using SQLite library function calls.

```
#import "/usr/include/sqlite3.h"
int main(int argc, char *argv[]) {
    char    *sqlStatement;
    sqlite3 *pDb;
    char    *errorMsg;
    int     returnCode;
    char    *databaseName;

    databaseName = "financial.db";
    returnCode = sqlite3_open(databaseName, &pDb);
    if(returnCode!=SQLITE_OK) {
        fprintf(stderr, "Error in opening the database. Error: %s",
                sqlite3_errmsg(pDb));
        sqlite3_close(pDb);
        return -1;
    }
    sqlStatement = "DROP TABLE IF EXISTS stocks";
    returnCode = sqlite3_exec(pDb, sqlStatement, NULL, NULL, &errorMsg);
    if(returnCode!=SQLITE_OK) {
        fprintf(stderr,
                "Error in dropping table stocks. Error: %s", errorMsg);
        sqlite3_free(errorMsg);
    }

    sqlStatement = "CREATE TABLE stocks (symbol VARCHAR(5), "
                  "purchasePrice FLOAT(10,4), "
                  "unitsPurchased INTEGER, "
                  "purchase_date VARCHAR(10))";
    returnCode = sqlite3_exec(pDb, sqlStatement, NULL, NULL, &errorMsg);
    if(returnCode!=SQLITE_OK) {
        fprintf(stderr, "Error in creating the stocks table. Error: %s",
                errorMsg);
        sqlite3_free(errorMsg);
    }

    insertStockPurchase(pDb, "ALU", 14.23, 100, "03-17-2007");
    insertStockPurchase(pDb, "GOOG", 600.77, 20, "01-09-2007");
    insertStockPurchase(pDb, "NT", 20.23, 140, "02-05-2007");
    insertStockPurchase(pDb, "MSFT", 30.23, 5, "01-03-2007");
    sqlite3_close(pDb);
    return 0;
}
```

11.1.1 Opening, creating, and closing databases

The first thing that you do before working with a database is open it. The SQLite function for opening a database is `sqlite3_open()`. The function is declared as:

```
int sqlite3_open(
    const char *filename,      /* Database filename (UTF-8) */
    sqlite3 **ppDb            /* OUT: SQLite db handle */
);
```

A database in SQLite is stored in a file. To open a database, you need to specify the filename of that database in the first parameter `filename`. Upon successfully opening the database, the function will return a value of `SQLITE_OK`. For other SQLite functions to work with this database, a handle is needed. You specify a reference to a handle pointer in the second parameter. If the database was successfully opened, a handle is written in that address. The database connection handle is of type `sqlite3`. You pass the address of a variable of type `sqlite3*` in the second parameter. It is worth noting that if the database does not exist, it is created; thus this function is used for both opening an existing database and creating a new one.

If the database was not opened successfully, you need to display an error message and close the database. The SQLite function `sqlite3_errmsg()` takes a pointer to a database handle and returns a meaningful string describing the error. The program shown in Listing 11.1 uses this function in displaying the error message for failed database opening. Once you are finished with a database, you should close it. The SQLite function `sqlite3_close()` is used for that purpose. It takes, as the sole parameter, a pointer to the opened database handle (`sqlite3*`) received when you opened the database.

11.1.2 Table operations

Once we have successfully opened a database, we would like to perform some table operations. SQLite provides a helper function that does a one-time evaluation of SQL statements. This function `sqlite3_exec()` is easy to use and works very well with many SQL statements. Later, we will talk about how this function is implemented using other SQLite functions. The `sqlite3_exec()` is declared as:

```
int sqlite3_exec(
    sqlite3*,                  /* An open database */
    const char *sql,           /* SQL to be evaluated */
    int (*callback)(void*,int,char**,char**),/*Callbk func*/
    void *,                   /* 1st argument to callback */
    char **errmsg             /* Error msg written here */
);
```

The first parameter is the pointer to the database handle we received from the `sqlite3_open()` function. The second parameter is the C string SQL statement. If an error occurs, an error message is written

into memory obtained from `sqlite3_malloc()`, and `*errmsg` is made to point to that message. You are responsible for freeing that space using the SQLite function `sqlite3_free()`. The third and fourth parameters are used for callback functions operating on the result of the SQL statement. The callback function, if specified, will be called for every row in the result. We will cover callback functions later, but note that the first parameter passed to this callback function can be specified in the fourth parameter of the `sqlite3_exec()` function. A return value of `SQLITE_OK` indicates successful execution of the SQL statement.

The first thing that we do in the `main()` function is to delete the table `stocks` if it exists. The SQL statement for that is:

```
DROP TABLE IF EXISTS stocks
```

This SQL statement does not return records. Therefore, in the invocation of the `sqlite3_exec()` function, we pass `NULL` for both the callback function and its first argument. The execution of this SQL statement is achieved by the following:

```
returnCode = sqlite3_exec(pDb, sqlStatement, NULL, NULL, &errorMsg);
```

Once we have deleted the `stocks` table, we can go ahead and create a new one. The SQL statement for creating the `stocks` table is as follows:

```
CREATE TABLE stocks (
    symbol VARCHAR(5),
    purchasePrice FLOAT(10, 4),
    unitsPurchased INTEGER,
    purchase_date VARCHAR(10)
)
```

This SQL statement should be familiar to you. It states that the `stocks` table should have four columns. The first column is of variable (maximum five) character. The second is of type float with ten digits in total and four of these digits are used after the decimal point. The third column is of type integer, and the fourth and final column is of variable character with maximum size of ten characters.

Internally, SQLite has the following five classes for data storage:

- **INTEGER.** Used to store a signed integer value. The number of bytes actually used for storage depends on the magnitude of the value and ranges from one to eight bytes.
- **REAL.** An eight-byte IEEE floating-point storage representing a floating point number.
- **TEXT.** A storage area for text. The text can be in any of the following encodings: `UTF-8`, `UTF-16BE`, or `UTF-16-LE`.
- **BLOB.** Used to store data exactly as entered, for example, an image.
- **NULL.** Used to store the value `NULL`.

After creating the table `stocks`, we insert several records into it. The function `insertStockPurchase()` shown in Listing 11.2 is used for that purpose.

Listing 11.2 The function `insertStockPurchase()` for adding records into the `stocks` table.

```
#import "/usr/include/sqlite3.h"
void insertStockPurchase(sqlite3 *pDb, const char*symbol,
                        float price, int units, const char* theDate) {
    char *errorMsg;
    int returnCode;
    char *st;
    st = sqlite3_mprintf("INSERT INTO stocks VALUES"
                         " ('%q', %f, %d, '%q')", symbol, price, units, theDate);
    returnCode = sqlite3_exec(pDb, st, NULL, NULL, &errorMsg);
    if(returnCode!=SQLITE_OK) {
        fprintf(stderr,
                "Error in inserting into the stocks table. Error: %s",
                errorMsg);
        sqlite3_free(errorMsg);
    }
    sqlite3_free(st);
}
```

As an example, the following SQL statement adds a record for purchasing 100 shares of Alcatel-Lucent's stock at \$14.23 on 03-17-2007.

```
INSERT INTO stocks VALUES ('ALU', 14.23, 100, '03-17-2007')
```

We use the SQLite function `sqlite3_mprintf()` for formatted string printing. This function is similar to the standard C library function `printf()` except that it writes the result into memory obtained from the `sqlite3_malloc()` function, so you should release the string when you are finished with it using the `sqlite3_free()` function. In addition to the well-known formatting options, you have access to the options `%q` and `%Q`. You should use these options instead of the `%s` options when dealing with text. The option `%q` works like `%s` except that it doubles every '`'` character. For example, the string "She said: 'Hey Ya'all whats up?'" will be printed to the string as "She said: "Hey Ya'all whats up?"". The `%Q` option works like the `%q` option except that it produces the string `NULL` when the value of the pointer being printed is equal to `NULL`. It also surrounds the whole string with a pair of '`'`. The previous string will be printed as "'She said: Hey Ya'all whats up?'" when `%Q` is used.

The complete application can be found in the `Database 1` project in the source downloads.

11.2 Processing Row Results

In the previous section, we saw how the function `sqlite3_exec()` can be used in executing SQL statements that either do not produce results, or the caller is not interested in processing the results.

If you are interested in the result set, however, you can pass a callback function pointer as the fourth parameter to the `sqlite3_exec()` function. This callback function will be invoked for every row in the result set.

The callback function should follow the following signature:

```
int (*callback) (void*, int, char**, char**)
```

The first parameter of this function is the same as the fourth parameter when the `sqlite3_exec()` function is invoked. The second parameter is the number of columns in the current row result. The third parameter is an array of pointers to strings holding the values for each column in the current result set row. The fourth parameter is an array of pointers to strings holding the names of result columns. If the callback function returns a value other than zero, the `sqlite3_exec()` function will stop executing and will return `SQLITE_ABORT`.

In the function `main()` shown in Listing 11.3, we demonstrate how a callback function can be used to process the result set. The database `financial.db` is opened as we have seen before and a `SELECT` query is executed. The query

```
SELECT * from stocks
```

retrieves all the records in the table `stocks`. The SQLite function call for executing the statement is as follows:

```
returnCode = sqlite3_exec(pDb, sqlStatement, processRow, NULL, &errorMsg);
```

The third parameter is not `NULL` as we saw in the previous section. Instead, we pass in the function pointer `processRow`. The function `processRow()` is shown in Listing 11.4.

Listing 11.3 The function `main()` for retrieving records using `sqlite3_exec()` function.

```
#import "/usr/include/sqlite3.h"
int main(int argc, char *argv[]) {
    char    *sqlStatement;
    sqlite3 *pDb;
    char    *errorMsg;
    int     returnCode;
    char    *databaseName;

    databaseName = "financial.db";
    returnCode = sqlite3_open(databaseName, &pDb);
    if(returnCode!=SQLITE_OK) {
        fprintf(stderr, "Error in opening the database. Error: %s",
                sqlite3_errmsg(pDb));
        sqlite3_close(pDb);
        return -1;
    }
    sqlStatement = "SELECT * from stocks";
    returnCode = sqlite3_exec(pDb, sqlStatement, processRow, NULL, &errorMsg);
    if(returnCode!=SQLITE_OK) {
        fprintf(stderr, "Error in selecting from stocks table. Error: %s",
                errorMsg);
        sqlite3_free(errorMsg);
```

```

    }
    sqlite3_close(pDb);
    return 0;
}

```

This function follows the callback function signature. Inside the function, we have a for-loop where we display the column name, and the row value for that column.

The result of executing the program is:

```

Record Data:
The value for Column Name symbol is equal to ALU
The value for Column Name purchasePrice is equal to 14.23
The value for Column Name unitsPurchased is equal to 100
The value for Column Name purchase_date is equal to 03-17-2007

Record Data:
The value for Column Name symbol is equal to GOOG
The value for Column Name purchasePrice is equal to 600.77002
The value for Column Name unitsPurchased is equal to 20
The value for Column Name purchase_date is equal to 01-09-2007

Record Data:
The value for Column Name symbol is equal to NT
The value for Column Name purchasePrice is equal to 20.23
The value for Column Name unitsPurchased is equal to 140
The value for Column Name purchase_date is equal to 02-05-2007

Record Data:
The value for Column Name symbol is equal to MSFT
The value for Column Name purchasePrice is equal to 30.23
The value for Column Name unitsPurchased is equal to 5
The value for Column Name purchase_date is equal to 01-03-2007

```

Listing 11.4 The function processRow() for processing row results.

```

#import "/usr/include/sqlite3.h"

static int processRow(void *argument,
    int argc, char **argv, char **colName) {
    printf("Record Data:\n");
    for(int i=0; i<argc; i++){
        printf("The value for Column Name %s is equal to %s\n",
            colName[i], argv[i] ? argv[i] : "NULL");
    }
    printf("\n");
}

```

```
    return 0;
}
```

The complete application can be found in the Database 2 project in the source downloads.

11.3 Prepared Statements

In the previous two sections, we used the `sqlite3_exec()` function to execute SQL statements. This function is more appropriate for SQL statements that do not return data (such as `INSERT`, `DROP`, and `CREATE`). For SQL statements that return data, such as `SELECT`, *prepared statements* are usually used.

The use of prepared statements involves three phases:

1. **Preparation.** In the preparation phase, you present a statement for the SQLite engine for compilation. The engine compiles this statement into byte code and reserves the resources needed for its actual execution.
2. **Execution.** This phase is used to actually execute the byte code and obtain rows from the result of the statement. You repeat this phase for every row in the result set.
3. **Finalization.** After obtaining all rows in the result set, you finalize the prepared statement so that resources reserved for it can be freed.

In the following sections, we discuss these three phases in detail.

11.3.1 Preparation

You prepare an SQL statement using `sqlite3_prepare_v2()` function. The function is declared as follows:

```
int sqlite3_prepare_v2(
    sqlite3 *db,           /* Database handle */
    const char *zSql,      /* SQL statement, UTF-8 encoded */
    int nBytes,            /* Length of zSql in bytes. */
    sqlite3_stmt **ppStmt, /* OUT: Statement handle */
    const char **pzTail   /*OUT: Ptr to unused portion of zSql*/
)
```

The first parameter, `db`, is the pointer to the database handle obtained from a prior `sqlite3_open()` call. The SQL statement (e.g., `SELECT` statement) is passed in the `zSql` parameter. You pass the length (in bytes) of that statement in the third parameter. The fourth parameter is used to obtain a statement handle. You pass a reference to a variable of type `sqlite3_stmt*`, and on successful preparation of the SQL statement, that variable will hold the statement handle. In the case that `*zSql`

points to multiple SQL statements, the function will make `*pzTail` point to the first byte past the first SQL statement in `zSql`. If `*zSql` points to a single SQL statement, passing a `NULL` for the fifth parameter is appropriate.

11.3.2 Execution

Once you have compiled the SQL statement, you need to execute it and retrieve the first row result. The SQL statement is executed using the function `sqlite3_step()`. The declaration of the function is as follows:

```
int sqlite3_step(sqlite3_stmt*);
```

The function takes a pointer to the statement handle as its sole parameter. As long as there is a new row in the result set, the function returns `SQLITE_ROW`. When all rows have been exhausted, the function returns `SQLITE_DONE`.

11.3.3 Finalization

After retrieving the last row, the statement is finalized by calling `sqlite3_finalize()`. The function's declaration is as follows:

```
int sqlite3_finalize(sqlite3_stmt *pStmt);
```

It takes as the sole parameter a pointer to the statement handle. Finalization closes the statement and frees resources.

11.3.4 Putting it together

Let's demonstrate these concepts by showing a small working example. The function `main()` in Listing 11.5 is where we open a database, select some records from a table, and print them one by one.

Listing 11.5 The function `main()` demonstrating prepared statements.

```
#import "/usr/include/sqlite3.h"
int main(int argc, char *argv[]) {
    char *sqlStatement;
    sqlite3 *database;
    int returnCode;
    char *databaseName;
    sqlite3_stmt *statement;

    databaseName = "financial.db";
    returnCode = sqlite3_open(databaseName, &database);
```

```
if(returnCode!=SQLITE_OK) {
    fprintf(stderr, "Error in opening the database. Error: %s",
            sqlite3_errmsg(database));
    sqlite3_close(database);
    return -1;
}
sqlStatement = sqlite3_mprintf(
    "SELECT S.symbol, S.unitsPurchased, "
    "S.purchasePrice FROM stocks AS S WHERE "
    "S.purchasePrice >= %f", 30.0);
returnCode =
    sqlite3_prepare_v2(database,
    sqlStatement, strlen(sqlStatement),
    &statement, NULL);
if(returnCode != SQLITE_OK) {
    fprintf(stderr, "Error in preparation of query. Error: %s",
            sqlite3_errmsg(database));
    sqlite3_close(database);
    return -1;
}
returnCode = sqlite3_step(statement);
while(returnCode == SQLITE_ROW){
    char *symbol;
    int units;
    double price;
    symbol = sqlite3_column_text(statement, 0);
    units = sqlite3_column_int(statement, 1);
    price = sqlite3_column_double(statement, 2);
    printf("We bought %d from %s at a price equal to %.4f\n",
           units, symbol, price);
    returnCode = sqlite3_step(statement);
}
sqlite3_finalize(statement);
sqlite3_free(sqlStatement);
return 0;
}
```

After opening the database, we invoke the `sqlite3_prepare_v2()` function on the following SQL statement:

```
SELECT
    S.symbol, S.unitsPurchased, S.purchasePrice
    FROM stocks AS S
    WHERE S.purchasePrice >= 30.0
```

The SQL statement will result in a set of records from the table `stocks` whose `purchasePrice` is greater than or equal to \$30. The statement is compiled as follows:

```
returnCode = sqlite3_prepare_v2(database,
                               sqlStatement, strlen(sqlStatement),
                               &statement, NULL);
```

Notice that we pass **NULL** for the last parameter as we only have one SQL statement to compile. If the statement compilation is successful, the return code will be **SQLITE_OK**. If there is an error, we display the error message and exit the `main()` function.

After compiling the statement, we execute the statement to retrieve the first result record. The function used in the execution of the statement is `sqlite3_step()`. If there is a successful retrieval of a row, the return code will be **SQLITE_ROW**. If we receive an **SQLITE_ROW** return code, we retrieve the values for the columns in that row. To retrieve a column value, you use an SQLite function of the form `sqlite3_column_XXX()`. The first parameter to this function is a pointer to the SQL statement (type `sqlite3_stmt`) that was returned by the `sqlite3_prepare_v2()` function. The second parameter is the column index, where the left-most column has an index of 0. The return value depends on the version of the function.

We have the following three statements corresponding to the three columns:

```
symbol = sqlite3_column_text(statement, 0);
units   = sqlite3_column_int(statement, 1);
price   = sqlite3_column_double(statement, 2);
```

The first statement corresponds to the `S.symbol` column. The column belongs to the `TEXT` storage class. The function `sqlite3_column_text()` will return a C-string of the `symbol` column that is stored in that row. The other functions, `sqlite3_column_int()` and `sqlite3_column_double()`, work in the same way except that they return an integer and a double value, respectively.

After printing the values for the columns constituting the row, we move to the next row in the result by again invoking the `sqlite3_step()` function. When we are finished with the result, we exit the while-loop and finalize the statement by invoking the `sqlite3_finalize()` function. The result of running this query, provided that the `stocks` table was populated as in the previous sections, is as follows:

```
We bought 20 from GOOG at a price equal to 600.7700
We bought 5 from MSFT at a price equal to 30.2300
```

The complete application can be found in the `Database 3` project in the source downloads.

11.4 User-defined Functions

Often, you are faced with a situation requiring you to use a function that the SQL engine does not implement. SQLite provides a mechanism for extending the C API and allows for user-defined functions. The user can define new custom functions for use in SQL statements for a specific database

connection. Such functions are transient in that they are only available during the life of a database connection. They are not stored in the database.

In this section, we demonstrate the use of user-defined functions by adding the function `Palindrome()` to a database connection. The function `Palindrome(t)` takes a text-based parameter, `t`, and checks to see if `t` is the same whether it is read from the right or from the left. Listing 11.6 shows the `main()` function demonstrating the installation of a user-defined function for an opened database connection.

Listing 11.6 The `main()` function demonstrating the installation of a user-defined function for an opened database connection.

```
int main(int argc, char *argv[]) {
    char      *sqlStatement;
    sqlite3  *database;
    int       returnCode;
    char      *databaseName;
    sqlite3_stmt *statement;

    databaseName = "financial.db";
    returnCode = sqlite3_open(databaseName, &database);
    if(returnCode!=SQLITE_OK) {
        fprintf(stderr, "Error in opening the database. Error: %s",
            sqlite3_errmsg(database));
        sqlite3_close(database);
        return -1;
    }
    sqlite3_create_function(database, "Palindrome", 1,
        SQLITE_UTF8, NULL, palindrome, NULL, NULL);
    sqlStatement = sqlite3_mprintf(
        "SELECT S.symbol, S.unitsPurchased, S.purchasePrice "
        "FROM stocks AS S WHERE "
        "Palindrome(S.symbol) = 1 AND S.purchasePrice  >= %f",
        30.0);

    returnCode = sqlite3_prepare_v2(
        database, sqlStatement, strlen(sqlStatement),
        &statement, NULL);
    if(returnCode!=SQLITE_OK) {
        fprintf(stderr, "Error in preparation of query. Error: %s",
            sqlite3_errmsg(database));
        sqlite3_close(database);
        return -1;
    }
    returnCode = sqlite3_step(statement);
    while(returnCode == SQLITE_ROW) {
        char *symbol;
        int   units;
        double price;
```

```

        symbol = sqlite3_column_text(statement, 0);
        units  = sqlite3_column_int(statement, 1);
        price  = sqlite3_column_double(statement, 2);
        printf("We bought %d from %s at a price equal to %.4f\n",
               units, symbol, price);
        returnCode = sqlite3_step(statement);
    }
    sqlite3_finalize(statement);
    sqlite3_free(sqlStatement);
    return 0;
}

```

The user-defined function is installed for a given connection by calling `sqlite3_create_function()`. The function is declared as:

```

int sqlite3_create_function(
    sqlite3 *connectionHandle,
    const char *zFunctionName,
    int nArg,
    int eTextRep,
    void *,
    void (*xFunc) (sqlite3_context*,int,sqlite3_value**),
    void (*xStep) (sqlite3_context*,int,sqlite3_value**),
    void (*xFinal) (sqlite3_context*)
)

```

The first parameter of this function is the connection (database) handle. The second parameter is the function name as it is used in SQL statements. This name can be different from the C function name that actually implements the function. The third parameter is used to specify the number of parameters for the custom function being created. The fourth parameter is used to specify the encoding of the parameters. You can install different versions of the same function that use different encodings. The SQLite engine will be able to route the calls to the appropriate function. The fifth parameter is an arbitrary pointer. Inside your user-defined function, you can access this pointer using `sqlite3_user_data()`. The seventh parameter is a pointer to the C function implementing the behaviour whose logical name is the second parameter, `zFunctionName`. More on this in a moment. The eighth and ninth parameters are aggregate step and finalize functions, respectively. These two functions are used in executing aggregate SQL statements.

All user-defined functions have the same signature:

```
void (sqlite3_context *context, int nargs,sqlite3_value **values)
```

The function returns `void` and all its three parameters are input parameters. The first parameter is the SQL function context. Think of it as a channel ID for the function and the SQL engine to communicate on. The second parameter is the number of arguments used when the logical function was called from within the SQL statement. The third parameter is the array of parameter values passed to the function.

Since all user-defined functions are `void`, the results/errors are signaled back using `SQLite3` routines. To signal back an error message to the caller, you use the function `sqlite3_result_error()`. The first parameter in this function is the context (so that the engine knows which SQL statement this error is related to). The second parameter is a C-string providing the error message in text. Finally, the last parameter is the length of the error message.

The `SELECT` statement that we use here is similar to the one in the previous section, except that we require the stock transaction to have a palindrome symbol. The `SELECT` statement is as follows:

```
SELECT
  S.symbol, S.unitsPurchased, S.purchasePrice
FROM stocks AS S
WHERE Palindrome(S.symbol) = 1 AND S.purchasePrice >= 30.0
```

For the `SQLite` engine to execute this query, the `Palindrome()` needs to be defined for this connection. We define the function by the following statement:

```
sqlite3_create_function(database, "Palindrome", 1,SQLITE_UTF8, NULL,
                      palindrome, NULL, NULL);
```

Listing 11.7 shows the implementation of the `palindrome()` function.

Listing 11.7 The user-defined function `palindrome()` and its implementation.

```
#import "/usr/include/sqlite3.h"
int isPalindrome(char *text){
    unsigned char *p1, *p2;
    p1 = text;
    p2 = p1+strlen(text)-1;
    while (*p1==*p2 && (p1<=p2)) {
        p1++;p2--;
    }
    if(p1>= p2)
        return 1;
    return 0;
}

void
palindrome(sqlite3_context *context,int nargs,sqlite3_value ***values) {
    char *errorMessage;
    if(nargs != 1){
        errorMessage = "Incorrect no of arguments. palindrome(string)";
        sqlite3_result_error(context, errorMessage, strlen(errorMessage));
        return;
    }
    if((sqlite3_value_type(values[0]) != SQLITE_TEXT)){
        errorMessage = "Argument must be of type text.";
        sqlite3_result_error(context, errorMessage, strlen(errorMessage));
        return;
    }
}
```

```

    }
unsigned char *text;
text = sqlite3_value_text(values[0]);
sqlite3_result_int(context, isPalindrome(text));
}

```

The `palindrome()` function first checks to see that the number of parameters is equal to 1. If not, an error message is signaled back and the function returns. The function also checks the type of the parameter passed as we are expecting a TEXT value. The function `sqlite3_value_type()` returns the type of the parameter. The function is declared as:

```
int sqlite3_value_type(sqlite3_value*)
```

It takes a pointer to a value of type `sqlite3_value` and returns one of the following types: `SQLITE_INTEGER`, `SQLITE_FLOAT`, `SQLITE_BLOB`, `SQLITE_NULL`, or `SQLITE3_TEXT`.

After making sure that the type of the parameter is TEXT, we need to obtain the actual text value. The SQLite function `sqlite3_value_text()` is used for that purpose. There are other similar functions (e.g., `sqlite3_value_int()`) for the other types. Once we have the string passed to us, we check if it is a palindrome using the function `isPalindrome()`. You should be familiar with this function from introductory computer science classes.

To send the result back to the SQLite engine, you use a function of the form `sqlite3_result_xxx()`, which takes the context as the first parameter and the result value as the second parameter. For example, we use the function `sqlite3_result_int()` to return an integer as follows:

```
sqlite3_result_int(context, isPalindrome(text))
```

The complete application can be found in the `Database 4` project in the source downloads.

11.5 Storing BLOBS

In the previous sections, we dealt primarily with simple data types (strings, integers, and floating points). In addition to scalar and text data types, the SQLite database engine also supports the BLOB data type. A BLOB storage class allows you to store binary data (e.g., image files) as-is. We will demonstrate the mechanism for storing BLOBs in this section, and retrieving them in the next section.

To explain the main concepts behind inserting BLOB values in a database, we consider a new table in the database that stores information about the companies we are investing in. In addition to the company's symbol and name, we add an image column of type BLOB that stores the logo of the company in PNG format.

Listing 11.8 shows the `main()` function. It creates a new `companies` table using the following SQL statement:

```
CREATE TABLE companies
(symbol VARCHAR(5) PRIMARY KEY, name VARCHAR(128), image BLOB)
```

Listing 11.8 The main() function demonstrating storing BLOBS in a table.

```
#import "/usr/include/sqlite3.h"
int main(int argc, char *argv[]) {

    char      *sqlStatement;
    sqlite3   *pDb;
    char      *errorMsg;
    int       returnCode;
    char      *databaseName;

    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    databaseName = "financial.db";
    returnCode = sqlite3_open(databaseName, &pDb);
    if(returnCode!=SQLITE_OK) {
        fprintf(stderr, "Error in opening the database. Error: %s",
            sqlite3_errmsg(pDb));
        sqlite3_close(pDb);
        return -1;
    }
    sqlStatement = "DROP TABLE IF EXISTS companies";
    returnCode = sqlite3_exec(pDb, sqlStatement, NULL, NULL, &errorMsg);
    if(returnCode!=SQLITE_OK) {
        fprintf(stderr, "Error in dropping table companies. Error: %s",
            errorMsg);
        sqlite3_free(errorMsg);
    }

    sqlStatement =
        "CREATE TABLE companies "
        "(symbol VARCHAR(5) PRIMARY KEY, "
        " name VARCHAR(128), image BLOB)";
    returnCode = sqlite3_exec(pDb, sqlStatement, NULL, NULL, &errorMsg);
    if(returnCode!=SQLITE_OK) {
        fprintf(stderr, "Error in creating the companies table. Error: %s",
            errorMsg);
        sqlite3_free(errorMsg);
        return -1;
    }
    insertCompany(pDb, "ALU", "Alcatel-Lucent");
    insertCompany(pDb, "GOOG", "Google");
    insertCompany(pDb, "MSFT", "Microsoft");
    insertCompany(pDb, "NT", "Nortel");
    sqlite3_close(pDb);
    [pool release];
```

```
    return 0;
}
```

After creating the `companies` table, we add four records by invoking the `insertCompany()` function shown in Listing 11.9.

Listing 11.9 The `insertCompany()` function for inserting a company record that includes a BLOB image.

```
#import "/usr/include/sqlite3.h"

void insertCompany(sqlite3 *pDb, const char* symbol, const char* name) {
    int             returnCode;
    sqlite3_stmt     *pStmt;
    unsigned char    *buffer;

    char    *st = "INSERT INTO companies VALUES (?, ?, ?)";
    returnCode = sqlite3_prepare_v2(pDb, st, -1, &pStmt, 0);
    if(returnCode != SQLITE_OK) {
        fprintf(stderr, "Error in inserting into companies table.");
        return;
    }

    NSMutableString *imageFileName =
        [NSMutableString stringWithCString:symbol];
    [imageFileName appendString:@".png"];
    NSData * pData = [NSData dataWithContentsOfFile:imageFileName];
    buffer = malloc([pData length]);
    [pData getBytes:buffer];

    sqlite3_bind_text(pStmt, 1, symbol, -1, SQLITE_STATIC);
    sqlite3_bind_text(pStmt, 2, name, -1, SQLITE_STATIC);
    sqlite3_bind_blob(pStmt, 3, buffer,[pData length], SQLITE_STATIC);
    returnCode = sqlite3_step(pStmt);
    if(returnCode != SQLITE_DONE) {
        fprintf(stderr, "Error in inserting into companies table.");
    }
    returnCode = sqlite3_finalize(pStmt);
    if(returnCode != SQLITE_OK) {
        fprintf(stderr, "Error in inserting into companies table. ");
    }
    free(buffer);
}
```

The `insertCompany()` function starts by compiling the following `INSERT` statement:

```
INSERT INTO companies VALUES (?, ?, ?)
```

This statement is a little bit different from what we have used before. This type of statement is called a **parametrized statement**. It uses “?” indicating that a value that will be bound later. To actually bind a parameter to a specific value, you use one of several functions that have the form `sqlite3_bind_xxxx()`. For example, to bind an integer, you use `sqlite3_bind_int()`. The following are the important bind functions:

- **Binding BLOBs.** The bind function for BLOBS is declared as:

```
int sqlite3_bind_blob(sqlite3_stmt*, int, const void*, int n,
                      void(*)(void*))
```

The first parameter of this, and all bind functions, is a pointer to a statement handle received from the statement preparation function `sqlite3_prepare_v2()`. The second parameter is the index of the SQL statement’s parameter that you want to bind. Note that the index starts at 1. The third parameter is the number of bytes in the BLOB. The fourth parameter is a pointer to a function that will be invoked when the SQLite engine finishes with the execution of the statement to release the BLOB’s memory. There are two special values for this parameter:

- `SQLITE_STATIC`. This special value informs the SQLite engine that the BLOB is static and does not need to be freed.
- `SQLITE_TRANSIENT`. This special value informs the SQLite engine that the BLOB is transient and needs to be copied. The SQLite engine makes a copy of the BLOB before the bind function returns.

- **Binding text.** The bind function for text is very similar to the one for BLOBS.

```
int sqlite3_bind_text(sqlite3_stmt*, int, const char*,
                      int n, void(*)(void*))
```

The first two parameters, as well as the last one, are the same as the BLOB’s bind function. The third parameter is the zero-terminated text that you would like to bind. The fourth parameter is the length (in bytes) of the text, excluding the zero-terminator. If the value is negative, then the number of bytes up to the first zero terminator is used.

- **Binding integers.** The bind function for integers is very simple:

```
int sqlite3_bind_int(sqlite3_stmt*, int, int)
```

The first two parameters are the same as above. The last parameter is the integer value.

- **Binding reals.** The bind function for real numbers is also very simple, and is similar to binding integers:

```
int sqlite3_bind_double(sqlite3_stmt*, int, double)
```

The first two parameters are the same as above. The last parameter is the real number value.

- **Binding a NULL.** This is the simplest of them all:

```
int sqlite3_bind_null(sqlite3_stmt*, int)
```

The first two parameters are the same as above and the value is, of course, implicit.

The `insertCompany()` (see Listing 11.9) function assumes that a PNG file for each company is available. The file names are assumed to have the same name as the symbol. For example, for Alcatel-Lucent, the logo is stored in the `ALU.png` file. To retrieve the bytes of an image file, we create an `NSData` object using `NSData`'s class method `dataWithContentsOfFile:`. This method retrieves the contents of a file and builds an `NSData` around it. Once we have the bytes in the Objective-C object, we retrieve them into a C-string using the following two statements:

```
buffer = malloc([pData length]);
[pData getBytes:buffer];
```

The first statement allocates a buffer of length equal to the `NSData` object length. To retrieve the bytes, we use the instance method `getBytes:` in the second statement.

Now that we have the three values for the three SQL parameters, we use the appropriate bind function in order to complete the SQL statement. Executing the `INSERT` statement is the same as any prepared statement: just use `sqlite3_step()`. Lastly, we finalize the statement and free the allocated buffer since we have specified `SQILITE_STATIC` in the BLOB bind function.

The complete application can be found in the `Database 5` project in the source downloads.

11.6 Retrieving BLOBS

In the previous section, we saw how we can populate a table with records containing BLOB columns. In this section, we will learn how we can retrieve these BLOB columns. The presentation will use the same `companies` table populated before.

Listing 11.10 shows the `main()` function used to demonstrate the retrieval of BLOBS. What we would like to do is to retrieve these images and write them to the file system with a different name. The `main()` function opens the database and retrieves the images by invoking the `retrieveCompany()` function shown in Listing 11.11.

Listing 11.10 The `main()` function demonstrating the retrieval of BLOB columns from a database.

```
int main(int argc, char *argv[]) {
    sqlite3 *pDb;
    int returnCode;
    char *databaseName;
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    databaseName = "financial.db";
    returnCode = sqlite3_open(databaseName, &pDb);
    if(returnCode!=SQLITE_OK) {
        fprintf(stderr,"Error in opening the database. Error: %s",
               sqlite3_errmsg(pDb));
        sqlite3_close(pDb);
    }
    return -1;
```

```
    }
    retrieveCompany(pDb, "ALU");
    retrieveCompany(pDb, "GOOG");
    retrieveCompany(pDb, "MSFT");
    retrieveCompany(pDb, "NT");
    sqlite3_close(pDb);
    [pool release];
    return 0;
}
```

We start by preparing the following parametrized SQL statement:

```
SELECT image FROM companies WHERE symbol = ?
```

After that, we bind the sole parameter with the `symbol` parameter of the function. Note that we could have just used `sqlite3_mprintf()` to do that job without using parametrized queries. We then execute the query and check for a row result. Since there should be at most one record (the symbol is a primary key), we retrieve the BLOB column value at most once. We use `NSData` as a wrapper of the image bytes as in the following statement:

```
NSData * pData =
    [NSData dataWithBytes:sqlite3_column_blob(pStmt, 0)
        length:sqlite3_column_bytes(pStmt, 0)];
```

The class method `dataWithBytes:length:` is declared as follows:

```
+ (id)dataWithBytes:(const void *)bytes length:(NSUInteger)length
```

It takes the bytes and length as two parameters. To retrieve the BLOB bytes from the column result, we use the function `sqlite3_column_blob()`. This function takes a pointer to the statement handle we received when we invoked the `sqlite3_prepare_v2()` function and the column index (starting from 0). The length of the BLOB bytes can be retrieved by the function `sqlite3_column_bytes()`.

Once we have retrieved the image from the database and have used an `NSData` instance as a wrapper around it, we can use the `NSData`'s instance method `writeToFile:atomically:` to write the contents of this data to a file. The method is declared as:

```
- (BOOL)writeToFile:(NSString *)path atomically:(BOOL)useAuxiliaryFile
```

In addition to the file path, the `useAuxiliaryFile` is used to specify whether a temporary file should be used. If the value is YES, the data will be written first to a temporary file and then that temporary file will be renamed to the new name. Once we have written the file, we finalize the statement and return from the function.

Listing 11.11 The `retrieveCompany()` function used to retrieve BLOB images from the database and write them back to the file system.

```
#import "/usr/include/sqlite3.h"
void retrieveCompany(sqlite3 *pDb, const char* symbol) {
```

```
int returnCode;
sqlite3_stmt *pStmt;
char *st = "SELECT image FROM companies WHERE symbol = ?";
returnCode = sqlite3_prepare_v2(pDb, st, -1, &pStmt, 0);
if(returnCode!=SQLITE_OK) {
    fprintf(stderr, "Error retrieving image from companies.");
    return;
}
sqlite3_bind_text(pStmt, 1, symbol, -1, SQLITE_STATIC);
returnCode = sqlite3_step(pStmt);
if(returnCode == SQLITE_ROW) {
    NSData * pData =
        [NSData dataWithBytes:sqlite3_column_blob(pStmt, 0)
                           length:sqlite3_column_bytes(pStmt, 0)];
    NSMutableString *imageFileName =
        [NSMutableString stringWithCString:symbol];
    [imageFileName appendString:@"-2.png"];
    [pData writeToFile:imageFileName atomically:YES];
}
returnCode = sqlite3_finalize(pStmt);
if(returnCode != SQLITE_OK) {
    fprintf(stderr, "Error inserting into companies.");
}
```

The complete application can be found in the `Database 6` project in the source downloads.

11.7 Summary

This chapter covered the main aspects of using the SQLite database engine from within an iPhone application. We presented the main concepts through concrete examples. We started by talking about the basic SQL statements and their implementation using SQLite function calls in Section 11.1. Then, we discussed the handling of result sets generated by SQL statements in Section 11.2. After that, we addressed the topic of prepared statements in Section 11.3. Next, in Section 11.4 we talked about extensions to the SQLite C API and demonstrated that, through the use of a simple user-defined function. Finally, we presented a detailed treatment of BLOB handling through the storage and retrieval of image files in Sections 11.5 and 11.6, respectively.

Problems

- (1) After reading the related chapters in this text, write a proxy that intercepts the communication with a server and caches the response for every unique URL. The proxy should return cached responses when the device is offline.
- (2) Visit the SQLite homepage at <http://www.sqlite.org> and explore the API further.

12

XML Processing

In this chapter you learn how to effectively use XML in your iPhone application. The chapter follows the same theme used in others chapters and exposes the main concepts through a working iPhone application: an RSS feed reader.

The chapter is organized as follows. Section 12.1 explains the main concepts behind XML and RSS. Section 12.2 presents a detailed discussion of DOM parsing. Section 12.3 offers another, different XML parsing technique, SAX, and shows how you can write a SAX iPhone client. In Section 12.4 we look at a table-based RSS reader application. After that, Section 12.5 presents the final thoughts on this subject. Lastly, Section 12.6 provides a summary of the chapter.

12.1 XML and RSS

In this section we discuss XML and then talk about RSS as one of its applications.

12.1.1 *XML*

Extensible Markup Language (XML) is a meta-language specification for exchanging information over the Internet. As a meta-language, it can be used to define application-specific languages which are then used to instantiate XML documents that adhere to the semantics of these languages.

The power behind XML is due to:

- its extensibility, which allows anyone to define new XML elements
- it being based on text, thus opening your application data to being used on any computing system.

To create/use an XML language, you need to identify the elements used in that language. An XML element uses:

- begin-tag
- text content
- end-tag.

For example, the element `person` can appear in an XML document as:

```
<person>
content ...
</person>
```

Where `<person>` is the begin-tag and `</person>` is the end-tag. The content can itself be composed of text and other elements. For example:

```
<person>
  <name>content of name...</name>
  <address>content of address...</address>
</person>
```

If the text content of a given element contains characters that are difficult to include (e.g., “`<`”, “`>`”, “`&`”, etc.), entities can be used for their representation. For example, “`<`” can be represented by the entity reference `<`:

The fact that an XML document must have exactly one root element, and that any given element may contain other elements, allows us to naturally represent the XML document as a tree. For example, the following XML document can be represented as a tree (see Figure 12.1).

```
<?xml version="1.0"?>
<person>
  <name>
    <first>Homer</first>
    <last>Simpson</last>
  </name>
  <address>
    <street>1094 Evergreen Terrace</street>
    <city>Springfield</city>
    <state>TA</state>
  </address>
</person>
```

To work with an XML document, you need to be able to parse it (e.g., construct a tree representation of the document in memory as shown in Figure 12.1). There are several techniques for parsing and we will cover those shortly. `libxml2` is an XML parser written in C that is available on, and recommended for use with, the iPhone OS. As we will see shortly, working with this library is very easy. You will be able to use a few function calls to the library in order to construct a tree similar to the one shown in Figure 12.1.

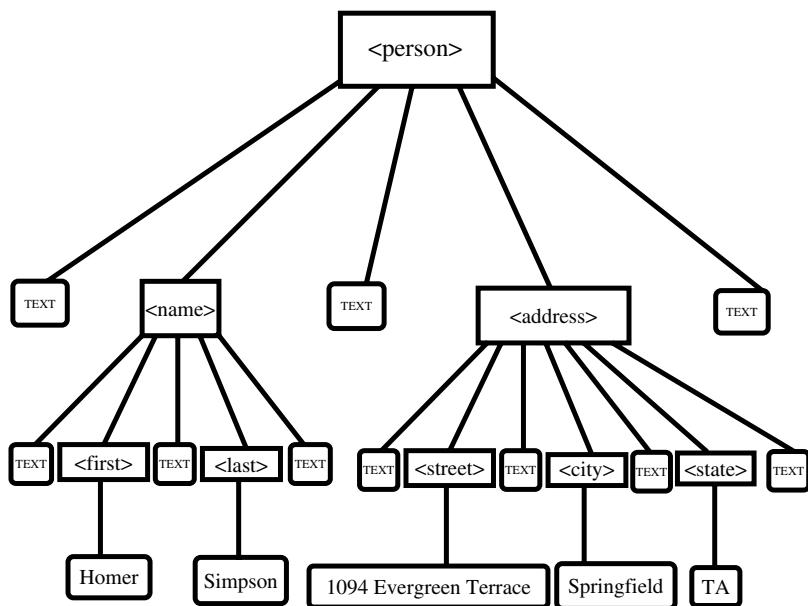


Figure 12.1 A tree representation of an XML document.

We need to remember that white spaces are not ignored in XML. In Figure 12.1, we show the white spaces as TEXT nodes. In libxml2, text nodes are of type `XML_TEXT_NODE`, while element nodes are of type `XML_ELEMENT_NODE`.

Now that we have an understanding of what XML is, let's look at one of its applications: RSS.

12.1.2 RSS

Really Simple Syndication (RSS) is an XML language used for sharing web content. As a content publisher, RSS gives you the power to inform your readers about new content on your information channel. RSS allows you, as a content consumer, to target your web activities towards information that you are actually interested in. For example, if you are mainly interested in health news, you do not want to spend a lot of time on `cnn.com` or `msnbc.com` looking for health articles. What you want is a way for `cnn.com` or `msnbc.com` to tell you when new health articles become available on their websites. The news channel can set up an XML instance file, based on the RSS language, advertising the newest health articles on its website. You use RSS reader software to subscribe to this XML file. The reader can refresh the copy of this XML file and present it to you. This scheme provides you with efficiency and also privacy as the website does not have to know your email

address in order to inform you of new content. RSS can be thought of as both a *push* and a *pull* technology. The producer pushes filtered content that the consumer pulls.

Websites advertise the existence of specific channels using several icons. Figure 12.2 shows some of these icons. The *universal feed icon* (bottom icon) is gaining wide acceptance.



Figure 12.2 Several RSS icons. The *universal feed icon* (bottom icon) is gaining wide acceptance.

Let's illustrate the basics of an RSS feed through an example. The Nebraska State Patrol provides an RSS feed about absconded offenders. Individuals can subscribe to this channel to stay informed. Like everything else on the Internet, an RSS feed has a URL. For example, the URL for absconded offenders in the state of Nebraska is: <http://www.nsp.state.ne.us/SOR/Abscondedrss.xml>. Listing 12.1 shows a sample XML document of this feed.

Listing 12.1 An example of an RSS document.

```
<?xml version="1.0" encoding="UTF-8"?>
<rss version="2.0">
    <channel>
        <title>
            Nebraska State Patrol | Absconded Offenders
        </title>
        <link>
            http://www.nsp.state.ne.us/sor/
        </link>
        <description>
            The Nebraska State Patrol is currently
            seeking information on the location of the
            following individuals to determine if they are in
            compliance with the Nebraska Sex Offender
            Registration Act. This site is intended to
            generate information on these individuals
            and should not be used solely for the purpose
            of arrest. Anyone with information
            please call 402-471-8647.
        </description>
    </channel>
</rss>
```

```
</description>
<image>
    <title>Nebraska State Patrol | SOR</title>
    <url>http://www.nsp.state.ne.us/sor/rsslogo.jpg
    </url>
    <link>http://www.nsp.state.ne.us/sor/</link>
</image>

    <item>
        <title>Austen, Kate</title>
        <link>
            http://www.nsp.state.ne.us/sor/200403KA2
        </link>
        <description>
            Absconded - Jefe de una loca mujer
        </description>
    </item>

</channel>
</rss>
```

Every RSS feed document starts with the following :

```
<?xml version="1.0" encoding="UTF-8"?>
```

This line indicates that this is an XML document. The `version` attribute is mandatory while the `encoding` attribute is not.

The root of the RSS feed is the `rss` element. This root element has only one child: the `channel` element. The `channel` element has three mandatory child elements: `title`, `link`, and `description`. In addition, it can hold several optional child elements such as: `webMaster`, `image`, `copyright`.

The mandatory elements are required for an RSS feed to be valid. However, valid does not necessarily mean useful. To be useful, the `channel` element should have one or more `item` child elements. Each story in an RSS feed file is represented by an `item` element. An `item` element contains three child elements: (1) a `title` element, (2) a `link` element, and (3) an optional `description` element. The reader presents to you the title of the story, its link, and, optionally, its description. If you are interested in the story, you click the link (a URL) to visit the web page of that story.

Now that we know the structure of an RSS feed document, let's use the `libxml2` library to extract information from an RSS feed. First, we present a reader using DOM, then another one using SAX.

But before getting into the use of the `libxml2` library, we need to do some additional configurations to the XCode project.

12.1.3 Configuring the XCode project

Follow these steps to configure your project to use `libxml2` library:

- **Add to Other Linker Flags of the project.** Double-click on your project node. Select the Build tab and search for “other”. Double-click on Other Linker Flags, and enter `-lxml2`. See Figure 12.3.

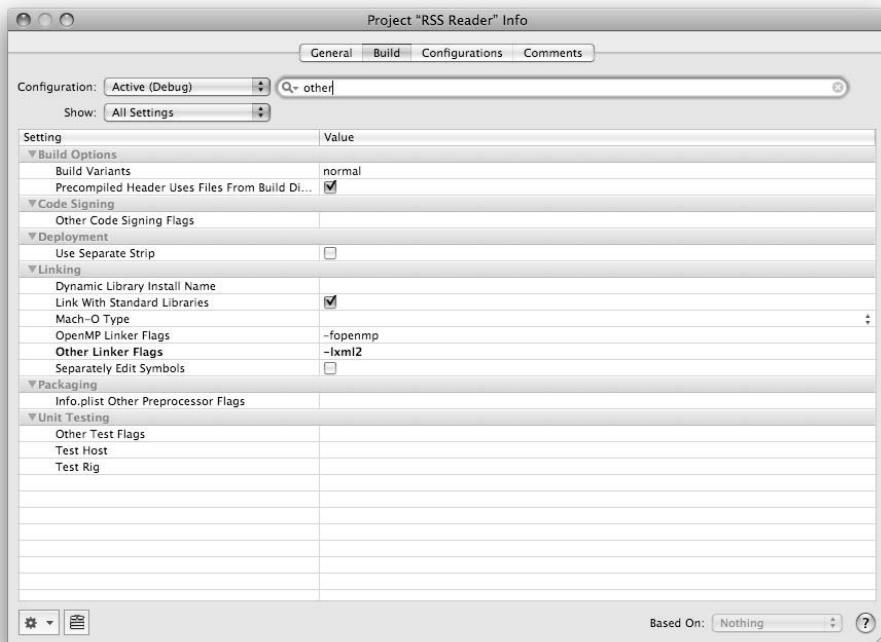


Figure 12.3 Adding OTHER_LDFLAGS = `-lxml2` to the project.

- **Add to Other Linker Flags of the target.** You also need to repeat the previous step, but instead of adding the flag to the project, you need to add it to the target. Choose Project > Edit Active Target from the menu. Select the Build tab and search for “other”. Double-click on Other Linker Flags and enter `-lxml2`. See Figure 12.4.
- **Add to the Header Search Path.** You need to add the following line to the project:

```
HEADER_SEARCH_PATHS = /usr/include/libxml2
```

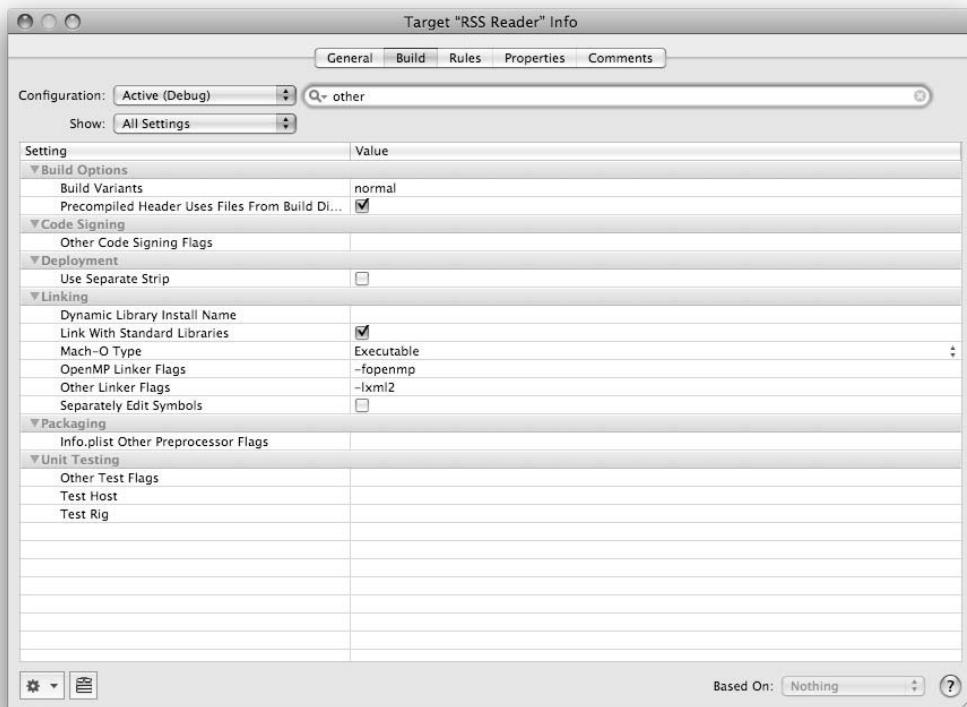


Figure 12.4 Adding OTHER_LDFLAGS = -lxml2 to the target.

Double-click on the project node, and select the Build tab. Search for “header” and enter the value as shown in Figure 12.5.

- **Add the libxml2 library to the target.** Add the libxml2 library as explained in Section D.4. See Figure 12.6.

12.2 Document Object Model (DOM)

Using this model, the parser will load the whole XML document to memory and present it to the client as a tree. You can navigate the nodes of this tree and extract relevant information.

Listing 12.2 shows Objective-C code that first fetches the RSS XML document from a URL, puts it into a string that the libxml2 library can work with, and then uses libxml2’s functions to navigate the parsed tree and extract the relevant information.

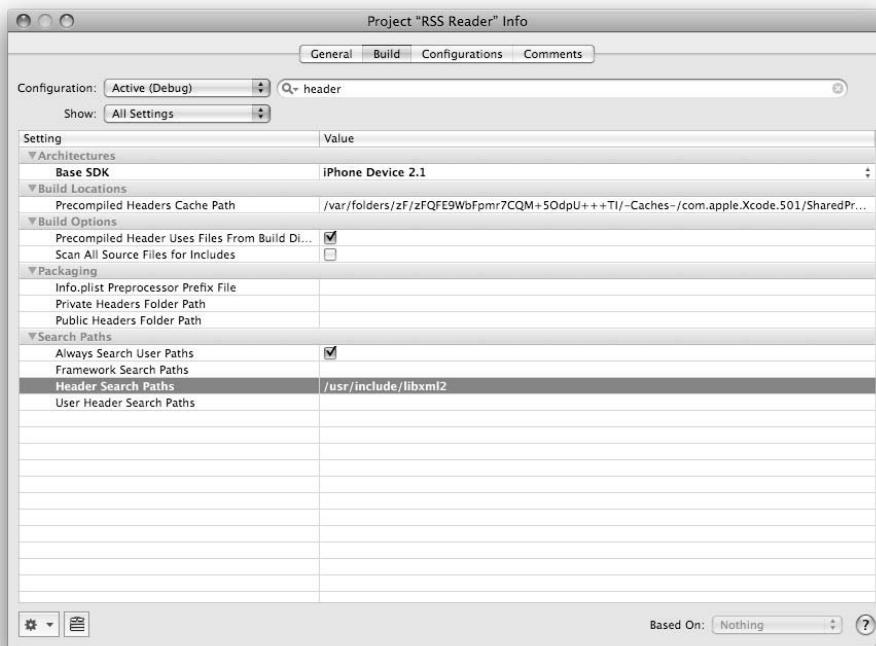


Figure 12.5 Adding HEADER_SEARCH_PATHS = /usr/include/libxml2 to the project.

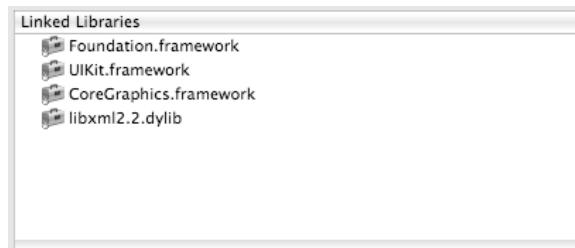


Figure 12.6 Adding libxml2 library to the target.

Listing 12.2 DOM XML Parsing.

```

1 #include <libxml/xmlmemory.h>
2 #include <libxml/parser.h>
3
4 - (void)fetchAbsconders{

```

```

5   NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
6   NSError *err = nil;
7   NSURL * url = [NSURL URLWithString:feedURL];
8   NSString *URLContents = [NSString stringWithContentsOfURL:url
9                                     encoding:NSUTF8StringEncoding error:&err];
10  if(!URLContents)
11    return;
12  const char *XMLChars =
13  [URLContents cStringUsingEncoding:NSUTF8StringEncoding];
14
15  if(parser == XML_PARSER_DOM) {
16    xmlDocPtr doc = xmlParseMemory(XMLChars, strlen(XMLChars));
17    xmlNodePtr cur;
18    if (doc == NULL) {
19      return;
20    }
21    cur = xmlDocGetRootElement(doc);
22    cur = findNextItem(cur);
23    while (cur) {
24      XOAbsconder *absconder = getitem(doc, cur);
25      if(absconder) {
26        [absconders addObject:absconder];
27      }
28      cur = findNextItem(cur->next);
29    }
30    xmlFreeDoc(doc);
31  }

```

On line 7, we create an `NSURL` object from the URL address string representation, `feedURL`, of the RSS feed address. The statement on lines 8 and 9 uses the `NSString`'s class method `stringWithContentsOfURL:encoding:error:` to create a string containing the contents of the URL. The method fetches the RSS feed file from the server and puts it in the `NSString` instance, `URLContents`.

On line 10, we check to see if the string was successfully created. If it was not, the `fetchAbsconders` method returns without changing the `absconders` array. Of course, in a production code, you will use the `error` object to propagate the error to the client.

Once we have an `NSString` object with the contents of the RSS feed file, we need to convert it to a C-string (`char*`), the format that `libxml2` works with. The statement on lines 12 and 13 does just that. We use the `NSString` instance method `cStringUsingEncoding:` with the encoding `NSUTF8StringEncoding`.

The `fetchAbsconders` method demonstrates the use of two XML parsing schemes. Listing 12.2 shows the first half of this method and it covers the DOM parsing.

To work with any XML document using DOM, you first need to load it into memory in the form of a tree. The function to achieve that is `xmlParseMemory()`. The function is declared in `parser.h` as:

```
 xmlDocPtr xmlParseMemory (const char * buffer, int size)
```

It takes the XML document, represented by a C-string, and the size of this string as input. It returns a pointer to the tree representation of the parsed document in the form of `xmlDocPtr` (a pointer to `xmlDoc`).

The `xmlDoc` is a structure defined in `tree.h`. The following shows the first few lines of this structure.

```
struct _xmlDoc {
    void          *_private; /* application data */
    xmlElementType type;      /* XML_DOCUMENT_NODE */
    char   *name;  /* name/filename/URI of the document */
    struct _xmlNode *children; /* the document tree */
    struct _xmlNode *last;   /* last child link */
    struct _xmlNode *parent; /* child->parent link */
    ...
};
```

Now that we have a tree representation of the XML document, we can start traversing it. To begin traversing, line 21 obtains the root node using the function `xmlDocGetRootElement()`. The function returns `xmlNodePtr`, which is a pointer to the root node, `xmlNode`.

Every node is represented by the `xmlNode` structure defined in `tree.h` as follows:

```
typedef struct _xmlNode xmlNode;
typedef xmlNode *xmlNodePtr;

struct _xmlNode {
    void          *_private; /* application data */
    xmlElementType type; /* type number */
    const xmlChar   *name; /* name of the node, or entity */
    struct _xmlNode *children; /* parent->children link */
    struct _xmlNode *last; /* last child link */
    struct _xmlNode *parent; /* child->parent link */
    struct _xmlNode *next; /* next sibling link */
    struct _xmlNode *prev; /* previous sibling link */
    struct _xmlDoc  *doc; /* the containing document */

    /* End of common part */
    xmlNs   *ns; /* pointer to the associated namespace */
    xmlChar  *content; /* the content */
    struct _xmlAttr *properties; /* properties list */
    xmlNs   *nsDef; /* namespace definitions on this node */
    void    *psvi; /* for type/PSVI informations */
```

```

    unsigned short    line; /* line number */
    unsigned short    extra; /* extra data for XPath/XSLT */
};

}

```

Most of these fields are self-explanatory. You will be dealing mostly with the fields which link to other nodes. If you are at a given node, you can go to its parent using the `parent` field. If you want its children, use `children`. If you want the siblings (i.e., those nodes with same parent as your parent), use the `next` field.

Figure 12.7 shows a graphical representation of the navigational links available for various nodes in the document tree.

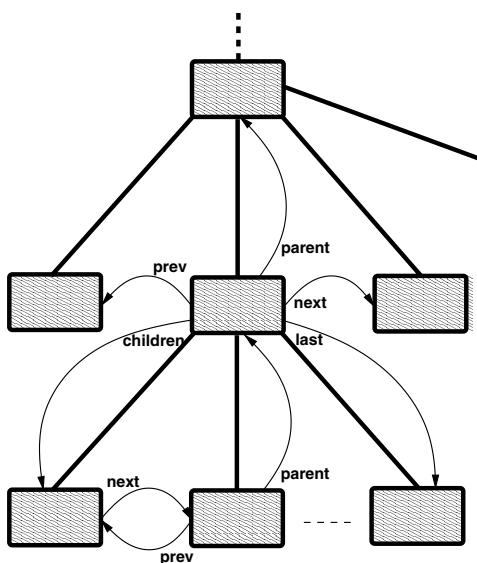


Figure 12.7 Representation of the navigational links available for various nodes in the document tree.

Now that we have a pointer to the root of the document, we search for the first `item` in the RSS feed. This is shown in the statement on line 22: `cur = findNextItem(cur)`. The function `findNextItem()` is defined in Listing 12.3.

Listing 12.3 Searching for an `item` element in the RSS feed.

```

xmlNodePtr findNextItem(xmlNodePtr curr) {
    if(!curr)
        return curr;
    if ((!xmlstrcmp(curr->name, (const xmlChar *)"item")) &&
        (curr->type == XML_ELEMENT_NODE)) {
        return curr;
    }
}

```

```
if (curr->type == XML_TEXT_NODE) {
    return findNextItem(curr->next);
}
if (curr->type == XML_ELEMENT_NODE) {
    if ((!xmlStrcmp(curr->name, (const xmlChar *)"channel"))
        || (!xmlStrcmp(curr->name, (const xmlChar *)"rss"))){
        return findNextItem(curr->xmlChildrenNode);
    }
}
if (curr->type == XML_ELEMENT_NODE) {
    if ((!xmlStrcmp(curr->name, (const xmlChar *)"title"))
        || (!xmlStrcmp(curr->name, (const xmlChar *)"link"))
        || (!xmlStrcmp(curr->name, (const xmlChar *)"description"))
        || (!xmlStrcmp(curr->name, (const xmlChar *)"image"))){
        return findNextItem(curr->next);
    }
}
return NULL;
}
```

The function makes recursive calls to itself as long as the `item` tag has not been found. At the beginning, we check for the termination condition. We use the `xmlStrcmp()` function to see if the node's name is "item". If yes, we return the pointer to that node. The rest of the code has similar logic. The only difference is that, when we are interested in a given subtree, we use the `xmlChildrenNode` link to traverse that subtree. If we are not interested in the node, we skip the subtree altogether and go to the next sibling using the `next` link.

Now that we have a pointer to an `item` element node, we retrieve the three element children and build an Objective-C object from the data. The function `getitem()` is where such logic is found. The function is called as follows:

```
XOAbsconder *absconder = getitem(doc, cur);
```

`getitem()` takes the document and node pointers and returns either the `XOAbsconder` object or `nil`. Listing 12.4 presents the implementation of the `getitem()` function.

Listing 12.4 Building an `XOAbsconder` object from an `item` element.

```
XOAbsconder* getitem ( xmlDocPtr doc, xmlNodePtr curr) {
    xmlChar *name, *link, *description;
    curr = curr->xmlChildrenNode;
    if (!curr)
        return nil;
    while (curr && (curr->type == XML_TEXT_NODE))
        curr = curr->next;
    if (!curr)
        return nil;
```

```
if ((!xmlStrcmp(curr->name, (const xmlChar *)"title")) &&
    (curr->type == XML_ELEMENT_NODE)) {
    name = xmlNodeListGetString(doc, curr->xmlChildrenNode, 1);
    curr = curr->next;
    while (curr && (curr->type == XML_TEXT_NODE))
        curr = curr->next;
    if (!curr) {
        xmlFree(name);
        return nil;
    }
}
else
    return nil;
if ((!xmlStrcmp(curr->name, (const xmlChar *)"link")) &&
    (curr->type == XML_ELEMENT_NODE)) {
    link = xmlNodeListGetString(doc, curr->xmlChildrenNode, 1);
    curr = curr->next;
    while (curr && (curr->type == XML_TEXT_NODE))
        curr = curr->next;
    if (!curr) {
        xmlFree(name);
        xmlFree(link);
        return nil;
    }
}
else
    return nil;
if ((!xmlStrcmp(curr->name, (const xmlChar *)"description")) &&
    (curr->type == XML_ELEMENT_NODE)) {
    description = xmlNodeListGetString(doc, curr->xmlChildrenNode, 1);
}
else{
    xmlFree(name);
    xmlFree(link);
    xmlFree(description);
    return nil;
}
XOAbsconder *abscender = [[XOAbsconder alloc]
    initWithName:[NSString stringWithCString:name]
    andURL:[NSString stringWithCString:link]
    andDescription:[NSString stringWithCString:description]];
[abscender autorelease];
xmlFree(name);
xmlFree(link);
xmlFree(description);
return abscender;
}
```

We traverse all the children of the node. Since in XML a whitespace is recognized as a valid child node, we skip those at the beginning:

```
while (curr && (curr->type == XML_TEXT_NODE))
    curr = curr->next;
```

Once we have skipped the text nodes, we check for the three elements: title, link, and description. The function requires that they appear in that order.

To retrieve the text value for each of these three elements, we can use the `xmlNodeListGetString` function. The function is declared in `tree.h` as:

```
xmlChar *xmlNodeListGetString ( xmlDocPtr doc, xmlNodePtr list, int inLine)
```

It constructs a string from the node list. If `inLine` is 1, the entity contents are replaced. The function returns the string and the caller is responsible for freeing the memory of the string using the `xmlFree()` function.

After retrieving the text of the three elements, we create the `XOAbsconder`, autorelease it, free the memory of the three strings, and return the `XOAbsconder` object.

Back to Listing 12.2, the `fetchAbsconders` method keeps calling the `getItem()` function and adding the objects to the `absconders` array in the statement:

```
[absconders addObject:absconder];
```

When the `fetchAbsconders` method is finished, the `absconders` array contains the absconder objects created and populated from the RSS feed document.

12.3 Simple API for XML (SAX)

We have seen in Section 12.2 how DOM loads the entire XML document to memory and allows you to navigate the nodes. In some applications, the size of the XML document may prevent loading the whole document due to limited device memory. The Simple API for XML (SAX) is another XML parsing model that is different from DOM. In SAX, you configure the parser with callback functions. The SAX parser will use these function pointers to call your functions, informing you of important events. For example, if you are interested in the event Start of Document, you set up a function for this event and give the parser a pointer to it.

Listing 12.5 shows the remainder of the `fetchAbsconders` method pertaining to SAX parsing.

Listing 12.5 SAX XML Parsing. Remainder of `fetchAbsconders` method.

```
else if(parser == XML_PARSER_SAX) {
    xmlParserCtxtPtr ctxt = xmlCreateDocParserCtxt(XMLChars);
    int parseResult =
        xmlSAXUserParseMemory(&rssSAXHandler, self, XMLChars,
                             strlen(XMLChars));
```

```

        xmlFreeParserCtxt(ctxt);
        xmlCleanupParser();
    }
    [pool release];
}

```

To use SAX in libxml2, you first set up a parser context using the function `xmlCreateDocParserCtxt()`, which takes a single parameter: the XML document represented as a C-string. After that, you start the SAX parser by calling the `xmlSAXUserParseMemory()` function. The function is declared in `parser.h` as:

```
int xmlSAXUserParseMemory (xmlSAXHandlerPtr sax, void * user_data,
                           const char * buffer, int size)
```

This function parses an in-memory buffer and calls your registered functions as necessary. The first parameter to this function is a pointer to the SAX handler. The SAX handler is a structure holding the pointers to your callback functions. The second parameter is an optional pointer that is application-specific. The value specified will be used as the context when the SAX parser calls your callback functions. The third and fourth parameters are used for the C-string XML document in memory and its length, respectively.

The SAX handler is where you store the pointers to your callback functions. If you are not interested in an event type, just store a NULL value in its field. The following is the definition of the structure in `tree.h`:

```
struct _xmlSAXHandler {
    internalSubsetSAXFunc internalSubset;
    isStandaloneSAXFunc isStandalone;
    hasInternalSubsetSAXFunc hasInternalSubset;
    hasExternalSubsetSAXFunc hasExternalSubset;
    resolveEntitySAXFunc resolveEntity;
    getEntitySAXFunc getEntity;
    entityDeclSAXFunc entityDecl;
    notationDeclSAXFunc notationDecl;
    attributeDeclSAXFunc attributeDecl;
    elementDeclSAXFunc elementDecl;
    unparsedEntityDeclSAXFunc unparsedEntityDecl;
    setDocumentLocatorSAXFunc setDocumentLocator;
    startDocumentSAXFunc startDocument;
    endDocumentSAXFunc endDocument;
    startElementSAXFunc startElement;
    endElementSAXFunc endElement;
    referenceSAXFunc reference;
    charactersSAXFunc characters;
    ignorableWhitespaceSAXFunc ignorableWhitespace;
    processingInstructionSAXFunc processingInstruction;
    commentSAXFunc comment;
    warningSAXFunc warning;
```

```
errorSAXFunc error;
fatalErrorSAXFunc fatalError;
getParameterEntitySAXFunc getParameterEntity;
cdataBlockSAXFunc cdataBlock;
externalSubsetSAXFunc externalSubset;
unsigned int initialized;
// The following fields are extensions
void * _private;
startElementNsSAX2Func startElementNs;
endElementNsSAX2Func endElementNs;
xmlStructuredErrorFunc serror;
};

}
```

Listing 12.6 shows our SAX handler.

Listing 12.6 Our SAX handler.

```
static xmlSAXHandler rssSAXHandler ={  
NULL, /* internalSubset */  
NULL, /* isStandalone */  
NULL, /* hasInternalSubset */  
NULL, /* hasExternalSubset */  
NULL, /* resolveEntity */  
NULL, /* getEntity */  
NULL, /* entityDecl */  
NULL, /* notationDecl */  
NULL, /* attributeDecl */  
NULL, /* elementDecl */  
NULL, /* unparsedEntityDecl */  
NULL, /* setDocumentLocator */  
NULL, /* startDocument */  
NULL, /* endDocument */  
NULL, /* startElement */  
NULL, /* endElement */  
NULL, /* reference */  
NULL, /* characters */  
NULL, /* ignorableWhitespace */  
NULL, /* processingInstruction */  
NULL, /* comment */  
NULL, /* warning */  
errorEncounteredSAX, /* error */  
fatalErrorEncounteredSAX, /* fatalError */  
NULL, /* getParameterEntity */  
NULL, /* cdataBlock */  
NULL, /* externalSubset */  
XML_SAX2_MAGIC, /* */  
NULL, /* startElementNs */  
};
```

```
endElementSAX,           /* endElementNs */
NULL,                  /* serror */
};
```

Aside from the function pointers, the initialized field should be set to the value XML_SAX2_MAGIC in order to indicate that the handler is used for a SAX2 parser. Once you call the `xmlSAXUserParseMemory()`, the SAX parser starts the parsing of the document and calling your registered callback functions.

We are mainly interested in three functions: `startElementNsSAX2Func()`, `endElementNsSAX2Func()`, and `charactersSAXFunc()`.

`startElementNsSAX2Func()` is called when the parser encounters the start of a new element. `startElementNsSAX2Func()` is defined in `tree.h` as:

```
void startElementNsSAX2Func (void * ctx, const xmlChar * localname,
                             const xmlChar * prefix, const xmlChar *URI,
                             int nb_namespaces,
                             const xmlChar ** namespaces,
                             int nb_attributes, int nb_defaulted,
                             const xmlChar ** attributes)
```

`ctx` is the user data, and it is the second value you used when you called the function `xmlSAXUserParseMemory()`. In our case, it is a pointer to the class `XORSSFeedNebraska`. Then `localname` is the local name of the element. `prefix` is the element namespace prefix (if available). `URI` is the element namespace name (if available). `nb_namespaces` is number of namespace definitions on that node. `namespaces` is a pointer to the array of `prefix/URI` pair namespace definitions. `nb_attributes` is the number of attributes on that node. `nb_defaulted` is the number of defaulted attributes. The defaulted ones are at the end of the array. `attributes` is a pointer to the array of (localname/prefix/URI/value/end) attribute values.

Listing 12.7 shows the definition of our `startElementNsSAX2Func()` function.

Listing 12.7 The `startElementSAX()` callback function.

```
static void
startElementSAX(void *ctx,
               const xmlChar *localname,
               const xmlChar *prefix,
               const xmlChar *URI,
               int nb_namespaces,
               const xmlChar **namespaces,
               int nb_attributes,
               int nb_defaulted,
               const xmlChar **attributes)
{
    NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
    XORSSFeedNebraska *feedNebraska = (XORSSFeedNebraska*) ctx;
    if (feedNebraska.currentElementContent) {
```

```
[feedNebraska.currentElementContent release];
feedNebraska.currentElementContent = nil;
}
if ((!xmlStrcmp(localname, (const xmlChar *)"item"))) {
    feedNebraska.currAbsconder = [[XOAbsconder alloc] init];
}
[pool release];
}
```

It's good practice to have an autorelease pool per function. We first start by casting the `ctx` to a pointer to our class `XORSSFeedNebraska`. The class and its parent are declared in Listings 12.8 and 12.9.

Listing 12.8 The `XORSSFeedNebraska` class declaration.

```
#import "XORSSFeed.h"
@interface XORSSFeedNebraska : XORSSFeed {
}
@end
```

Listing 12.9 The `XORSSFeed` class declaration.

```
@class XOAbsconder;
typedef enum {
    XML_PARSER_DOM,
    XML_PARSER_SAX
} XMLParser;

@interface XORSSFeed : NSObject {
    NSString          *feedURL;
    NSMutableArray    *absconders;
    XMLParser         parser;
    NSMutableString   *currentElementContent;
    XOAbsconder      *currAbsconder;
}
@property(nonatomic, copy) NSString          *feedURL;
@property(nonatomic, assign) XMLParser         parser;
@property(nonatomic, assign) NSMutableString   *currentElementContent;
@property(nonatomic, assign) XOAbsconder      *currAbsconder;
- (id) init;
- (id) initWithURL: (NSString*) feedURL;
- (void) fetchAbsconders;
- (NSUInteger) numberOfAbsconders;
- (XOAbsconder*) absconderAtIndex: (NSUInteger) index;
- (void) addAbsconder: (XOAbsconder*) absconder;
@end
```

The XORSSFeedNebraska object has an instance variable of type `NSMutableString` called `currentElementContent`. This variable holds the text value inside an element. It's constructed in our `charactersFoundSAX()` function and used in the `endElementSAX()` function. The function `startElementSAX()` always releases and so we set this instance variable to `nil` (if it is not already `nil`). This will ensure that we start with an empty string for holding the text. If the element name is `item`, we create a new object of the `XOAbsconder` class. This is a simple class holding the three pieces of data information about an individual absconder. Listing 12.10 shows the declaration of the `XOAbsconder` and Listing 12.11 shows its definition.

Listing 12.10 The `XOAbsconder` class declaration.

```
#import <UIKit/UIKit.h>
@interface XOAbsconder : NSObject {
    NSString *name;
    NSString *furtherInfoURL;
    NSString *desc;
}

@property(copy) NSString *name;
@property(copy) NSString *furtherInfoURL;
@property(copy) NSString *desc;
-(id)init;
-(id)initWithName:(NSString*)name
             andURL:(NSString*)url
            andDescription:(NSString*)desc;
-(NSString*)description;
@end
```

Listing 12.11 The `XOAbsconder` class definition.

```
#import "XOAbsconder.h"

@implementation XOAbsconder
@synthesize name;
@synthesize furtherInfoURL;
@synthesize desc;

-(id)initWithName:(NSString*)name
             andURL:(NSString*)url
            andDescription:(NSString*)description{
    self = [super init];
    if(self) {
        self.name = name;
        self.furtherInfoURL = url;
        self.desc = description;
    }
    return self;
}
```

```
- (id) init{
    return [self initWithName:@"" andURL:@"" andDescription:@""];
}

- (NSString*) description{
    return [NSString stringWithFormat:name];
}

- (void) dealloc{
    [name release];
    [furtherInfoURL release];
    [desc release];
    [super dealloc];
}
@end
```

Our `endElementNsSAX2Func()` function is called `endElementSAX()` and is shown in Listing 12.12.

Listing 12.12 The `endElementSAX()` function definition.

```
static void
endElementSAX (void *ctx,
               const xmlChar *localname,
               const xmlChar *prefix,
               const xmlChar *URI)
{
    NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
    XORSSFeedNebraska *feedNebraska = (XORSSFeedNebraska*) ctx;
    if ((!xmlStrcmp(localname, (const xmlChar *)"item"))) {
        if (feedNebraska.currAbsconder) {
            [feedNebraska addAbsconder:feedNebraska.currAbsconder];
        }
        [feedNebraska.currAbsconder release];
        feedNebraska.currAbsconder = nil;
    }
    else if ((!xmlStrcmp(localname, (const xmlChar *)"title"))) {
        if (feedNebraska.currAbsconder) {
            feedNebraska.currAbsconder.name =
                feedNebraska.currentElementContent;
        }
    }
    else if ((!xmlStrcmp(localname, (const xmlChar *)"link"))) {
        if (feedNebraska.currAbsconder) {
            feedNebraska.currAbsconder.furtherInfoURL =
                feedNebraska.currentElementContent;
        }
    }
}
```

```

    }
    else if ((!xmlstrcmp(localname, (const xmlChar *)"description"))) {
        if(feedNebraska.currAbsconder) {
            feedNebraska.currAbsconder.desc =
                feedNebraska.currentElementContent;
        }
    }

    if (feedNebraska.currentElementContent) {
        [feedNebraska.currentElementContent release];
        feedNebraska.currentElementContent = nil;
    }
    [pool release];
}

```

The function first checks to see if the element's name is `item`. If it is, then we add the `XOAbsconder` object which was constructed by the other callback functions. Otherwise, we check for the three element names: `title`, `link`, and `description`. For each of these elements, we set its respective text value gathered by the `charactersSAXFunc()` function. For example, the following sets the `desc` instance variable with the current text value.

```
feedNebraska.currAbsconder.desc = feedNebraska.currentElementContent;
```

The text of the element is stored in `charactersSAXFunc()`. The function is declared in `parser.h` as:

```
void charactersSAXFunc (void * ctx, const xmlChar * ch, int len)
```

This function is called by the parser informing you of new found characters. In addition to the context, you receive the string of characters and its length. Between the start of an element and the end of that element, this function might be called several times. Your function should take this into account and append the new text to the current string.

Our `charactersFoundSAX()` function is shown in Listing 12.13.

Listing 12.13 The `charactersFoundSAX()` function definition.

```
static void charactersFoundSAX(void * ctx, const xmlChar * ch, int len) {
    NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
    XORSSFeedNebraska *feedNebraska = (XORSSFeedNebraska*) ctx;
    CFStringRef str =
        CFStringCreateWithBytes(kCFAllocatorSystemDefault,
                               ch, len, kCFStringEncodingUTF8, false)
    if (!feedNebraska.currentElementContent) {
        feedNebraska.currentElementContent = [[NSMutableString alloc] init];
    }
    [feedNebraska.currentElementContent appendString:(NSString *)str];
```

```
CFRelease(str);
[pool release];
}
```

The function starts by casting the `ctx` into a `XORSSFeedNebraska` instance. Using this pointer, we can call our Objective-C class. After that, we create a string from received characters by using the function `CFStringCreateWithBytes()`, which is declared as follows:

```
CFStringRef CFStringCreateWithBytes (
    CFAllocatorRef alloc,
    const UInt8 *bytes,
    CFIndex numBytes,
    CFStringEncoding encoding,
    Boolean isExternalRepresentation
);
```

The first parameter is used to specify the memory allocator. `kCFAllocatorDefault` is used for the current default allocator. The second parameter is the buffer which contains the characters. The third parameter specifies the number of bytes. The fourth parameter is the encoding. We use `kCFStringEncodingUTF8` for UTF8 encoding. The fifth parameter is used to specify if the characters in the buffer are in an external representation format. Since they are not, we use `false`.

Once we have the string representation of the characters, we check to see if this is the first time `charactersFoundSAX` has been called for the current element. Recall that the parser can call this function multiple times, supplying the content of a single element. If it is the first time, we allocate our mutable string. After that, we append the string that we created from the character buffer to the mutable string. When the `endElementSAX()` function is called, we retrieve this string to build our Objective-C object, `currAbsconder`. When we are finished with the string `str`, we use the `CFRelease()` function to deallocate it.

Finally, the error handling functions are shown in Listings 12.14 and 12.15. As in all other event functions, what you do for error-handling depends on your application. In our example, we release the `currAbsconder` object that we are constructing and log the problem.

Listing 12.14 The `errorEncounteredSAX()` function definition.

```
static void errorEncounteredSAX (void * ctx, const char * msg, ...){
    XORSSFeedNebraska *feedNebraska = (XORSSFeedNebraska*) ctx;
    if(feedNebraska.currAbsconder) {
        [feedNebraska.currAbsconder release];
        feedNebraska.currAbsconder = nil;
    }
    NSLog(@"%@", @"errorEncountered: %s", msg);
}
```

Listing 12.15 The fatalErrorEncounteredSAX() function definition.

```
static void fatalErrorEncounteredSAX (void * ctx, const char * msg, ...) {
    XORSSFeedNebraska *feedNebraska = (XORSSFeedNebraska*) ctx;
    if(feedNebraska.currAbsconder) {
        [feedNebraska.currAbsconder release];
        feedNebraska.currAbsconder = nil;
    }
    NSLog(@"fatalErrorEncountered: %s", msg);
}
```

12.4 An RSS Reader Application

In this section, we present a working iPhone application based on the code developed so far. The application will present the contents of an RSS feed to the user in a scrollable table view. The complete application can be found in the `RSS Reader` project in the source downloads.

Listing 12.16 shows the application delegate declaration and definition. The application delegate uses an instance of the class `XORSSFeedNebraska` to retrieve the XML document and parse it to generate the items.

Listing 12.16 The RSS reader application delegate declaration and definition.

```
#import <UIKit/UIKit.h>
#import "XORSSFeedNebraska.h"
@interface XORSSFeedAppDelegate : NSObject {
    UIWindow *window;
    UINavigationController *navigationController;
    XORSSFeedNebraska *rssFeed;
}
@property (nonatomic, retain)
    UINavigationController *navigationController;
@end

#import "XORSSFeedAppDelegate.h"
#import "XORSSFeedNebraska.h"
#import "RootViewController.h"

@implementation XORSSFeedAppDelegate
@synthesize navigationController;
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]];
    // Create the navigation and view controllers
    RootViewController *rootViewController =
        [[RootViewController alloc] init];
    UINavigationController *aNavController =
        [[UINavigationController alloc]
            initWithRootViewController:rootViewController];
}
```

```
self.navigationController = aNavController;
[aNavController release];
[rootViewController release];
// Configure and show the window
[window addSubview:[navigationController view]];
rssFeed = [[XORSSFeedNebraska alloc] init];
[rssFeed fetchAbsconders];
>window makeKeyAndVisible];
}
- (NSString*)xoTitle{
    return @"Nebraska Absconders";
}
- (NSInteger)countOfList {
    return [rssFeed numberOfRows];
}
- (id)objectInListAtIndex:(NSUInteger)theIndex {
    return [rssFeed absconderAtIndex:theIndex];
}
- (void)dealloc {
    [window release];
    [navigationController release];
    [rssFeed release];
    [super dealloc];
}
@end
```

The delegate's `applicationDidFinishLaunching:` method creates a window and the table view controller. It then asks the instance of `XORSSFeedNebraska` to fetch the XML and parse it by calling the `fetchAbsconders` method. The table view controller's declaration and definition are shown in Listing 12.17.

Listing 12.17 The RSS reader table controller declaration and definition.

```
#import <UIKit/UIKit.h>
@interface RootViewController : UITableViewController {
}
@end

#import "RootViewController.h"
#import "XOAbsconder.h"
#import "XORSSFeedAppDelegate.h"
@implementation RootViewController
- init {
    if (self = [super init]) {
        XORSSFeedAppDelegate *appDelegate =
            (XORSSFeedAppDelegate*)[[UIApplication sharedApplication] delegate];
        self.title = [appDelegate xoTitle];
    }
}
```

```
    return self;
}
- (NSInteger)numberOfSectionsInTableView: (UITableView *)tableView {
    return 1;
}
- (NSInteger)tableView: (UITableView *)tableView
    numberOfRowsInSection: (NSInteger)section {
    XORSSFeedAppDelegate *appDelegate =
        (XORSSFeedAppDelegate*) [[UIApplication sharedApplication] delegate];
    return [appDelegate countOfList];
}
- (UITableViewCell *)tableView: (UITableView *)tableView
    cellForRowAtIndexPath: (NSIndexPath *)indexPath{
    UITableViewCell *cell =
        [tableView dequeueReusableCellWithIdentifier:@"XO"];
    if (cell == nil) {
        cell = [[[UITableViewCell alloc]
                  initWithStyle:UITableViewCellStyleDefault
                  reuseIdentifier:@"XO"] autorelease];
    }
    XORSSFeedAppDelegate *appDelegate =
        (XORSSFeedAppDelegate*) [[UIApplication sharedApplication] delegate];
    XOAbsconder *absconder =
        [appDelegate objectInListAtIndex:indexPath.row];
    cell.textLabel.text = [absconder description];
    return cell;
}
@end
```

As you have learned from previous chapters, the table view controller is the data source and delegate of the table view. It uses the application delegate to respond to the queries about the table's data model (e.g., number of rows, etc.).

Figure 12.8 shows a screenshot of the application main window.

12.5 Putting It Together

There are two approaches to XML parsing: DOM and SAX. DOM builds a tree representation of the XML document and allows you to navigate the nodes. SAX sequentially parses the document, calling your registered functions appropriately. If you like to write the least amount of code, use DOM. If the XML document is large, use SAX. If you are interested in a couple of nodes in the XML document, use SAX. If you will process most of the document, use DOM. If you would like to write the XML document back to a file, use DOM. If the application accesses the XML document sequentially, use SAX. If you want to make a lot of modifications to the XML document, use DOM. If the XML document is central to your application and you have many methods/objects working on it, use DOM.



Figure 12.8 The Nebraska Absconders RSS reader application.

To use DOM parsing in your application, follow the following steps:

1. Create an `NSURL` object from the XML document URL address.
2. Create an `NSString` instance to hold the actual XML document by calling `NSString`'s class method `stringWithContentsOfURL:encoding:error:`. This method will fetch the XML document from the Internet and store it in a Cocoa string.
3. Convert the Cocoa string to a C-based string using the `NSString` instance method `cStringUsingEncoding:`, and use `NSUTF8StringEncoding`.
4. Use the `libxml2` function `xmlParseMemory()` to load the C-string XML document into memory in the form of a tree.
5. Obtain a pointer to the root element and start traversing the tree according to your application's requirements.
6. To obtain the text value of an element, use the function `xmlNodeListGetString()`.
7. Any time you retrieve a string value from `libxml2`, know that it is your responsibility to deallocate it. Use the `xmlFree()` function to do just that. Call `xmlFreeDoc()` when you are finished.

To use SAX parsing in your application, do the following steps:

1. Create a structure of type `xmlSAXHandler`. Fill the entries representing the events that you are interested in receiving with pointers to your event functions. Make sure that the initialized entry is set to `XML_SAX2_MAGIC`.

2. Different events have different function signatures. For example, `charactersFoundSAX()` is declared as:

```
charactersFoundSAX(void *ctx, const xmlChar *ch, int len)
```

Locate the appropriate function signature in `libxml2's tree.h` file.

3. For meaningful XML parsing, create at least three functions:

(a) `startElementNsSAX2Func`. This function is called when the parser encounters a begin-tag.

(b) `charactersSAXFunc`. This function is called (potentially more than once for a given element) to provide you with characters found inside the element.

(c) `endElementNsSAX2Func`. This function is called when the parser encounters an end-tag.

4. Before you start parsing the document, create a document parser context by calling `xmlCreateDocParserCtxt()` and passing the C-string XML document as the sole argument.

5. After setting up the event functions and the SAX handler, call `libxml2's` function `xmlSAXUserParseMemory()` passing in:

(a) a pointer to the handler

(b) a pointer to a context. The context can point to any object (e.g., a Cocoa object)

(c) the C-string representing the XML document and its length in bytes.

6. The parser will start parsing the document and firing the events. If you have registered in the handler a function for a given event, that function will be called.

7. Following the call to `xmlSAXUserParseMemory()`, free the context by calling `xmlFreeParserCtxt()`, and clear the parser by calling `xmlCleanupParser()`.

12.6 Summary

This chapter addressed the techniques used to natively process XML on the iPhone. Section 12.1 explained the main concepts behind XML and one of its languages, RSS. Section 12.2 presented a detailed discussion of DOM parsing. Section 12.3 offered another, different XML parsing technique, SAX, and showed how you can write a SAX iPhone client. In Section 12.4 we looked at a table-based RSS reader application. Finally, Section 12.5 presented the final thoughts on this subject.

Problems

- (1) There are several web services available on <http://ws.geonames.org/>. The *Wikipedia Full-text Search* returns the Wikipedia entries found for a given query. The returned result of executing

this web service is an XML document. There are several parameters for this web service. The parameter `q` is where you specify the query, and `maxRows` is the maximum number of records that can be returned. The full description of the web service can be found at:

www.geonames.org/export/wikipedia-webserice.html#wikipediaSearch.

As an example, the following URL request:

`http://ws.geonames.org/wikipediaSearch?q=plano,texas&maxRows=10`

will return an XML document with result entries. Here is a partial listing of the XML document:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<geonames>
<entry>
<lang>en</lang>
<title>Plano, Texas</title>
<summary>
Plano is a city in Collin and Denton Counties in
the US state of Texas. Located mainly within
Collin County, it is a wealthy northern suburb
of Dallas. The population was 222,030 at the
2000 census, making it the ninth largest city in
Texas. According to a 2005 census estimate,
Plano had grown to 250,096 making
Plano the sixty-ninth most populous city in the
United States (...)</summary>
<feature>city</feature>
<countryCode>US</countryCode>
<population>245411</population>
<elevation>0</elevation>
<lat>33.0193</lat>
<lng>-96.7008</lng>
<.wikipediaUrl>
http://en.wikipedia.org/wiki/Plano%2C_Texas
</ wikipediaUrl>
<thumbnailImg/>
</entry>
.
.
.
</geonames>
```

Write an iPhone application that presents this information in a tabular form.

- (2) XPath (XML Path Language) is a language for selecting nodes from an XML document. Read more about it at www.w3.org/TR/xpath and investigate how you can use the `libxml2` library to perform XPath operations.

13

Location Awareness

This chapter addresses the topic of Location Awareness. First, Section 13.1 covers the Core Location framework and how to use it to build location-aware applications. After that, Section 13.2 discusses a simple location-aware application. Next, Section 13.3 covers the topic of geocoding. In that section, you learn how to translate postal addresses into geographical locations. In Section 13.4, you learn how to sample movement of the device and display that information on maps. After that, Section 13.5 discusses how to relate zip codes to geographical information. In that section, you also learn the actual formula that implements the distance between two locations. Next, Section 13.6 shows you how to utilize the Map Kit API to add an interactive map to your view hierarchy. Finally, we summarize the chapter in Section 13.7.

13.1 The Core Location Framework

The second generation of the iPhone (iPhone 3G) is equipped with a Global Positioning System (GPS) chip. GPS utilizes three or four satellites to triangulate the position of a point on earth. The accuracy of the point's position using this technique ranges from 5 to 40 meters.

The first generation of the iPhone uses non-GPS techniques for identifying the location of the device. Non-GPS techniques such as Cell-Identification, Time-of-Arrival (TOA) and Enhanced Observed Time Difference (E-OTD) can be used in conjunction with Wi-Fi and Bluetooth to provide a reasonable substitute for the lack of a GPS chip [3]. Of course, the locational accuracy of these methods is much lower than GPS and ranges from 100 to 500 meters.

Regardless of the technique used, the iPhone provides the Core Location framework [4] as a software interface with whatever technique(s) are used to find the location. The framework provides classes and protocols that you can use to get the current location within a specified accuracy as well as to schedule future updates of the current location.

The main class of the Core Location framework is `CLLocationManager`. `CLLocationManager` is the entry point that the developer uses to gain current and future location information. You use an instance of `CLLocationManager` to schedule future updates of the current location of the device.

To gain access to the current location's information, follow these steps:

1. You only need to create an instance of `CLLocationManager` if one does not exist.
2. Configure the `CLLocationManager` instance. You need to configure the instance of the manager with the following parameters:

- `desiredAccuracy`. Using this property, you tell the framework about your needs with respect to the accuracy of the location (in terms of meters). The `desiredAccuracy` property is declared as follows:

```
@property(assign, nonatomic) CLLocationAccuracy desiredAccuracy
```

Different applications require different accuracies. The framework tries to deliver location accuracies according to the value of this property, but it cannot guarantee that. There are several values you can choose from:

- `kCLLocationAccuracyBest`. This specifies the best accuracy available and it is the default.
 - `kCLLocationAccuracyNearestTenMeters`. This represents an accuracy within ten meters.
 - `kCLLocationAccuracyHundredMeter`. This represents an accuracy within a hundred meters.
 - `kCLLocationAccuracyKilometer`. This value represents an accuracy within 1000 meters.
 - `kCLLocationAccuracyThreeKilometers`. This value represents an accuracy within 3000 meters.
- `distanceFilter`. The value of this property determines how often you will receive location updates. You will receive a new update only when the device moves a distance greater than or equal to this distance. If a more accurate reading is available, this value is ignored and you will receive a new location update. This property is declared as:

```
@property(assign, nonatomic) CLLocationDistance distanceFilter
```

where `CLLocationDistance` is declared as:

```
typedef double CLLocationDistance
```

All values are in meters. If you specify `kCLDistanceFilterNone`, you will get updates for all device movements.

- `delegate`. This property specifies the delegate object receiving the updates. The property is declared as:

```
@property(assign, nonatomic) id<CLLocationManagerDelegate> delegate
```

The delegate implements the `CLLocationManagerDelegate` protocol. This protocol has two optional methods:

- (a) `locationManager:didUpdateToLocation:fromLocation:`.

This method is invoked whenever the location manager wants to update you with a location. The method is declared as follows:

```
- (void)locationManager: (CLLocationManager *)manager  
didUpdateToLocation: (CLLocation *)newLocation  
fromLocation: (CLLocation *)oldLocation
```

You receive a reference to the location manager in the first parameter. The second parameter is an instance of the `CLLocation` class encapsulating the new location. The third parameter is another, possibly `nil`, `CLLocation` object holding the previous location.

- (b) `locationManager:didFailWithError:`. This method of the delegate gets called whenever the manager fails to compute the current location. The method is declared as follows:

```
- (void)locationManager: (CLLocationManager *)manager  
didFailWithError: (NSError *)error
```

You should implement a class that adopts the `CLLocationManagerDelegate` protocol and assign the instance of this class to the `delegate` property of the `CLLocationManager` instance.

3. Invoke `startUpdatingLocation`. Call the `startUpdatingLocation` method of the `CLLocationManager` instance to start receiving location updates.
4. Invoke `stopUpdatingLocation`. You should call `stopUpdatingLocation` as soon as you are satisfied with the current location information.

The previous steps represent the basic usage of the location services.

13.1.1 The `CLLocation` class

Latitude and longitude define a logical grid system of the world. They are developed and implemented to locate places on earth. Latitude lines are parallel with equal distance from each other. The equator is 0 degrees, the north and south poles are 90 degrees. A degree is approximately 69 miles. Longitude lines run from north to south. The range for longitudes is 0 to 180 degrees east and 0 to 180 degrees west.

To locate a point on earth, you can describe it by a (latitude, longitude) pair. For example, $(33^{\circ}1'12'', -96^{\circ}44'19.67'')$. This degree-minute-second format can be converted to decimal format. The previous location can be written in decimal form as: $(33.02, -96.7388)$.

The location of the device is encapsulated by the class `CLLocation`, which contains the geographical position of the device represented by the latitude and longitude. In addition, it holds the altitude of the device and various values describing the location measurement. You typically receive objects of this kind from the location manager.

The following are some of the important properties of this class:

- `coordinate`. The latitude and longitude of the device in degrees. This property is declared as follows:

```
@property(nonatomic, nonatomic) CLLocationCoordinate2D coordinate
```

`CLLocationCoordinate2D` is a structure declared as follows:

```
typedef struct {
    CLLocationDegrees latitude;
    CLLocationDegrees longitude;
} CLLocationCoordinate2D;
```

where `CLLocationDegrees` is of type **double**.

- `altitude`. This returns the altitude of the device in meters. Positive values indicate above sea level while negative ones indicate below sea level. The property is declared as follows:

```
@property(nonatomic, nonatomic) CLLocationDistance altitude
```

- `horizontalAccuracy`. If you imagine that the latitude and longitude are the coordinates of the center of a circle, and the `horizontalAccuracy` is the radius of that circle, then the device can be within any point inside that circle. The property is declared as:

```
@property(nonatomic, nonatomic) CLLocationAccuracy horizontalAccuracy
```

The property is of type `CLLocationAccuracy`, which is defined as **double**. A negative value indicates an invalid lateral location.

- `verticalAccuracy`. This property provides the vertical accuracy of the location. The altitude is within $+/-$ of this value. The property is declared as follows:

```
@property(nonatomic, nonatomic) CLLocationAccuracy verticalAccuracy
```

Negative values indicate an invalid altitude reading.

- `timestamp`. This provides the time when the location was determined. The property is declared as follows:

```
@property(nonatomic, nonatomic) NSDate *timestamp
```

Most of the time, you receive `CLLocation` objects from the location manager. If you would like to cache objects of this type, you need to allocate and initialize a new location object. You can use one of the following two initialization methods depending on your situation:

- `initWithLatitude:longitude:`. This method is declared as follows:
 - (**id**)`initWithLatitude:(CLLocationDegrees)latitude longitude:(CLLocationDegrees)longitude`
- `initWithCoordinate:altitude:horizontalAccuracy:verticalAccuracy:timestamp:`. This method is declared as follows:

```
- (id)initWithCoordinate:(CLLocationCoordinate2D)coordinate
    altitude:(CLLocationDistance)altitude
    horizontalAccuracy:(CLLocationAccuracy)hAccuracy
    verticalAccuracy:(CLLocationAccuracy)vAccuracy
    timestamp:(NSDate *)timestamp;
```

There is one last method that can be useful in finding the distance (in meters) from one given location to another. This method is `getDistanceFrom:` and it returns the lateral distance from the location provided in the first parameter to the location encapsulated by the receiver. The method is declared as follows:

```
- (CLLocationDistance) getDistanceFrom:(const CLLocation *)location
```

Later in this chapter, we will show how such a method can be implemented and used within a database engine.

13.2 A Simple Location-aware Application

This section starts by providing a simple location-aware application. The application will configure a location manager and display the updates in a text view. To keep things simple, we implement the functionality of the application in one class: the application delegate.

Listing 13.1 shows the declaration of the application delegate class. The class maintains references to the text view and the location manager. The `noUpdates` instance variable is used to count the number of location updates received by the application delegate so far. We stop the location updates when we reach ten updates. Notice that we have added a new `#import` statement for the Core Location framework.

Listing 13.1 The declaration of the application delegate class used in the simple location-aware example.

```
#import <UIKit/UIKit.h>
#import <CoreLocation/CoreLocation.h>

@interface Location1AppDelegate : NSObject
<UIApplicationDelegate, CLLocationManagerDelegate> {
    UIWindow          *window;
    UITextView        *textView ;
    CLLocationManager *locationMgr;
    NSUInteger        noUpdates;
}
@property (nonatomic, retain) UIWindow *window;
@end
```

Listing 13.2 shows the implementation of the application delegate class. The `applicationDidFinishLaunching:` method configures a text view and adds it as a subview to the main window.

An instance of the location manager is created, and its `delegate` property is set to the application delegate instance. The location manager is made to start updating, and the window is made visible.

Location updates are received by the `CLLocationManagerDelegate`'s method `locationManager:didUpdateToLocation:fromLocation:`. In our implementation of this method, we simply concatenate the text in the text view with the description of the new location object. The text view's `text` property is then set to this value. When ten updates have been received, the location manager is made to stop updating us by invoking its `stopUpdatingLocation` method.

Listing 13.2 The implementation of the application delegate class used in the simple location-aware example.

```
#import "Location1AppDelegate.h"

@implementation Location1AppDelegate
@synthesize window;

- (void)locationManager:(CLLocationManager *)manager
    didUpdateToLocation:(CLLocation *)newLocation
    fromLocation:(CLLocation *)oldLocation{
    noUpdates++;
    if (noUpdates >= 10) {
        [locationMgr stopUpdatingLocation];
    }
    [self updateLocation:[newLocation description]];
}

- (void) updateLocation:(NSString*) update{
    NSMutableString *newMessage =
        [[NSMutableString alloc] initWithCapacity:100];
    [newMessage appendString:
        [NSString stringWithFormat:@"Update #:%i\n", noUpdates]];
    [newMessage appendString:update];
    [newMessage appendString:@"\n"];
    [newMessage appendString:[textView text]];
    textView.text = newMessage;
    [newMessage release];
}

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]];
    CGRect rectFrame = [UIScreen mainScreen].applicationFrame;
    textView = [[UITextView alloc] initWithFrame:rectFrame];
    textView.editable = NO;
    locationMgr = [[CLLocationManager alloc] init];
    locationMgr.delegate = self;
    noUpdates = 0;
    [locationMgr startUpdatingLocation];
    [window addSubview:textView];
}
```

```
[window makeKeyAndVisible];
}

- (void)dealloc {
    [textView release];
    [locationMgr release];
    [window release];
    [super dealloc];
}
@end
```

For this code to build successfully, you need to add a reference to the Core Location library. See Section D.4. The complete application can be found in the `Location1` project available in the source downloads.

Figure 13.1 shows a screenshot of the application after receiving ten location updates.

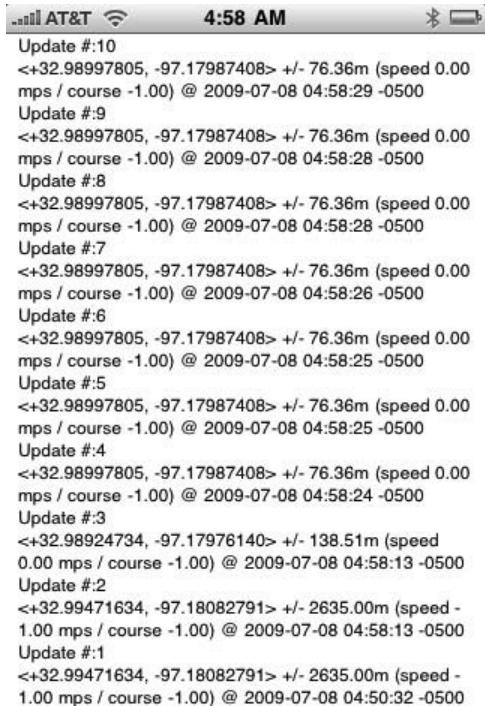


Figure 13.1 A screenshot of the application after receiving ten location updates.

13.3 Google Maps API

Google provides an HTTP interface for *geocoding*. Geocoding is a translation process where addresses such as: 3400 W Plano Pkwy, Plano, TX 75075 can be converted to actual geographic coordinates in latitude and longitude. To access this service, the client sends an HTTP request to `http://maps.google.com/maps/geo?` with the following parameters:

- `q`. This parameter represents the address for which you want to find its geo data.
- `output`. The format of the result to be sent back to you. Several formats exist such as `xml` and `csv`. The comma separated values (`csv`) is the easiest to deal with.
- `key`. To access the service, you need an API key from Google. At the time of writing, the usage is free for public websites. Google does, however, police the service.

For example, sending the following HTTP request:

```
http://maps.google.com/maps/geo?q=3400+W+Plano+Pkwy+Plano,  
+TX+75075&output=csv&  
key=ABQIAAAAERNgBiSqUogvAN307LdVDxSkQMtcTv75TNsQ97PejimT5pm-  
BxST0Gma_YCBaUccn3pRis8XjkxM8w
```

will, provided you use your Google-supplied key, return:

```
200,8,33.010003,-96.757923
```

There are four comma-separated values received from Google when you use `csv` format. The first value is the HTTP protocol status code. 200 is OK (see RFC 2616 for more information). The second value is the accuracy. A value of 8 means Address Level Accuracy. For a complete list, see `GGeoAddressAccuracy` in the Google Maps API reference. The last two pieces of the result, which is what we are really interested in, are the `latitude` and the `longitude`, respectively.

13.3.1 A geocoding application

In this section, we build an application that finds the distance between two addresses. First, we build the `GoogleMapsWrapper` helper class, a class which encapsulates the geocoding service. After that, we show an application delegate that uses this helper class to display the distance between two addresses using a text view.

Listing 13.3 shows the declaration of the `GoogleMapsWrapper` class. The main method declared by this class is the `findGeoInfoForAddress:andReturnLatitude:andLongitude:` method. This method takes the address as an input parameter and returns the latitude and longitude as output parameters. The return code for success is 0.

The GoogleMapsWrapper also maintains a set of Google Maps keys. These keys can be used to load-balance the HTTP requests as Google puts a limit on the number of queries used per key. The method `addKey:` is used to store a key, and the method `getKey` is used to retrieve one.

Listing 13.3 The declaration of the `GoogleMapsWrapper` class used in the geocoding application.

```
#import <UIKit/UIKit.h>

@interface GoogleMapsWrapper : NSObject {
    NSMutableArray *keys;
}
- (id) init;
- (void) addKey: (NSString*) key;
- (NSString*) getKey;
- (int) findGeoInfoForAddress: (NSString*) address
    andReturnLatitude: (float*) latitude
    andLongitude: (float*) longitude;
@end
```

Listing 13.4 shows the implementation of the `GoogleMapsWrapper` class.

Listing 13.4 The implementation of the `GoogleMapsWrapper` class used in the geocoding application.

```
#import "GoogleMapsWrapper.h"

#define GEO_QUERY      @"http://maps.google.com/maps/geo?q="
#define GEO_CSV_KEY    @"&output=csv&key="
@implementation GoogleMapsWrapper

- (int) findGeoInfoForAddress: (NSString*) address
    andReturnLatitude: (float*) latitude
    andLongitude: (float*) longitude{
    if (!address || !latitude || !longitude) {
        return -1;
    }
    NSMutableString *query =
        [[NSMutableString alloc] initWithString:GEO_QUERY];
    [query appendString:address];
    [query appendString:GEO_CSV_KEY];
    [query appendString:[self getKey]];
    [query replaceOccurrencesOfString:@" "
        withString:@"%20" options:NSLiteralSearch
        range:NSMakeRange(0, [query length])];
    NSURL *url= [[NSURL alloc] initWithString:query];
    if (!url) {
        [query release];
        return -1;
    }
    NSData *data = [[NSData alloc] initWithContentsOfURL:url];
```

```
if(!data) {
    [query release];
    [url release];
    *latitude = *longitude = 404;
    return -1;
}
NSString *contents = [[NSString alloc] initWithData:data
                                                encoding:NSUTF8StringEncoding];
if(!contents) {
    [query release];
    [url release];
    [data release];
    return -1;
}
/*
A reply returned in the csv format consists of four numbers,
separated by commas:
HTTP status code
accuracy (See accuracy constants)
latitude
longitude
example: 200,6,42.730070,-73.690570
*/
NSScanner *theScanner;
NSCharacterSet *comma =
    [NSCharacterSet characterSetWithCharactersInString:@", "];
NSString *statusCode;
theScanner = [NSScanner scannerWithString:contents];
if([theScanner scanUpToCharactersFromSet:comma
                                intoString:&statusCode]) {
    if([statusCode intValue] != 200) {
        *latitude = *longitude = 404;
        [query release];
        [url release];
        [data release];
        [contents release];
        return -1;
    }
}
if(
    [theScanner scanCharactersFromSet:comma intoString:NULL] &&
    [theScanner scanUpToCharactersFromSet:comma intoString:NULL] &&
    [theScanner scanCharactersFromSet:comma intoString:NULL] &&
    [theScanner scanFloat:latitude] &&
    [theScanner scanCharactersFromSet:comma intoString:NULL] &&
    [theScanner scanFloat:longitude]
) {
    [query release];
}
```

```

[url release];
[data release];
[contents release];
return 0;
}
[query release];
[url release];
[data release];
[contents release];
return -1;
}

- (NSString*)getKey{
if([keys count] < 1){
    return @"NULL_KEY";
}
return [keys objectAtIndex:0];
}

- (void)addKey:(NSString*) key{
[keys addObject:key];
}

- (id)init{
self = [super init];
keys = [[NSMutableArray arrayWithCapacity:1] retain];
return self;
}

- (void)dealloc {
[keys release];
[super dealloc];
}
@end

```

The `findGeoInfoForAddress:andReturnLatitude:andLongitude:` method first builds the query to be used in the HTTP request. After creating an `NSURL` object for the request, it contacts Google by invoking the `initWithContentsOfURL:` of `NSData`.

The response of the query is in comma-separated format (`csv`) that needs to be parsed. To retrieve the four values in the response, we utilize the Cocoa class `NSScanner`. An `NSScanner` class is used to scan an `NSString` object for strings and numbers by progressing through the string. In addition, you can use it to skip over characters in a given set. The response of the query is first converted to an `NSString` object, `contents`. After that, an `NSScanner` object is created by invoking the `scannerWithString:` class method of `NSScanner` passing in that string.

First, we need to check the status code value of the response. To retrieve the status code, we ask the scanner to extract all characters starting from the current position (beginning of string) up to the first comma. The method `scanUpToCharactersFromSet:intoString:` is used for that purpose. Once we have the status code in the string `statusCode`, we check to see if it is equal to the value 200. If it is not, we return a -1, indicating an error. If the status code is equal to 200, we retrieve the latitude and the longitude values using the `scanFloat:` method.

The `GoogleMapsWrapper` class does not implement load-balancing (e.g., a simple randomization algorithm). We use only one key in our application.

Listing 13.5 shows the declaration of the application delegate class.

Listing 13.5 The declaration of the application delegate class used in the geocoding example.

```
#import <UIKit/UIKit.h>
#import <CoreLocation/CoreLocation.h>
#import "GoogleMapsWrapper.h"

@interface Location2AppDelegate : NSObject <UIApplicationDelegate> {
    UIWindow *window;
    UITextView *textView ;
    GoogleMapsWrapper *gWrapper;
}
@property (nonatomic, retain) UIWindow *window;
@end
```

As we have mentioned before, the application delegate will create the main window and attach a text view to it. It will then use the `GoogleMapsWrapper` class to find the distance between two addresses and display that information to the user in a text view as shown in Figure 13.2. The class maintains references to the `UITextView` and the `GoogleMapsWrapper` classes.

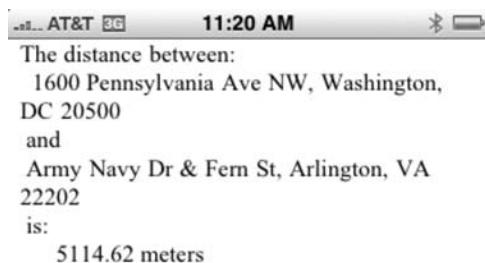


Figure 13.2 A screenshot of the geocoding application showing the distance between two addresses.

Listing 13.6 shows the implementation of the application delegate class. The `applicationDidFinishLaunching:` method configures the GUI and invokes the method `findDistanceFromAddress:toAddress:` to find the distance between the White House and the Pentagon. The result is then formatted and assigned to the `text` property of the text view object.

Listing 13.6 The implementation of the application delegate class used in the geocoding example.

```
#import "Location2AppDelegate.h"
#import "GoogleMapsWrapper.h"

#define FROM_ADDRESS @"1600 Pennsylvania Ave NW, Washington, DC 20500"
#define TO_ADDRESS @"Army Navy Dr & Fern St, Arlington, VA 22202"

@implementation Location2AppDelegate

@synthesize window;

-(double) findDistanceFromAddress:(NSString*) from
                           toAddress:(NSString *) to{
    float lat, lon;
    CLLocation *fromLocation;
    CLLocation *toLocation;
    if([gWrapper findGeoInfoForAddress:from
                                 andReturnLatitude:&lat andLongitude:&lon] == 0) {
        fromLocation =
            [[[CLLocation alloc] initWithLatitude:lat longitude:lon]
             autorelease];
        if([gWrapper findGeoInfoForAddress:to andReturnLatitude:&lat
                                 andLongitude:&lon] == 0) {
            toLocation = [[CLLocation alloc]
                          initWithLatitude:lat longitude:lon] autorelease];
            return [toLocation getDistanceFrom:fromLocation];
        }
        return -1;
    }
    return -1;
}

-(void)applicationDidFinishLaunching:(UIApplication *)application {
    window =
        [[UIWindow alloc] initWithFrame:[[UIScreen mainScreen] bounds]];
    CGRect rectFrame = [UIScreen mainScreen].applicationFrame;
    textView = [[UITextView alloc] initWithFrame:rectFrame];
    textView.editable = NO;
    gWrapper = [[GoogleMapsWrapper alloc] init];
    [gWrapper addKey:@"ABQIAAAAERNgBiSqUogvAN307LdVDx"
              "SkQMtcTv75TNsQ97PejimT5pm-MAxST0Gma_Y"
              "CBaUccn3pRis8XjkxM8w"];
    NSMutableString *outStr = [[NSMutableString alloc]
```

```
initWithFormat:@"The distance between: \n %@ \n and"
    @"\n %@ \n is:\n \t \t %.2f meters\n",
    FROM_ADDRESS, TO_ADDRESS,
    [self findDistanceFromAddress:FROM_ADDRESS
        toAddress:TO_ADDRESS]];
textView.text = outStr;
[window addSubview:textView];
[window makeKeyAndVisible];
}

- (void)dealloc {
    [gWrapper release];
    [textView release];
    [window release];
    [super dealloc];
}
@end
```

The complete application can be found in the `Location2` project available in the source downloads.

13.4 A Tracking Application with Maps

Many iPhone applications require the display of a map. If you are faced with the task of developing one of these applications, you can use Google Maps API and the `UIWebView` class for that purpose.

In this section we develop a tracking application. The application will first track and store the movement of the device for a configurable number of movements. The user can interrupt the tracking or wait until a specified number of movements have been recorded. In either case, the user is able to go through these movements and visualize (on a map) the geographic location and the time of the recording of each movement.

Listing 13.7 shows the declaration of the application delegate class. The application delegate will have a navigation controller for the GUI; thus, it maintains references to a view and a navigation controller.

Listing 13.7 The declaration of the application delegate class used in the tracking application.

```
#import <UIKit/UIKit.h>
#import "LocationsViewController.h"

@interface Location3AppDelegate : NSObject <UIApplicationDelegate> {
    UIWindow *window;
    LocationsViewController *ctrl;
    UINavigationController *navCtrl;
}
@property (nonatomic, retain) UIWindow *window;
@end
```

Listing 13.8 shows the implementation of the application delegate class. The `applicationDidFinishLaunching:` method simply creates a view controller of type `LocationsViewController` and uses it as the root controller for a navigation controller. The view of the navigation controller is then added as a subview to the main window and the main window is made visible.

Listing 13.8 The implementation of the application delegate class used in the tracking application.

```
#import "Location3AppDelegate.h"
@implementation Location3AppDelegate
@synthesize window;

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    window = [[UIWindow alloc]
              initWithFrame:[UIScreen mainScreen] bounds]];
    ctrl = [[LocationsViewController alloc]
            initWithNibName:nil bundle:nil];
    navCtrl = [[UINavigationController alloc]
               initWithRootViewController:ctrl];
    [window addSubview:navCtrl.view];
    [window makeKeyAndVisible];
}

- (void)dealloc {
    [ctrl release];
    [navCtrl release];
    [window release];
    [super dealloc];
}
@end
```

Our view controller is declared in Listing 13.9. The view controller adopts the `CLLocationManagerDelegate` as it will be the delegate of the location manager that it will create. It declares two bar buttons for stopping the sampling of movements, navigating to the next recording, and navigating to the previous recording. The right bar button will be used for both stopping the sampling of movements and as a “Next” button. In addition, the view controller maintains a reference to a web view for visualizing the locations sampled.

Listing 13.9 The declaration of `LocationsViewController` view controller class used in the tracking application.

```
#import <UIKit/UIKit.h>
#import <CoreLocation/CoreLocation.h>

@interface LocationsViewController : UIViewController <CLLocationManagerDelegate>{
    CLLocationManager *locationMgr;
   NSUInteger noUpdates;
    NSMutableArray *locations;
    UIWebView *webView;
```

```
    UIBarButtonItem *rightButton, *leftButton;
    NSUInteger current;
}
@end
```

Listing 13.10 shows the implementation of the view controller. In the initialization method, `initWithNibName:bundle:`, we create two bar buttons. The right button is labelled “Stop” and the left “Previous”. The left button is made disabled.

Listing 13.10 The implementation of `LocationsViewController` view controller class used in the tracking application.

```
#import "LocationsViewController.h"

#define NO_OF_LOCATIONS 100
#define MIN_DISTANCE 100

@implementation LocationsViewController

- (void)locationManager:(CLLocationManager *)manager
    didUpdateToLocation:(CLLocation *)newLocation
    fromLocation:(CLLocation *)oldLocation{
    noUpdates++;
    [locations addObject:newLocation];
    self.title = [NSString stringWithFormat:@"Locations: %i", noUpdates];
    if(noUpdates == 1){
        [self centerMap:0];
    }
    if(noUpdates >= NO_OF_LOCATIONS){
        [locationMgr stopUpdatingLocation];
        leftButton.enabled = YES;
        rightButton.title = @"Next";
        current = 0;
        [self centerMap:current];
    }
}

- (void) centerMap:(NSUInteger) index{
    CLLocation *loc = [locations objectAtIndex:index];
    NSString *js = [NSString stringWithFormat:
        @"var map = "
        "new GMap2(document.getElementById(\"map_canvas\"));"
        "map.setMapType(G_HYBRID_MAP);"
        "map.setCenter(new GLatLng(%lf, %lf), 18);"
        "map.panTo(map.getCenter());"
        "map.openInfoWindow(map.getCenter(),"
        "document.createTextNode(\"Loc: (%i/%i), Time: %@\"));",
        [loc coordinate].latitude, [loc coordinate].longitude,
```

```
    index+1, [locations count], [loc timestamp]];
    [webView stringByEvaluatingJavaScriptFromString:js];
}

- (id)initWithNibName:(NSString *)NibNameOrNil
    bundle:(NSBundle *)nibBundleOrNil {
    if ([self=[super initWithNibName:nibNameOrNil bundle:nibBundleOrNil]) {
        rightButton = [[UIBarButtonItem alloc]
            initWithTitle:@"Stop"
            style:UIBarButtonItemStyleDone
            target:self action:@selector(stopOrNext)];
        self.navigationItem.rightBarButtonItem = rightButton;
        leftButton = [[UIBarButtonItem alloc]
            initWithTitle:@"Previous"
            style:UIBarButtonItemStyleDone
            target:self action:@selector(prev)];
        self.navigationItem.leftBarButtonItem = leftButton;
        leftButton.enabled = NO;
    }
    return self;
}

- (void)stopOrNext{
    if([rightButton.title isEqualToString:@"Stop"] == YES) {
        [locationMgr stopUpdatingLocation];
        leftButton.enabled = YES;
        rightButton.title = @"Next";
        current = 0;
        [self centerMap:current];
    }
    else
    if(current < ([locations count]-1)){
        [self centerMap:++current];
    }
}

- (void)prev{
    if(current > 0 && (current < [locations count])) {
        current = current -1;
        [self centerMap:current];
    }
}

- (void)loadView {
    locations = [[NSMutableArray arrayWithCapacity:10] retain];
    locationMgr = [[CLLocationManager alloc] init];
    locationMgr.distanceFilter = MIN_DISTANCE;
    locationMgr.delegate = self;
```

```
noUpdates = 0;

CGRect rectFrame = [UIScreen mainScreen].applicationFrame;
webView = [[UIWebView alloc] initWithFrame:rectFrame];
NSString *htmlFilePath =
    [[NSBundle mainBundle] pathForResource:@"map3" ofType:@"html"];
NSData *data = [NSData dataWithContentsOfFile:htmlFilePath];
[webView loadData:data MIMEType:@"text/html"
    textEncodingName:@"utf-8" baseURL:[NSURL
        URLWithString:@"http://maps.google.com/"]];
[locationMgr startUpdatingLocation];
self.view = webView;
}

- (void)dealloc {
    [rightButton release];
    [leftButton release];
    [locationMgr release];
    [locations release];
    [super dealloc];
}
@end
```

The `loadView` method creates and configures a location manager. The distance needed to receive an update is made to be equal to `MIN_DISTANCE`. In addition, a web view is created and initialized with the contents of an HTML file stored in the bundle. The file `map3.html` is shown in Listing 13.11. This file is one of many sample files demonstrating the use of the Google Maps API provided by Google. As you will see shortly, we will use JavaScript to modify the appearance of the map dynamically.

Listing 13.11 The HTML page used for displaying a Google map for the geo-tracking application.

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml"
      xmlns:v="urn:schemas-microsoft-com:vml">
<head>
<meta http-equiv="content-type" content="text/html;
    charset=utf-8"/>
<title>Geo-tracking Example</title>
<script
src="http://maps.google.com/maps?file=api&v=2&key=K"
    type="text/javascript">
</script>
<script type="text/javascript">
function initialize() {
}
</script>
```

```
</head>
<body onload="initialize()" onunload="GUnload()">
    <div id="map_canvas" style="width: 500px; height: 500px">
    </div>
</body>
</html>
```

On receiving location updates, we store these locations in an array. When we have sampled NO_OF_LOCATIONS locations, we enable the left bar button, change the title of the right button to “Next” and point out the first location on the map.

The method `centerMap:` is used to display the location on the map. The method takes as an input parameter the index of the location in the array of sampled locations. It extracts the latitude and longitude information from the location, sets the center of the map to that location, and pans to the center. In addition, it opens an information window with the time of the sampling of the location. All of this is done in JavaScript such as the one shown below. Finally, we execute the JavaScript code using the web view’s method `stringByEvaluatingJavaScriptFromString::`

```
var map = new GMap2(document.getElementById("map_canvas"));
map.setMapType(G_HYBRID_MAP);
map.setCenter(new GLatLng(37.331689, -122.030731), 18);
map.panTo(map.getCenter());
map.openInfoWindow(map.getCenter(), document.createTextNode("Loc: (1/1),
Time: 2008-08-06 19:51:27 -0500"));
```

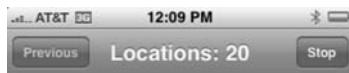


Figure 13.3 A screenshot of the tracking application while sampling movements.



Figure 13.4 A screenshot of the tracking application while viewing a sampled location.

Figure 13.3 shows a screenshot of the tracking application while sampling movements, and Figure 13.4 shows a screenshot of the tracking application while viewing one of those sampled locations.

The application poses some ethical (and maybe legal) issues. If you find a need to launch this application and hide it in someone's car or bag, you should think again! Spying is not nice and it may land you in jail. Moms, of course, are an exception! One may want to modify the application and add real-time reporting of movements to interested parties. This is left to the reader as an exercise.

13.5 Working with ZIP Codes

The United States Postal Service (USPS) uses a coding system to help in the efficient distribution of mail in the US. Each potential recipient of mail is thought to live in a specific zone represented by a Zone Improvement Plan (ZIP) code. ZIP codes are, in theory, tied to geographical locations.

There are various databases available on ZIP codes. These databases differ in their accuracy and pricing. Databases referring to the latitude and longitude of a given ZIP code can be thought to describe the center of the ZIP code servicing area. There are several places where you can buy US ZIP code databases. You can even download a recent database for free from the site in [1].

The contents of the US ZIP codes file [1] is comma-separated. For example, the last few entries in the file are as follows:

```
89508,Reno,NV,39.5296329,-119.8138027,Washoe
91008,Duarte,CA,34.1394513,-117.9772873,Los Angeles
92058,Oceanside,CA,33.1958696,-117.3794834,San Diego
94505,Discovery Bay,CA,37.9085357,-121.6002291,Contra Costa
95811,Sacramento,CA,38.5815719,-121.4943996,Sacramento
```

In the following, we present the major steps that you can take in order to answer questions like the following: give me all ZIP codes that are within 10 miles of 68508.

1. **Create an SQLite zipcodes table.** To efficiently search, it is advisable to represent your data in a database. The following table can be used to store the ZIP code data.

```
CREATE TABLE zipcodes (
    zipcode int NOT NULL PRIMARY KEY,
    latitude float(10,8), longitude float(10,8),
    state varchar(2), city varchar(128),
    county varchar(128))
```

The zipcode will be our primary key and for each ZIP code, we have the latitude, longitude, state, city, and county.

2. **Populate the zipcodes table.** Populate the table with the ZIP code geographical data obtained from the text file. The data is stored in a comma-separated ASCII file. Use an NSScanner object for value extraction. The extracted tokens of each line are used as input to an **INSERT** SQL statement.
3. **Construct an Objective-C class for answering questions.** After you have produced the database for online use, you need to develop a new class that will answer geographical queries. A major query that one would like to ask is: give me all ZIP codes that are within 10 miles of 20007. This query might be implemented with a method having the following signature:

```
- (NSArray*)zipcodesNearLatitude:(float)lat andLongitude:(float)lon
                           withinDistance:(float)distance;
```

Let's take a look at a possible implementation of the above method. The method's main focus is the execution and the manipulation of results of the following SQL statement:

```
SELECT Z.zipcode FROM zipcodes AS Z WHERE
Distance(latitude1, longitude1, Z.latitude, Z.longitude) <= distance
```

This **SELECT** statement finds all ZIP codes such that the distance between a ZIP code's (latitude, longitude) and a given point (latitude1, longitude1) is within the value distance (in kilometers).

You have learned how to write code for these SQL statements. You have also learned how to create C-functions and use them in SQL queries. The **Distance()** function in the above SQL statement must be implemented by you. Listing 13.12 presents a C-implementation.

Listing 13.12 The C implementation of the Distance user-defined function.

```
void distance(sqlite3_context *context, int nargs,
              sqlite3_value **values){
    char *errorMessage;
    double pi = 3.14159265358979323846;
    if(nargs != 4){
        errorMessage="Wrong # of args. Distance(lat1,lon1,lat2,lon2)";
        sqlite3_result_error(context,errorMessage,strlen(errorMessage));
        return;
    }
    if((sqlite3_value_type(values[0]) != SQLITE_FLOAT) ||
       (sqlite3_value_type(values[1]) != SQLITE_FLOAT) ||
       (sqlite3_value_type(values[2]) != SQLITE_FLOAT) ||
       (sqlite3_value_type(values[3]) != SQLITE_FLOAT)){
        errorMessage ="All four arguments must be of type float.";
        sqlite3_result_error(context, errorMessage,strlen(errorMessage));
        return;
    }
    double latitude1, longitude1, latitude2, longitude2;
    latitude1 = sqlite3_value_double(values[0]);
    longitude1 = sqlite3_value_double(values[1]);
    latitude2 = sqlite3_value_double(values[2]);
    longitude2 = sqlite3_value_double(values[3]);
    double x = sin( latitude1 * pi/180 ) *
               sin( latitude2 * pi/180 ) + cos(latitude1 *pi/180 ) *
               cos( latitude2 * pi/180 ) *
               cos( abs( (longitude2 * pi/180) -
                         (longitude1 *pi/180) ) );
    x = atan( ( sqrt( 1- pow( x, 2 ) ) ) / x );
    x = ( 1.852 * 60.0 * ((x/pi)*180) ) / 1.609344;
    sqlite3_result_double(context, x);
}
```

The complete application can be found in the `Location3` project available in the source downloads.

13.6 Working with the Map Kit API

The Map Kit framework provides the ability to embed an interactive map as a subview in an application. The map behaves similarly to the one used by the `Maps.app` application that ships with the iPhone OS.

You can specify the center of this map and annotate it with any number of items. The map has a delegate which allows it to communicate touch events on the annotated objects that you provide.

13.6.1 The MKMapView class

The `MKMapView` class is the center of the Map Kit API. It is a subclass of `UIView`, which means that you can create an instance of it as you do with any `UIView` class.

To use this class, you need to add the `MapKit.framework` to your application and `#import <MapKit/MapKit.h>`. Adding a framework to your project is explained in Section D.4.

The following shows a code fragment that creates an instance of this class and adds it as a subview:

```
MKMapView *mapView =
    [[[MKMapView alloc] initWithFrame:
        [UIScreen mainScreen].applicationFrame] autorelease];
[self.view addSubview:mapView];
```

The above code specifies the size of the map to be full-screen. You can specify any dimension you want.

13.6.2 The MKCoordinateRegion structure

When you present a map, you need to specify the area that this map should display and the zoom-level of that area. The `MKCoordinateRegion` structure encapsulates this as shown below:

```
typedef struct {
    CLLocationCoordinate2D center;
    MKCoordinateSpan span;
} MKCoordinateRegion;
```

From the above declaration, we see that the `center` of the region is a latitude/longitude pair. The zoom level is specified by an `MKCoordinateSpan` value, which is basically a pair of two `double` values as shown below:

```
typedef struct {
    CLLocationDegrees latitudeDelta;
    CLLocationDegrees longitudeDelta;
} MKCoordinateSpan;
```

Both the `latitudeDelta` and `longitudeDelta` are specified in degrees. One degree of `latitudeDelta` corresponds to approximately 111 kilometers (69 miles). One degree of `longitudeDelta` varies depending on the `center` value. The value ranges from 111 kilometers (69 miles) at the equator to 0 kilometers at the poles.

The `MKMapView` class declares the following property for use as its region:

```
@property (nonatomic) MKCoordinateRegion region
```

The following shows an example of setting up the region of a map:

```
MKCoordinateRegion region;
region.center.latitude = 33.5;
region.center.longitude = -97;
region.span.latitudeDelta = 1;
region.span.longitudeDelta = 1;
mapView.region = region;
```

You can change the map's region at any time, with the option of animating the change, by using the following method:

- (**void**)setRegion:(MKCoordinateRegion)region animated:(BOOL)animated

13.6.3 The MKAnnotation protocol

Locations that you wish to show on the map can be specified as *annotations*. An annotation is composed of a data model and a view. The data model specifies the title, subtitle, and latitude/longitude of the location. The view is a visual representation of the data model.

The MKAnnotation protocol describes the data model of the annotation. This protocol is declared as follows:

```
@protocol MKAnnotation <NSObject>
@property (nonatomic, readonly) CLLocationCoordinate2D coordinate;
@optional
- (NSString *)title;
- (NSString *)subtitle;
@end
```

The above protocol basically says that any annotation must be able to specify its coordinate and optionally specify its title and subtitle. You usually adapt your data model to adopt this protocol and use instances of your data model as annotation objects.

For example, the following shows the declaration of a data model `Person` that adopts the MKAnnotation protocol:

```
@interface Person : NSObject <MKAnnotation>{
    NSString *_title, *_subTitle;
    CLLocationCoordinate2D _coordinate;
}
@property (nonatomic, readonly) CLLocationCoordinate2D coordinate;
@property (nonatomic, readonly) NSString *title;
@property (nonatomic, readonly) NSString *subtitle;
@end
```

The following shows the implementation of the `Person` class.

```

@implementation Person
@synthesize coordinate=_coordinate, title=_title, subtitle=_subTitle;

- (id)initWithTitle:(NSString*)theTitle subTitle:(NSString*)theSubTitle
    andCoordinate:(CLLocationCoordinate2D) theCoordinate{
    if(self = [super init]){
        _title = [theTitle copy];
        _subTitle = [theSubTitle copy];
        _coordinate = theCoordinate;
    }
    return self;
}
- (void)dealloc{
    [_title release];
    [_subTitle release];
    [super dealloc];
}
@end

```

To add an annotation to a map, you simply use the `addAnnotation:` method as shown in the example below:

```

CLLocationCoordinate2D coordinate = {33, -97};
[mapView addAnnotation:
    [[[Person alloc]
        initWithTitle:@"Homer" subTitle:@"Father"
        andCoordinate:coordinate] autorelease]];

```

13.6.4 The MKAnnotationView class

To show the annotation to the user on the screen, you need to set a delegate object to the map view instance and implement a specific method that returns a view for a given annotation.

The `delegate` property of the `MKMapView` class is declared as follows:

```
@property (nonatomic, assign) id <MKMapViewDelegate> delegate
```

The delegate method that is called to retrieve a visual representation of an annotation is declared as follows:

```
- (MKAnnotationView *)mapView:(MKMapView *)mapView
    viewForAnnotation:(id <MKAnnotation>)annotation;
```

The `MKAnnotationView` class is a subclass of `UIView`. To create a new instance of this class and return it from the delegate method above so that it is used to represent the `annotation` object, you are encouraged to reuse existing views whose annotation objects are outside the current viewing area of the map.

The `MKMapView` method `dequeueReusableAnnotationViewWithIdentifier:` should be called before attempting to create a new view. This method is declared as follows:

```
- (MKAnnotationView *)  
    dequeueReusableAnnotationViewWithIdentifier:(NSString *)identifier;
```

If this method returns a `nil` value, you can create the view and initialize it with the `initWithAnnotation:reuseIdentifier:` method. This initializer is declared as follows:

```
- (id)initWithAnnotation:(id <MKAnnotation>)annotation  
    reuseIdentifier:(NSString *)reuseIdentifier;
```

The following shows an example of how you should obtain a view for a given annotation:

```
MKAnnotationView *view =  
    [mapView dequeueReusableCellWithIdentifier:@"ID1"];  
if (!view) {  
    view = [[[MKAnnotationView alloc]  
        initWithAnnotation:annotation reuseIdentifier:@"ID1"] autorelease];  
}
```

You can, if you choose to, give the view an image. This can be achieved by setting the `image` property of the annotation view.

The callout view

An annotation view can display a standard callout bubble when tapped. To enable this feature, you need to set the `canShowCallout` property of the `MKAnnotationView` instance to `YES`.

If the callout bubble is enabled, the title and the subtitle of the corresponding annotation are displayed when the user taps on the view.

You can also configure a right and a left accessory view if you want to. The right callout accessory view property is declared as follows:

```
@property (retain, nonatomic) UIView *rightCalloutAccessoryView
```

As you can see, it can be just a simple view. Normally, however, this property is set to an accessory button (e.g., `UIButtonTypeDetailDisclosure`) used by the user to get more information about the annotation. The left callout view is declared similarly.

There is a default behavior that the API provides for you if you make the right/left callout view an instance of `UIControl` or one of its subclasses. This default behavior is to invoke a specific method in the delegate when the user taps on the accessory view. You can, however, bypass this default behavior and handle the touch events yourself.

The following code fragment creates/dequeues an annotation view and configures both its right and left callout accessory views. The right callout accessory view is configured to be a button, while the left callout accessory view is configured to be a simple yellow view.

```

MKAnnotationView *view =
    [mapView dequeueReusableCellWithIdentifier:ReuseIdentifier:Reuse_ID1];
if(!view) {
    view = [[[MKAnnotationView alloc]
        initWithAnnotation:annotation reuseIdentifier:ReuseIdentifier]
        autorelease];
}
view.canShowCallout = YES;
view.image = [UIImage imageNamed:@"7.png"];
view.rightCalloutAccessoryView =
    [UIButton buttonWithType:UIButtonTypeDetailDisclosure];
UIView *aView =
    [[[UIView alloc] initWithFrame:CGRectMake(0, 0, 50, 20)]
        autorelease];
aView.backgroundColor = [UIColor yellowColor];
view.leftCalloutAccessoryView = aView;

```

Figure 13.5 shows the annotation view created by the above code.

When the user taps on any of the right/left accessory views (provided the view is a UIControl), the delegate method `mapView:annotationView:calloutAccessoryControlTapped:` gets called.

You can provide your own logic in this method. For example, the following code fragment displays an alert view only if the annotation's title that is tapped is equal to `Marge`.

```

- (void)mapView:(MKMapView *)mapView
    annotationView:(MKAnnotationView *)view
    calloutAccessoryControlTapped:(UIControl *)control{
if([view.annotation.title isEqualToString:@"Marge"]){
    [[[UIAlertView alloc] initWithTitle:view.annotation.title
        message:view.annotation.subtitle
        delegate:nil cancelButtonTitle:@"OK"
        otherButtonTitles:nil] autorelease] show];
}

```

13.6.5 The `MKUserLocation` class

The map view provides an annotation for the user's location. This annotation is an instance of the `MKUserLocation` class.

To access the user's location annotation object, you can use the `userLocation` property which is declared as follows:

```
@property (nonatomic, readonly) MKUserLocation *userLocation
```

If you want to use the built-in view for the user's location annotation, you need to return `nil` in the `mapView:viewForAnnotation:` delegate method. For example:



Figure 13.5 An example of an annotation view.

```
- (MKAnnotationView *)mapView:(MKMapView *)mapView  
    viewForAnnotation:(id <MKAnnotation>)annotation {  
    if (NSClassFromString(@"MKUserLocation") == [annotation class]) {  
        return nil;  
    }  
    //process regular annotations ...  
}
```

The above code fragment first checks to see if the annotation is an instance of the `MKUserLocation` class. If that is the case, a `nil` value is returned which will result in the default visual element being displayed (see Figure 13.6).



Figure 13.6 The default annotation view for the user's current location.

If you do not want the user's location to show up on the map, you can set the map's `viewShowsUserLocation` property to `NO`.

13.6.6 The MKPinAnnotationView class

The `MKPinAnnotationView` is a subclass of the `MKAnnotationView` class that you can use as a visual representation of your annotations. This view represents a pin icon. You can specify the color of this pin as well as whether the pin should be animated when it is dropped on the map.

For example, the following code fragment creates a new pin view, if one is not available, configures the pin to animate when it's dropped, and gives it a green color.

```
//... Code continues in the delegate method
MKPinAnnotationView *pin =
    (MKPinAnnotationView*)
    [mapView dequeueReusableCellWithIdentifier:ReuseIdentifier:Reuse_ID2];
if(!pin) {
    pin = [[[MKPinAnnotationView alloc]
        initWithAnnotation:annotation reuseIdentifier:ReuseIdentifier]
        autorelease];
}
pin.animatesDrop = YES;
pin.pinColor = MKPinAnnotationColorGreen;
return pin; // return a pin for an annotation object
```

Figure 13.7 shows the pin annotation view.

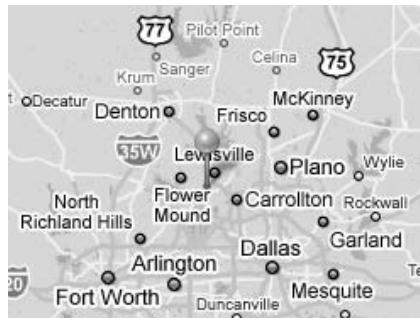


Figure 13.7 The pin annotation view.

Refer to the `MapView` project in the code downloads for a complete application that utilizes the Map Kit API.

13.7 Summary

In this chapter, we addressed the topic of Location Awareness. First, we talked in Section 13.1 about the Core Location framework and how to use it to build location-aware applications. After that,

Section 13.2 discussed a simple location-aware application. Next, Section 13.3 covered the topic of geocoding. In that section, you learned how to translate postal addresses into geographical locations. In Section 13.4, you learned how to sample movement of the device and display that information on maps. After that, Section 13.5 discussed how to relate ZIP codes to geographical information. In that section, you also learned the actual formula that implements the distance between two locations. Finally, Section 13.6 showed you how to utilize the Map Kit API to add an interactive map to your view hierarchy.

Problems

- (1) Study the `MKMapView` class in the `MKMapView.h` header file and the documentation. If this class references other Map Kit classes, study those too.
- (2) Write a view controller that takes as input a set of points (latitude and longitude pairs) and displays these points on an interactive map. When the right accessory view of the annotation view of any of these points is tapped, a new table view controller is pushed showing a table view. Each cell of this table view shows the distance between the point represented by the tapped annotation view and another point in the set. Order the table rows such that closer points are shown first.

14

Working with Devices

In this chapter, we demonstrate the use of the several devices available on the iPhone. Section 14.1 discusses the usage of the accelerometer. In Section 14.2, you learn how to play short and long audio files, how to record audio files, and how to utilize the iPod library. Next, Section 14.3 shows how to play video files. After that, Section 14.4 shows how to obtain iPhone/iPod touch device information. Using the camera and the photo library is described in Section 14.5. After that, Section 14.6 shows you how to obtain state information regarding the battery of the device. Next, we discuss the proximity sensor in Section 14.7. Finally, we summarize the chapter in Section 14.8.

14.1 Working with the Accelerometer

The iPhone is equipped with an easy-to-use accelerometer. The accelerometer provides you with the current orientation of the device in 3D space. You subscribe to these updates with a given frequency (10 updates/s to 100 updates/s) and you receive three floating-point values in each update. These values represent the acceleration of x, y, and z in space. The acceleration on each axis is measured in gs, where g is the acceleration due to gravity on earth at sea-level (1g is equal to 9.80 m s^{-2}).

14.1.1 Basic accelerometer values

If you hold the iPhone in front of you and imagine an axis that goes through the Home button and the earpiece that is orthogonal to the floor, then that axis is the y-axis. Positive values of y indicate that the phone is accelerating up and negative values indicate that it is accelerating down towards the floor. The x-axis goes from right to left perpendicular to the y-axis. Positive values indicate that the force is towards your right side and negative values indicate that the force is towards the left. The z-axis passes through the device. Negative values indicate that the device is moving away from you and positive values indicate that the force is moving the device towards you.

Due to the force of gravity, the device will report non-zero values on some or all of the axes even if the device is stationary. For example, if you hold the device in front of you in portrait mode as shown

in Figure 14.1, the x- and z-axes will report $0g$ while the y-axis will report $-1g$. This basically says that there is no force moving the device to the right/left or forward/backward, but there is a $1g$ force on the device downwards. This force, of course, is gravity.

If you hold the device in landscape mode as shown in Figure 14.2, the x-axis becomes the axis affected by the force of gravity. The value of the x component of the vector reported by the accelerometer will be $1g$. If you hold the device as in Figure 14.3, the value will be $-1g$. If you rest the iPhone face up on the table, the z reading will be $-1g$ and if you put it face down, it will report $1g$.

If you hold the iPhone facing you as shown in Figure 14.1 and tilt it to the right, the y value will start increasing and the x value increasing. If you tilt it to the left, the y value will start increasing and the x value decreasing.



Figure 14.1 Stationary iPhone reporting an accelerometer vector of $(0, -1, 0)$.

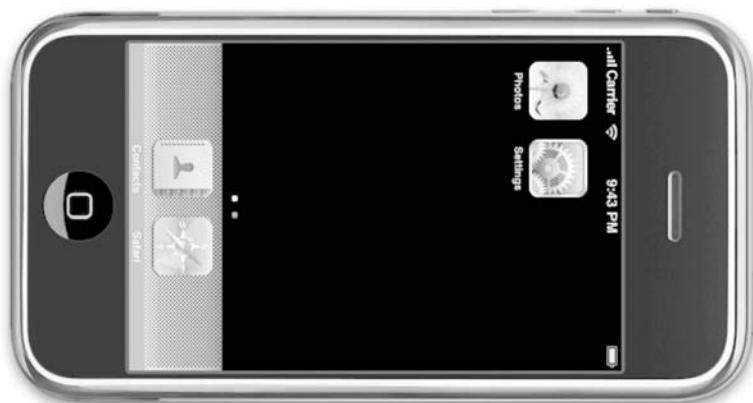


Figure 14.2 Stationary iPhone reporting an accelerometer vector of $(1, 0, 0)$.

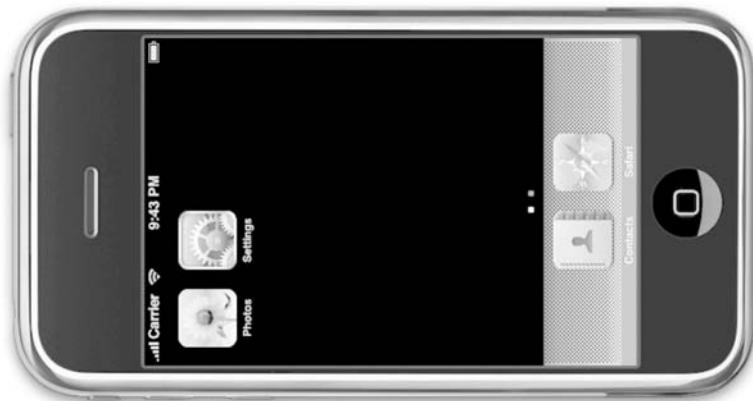


Figure 14.3 Stationary iPhone reporting an accelerometer vector of $(-1, 0, 0)$.

14.1.2 Example

In this section, we present a simple application that demonstrates the use of the accelerometer. The example will show you how to configure the accelerometer and how to intercept a *shake*, a *hug* and a *push*. In addition, the application will report when the iPhone is in portrait mode with the Home button up or down while being perpendicular to the floor.

To use the accelerometer, follow these steps:

1. **Obtain the shared accelerometer object.** The application has one accelerometer object. Use the `sharedAccelerometer` method to obtain that object. The method is declared as follows:

```
+ (UIAccelerometer *) sharedAccelerometer
```

2. **Configure the accelerometer.** Configure the frequency of updates using the `updateInterval` property. This property is declared as follows:

```
@property(nonatomic) NSTimeInterval updateInterval;
```

`NSTimeInterval` is declared as `double`. The value you specify for this property ranges from 0.1 (a frequency of 10Hz) to 0.01 (a frequency of 100Hz) seconds.

You also need to configure the delegate property `delegate` which is declared as follows:

```
@property(nonatomic, assign) id<UIAccelerometerDelegate> delegate
```

The protocol `UIAccelerometerDelegate` has a single optional method `accelerometer:didAccelerate:`, which is declared as follows:

```
- (void) accelerometer:(UIAccelerometer *)accelerometer  
didAccelerate:(UIAcceleration *)acceleration;
```

The method receives the accelerometer object and a `UIAcceleration` instance. The `UIAcceleration` object holds the values for the 3D vector (`x`, `y`, and `z`) and a timestamp (`timestamp`).

Listing 14.1 shows the application delegate class declaration for the accelerometer example. The application delegate adopts both `UIApplicationDelegate` and `UIAccelerometerDelegate` protocols. In addition, it maintains the previous accelerometer reading in the `accelerationValues` instance variable.

Listing 14.1 The application delegate class declaration for the accelerometer example.

```
#import <UIKit/UIKit.h>

@interface AccelAppDelegate :  
    NSObject <UIApplicationDelegate,UIAccelerometerDelegate> {  
    UIWindow *window;  
    UIAccelerationValue accelerationValues[3];  
}  
@end
```

Listing 14.2 shows the implementation of the application delegate class.

Listing 14.2 The implementation of the application delegate class used in the accelerometer example.

```
#import "AccelAppDelegate.h"

#define BETWEEN(arg, v1, v2) ((arg >= v1) && (arg <= v2))
```

```
@implementation AccelAppDelegate

- (void)accelerometer:(UIAccelerometer *)accelerometer
    didAccelerate:(UIAcceleration *)acceleration{
    UIAccelerationValue x, y, z;
    x = acceleration.x;
    y = acceleration.y;
    z = acceleration.z;
    NSLog(@"X: %4.2f, Y:%4.2f, Z:%4.2f", x, y, z);
    // shake
    BOOL x_big_difference = (fabs(x - accelerationValues[0]) >3);
    BOOL y_big_difference = (fabs(y - accelerationValues[1]) >3);
    BOOL z_big_difference = (fabs(z - accelerationValues[2]) >3);
    int axes = x_big_difference + y_big_difference + z_big_difference;
    if(axes>= 2){
        NSLog(@"%@", @"iPhone Shaken!");
    }
    // orientation
    if(BETWEEN(x, -0.05, 0.05) && BETWEEN(y, -1, -0.95) &&
       BETWEEN(z, -0.05, 0.05)){
        NSLog(@"%@", @"iPhone perpendicular to ground, Home button down");
    }
    if(BETWEEN(x, -0.05, 0.05) && BETWEEN(y, 0.95, 1) &&
       BETWEEN(z, -0.05, 0.05)){
        NSLog(@"%@", @"iPhone perpendicular to ground, Home button up");
    }
    // hug/punch
    BOOL x_change = (fabs(x - accelerationValues[0]) < 1);
    BOOL y_change = (fabs(y - accelerationValues[1]) < 1);
    BOOL z_change = (fabs(z - accelerationValues[2]) >= 3);
    if(x_change && y_change && z_change){
        if(z > accelerationValues[2])
            NSLog(@"%@", @"hug");
        else
            NSLog(@"%@", @"punch");
    }
    accelerationValues[0] = x;
    accelerationValues[1] = y;
    accelerationValues[2] = z;
}

- (void)applicationDidFinishLaunching:(UIApplication *)application {
    CGRect fullScreen = [[UIScreen mainScreen] bounds];
    window = [[UIWindow alloc] initWithFrame:fullScreen];
    UIAccelerometer *accelerometer =
        [UIAccelerometer sharedAccelerometer];
    accelerometer.updateInterval = 0.1; // 10Hz
```

```
accelerometer.delegate = self;
[window makeKeyAndVisible];
}

- (void)dealloc {
[window release];
[super dealloc];
}
@end
```

The `applicationDidFinishLaunching:` method starts by configuring the accelerometer to a 10Hz frequency of updates and setting the delegate to the application delegate.

The `accelerometer:didAccelerate:` method is where we have the recognition logic for the movements described above. To recognize a shake, it suffices to observe an alteration of acceleration on at least two axes. We use a $3g$ value-difference for each axis. For example, the statement:

```
BOOL x_big_difference = (fabs(x - accelerationValues[0]) >3);
```

will result in the value YES (1) if the difference between the previous and the current acceleration on the x-axis is larger than $3g$.

To recognize that the iPhone is in portrait mode with the axis of the Home–earpiece orthogonal to the floor while the Home button is at the bottom, we make sure that the x and z values are 0 with some tolerance interval, and the y value is about -1 . Similarly, to recognize that the iPhone is upside down, the value of y must be around $1g$.

To check for an iPhone hug/punch, the method checks to see a major acceleration on the z-axis with a negligible change on the x- and y-axes. If the z value has changed towards a negative acceleration, we interpret that as a punch. If, on the other hand, the value has changed to a positive acceleration, we interpret that as a hug.

14.2 Working with Audio

In this section, you learn how to play short and long audio files, how to record audio files, and how to utilize the iPod library.

14.2.1 Playing short audio files

In this section, we demonstrate the playing of short audio files (< 30 seconds in length). To play a short sound file, you first register the file as a system sound and obtain a handle. After that you can play the sound using this handle. When you are finished and do not want to play this sound again, you deallocate that system sound.

To register a sound file as a system sound, use the function `AudioServicesCreateSystemSoundID()` which is declared as follows:

```
OSStatus
AudioServicesCreateSystemSoundID(
    CFURLRef           inFileURL,
    SystemSoundID      *outSystemSoundID)
```

The first parameter is a `CFURLRef` (or its counterpart `NSURL` instance). This parameter specifies the URL of the sound file. The second parameter is a reference to a `SystemSoundID`. In it, a 32-bit unsigned integer, representing the ID of the system sound, will be stored. The return value must be 0 to indicate successful registration of the system sound.

To play the system sound, use the `AudioServicesPlaySystemSound()` function which is declared as:

```
void AudioServicesPlaySystemSound(SystemSoundID inSystemSoundID)
```

You pass in the system sound handle you obtained from the previous function. The predefined identifier `kSystemSoundID_Vibrate` can be used to trigger vibration.

To deallocate the system sound, use the function `AudioServicesDisposeSystemSoundID()`, which is declared as follows:

```
OSStatus AudioServicesDisposeSystemSoundID(SystemSoundID inSystemSoundID)
```

You pass in the system sound handle which you obtained from the registration function.

Example

In this section, we build an application that plays a sound file every minute. Listing 14.3 shows the declaration of the application delegate class. Notice the include for the `<AudioToolbox/AudioToolbox.h>` header file. Also, you need to add the `AudioToolbox.framework` linked library to the project in XCode as explained in Section D.4.

Listing 14.3 The declaration of the application delegate class demonstrating the playing of small audio files.

```
#import <UIKit/UIKit.h>
#include <AudioToolbox/AudioToolbox.h>

@interface AudioAppDelegate : NSObject <UIApplicationDelegate> {
    UIWindow          *window;
    SystemSoundID     audiosID;
}
@end
```

Listing 14.4 shows the implementation of the application delegate class. The sound file is stored in the application bundle. In the `applicationDidFinishLaunching:` method, we first obtain the

absolute file path of the `sound.caf` file. Then, an `NSURL` object is created from this file path using the method `fileURLWithPath:isDirectory:`. The system sound is then registered. The types `CFURL` and `NSURL` are interchangeable or, in Cocoa's terminology, "toll-free bridged". Therefore, we pass in the `NSURL` object in place of the reference to `CFURL`, `CFURLRef`. If there is no error, the sound is played.

The `play:` method plays the sound and then schedules a timer to invoke the `play:` method in one minute.

Listing 14.4 The implementation of the application delegate class demonstrating the playing of small audio files.

```
#import "AudioAppDelegate.h"
@implementation AudioAppDelegate
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    CGRect screenFrame = [[UIScreen mainScreen] bounds];
    window = [[UIWindow alloc] initWithFrame:screenFrame];

    NSString *filePath = [[NSBundle mainBundle]
                          pathForResource:@"sound" ofType:@"caf"];
    NSURL *aFileURL = [NSURL fileURLWithPath:filePath isDirectory:NO];
    OSStatus error =
        AudioServicesCreateSystemSoundID((CFURLRef)aFileURL, &audioSID);
    if(error == 0)
        [self play:nil];
    [window makeKeyAndVisible];
}
- (void)play:(NSTimer*)theTimer{
    AudioServicesPlaySystemSound(audioSID);
    // schedule a 1 minute play
    [NSTimer scheduledTimerWithTimeInterval:60.0
                                    target:self selector:@selector(play:) userInfo:nil repeats:NO];
}
- (void)dealloc {
    AudioServicesDisposeSystemSoundID (audioSID);
    [window release];
    [super dealloc];
}
@end
```

14.2.2 Recording audio files

To record and to play long audio files, you need to utilize the `AVFoundation` framework. Just add this framework as explained in Section D.4 and include the following header files:

```
#import <AVFoundation/AVFoundation.h>
#import <CoreAudio/CoreAudioTypes.h>
```

The `AVAudioRecorder` adds audio recording features to your application. To use it, you first need to allocate it and then initialize it using the `initWithURL:settings:error:` method which is declared as follows:

```
- (id) initWithURL: (NSURL *)url settings: (NSDictionary *)settings  
error: (NSError **)outError;
```

You pass in an `NSURL` instance that represents a file in the first argument. In the second argument you pass in a dictionary holding key/value pair of the recording session. The third argument is a reference to an `NSError` pointer.

After initializing the recorder instance, you can send it a `record` message to start recording. To pause recording, send it a `pause` message. To resume from a pause, send it a `record` message. To stop recording and close the audio file, send it a `stop` message.

The following method demonstrates the basic use of this class. It assumes that it is the action of a `UIButton` instance. If we are currently recording (the `recorder` instance is not `nil`), the method simply stops the recording and changes the button's title to `Record`.

```
- (void) recordStop{  
    if(self.recorder){  
        [recorder stop];  
        self.recorder = nil;  
        UIButton *button = (UIButton*)[self.view viewWithTag:1000];  
        [button setTitle:@"Record" forState:UIControlStateNormal];  
        return;  
    }  
  
    NSString *filePath =  
        [NSHomeDirectory() stringByAppendingPathComponent:@"tmp/rec.aif"];  
    NSMutableDictionary *dic = [NSMutableDictionary dictionaryWithDictionary:dictionary];  
    [dic setObject:[NSNumber numberWithInt:kAudioFormatLinearPCM]  
        forKey:AVFormatIDKey];  
    [dic setObject:[NSNumber numberWithFloat:16000]  
        forKey:AVSampleRateKey];  
    [dic setObject:[NSNumber numberWithInt:2]  
        forKey:AVNumberOfChannelsKey];  
    self.recorder = [[[AVAudioRecorder alloc]  
        initWithURL:[NSURL URLWithString:filePath]  
        settings:dic error:NULL] autorelease];  
    [recorder record];  
    UIButton *button = (UIButton*)[self.view viewWithTag:1000];  
    [button setTitle:@"Stop" forState:UIControlStateNormal];  
}
```

If we are not currently recording, the method creates an instance of the recorder and initializes it with a URL pointing to the `rec.aif` audio file in the `tmp` directory of the `Home` directory of the application.

We use minimal settings for the recording session. We specify 16kHz for the sample rate, two audio channels, and a Linear PCM audio format.

Once the recorder has been initialized, we send it a `record` message and change the button's title to Stop.

14.2.3 Playing audio files

The counterpart of the `AVAudioRecorder` class is the `AVAudioPlayer` class. Using `AVAudioPlayer` you can play audio files of any size.

You allocate an instance of the audio player, and then initialize it using the `initWithContentsOfURL:error:` method passing in the URL of the file you want to play, and a pointer (possibly `nil`) to an `NSError` instance. After that, you send it a `play` message to start playing the audio file.

The following code fragment shows an example:

```
- (void)play{
    NSString *filePath = [NSSearchPathForDirectoriesInDomains(NSHomeDirectory(), NSStringByAppendingPathComponent:@"/tmp/recording.aif")];
    self.player = [[[AVAudioPlayer alloc]
                    initWithContentsOfURL:[NSURL URLWithString:filePath]
                    error:NULL] autorelease];
    [player play];
}
```

For a complete application that demonstrates recording and playing of audio files, consult the `RecordAudio` project available from the source downloads.

14.2.4 Using the media picker controller

The `MediaPlayer` framework provides a view controller that can be used to pick media items from the iPod library. Media items include music, podcasts, audio books, etc.

You present this controller modally and ask the user to select the media items from the iPod Library. Once the user taps on the `Done` button, you receive a collection of these items (no deletion, of course). You can then do whatever you intend to do with these items. For example, you could put them in a queue and play them all.

The `MPMediaPickerController` class

The media picker is represented by the `MPMediaPickerController` class. There are two initializers for this class:

- `init`. This method initializes the media picker to be able to pick any media type.
- `initWithMediaTypes:`. This method initializes the media picker to pick specific media types. The method is declared as follows:
 - `(id) initWithMediaTypes: (MPMediaType) mediaTypes`

`MPMediaType` is declared as integer and can be set to any combination of the following flags:

- `MPMediaTypeMusic`. This flag is used to denote music type.
- `MPMediaTypePodcast`. This flag is used to denote podcast type.
- `MPMediaTypeAudioBook`. This flag is used to denote audiobook type.
- `MPMediaTypeAnyAudio`. This flag is used to denote general audio type.
- `MPMediaTypeAny`. This flag is used to denote any media type.

After creating and initializing the controller, you can specify non-default behavior by setting its properties. For example, to allow the user to select more than one media item, you can set the `allowsPickingMultipleItems` property to YES (default is NO).

You can also specify some text that can be shown above the navigation bar by setting the `prompt` property to any `NSString` instance.

The following code fragment creates, initializes, configures, and presents a media picker:

```
MPMediaPickerController *mp =
    [ [[MPMediaPickerController alloc] initWithMediaTypes:MPMediaTypeAny]
        autorelease];
mp.delegate = self;
mp.allowsPickingMultipleItems = YES;
[self presentModalViewController:mp animated:YES];
```

The media controller delegate

The media controller has a `delegate` property that you can set. This property is declared as follows:

```
@property(nonatomic, assign) id<MPMediaPickerControllerDelegate> delegate
```

The `MPMediaPickerControllerDelegate` protocol declares two optional methods. The first method gives you the selected items and is invoked when the user taps on the Done button. This method is declared as follows:

```
- (void)mediaPickerController:(MPMediaPickerController *)mediaPickerController
didPickMediaItems:(MPMediaItemCollection *)mediaItemCollection;
```

The `MPMediaItemCollection` class represents a sorted set of media items from the iPod library. You can obtain an `NSArray` of the items by accessing the `items` property.

If the user chooses to cancel the media picker, the `mediaPickerControllerDidCancel:` method is called. This method is declared as follows:

```
- (void)mediaPickerControllerDidCancel:(MPMediaPickerController *)mediaPickerController
```

You should implement both of these methods and dismiss the controller in each of them.

The `MPMediaItem` class

Media items are represented by the `MPMediaItem` class. Every media item has a unique identifier. In addition, a number of metadata key/value pairs are associated with the item.

You can access the unique identifier or any of the metadata values using the `valueForProperty:` method which is declared as follows:

```
- (id)valueForProperty:(NSString *)property
```

The following shows some of the predefined properties:

- `MPMediaItemPropertyPersistentID`. The value for this property is an `NSNumber` object encapsulating a 64-bit integer (`unsigned long long`). This number is the unique identifier of the item in the iPod library.
- `MPMediaItemPropertyTitle`. The value for this property is an `NSString` object storing the title of the media item.
- `MPMediaItemPropertyArtist`. The value for this property is an `NSString` object storing the artist's name of the media item.
- `MPMediaItemPropertyPlaybackDuration`. The value for this property is an `NSNumber` object storing the duration (in seconds) of the media item. The duration is stored as a `double`.

Refer to the `MPMediaItem.h` header file for a complete list of available keys.

Putting it together

Assuming that we presented the media picker, and the user selected the items and tapped on the Done button, the following delegate method would be invoked:

```
- (void)mediaPickerController:(MPMediaPickerController *)mediaPickerController didPickMediaItems:(MPMediaItemCollection *)mediaItemCollection{
    for (MPMediaItem *item in mediaItemCollection.items) {
        NSLog(@"%@", item);
        NSLog(@"\nTitle: %@\nAlbum title: %@\nDuration: %.2f sec",
              [item valueForProperty:MPMediaItemPropertyTitle],
              [item valueForProperty:MPMediaItemPropertyTitle]);
```

```
[item valueForProperty:MPMediaItemPropertyAlbumTitle] ,  
[[item valueForProperty:MPMediaItemPropertyPlaybackDuration]  
    doubleValue]  
);  
}  
[self dismissModalViewControllerAnimated:YES];  
}
```

As you can see, the method simply iterates over the items in the collection. For each item, the method logs the values of some of its associated metadata. As always, you need to dismiss the controller.

You can see a complete application demonstrating the media picker in the `MediaPicker` project available from the source downloads.

14.2.5 Searching the iPod library

If you want to search the iPod library, you need to create and configure a *media query*. A media query is an instance of the `MPMediaQuery` class and can be configured with the following two important pieces of information:

- **Zero or one grouping scheme.** You can group the media items that are returned from executing the query according to a specific grouping scheme. For example, you can ask the `MPMediaQuery` object to group the result set according to the artist.
- **A query filter.** A query filter consists of zero or more *media property predicates*. For a media item to be returned as a result of executing this query, it has to pass through all the media property predicates that make up the filter provided. If you specify no predicates, all media items will be returned from the query.

Grouping method

The `groupingType` property of the `MPMediaQuery` class specifies the grouping method of the query. This property is declared as follows:

```
@property (nonatomic) MPMediaGrouping groupingType
```

The `MPMediaGrouping` type is an integer that can hold one of the the following values declared in an `enum`:

- `MPMediaGroupingTitle`. This value is used to specify grouping based on the media item title. This is the default.
- `MPMediaGroupingAlbum`. This value is used to specify grouping based on the media item album.

- `MPMediaGroupingArtist`. This value is used to specify grouping based on the media item artist.
- `MPMediaGroupingAlbumArtist`. This value is used to specify grouping based on the media item album artist.
- `MPMediaGroupingComposer`. This value is used to specify grouping based on the media item composer.
- `MPMediaGroupingGenre`. This value is used to specify grouping based on the media item genre.
- `MPMediaGroupingPlaylist`. This value is used to specify grouping based on the media item playlist.
- `MPMediaGroupingPodcastTitle`. This value is used to specify grouping based on the media item podcast title.

There are several class methods declared in the `MPMediaQuery` class that give you media queries with different groupings. For example, to create a media query that groups and sorts media items according to the album's name, you can use the following class method:

```
+ (MPMediaQuery *)albumsQuery
```

Other class methods include `artistsQuery`, `genresQuery`, and `playlistsQuery`.

Once you have configured the media query object, you can retrieve the result media items using the `MPMediaQuery` instance variable `items`. This instance variable is declared as follows:

```
@property(nonatomic, readonly) NSArray *items
```

The `items` array holds instances of `MPMediaItem` class that match the query. If the result of the query is empty, the array will contain no elements. If, on the other hand, an error occurred during the execution of the query, the value of this property will be `nil`.

The following code fragment retrieves all songs in the iPod library, grouping them based on the artist name. It then logs specific values of each media item.

```
MPMediaQuery *query = [MPMediaQuery songsQuery];
[query setGroupingType:MPMediaGroupingArtist];
for (MPMediaItem *item in query.items){
    NSLog(@"%@", item.valueForProperty:MPMediaItemPropertyTitle),
    NSLog(@"%@", item.valueForProperty:MPMediaItemPropertyAlbumTitle),
    NSLog(@"%@", item.valueForProperty:MPMediaItemPropertyArtist);
}
```

To actually retrieve the query result grouped, you need to access the `collections` property. This property is declared as follows:

```
@property(nonatomic, readonly) NSArray *collections
```

Each element of this array is an instance of the `MPMediaItemCollection` class. An instance of this class represents a set of media items that are sorted and grouped according to some criterion. To retrieve the items in a collection, you need to access the `items` property which is declared as follows:

```
@property (nonatomic, readonly) NSArray *items
```

The following code fragment shows the retrieval of the query results in a grouped form:

```
for (MPMediaItemCollection *mc in query.collections) {
    NSLog(@"-----");
    for (MPMediaItem *item in mc.items) {
        NSLog(@"\nTitle: %@\nAlbum title: %@\nArtist: %@",
              [item valueForProperty:MPMediaItemPropertyTitle],
              [item valueForProperty:MPMediaItemPropertyAlbumTitle],
              [item valueForProperty:MPMediaItemPropertyArtist]);
    }
}
```

Media property predicate

To specify conditions for the query, you need to add property predicates. A property predicate is an instance of the `MPMediaPropertyPredicate` class.

To create a predicate instance, you can use one of the following two class methods:

- `predicateWithValue:forProperty:comparisonType::` This method is declared as follows:

```
+ (MPMediaPropertyPredicate *)  
    predicateWithValue:(id)value  
    forProperty:(NSString *)property  
    comparisonType:(MPMediaPredicateComparison)comparisonType
```

You specify the value of the property you are matching on in the first argument. In the second argument, you specify the property name. The third argument is used to specify the comparison type. You can specify either `MPMediaPredicateComparisonEqualTo` or `MPMediaPredicateComparisonContains`.

- `predicateWithValue:forProperty::` This is a convenience method that behaves similar to the above factory method, except that it uses a `MPMediaPredicateComparisonEqualTo` comparison type.

The following code fragment shows the creation of a predicate and the addition of that predicate to a media query:

```
MPMediaPropertyPredicate *mPredicate =
[MPMediaPropertyPredicate predicateWithValue:artist
    forProperty:MPMediaItemPropertyArtist];
[query addFilterPredicate:mPredicate];
```

To add a predicate filter to the query, use the `addFilterPredicate:` method.

A predicate can only be created for *filterable* properties. You can check if a property is filterable or not by either looking it up in the header file or the documentation, or by using the `canFilterByProperty:` `MPMediaItem` class method which is declared as follows:

```
+ (BOOL)canFilterByProperty:(NSString *)property
```

14.3 Playing Video

To play video from within your application, you can use the `MPMoviePlayerController` class. You create and initialize an instance of this class and ask it to play. This controller plays the video file in full-screen mode. When playback is finished, the applications screen will become visible.

14.3.1 Using the `MPMoviePlayerController` class

The following code fragment plays the movie `MyMovie.m4v` stored in the application's bundle:

```
NSString *filePath =
    [[NSBundle mainBundle] pathForResource:@"MyMovie" ofType:@"m4v"];
NSURL     *fileUrl = [NSURL URLWithString:filePath];
MPMoviePlayerController *movieController =
    [[MPMoviePlayerController alloc] initWithContentURL:fileUrl];
movieController.backgroundColor = [UIColor grayColor];
movieController.movieControlMode = MPMovieControlModeDefault;
[movieController play];
```

The above code first finds the full path of the movie in the bundle and uses it to create an `NSURL` instance. The `MPMoviePlayerController` is created afterwards and initialized using the initializer `initWithContentURL:`, passing in the `NSURL` instance. Optionally, you can set the background color and the control mode. For the `movieControlMode` property, you can specify (or accept the default of) `MPMovieControlModeDefault` to allow for the standard controls (e.g., play, pause, timeline, etc.) to appear. To hide all controls, use `MPMovieControlModeHidden`. The `MPMovieControlModeVolumeOnly` is used to show only the volume control.

After the initialization phase, the controller is asked to play the movie using the method `play`.

To use the `MPMoviePlayerController` class, you need to add the `Media Player` framework as explained in Section D.4.

You can see a complete application that streams a movie off of the Internet by looking at the `Video1` project available from the source download. Figure 14.4 shows the view just after sending the `play` message to the controller.



Figure 14.4 Streaming a movie off of the Internet.

14.4 Accessing Device Information

The `UIDevice` class is used to provide information about the iPhone/iPod touch. There is a single instance of this class that can be obtained using the class method `currentDevice`. The following are some of the pieces of information you can obtain using this instance:

- **Unique identifier.** You can obtain a string that uniquely identifies the iPhone device using the property `uniqueIdentifier`. This property is declared as follows:

```
@property(nonatomic,readonly,retain) NSString *uniqueIdentifier
```

- **Operating system.** You can obtain the name of the operating system using the `systemName` property. This property is declared as follows:

```
@property(nonatomic,readonly,retain) NSString *systemName
```

- **Operating system version.** You can obtain the OS version using the `systemVersion` property. This property is declared as follows:

```
@property(nonatomic,readonly,retain) NSString *systemVersion
```

- **The model.** You can distinguish between iPhone and iPod Touch using the `model` property. This property is declared as follows:

```
@property(nonatomic,readonly,retain) NSString *model
```

- **Device orientation.** The orientation of the device can be obtained using the `orientation` property. This property is declared as follows:

```
@property(nonatomic,readonly) UIDeviceOrientation orientation
```

Possible values are:

- `UIDeviceOrientationUnknown`.
- `UIDeviceOrientationPortrait`.
- `UIDeviceOrientationPortraitUpsideDown`.
- `UIDeviceOrientationLandscapeLeft`.
- `UIDeviceOrientationLandscapeRight`.
- `UIDeviceOrientationFaceUp`.
- `UIDeviceOrientationFaceDown`.

14.5 Taking and Selecting Pictures

In this section, you learn how to use the camera for taking pictures. You learn that you do not have direct access to the camera or the photo library, but rather you use a supplied controller that handles the user's interaction for taking and editing the picture. The controller provides you with the final image when the user finishes. The same controller can be used to pick photos stored in the user's library. This section is organized as follows. In Section 14.5.1, we outline the major steps needed to access the camera and the photo library. Then, in Section 14.5.2 we provide a detailed example demonstrating taking and picking pictures.

14.5.1 Overall approach

To access the camera or to select pictures from the user's library, you have to use a system-supplied interface that is provided to you. The main class used for either taking new pictures or selecting existing ones is `UIImagePickerController`. The major steps for taking/selecting pictures are as follows:

1. **Check availability of action.** Whether you would like to take a new picture or select an existing one, you need to check if this function is available to you. The `UIImagePickerController`'s class method used for this purpose is `isSourceTypeAvailable:`.
2. **Create the controller instance.** If the specified action is available, you need to create an instance of `UIImagePickerController`, initialize it, and configure it with the specified function. If no source type is available, the controller should not be allocated.
3. **Set the delegate.** The `UIImagePickerController` will be responsible for the user's interaction while picking or taking a new picture. You need to set the delegate to an object and implement specific methods in order to receive the result. The delegate follows the `UIImagePickerControllerDelegate` protocol.

4. **Present the controller.** You modally present the controller to the user by calling `presentModalViewControllerAnimated:` on an existing view controller, passing the `UIImagePickerController` instance as the first parameter.
5. **Handle picture selection.** When the user picks a photo, the delegate's method `imagePickerController:didFinishPickingMediaWithInfo:` is called. You should retrieve the image from the dictionary and dismiss the picker controller that was modally presented.
6. **Handle cancellation.** If the user cancels the operation, the method `imagePickerControllerDidCancel:` of the delegate is called. You should dismiss the picker controller that was presented modally.

14.5.2 Detailed example

In this section, we present a detailed application demonstrating the use of the `UIImagePickerController` class. This application can be found in the `Camera` project available from the source downloads.

The application uses a navigation bar button item with the camera icon to take a picture. When this button is tapped, the application checks the availability of the camera. If there is a camera available, the image picker is configured to take a new picture. Otherwise, the image picker is configured to pick a photo from the photo library. Once an image is retrieved, either way, that image is put in a scroll view so that the user can play with it.

Presenting the image picker

When the user taps on the camera icon, the `takePic` method gets executed. This method starts by creating a picker controller. After that, it checks to see if the camera is available. If it is, the picker's source is configured to be the camera. Otherwise, the source is configured to be the photo library.

You can also allow editing of the image by the user by setting the `allowsImageEditing` property to YES. You will see shortly how you can obtain both the original and the edited photos. The `takePic` method is shown below:

```
- (void)takePic{
    UIImagePickerController *picker =
        [[[UIImagePickerController alloc] init] autorelease];
    if ([UIImagePickerController
        isSourceTypeAvailable:UIImagePickerControllerSourceTypeCamera]) {
        picker.sourceType = UIImagePickerControllerSourceTypeCamera;
    }
    else{
        picker.sourceType = UIImagePickerControllerSourceTypePhotoLibrary;
    }
    picker.allowsImageEditing = YES;
    picker.delegate = self;
```

```
[self presentModalViewController:picker animated:YES];
}
```

Handling successful picking of the photo

When the user selects a photo, the `imagePickerController:didFinishPickingMediaWithInfo:` delegate method is invoked. This method is declared as follows:

```
- (void)imagePickerController:(UIImagePickerController *)picker
    didFinishPickingMediaWithInfo:(NSDictionary *)info;
```

You get, in the second argument, a dictionary with several key/value pairs. Some of these keys are as follows:

- `UIImagePickerControllerOriginalImage`. Using this key you retrieve the original uncropped image selected by the user. For example, the following retrieves the original photo:

```
UIImage *image =
[info valueForKey:UIImagePickerControllerOriginalImage];
```

- `UIImagePickerControllerEditedImage`. Using this key you retrieve the edited image manipulated by the user. For example, the following retrieves the edited image:

```
UIImage *editedImage =
[info valueForKey:UIImagePickerControllerEditedImage];
```

- `UIImagePickerControllerCropRect`. Using this key you retrieve the original cropping rectangle applied by the user to the original image. Since `CGRect` is a structure and not an object, an `NSValue` instance is used to encapsulate the value. For example, the following retrieves the cropping rectangle:

```
CGRect cropRect;
[[info valueForKey:UIImagePickerControllerCropRect]
    getValue:&cropRect];
```

The following shows a possible implementation of the delegate method.

```
- (void)imagePickerController:(UIImagePickerController *)picker
    didFinishPickingMediaWithInfo:(NSDictionary *)info{
    UIImage *image =
    [info valueForKey:UIImagePickerControllerOriginalImage];
    UIImageView *imgView = (UIImageView*)[self.view viewWithTag:100];
    imgView.frame = CGRectMake(0, 0, image.size.width, image.size.height);
    imgView.image = image;
    [(UIScrollView*)self.view setContentSize:image.size];
    NSData *theData = UIImagePNGRepresentation(image);
```

```
NSLog(@"%@", [theData length]);
[self dismissModalViewControllerAnimated:YES];
}
```

The method obtains the original image and uses it to set the `image` property of the image view. After that, it dismisses the image picker controller.

Should you need to obtain the data of the image, for example, to upload it to a server, you can use the `UIImagePNGRepresentation()` function.

You also need to handle the cancellation of the image picking by implementing the following delegate method and dismissing the image picker controller:

```
- (void)imagePickerControllerDidCancel:(UIImagePickerController *)picker{
    [self dismissModalViewControllerAnimated:YES];
}
```

Figure 14.5 shows a screenshot of the application.



Figure 14.5 A screenshot of the application that demonstrates the image picker.

14.6 Monitoring Device Battery

The `UIDevice` class provides access to the current battery charge level and the state of the battery power.

14.6.1 Battery level

You can retrieve the current battery level using the `batteryLevel` property which is declared as follows:

```
@property(nonatomic,readonly) float batteryLevel
```

The value retrieved can range from 0.0 (fully discharged) to 1.0 (fully charged). If the battery level cannot be determined, the value is equal to -1.0 .

14.6.2 Battery state

You can retrieve the state of the battery using the `batteryState` property. This property is declared as follows:

```
@property(nonatomic,readonly) UIDeviceBatteryState batteryState
```

The returned value can be one of the following:

- `UIDeviceBatteryStateUnknown`. This value indicates that the battery state cannot be determined. This is the value you get when you use the Simulator.
- `UIDeviceBatteryStateUnplugged`. This value indicates that the battery is discharging due to the device being unplugged.
- `UIDeviceBatteryStateCharging`. This value indicates that the battery is charging and the device is plugged into power.
- `UIDeviceBatteryStateFull`. This value indicates that the battery is fully charged and the device is plugged into power.

14.6.3 Battery state and level notifications

Any object can be added as an observer to the following two notifications:

- `UIDeviceBatteryLevelDidChangeNotification`. This notification is sent when the battery level has changed. The rate of this notification is less than once a minute.

- `UIDeviceBatteryStateDidChangeNotification`. This notification is sent when the battery state has changed. For example, the device is plugged into power.

In order to receive notifications about the battery, you need to enable battery monitoring by setting the value of the property `batteryMonitoringEnabled` to YES.

14.6.4 Putting it together

The application `BatteryMonitor`, which is available from the source downloads, is used to monitor and show the state and level of the battery in real-time. Figure 14.6 shows a screenshot of that application.



Figure 14.6 A screenshot of the application that monitors and displays the battery level and state.

The application enables battery monitoring and adds its controller as an observer in the `loadView` method as shown below:

```
[UIDevice currentDevice].batteryMonitoringEnabled = YES;
[[NSNotificationCenter defaultCenter] addObserver:self
    selector:@selector(handleBatteryLevelDidChangeNotification:)
    name:UIDeviceBatteryLevelDidChangeNotification object:nil];
[[NSNotificationCenter defaultCenter] addObserver:self
    selector:@selector(handleBatteryStateChangeNotification:)]
```

```
    name:UIDeviceBatteryStateDidChangeNotification object:nil];
[self updateState];
```

The methods that get called when a notification is received are shown below:

```
- (void)
handleBatteryLevelChangeNotification: (NSNotification*)notification {
    [self updateState];
}

- (void)
handleBatteryStateChangeNotification: (NSNotification*)notification {
    [self updateState];
}
```

These methods simply update the display by calling the method `updateState` which is shown below.

```
- (void)updateState{
    message.text =
        [NSString stringWithFormat:
            @"%@\n\n%@",  

            [NSString stringWithFormat:@"Battery Level: %.2f",
                [UIDevice currentDevice].batteryLevel],
            [NSString stringWithFormat:
                @"Battery State: %@",  

                [UIDevice currentDevice].batteryState==
                    UIDeviceBatteryStateUnplugged?"Unplugged":
                [UIDevice currentDevice].batteryState==
                    UIDeviceBatteryStateCharging?"Charging":
                [UIDevice currentDevice].batteryState==
                    UIDeviceBatteryStateFull?"Full":@"Unknown")];
}
```

Refer to the `BatteryMonitor` project, available from the source downloads, for the complete listing of the application. Make sure you run it on the device in order to see the results.

14.7 Accessing the Proximity Sensor

Some of the devices running the iPhone OS are equipped with a proximity sensor. The proximity sensor monitors whether the device is held close to the user's face or not.

On the devices that are equipped with a proximity sensor, you can subscribe to notifications about the change in the proximity value. Before subscribing to these notifications, however, you need to successfully enable proximity monitoring.

14.7.1 Enabling proximity monitoring

To check whether a proximity sensor exists or not, you can enable monitoring of the proximity state and then check to see if the proximity monitoring is enabled.

To enable proximity monitoring, you can use the following `UIDevice` property:

```
@property(nonatomic, getter=isProximityMonitoringEnabled)
    BOOL proximityMonitoringEnabled
```

The following method enables proximity monitoring and returns YES if and only if monitoring is enabled:

```
- (BOOL) proximitySensoredIsEnabled{
    [UIDevice currentDevice].proximityMonitoringEnabled = YES;
    return [UIDevice currentDevice].isProximityMonitoringEnabled;
}
```

14.7.2 Subscribing to proximity change notification

After successfully enabling the proximity monitoring, you can subscribe to notifications regarding the change in the state of the proximity.

To subscribe to the proximity state notifications, you register an object (usually a view controller) as an observer to the `UIDeviceProximityStateDidChangeNotification` notification name.

The following shows an example:

```
if ([self proximitySensoredIsEnabled]) {
    [[NSNotificationCenter defaultCenter] addObserver:self
        selector:@selector(handleProximityChangeNotification:)
        name:UIDeviceProximityStateDidChangeNotification object:nil];
}
```

14.7.3 Retrieving the proximity state

To check whether the device is close to the user's face or not, you can use the `UIDevice` property `proximityState` which is declared as follows:

```
@property(nonatomic,readonly)     BOOL proximityState
```

The getter returns YES if and only if the device is close to the user's face.

You can use the above property in the method that receives the proximity state updates. For example, the following method logs a message relative to the closeness of the device to the user's face:

```
- (void)handleProximityChangeNotification:(NSNotification*)notification {
    if ([UIDevice currentDevice].proximityState) {
        NSLog(@"Whisper: I Love You!");
    }
    else{
        NSLog(@"Whisper: I Hate You!");
    }
}
```

You can see a fully functioning application that monitors the proximity sensor in the Whisper project available from the source downloads.

14.8 Summary

In this chapter, we demonstrated the use of the several devices available on the iPhone. Section 14.1 discussed the usage of the accelerometer. In Section 14.2, you learned how to play short and long audio files, how to record audio files, and how to utilize the iPod library. Next, Section 14.3 showed how to play video files. After that, Section 14.4 showed how to obtain iPhone/iPod touch device information. Using the camera and the photo library was described in Section 14.5. After that, Section 14.6 showed you how to obtain state information regarding the battery of the device. Finally, we discussed the proximity sensor in Section 14.7.

Problems

- (1) Read the documentation about `UIDevice` class and study the `UIDevice.h` header file.
- (2) Make the iPhone scream when it's dropped.
- (3) Detect a shake of the user's head.

15

Internationalization

Internationalization (abbreviated by i18n for 18 characters separating the “i” and the “n”), Globalization (g11n), or Localization (l10n) are terms used to describe equipping software with the ability to adapt to different regions, languages, and customs without modifying the binary code.

Building adaptable software is a major undertaking. It involves having localized text for every supported language, culture-sensitive images and colors, appropriate date and currency formats, and much more.

Once the business decision for globalizing the software has been made and the supported languages and regions have been chosen, developers can use the i18n support built into the iPhone SDK to provide localized behavior of the software.

At the heart of localization in the iPhone SDK is the `NSLocale` class. An `NSLocale` instance is an object that encapsulates parameters for language, country, currency, dates, etc. A locale can be identified by a string consisting of the language and the region. For example, US English is represented by `en_US`, while Arabic Saudi Arabia is represented by `ar_SA`.

You use the `NSLocale` class and create instances (using, for example, a locale identifier) from it to accomplish various tasks. For example, to obtain an array of the available locales on your system, use the following:

```
[NSLocale availableLocaleIdentifiers];
```

The above statement returns an `NSArray` instance of locale identifiers (`NSString` objects) whose content is similar to the following: `ti_ER`, `ar LY`, `kok_IN`, `mk_MK`, ..., `vi_VN`, `nl_BE`, or `or_IN`.

In this chapter, we start in Section 15.1 by looking at a step-by-step procedure for localizing strings for a set of supported languages. Next, we look in Section 15.2 at date formatting. After that, Section 15.3 covers formatting currencies and numbers. Next, we discuss in Section 15.4 how to generate a sorted list of countries of the world. Finally, we summarize the chapter in Section 15.5.

15.1 String Localization

There are several languages available on the iPhone. The user can switch to a specific language by launching the Settings App and navigating to General→International→Language and selecting a language. Once a new language is selected, Apple's applications such as Phone, Calendar, and Voice Memos, begin to interact with the user in that language. In addition, Apple's as well as third-party apps will show their names on the Home Screen in the new language.

As a developer, you can programmatically query the available languages on the device. The list of available languages can be retrieved from the user's defaults database by first obtaining the standard user defaults object and then retrieving that list (an `NSArray` instance) using the key `AppleLanguages`. The following code fragment shows how to do that:

```
NSUserDefaults *defaults = [NSUserDefaults standardUserDefaults];
NSArray *languages = [defaults objectForKey:@"AppleLanguages"];
NSLog(@"%@", languages);
```

The value for the key is an array of language codes in the ISO 639 style. Here is a partial list of what you might get: `ar`, `en`, `fr`, `de`, `ja`, `nl`, `it`, ..., `es`, `pt`, `sk`, `th`, `id`, `ms`. The preferred language is always number 1 (i.e., index 0). When the user switches languages, the order of the codes in this array changes.

Another method for querying the supported languages on the device is through the use of the `NSLocale` class as shown in the following statement:

```
[NSLocale preferredLanguages]
```

The contents of the `NSArray` instance returned is identical to the one obtained using the first method.

Let's assume that our application consists of a single view with a button in the middle of that view. We would like to support, in addition to English, Arabic and Spanish. Once the user switches to one of these languages, our application should show the title of the button in the chosen language. In addition, we would like to change the name of our application and display a localized name on the Home Screen in the currently chosen language.

Listing 15.1 shows the `loadView` method of the `MainViewController` of the `LocalizedStringString` project which is available from the source downloads.

The method simply creates a view and adds a button with the title `Validate` to it.

Listing 15.1 The `loadView` method in our `LocalizedStringString` project.

```
- (void)loadView {
    self.view = [[[UIView alloc] initWithFrame:CGRectMake(0, 0, 320, 480)]
        autorelease];
    self.view.backgroundColor = [UIColor grayColor];
    UIButton *button = [UIButton buttonWithType:UIButtonTypeRoundedRect];
    [button setTitle:@"Validate" forState:UIControlStateNormal];
    [button addTarget:self action:@selector(buttonPushed)
```

```

        forControlEvents:UIControlEventTouchUpInside];
button.frame = CGRectMake(100, 200, 95, 40);
[self.view addSubview:button];
}

```

Let's look at the steps needed to support the additional two languages.

- 1. Apply NSLocalizedString macro.** For every string that needs localization, you need to retrieve its value by calling the `NSLocalizedString` macro. In the code above, only the `Validate` string will be localized. Therefore the line for setting the title of the button should be changed to:

```
[button setTitle:
    NSLocalizedString(@"Validate",
                      @"A button's title asking the user to validate")
    forState:UIControlStateNormal];
```

- 2. Generate the .strings files for every supported language.** In the root directory of your XCode project, create the following three directories: `ar.lproj`, `en.lproj`, and `es.lproj`.
- 3. Generate the three Localizable.strings files.** Each directory needs to have a file named `Localizable.strings` that contains a value for every localized string. You can create this file manually, or you can use the `genstrings` command from the Terminal application. While in the root of your project, issue the following commands:

```
genstrings -o ar.lproj ./Classes/*.m
genstrings -o en.lproj ./Classes/*.m
genstrings -o es.lproj ./Classes/*.m
```

What these commands do is generate a `Localizable.strings` file in each of the three directories. Each line in the `Localizable.strings` file consists of a key and a value for a given localized string. In addition, each line will be preceded by the comment passed on from the `NSLocalizedString` macro. This is supposed to help the translator, who need not be the same as the developer.

- 4. Update the Localizable.strings files with the localized strings for each language.** Figures 15.1, 15.2, and 15.3 show the contents of the `Localizable.strings` for the English, Arabic, and Spanish languages, respectively.

```
/* A button's title asking the user to validate */
"Validate" = "Validate";
```

Figure 15.1 The `Localizable.strings` file for the English language.

```
/* A button's title asking the user to validate */
"Validate" = "ابعدن هامع";
```

Figure 15.2 The Localizable.strings file for the Arabic language. As a Semitic language, Arabic script goes from right to left and looks in reverse order in XCode. However, it shows in the right order on the button as we shall see.

```
/* A button's title asking the user to validate */
"Validate" = "Validar";
```

Figure 15.3 The Localizable.strings file for the Spanish language.

5. **Add references to the three files in XCode.** Drag each of these Localizable.strings files to the Resources group in your project. When prompted, choose not to copy and UTF-16 encoding as shown in Figure 15.4.

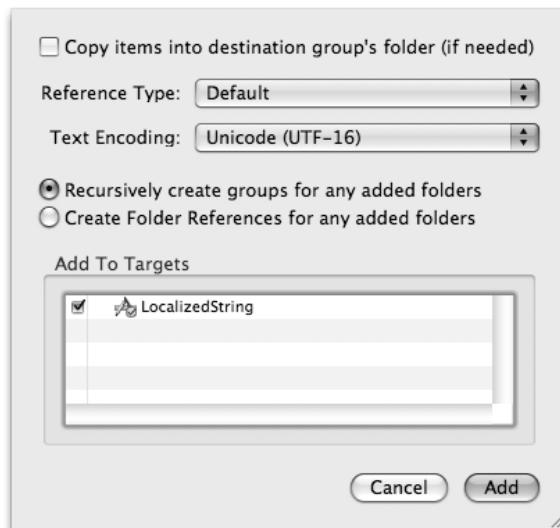


Figure 15.4 The options used in adding references to the three Localizable.strings files.

You'll notice (as shown in Figure 15.5) that XCode shows only one Localizable.strings group with three languages underneath it.

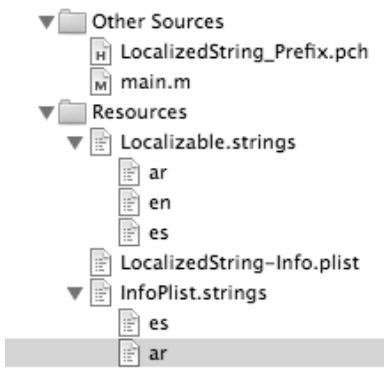


Figure 15.5 The three Localizable.strings files after being added to the project's Groups & Files in XCode.



Figure 15.6 The look of the button when the user selects English as the main language.



Figure 15.7 The look of the button when the user selects Arabic as the main language.



Figure 15.8 The look of the button when the user selects Spanish as the main language.

Figures 15.6, 15.7, and 15.8 show the button after the user selects each of the three languages.

In addition to localization of UI elements, you also need to localize the name of the app on the user's Home Screen. For that, you need to add two additional .strings files for the Arabic and Spanish languages. Each file will be used to specify the app name in a given language.

Create one `InfoPlist.strings` file for each of the two languages (in the corresponding directory) and add references to them in XCode. The English version of the app will use the main `plist` of the app shown in Figure 15.9.

Key	Value
▼ Information Property List	(12 items)
Localization native development	English
Bundle display name	Hello
Executable file	\${EXECUTABLE_NAME}
Icon file	
Bundle identifier	com.yourcompany.\${PRODUCT_NAME}rfc1034identifier
InfoDictionary version	6.0
Bundle name	\${PRODUCT_NAME}
Bundle OS Type code	APPL
Bundle creator OS Type code	????
Bundle version	1.0
Application requires iPhone env	<input checked="" type="checkbox"/>
Main nib file base name	MainWindow

Figure 15.9 The main `LocalizedStrings-Info.plist` of the project. The value for the `Bundle Display Name` key has, as its value, the name of the app in English.

To specify a display name of the app, enter one line in each file as shown in Figures. 15.10 and 15.11.

```
|CFBundleDisplayName = "مرأة";
```

Figure 15.10 Specifying the Bundle Display Name for the Arabic language.

```
|CFBundleDisplayName = "Hola";
```

Figure 15.11 Specifying the Bundle display name for the Spanish language.

Figures 15.12, 15.13, and 15.14 show the application as shown on the Home Screen.



Figure 15.12 The application as shown on the user's Home Screen when Arabic is the default language.



Figure 15.13 The application as shown on the user's Home Screen when Spanish is the default language.



Figure 15.14 The application as shown on the user's Home Screen when English is the default language.

15.2 Date Formatting

The `NSFormatter` class defines an interface for two subclasses: `NSDateFormatter` and `NSNumberFormatter`. These classes are used to manipulate textual representations of dates and numbers, respectively.

The `NSDateFormatter` class is used to convert a date to a string representation and vice versa. It performs these conversions relative to a specific locale. Before using this class, you need to set the default formatter behavior to a formatting behavior equivalent for Mac OS X 10.4. The following statement does just that:

```
[NSDateFormatter setDefaultFormatterBehavior:  
    NSDateFormatterBehavior10_4];
```

After that, you can create instances of this class and use them. The function shown in Listing 15.2, for example, prints out a formatted date in every available locale on the system.

Listing 15.2 A function that prints out today's date in every available locale.

```
void showTodayInAllAvailableLocales() {
    NSDateFormatter *formatter =
        [ [[NSDateFormatter alloc] init] autorelease];
    [formatter setDateStyle:NSDateFormatFullStyle];
    [formatter setTimeStyle:NSDateFormatFullStyle];
    NSArray *locales = [NSLocale availableLocaleIdentifiers];
    for (NSString *locale in locales) {
        [formatter setLocale:[[[NSLocale alloc]
                               initWithLocaleIdentifier:locale]
                               autorelease]];
        NSLog(@"Today is %@ in Locale %@", [formatter stringFromDate:[NSDate date]], locale);
    }
}
```

The function starts by creating an `NSDateFormatter` instance. After that, it sets the date and the time style of that instance to full style. The following styles are available:

- `NSDateFormatterNoStyle`. Used to force a no style. For example, setting the date component's style to this value results in removing the date component from the log generated by the function above.
- `NSDateFormatterShortStyle`. This style applied to both date and time components results in a string representation of the current date as: 3/26/09 7:13 PM.
- `NSDateFormatterMediumStyle`. This style applied to both date and time components results in a string representation of the current date as: Mar 26, 2009 7:19:39 PM.
- `NSDateFormatterLongStyle`. This style applied to both date and time components results in a string representation of the current date as: March 26, 2009 7:20:58 PM CDT.
- `NSDateFormatterFullStyle`. This style applied to both date and time components results in a string representation of the current date as: Thursday, March 26, 2009 7:22:12 PM CT.

Next, the function obtains a list of identifiers of available locales, and logs the current date for each of these locales. To do that, it creates an `NSLocale` instance for every locale identifier and simply logs today's date in the chosen style. The method `stringFromDate:` takes as a parameter an `NSDate` instance and produces a textual representation of that instance using the currently selected styles. For example, for the locale `ar_KW`, we have a textual representation of an `NSDate` instance as shown in Figure 15.15.

الخميس، ٢٦ مارس، ٢٠٠٩ الولايات المتحدة الأمريكية (شيكاغو) ٧:٢٢:١٢ م

Figure 15.15 The textual representation of an `NSDate` instance using `NSDateFormatterFullStyle` for both date and time in the `ar_KW` locale.

Let's look at another example. Suppose we want to show the days of the week in a given locale. This can be easily achieved using the following function:

```
void showWeekDaySymbols(NSString* locale) {
    NSDateFormatter *formatter =
        [ [[NSDateFormatter alloc] init] autorelease];
    [formatter setLocale:[[[NSLocale alloc]
        initWithLocaleIdentifier:locale] autorelease]];
    NSArray *wkDays = [formatter weekdaySymbols];
    NSLog(@"%@", wkDays);
}
```

The function above takes as input the locale identifier and uses the `weekdaySymbols` method to obtain the array of localized week days. For example, if we pass in the value `fr_FR`, the contents of the array will be as follows: `dimanche, lundi, mardi, mercredi, jeudi, vendredi, samedi.`

15.2.1 Custom formats

In addition to using `NSDateFormatter` with predefined styles, you can define flexible patterns and use them to generate textual representations of dates. You can also obtain `NSDate` instances from custom formats strings. To configure an `NSDateFormatter` with a custom format, use the `setDateFormat:` method. It takes an `NSString` object whose value is the custom pattern. The pattern should adhere to the Unicode Standard version tr35-4. For example, to generate the era of the date, add the letter `G` to your custom format.

In the discussion that follows, we will use the date `03/26/2009 6:15:09 PM` in Plano, TX local time. The following are the main date format patterns.

- **Year.** If the `NSDate` object represents the year 2009, then `yy` will produce `09`, and everything else such as `y`, `yyy`, and `yyyyyy` will produce `2009`.
- **Month.** An `M` or `MM` will produce `03`. An `MMM` will produce `Mar`, while an `MMMM` will produce `March`. An `MMMMM` will produce `M` (the short name).
- **Day.** A `d` or `dd` will produce `26`. A `D` will produce `86` (day of year).
- **Period.** An `a` will produce `PM`. The period of the day can be either `AM`, `PM`, or the overridden symbol(s) as we shall see shortly.
- **Hour.** An `h` will produce `6`, while `hh` will produce `06`. Use `H` for 24-hour presentation.
- **Minute.** An `m` will produce `15`, and so will `mm` (zero-padding is used if necessary).
- **Second.** An `s` will produce `9`, while `ss` will produce `09`.
- **Zone.** A `z` will produce `CDT`, while a `zzzz` will produce Central Daylight Time.

Using the above symbols, you can build the date format in the manner suitable for your application. Listing 15.3 shows a function that logs the custom representation of a given date. After creating the formatter and setting its behavior to 10.4, we set the custom date format. We also use the `setAMSymbol:` and `setPMSymbol:` methods to set a custom symbol for the output of the `a` pattern. The textual representation using this format is obtained, as before, using the `stringFromDate:` method. The output is something like this: Friday 27/03/2009 at 08:50:16 before midday CDT. The `EEEE` pattern is used to generate a full name of the week day.

Listing 15.3 A function that generates a custom format for a given `NSDate` instance.

```
void stringFromDate(NSDate *_date) {
    NSDateFormatter *formatter =
        [[[NSDateFormatter alloc] init] autorelease];
    [formatter setFormatterBehavior:NSDateFormatterBehavior10_4];
    [formatter setDateFormat:@"EEEE dd/MM/yyyy 'at' hh:mm:ss a zz"];
    [formatter setAMSymbol:@"before midday"];
    [formatter setPMSymbol:@"after midday"];
    NSLog([formatter stringFromDate:_date]);
}
```

As we mentioned above, you can use a formatter in the other direction: obtaining an `NSDate` instance from a string. To obtain the `NSDate` object, use the `dateFromString:` method as shown in Listing 15.4.

Listing 15.4 A function that generates an `NSDate` instance from a parsed `NSString` object.

```
void dateFromString(NSString *_stringDate) {
    NSDateFormatter *formatter =
        [[[NSDateFormatter alloc] init] autorelease];
    [formatter setFormatterBehavior:NSDateFormatterBehavior10_4];
    [formatter setDateFormat:@"EEEE dd/MM/yyyy 'at' hh:mm:ss a zz"];
    [formatter setAMSymbol:@"before midday"];
    [formatter setPMSymbol:@"after midday"];
    NSLog(@"%@", [formatter dateFromString:_stringDate]);
}
```

15.3 Number Formatting

The other concrete subclass of `NSFormatter` is `NSNumberFormatter`. This class can be used in the formatting of `NSNumber` objects. `NSNumber` is used to provide an object-oriented representation of C scalar (numeric) types such as `int` and `float`.

Let's start by looking at the `decimalNumbers()` function shown in Listing 15.5.

Listing 15.5 A function that displays a number in decimal format using a given locale.

```
void decimalNumbers(NSNumber* number, NSString *locale) {
    NSNumberFormatter *numberFormatter =
```

```

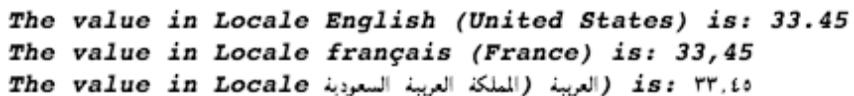
[[[NSNumberFormatter alloc] init] autorelease];
[numberFormatter setFormatterBehavior:NSNumberFormatterBehavior10_4];
[numberFormatter setNumberStyle:NSNumberFormatterDecimalStyle];
NSLocale *theLocale =
[[[NSLocale alloc] initWithLocaleIdentifier:locale] autorelease];
[numberFormatter setLocale:theLocale];
NSLog(@"The value in Locale %@ is: %@", 
[theLocale displayNameForKey:NSLocaleIdentifier value:locale],
[numberFormatter stringFromNumber:number]);
}

```

This function takes as a parameter an `NSNumber` object and a locale identifier in an `NSString` object. It outputs the number in the specified locale in decimal style.

It starts by creating an `NSNumberFormatter` instance and setting its behavior to Mac OS X 10.4. After that, its sets the number style to `NSNumberFormatterDecimalStyle` in order to specify a decimal style. Next, it creates an `NSLocale` instance representing the locale identifier argument. The textual representation of the number in the given locale and style is then obtained and logged using the method `stringFromNumber:`. Notice the use of the method `displayNameForKey:value:`. The first parameter is a constant representing the key and the second parameter is the value for that key. The key used here is `NSLocaleIdentifier` which has a non-nil display name. Another valid key is `NSLocaleCurrencySymbol` which is used to represent the currency symbol. The display name for it is a nil value, though. Not all keys have a display name. To obtain that symbol, you need to send an `objectForKey:` message to an `NSLocale` instance with `NSLocaleCurrencySymbol` as the argument.

Figure 15.16 shows the decimal textual representation of the floating-point value 33.45 in `en_US`, `fr_FR`, and `ar_SA` locales.



```

The value in Locale English (United States) is: 33.45
The value in Locale français (France) is: 33,45
The value in Locale العربية (الملكة العربية السعودية) is: ٣٣,٤٥

```

Figure 15.16 The decimal textual representation of the floating-point value 33.45 in `en_US`, `fr_FR`, and `ar_SA` locales.

You can use the `NSNumberFormatter` class to generate a spelled-out representation of a number. Listing 15.6 shows a function that does just that. The formatter's style is set to `NSNumberFormatterSpellOutStyle` and the representation of the number argument is generated, as before, using the `stringFromNumber:` method.

Listing 15.6 A function that displays a number in spelled-out format using a given locale.

```

void spellOutNumbers(NSNumber* number, NSString *locale) {
    NSNumberFormatter *numberFormatter =
        [[[NSNumberFormatter alloc] init] autorelease];

```

```
[numberFormatter setFormatterBehavior:NSNumberFormatterBehavior10_4];
[numberFormatter setNumberStyle:NSNumberFormatterSpellOutStyle];
NSLocale *theLocale =
    [[NSLocale alloc] initWithLocaleIdentifier:locale] autorelease];
[numberFormatter setLocale:theLocale];
NSLog(@"The spelled-out value in Locale %@ is: %@",  

    [theLocale displayNameForKey:NSLocaleIdentifier value:locale],  

    [numberFormatter stringFromNumber:number]);
}
```

Figure 15.17 shows the spelled-out representation of the integer 10239 in en_US, fr_FR, and ar_SA locales.

*The spelled-out value in Locale English (United States) is: ten thousand two hundred and thirty-nine
The spelled-out value in Locale français (France) is: dix mille deux cents trente-neuf
The spelled-out value in Locale العربية (المملكة العربية السعودية) is: ten thousand two hundred and thirty-nine*

Figure 15.17 The spelled-out representation of the integer 10239 in en_US, fr_FR, and ar_SA locales.

You can also use the NSNumberFormatter to generate a currency textual representation of a value. Listing 15.7 shows a function that does just that.

Listing 15.7 A function that generates a currency textual representation of a value.

```
void money(NSNumber* number, NSString *locale) {
    NSNumberFormatter *numberFormatter =
        [[NSNumberFormatter alloc] init] autorelease];
    [numberFormatter setFormatterBehavior:NSNumberFormatterBehavior10_4];
    [numberFormatter setNumberStyle:NSNumberFormatterCurrencyStyle];
    NSLocale *theLocale =
        [[NSLocale alloc] initWithLocaleIdentifier:locale] autorelease];
    [numberFormatter setLocale:theLocale];
    NSLog(@"I owe you %@ in Locale %@",  

        [numberFormatter stringFromNumber:number],
        [theLocale displayNameForKey:NSLocaleIdentifier value:locale]);
}
```

*I owe you \$99.00 in Locale English (United States)
I owe you 99,00 € in Locale français (France)
I owe you ٩٩٫٠٠ درهم in Locale العربية (المملكة العربية السعودية)*

Figure 15.18 The currency representation of 99 in en_US, fr_FR, and ar_SA locales.

Figure 15.18 shows the value 99 represented as currency in three different locales.

15.4 Sorted List of Countries

Before closing this chapter, let's look at the task of generating a sorted list of world countries. Listing 15.8 shows such a function. First, the function obtains the list of ISO country codes using the `ISOCountryCodes` class method of `NSLocale`. After that, the display name for that country code is obtained. Both the code and the display name are put in an array and that array is added to another array. After generating the list of code/display name pairs, we sort that list in alphabetical order of display names using the function `countrySort` shown below.

```
NSInteger countrySort(id number1, id number2, void *context) {
    return [[number1 objectAtIndex:1] compare:[number2 objectAtIndex:1]];
}
```

Listing 15.8 A function that logs a sorted list of countries.

```
void sortedListOfCountries() {
    NSMutableArray *sortedCountryArray = [NSMutableArray array];
    for (NSString *countryCode in [NSLocale ISOCountryCodes]) {
        NSString *displayNameString =
            [[NSLocale currentLocale] displayNameForKey:NLSCountryCode
                value:countryCode];
        [sortedCountryArray addObject:
            [NSArray arrayWithObjects:countryCode, displayNameString, nil]];
    }
    [sortedCountryArray sortUsingFunction:countrySort context:nil];
    NSLog(@"%@", sortedCountryArray);
}
```

15.5 Summary

In this chapter, we started in Section 15.1 by looking at a step-by-step procedure for localizing strings for a set of supported languages. Next, we looked in Section 15.2 at date formatting. After that, Section 15.3 covered formatting currencies and numbers. Finally, we discussed in Section 15.4 how to generate a sorted list of the countries of the world.

Problems

- (1) Study the `NSLocale` class in the documentation and the `NSLocale.h` header file.
- (2) Write a view controller that displays, in a table, all known countries. Each cell representing a country should display the name of that country and two subtitles: (1) the population, and (2) the current local time. The two subtitles should be localized for the country represented by that cell. You can use reasonable random numbers for the population size and the current time.

16

Custom UI Components

The SDK provides basic UI components for everyday use. Sometimes during the development of your projects, you need a UI component that is not provided by the SDK. 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, in Section 16.1. Next, Section 16.2 presents a table view inside an alert view. After that, Section 16.3 shows how to build a progress alert view. Finally, we summarize the chapter in Section 16.4.

16.1 Text Field Alert View

Often, you want to get a small piece of text from the user. You do not want to build a dedicated page for it, but you want a dialog box with a text field and OK/Cancel buttons. An example of this feature is the iTunes Store password prompt.

In this section, we will build such a custom UI component whose usage is shown in Figure 16.1.

The component can be configured for inputting telephone, password, or normal text. The trick is to add a `UITextField` as a subview to a `UIAlertView` instance.

Listing 16.1 shows the interface for our UI component, `InputAlertView`, a subclass of `UIAlertView`. Each instance of this class maintains a reference to the text field and its caller. The caller should implement the `InputAlertViewDelegate` protocol declared as follows:

```
@protocol InputAlertViewDelegate
- (void)handleEnteredValue: (NSString*)_value;
- (void)handleCancellation;
@end
```

The object using this class will be notified when the user taps the OK button using `handleEnteredValue:` method passing the text entered. In the case of tapping the Cancel button, `handleCancellation` gets called.

Listing 16.1 The interface for the InputalertView class.

```
@interface InputalertView : UIAlertView <UIAlertViewDelegate> {
    UITextField *textField;
    id<InputalertViewDelegate> caller;
}
@property(nonatomic, retain) UITextField *textField;
@property(nonatomic, retain) id<InputalertViewDelegate> caller;
- (NSString*) theText;
- (void) prepare;
- (void) makePassword;
- (void) makeTelephone;
+(InputalertView*) inputalertViewWithTitle:(NSString*)_title
                           initialFieldText:(NSString*)_text
                           caller:(id<InputalertViewDelegate>)_caller;
@end
```

To obtain an instance of this class, you call the factory method `inputalertViewWithTitle:-initialFieldText:caller:`. The `_title` parameter is the `UIAlertView` title, the `_text` is the initial text in the text field, and `_caller` is the object implementing the `InputalertViewDelegate` protocol.

Listing 16.2 shows the implementation of the factory method. It starts by creating an instance of `InputalertView` and uses the `UIAlertView` initializer. Notice the use of `self` as a substitute



Figure 16.1 A text field alert view.

to `InputAlertView`. This works the same as spelling out the class name because this method is a class method and `self` refers to the class object. The delegate of the alert view is set to be itself. After that, the `prepare` method which creates the text field is called.

Listing 16.2 Implementation of the `inputAlertViewWithTitle:initialFieldText:caller:factory` method.

```
+ (InputAlertView*) inputAlertViewWithTitle:(NSString*)_title
                                      initialFieldText:(NSString*)_text
                                         caller:(id<InputAlertViewDelegate>)_caller{
    InputAlertView *_alert =
        [[[self alloc]
            initWithTitle:_title
            message:@"\n" delegate:nil
            cancelButtonTitle:@"Cancel"
            otherButtonTitles:@"OK", nil] autorelease];
    _alert.delegate = _alert;
    _alert.caller = _caller;
    [_alert prepare];
    _alert.textField.text = _text;
    return _alert;
}
```

Listing 16.3 shows the `prepare` method. This method is used in setting up the text field and moving the alert view up in order to make space for the keyboard. A `UITextField` instance is created with rounded corners to match the rounded corners of the parent and then added as a subview to the alert view. The frame of the text field is such that it lies between the title and the OK/Cancel buttons. Since the alert view always shows up in the middle of the screen, you will be faced with the situation shown in Figure 16.2 where the OK/Cancel buttons sit behind the keyboard.

To fix this problem, we need to shift the alert view up 130 points. We can easily achieve that with two lines. First make a transform that translates the y-axis by 130 and then apply it to the view by setting its `transform` property.

Listing 16.3 The `prepare` method of `InputAlertView` class used in setting up the text field and moving the alert view up in order to make space for the keyboard.

```
- (void)prepare{
    self.textField = [[UITextField alloc]
        initWithFrame:CGRectMake(12.0, 45, 260.0, 30.0)]
        autorelease];
    [textField setBackgroundColor:[UIColor clearColor]];
    textField.borderStyle = UITextBorderStyleRoundedRect;
    textField.autocapitalizationType = UITextAutocapitalizationTypeWords;
    [self addSubview:textField];
    CGAffineTransform myTransform =
        CGAffineTransformMakeTranslation(0.0, 130.0);
    [self setTransform:myTransform];
}
```



Figure 16.2 An UIAlertView with the OK/Cancel buttons sitting behind the keyboard.

After obtaining an instance of UIAlertView, you send it a show message. The method simply brings up the keyboard and asks the alert view to show itself.

```
- (void) show{
    [textField becomeFirstResponder];
    [super show];
}
```

Since the object hosting the alert view is the alert view's delegate, the delegate method alertView:clickedButtonAtIndex: is overridden as follows:

```
- (void)alertView: (UIAlertView *)alertView
    clickedButtonAtIndex: (NSInteger)buttonIndex{
    if(buttonIndex == 1){
        [self.caller handleCancellation];
    }
    else{
        [self.caller handleEnteredValue:[self theText]];
    }
}
```

If the user taps the OK button, the value of the text field is obtained and passed on to the caller. If, on the other hand, the Cancel button is tapped, the caller is informed using the handleCancellation

method. The `InputAlertView` project, in the source downloads, demonstrates the use of this component, and the source code can be found there.

16.2 Table Alert View

Imagine that you are faced with the situation where you need to disambiguate some information. For example, the user enters a city name and there are multiple cities in the country with the same name. Instead of taking the user to a totally new page, for example, by pushing a new view controller or presenting it modally, you want some modal window to appear with a small table with the list of cities (with states) inside.

In this section, we will build such a UI component and make it available for reuse. Figure 16.3 shows an example of our component being utilized to disambiguate the city of Springfield. Notice how the table has rounded corners (courtesy of the grouped style) matching the alert view's rounded edges style. The table can be cancelled any time with the alert dismissed and the object using this component getting notified. Selecting any of the rows in the table will result in dismissal of the alert view and notification of the calling object.



Figure 16.3 A table alert view with scrollable content.

Figure 16.4 shows a table alert view with just two options. Notice how the table and alert views adjust their heights accordingly.

Listing 16.4 shows the interface for our `TableAlertView` UI component.



Figure 16.4 A table alert view with two items. Notice how the views adjust their heights.

Listing 16.4 The interface for our TableAlertView UI component.

```
@protocol TableAlertViewDelegate
- (void)didSelectRowAtIndexPath: (NSInteger)row withContext: (id)context;
@end

@interface TableAlertView : UIAlertView
<UITableViewDelegate, UITableViewDataSource>{
    UITableView *myTableView;
    id<TableAlertViewDelegate> caller;
    id context;
    NSArray *data;
    NSUInteger tableHeight;
}
- (id)initWithCaller: (id<TableAlertViewDelegate>)_caller
    data: (NSArray*)_data
    title: (NSString*)_title andContext: (id)_context;
@property(nonatomic, retain) id<TableAlertViewDelegate> caller;
@property(nonatomic, retain) id context;
@property(nonatomic, retain) NSArray *data;
@end

@interface TableAlertView(HIDDEN)
- (void)prepare;
@end
```

The caller of this component uses the `initWithCaller:data:title:andContext:` initializer. The first parameter is a reference to the calling object. The caller needs to implement the `didSelectRowAtIndexPath:withContext:` method declared in the `TableAlertViewDelegate` protocol. The second parameter is the array of items that need to be shown as options to the user. Each item in this array needs to override the `description` method to provide a textual representation of itself to the user. The third parameter is the title of the alert view. Finally, the last parameter is a context. This argument is used as a token by the caller to route the user selection in case of multiple usage of the component. It can be `nil`.

The `prepare` method is used internally by the component for the layout of the table view inside the alert view. It is not part of the public interface (defined in a category). As you know from previous chapters, this does not prevent other objects from using it since there are *no* private methods in Objective-C.

Listing 16.5 shows the implementation of the `initWithCaller:data:title:andContext:` initializer for the table alert view component.

```
- (id) initWithCaller:(_id<TableAlertViewDelegate>)_caller
    data:(NSArray*)_data
    title:(NSString*)_title andContext:(id)_context{
    tableHeight = 0;
    NSMutableString *msgString = [NSMutableString string];
    if([_data count] >= MAX_VISIBLE_ROWS) {
        tableHeight = 225;
        msgString = @"\n\n\n\n\n\n\n\n\n\n\n\n\n\n";
    }
    else{
        tableHeight = [_data count]*50;
        for(id value in _data){
            [msgString appendString:@"\n\n"];
        }
        if([_data count] == 1){
            tableHeight +=5;
        }
        if([_data count] == MAX_VISIBLE_ROWS-1){
            tableHeight -=15;
        }
    }
    if(self = [super initWithTitle:_title message:msgString
                           delegate:self cancelButtonTitle:@"Cancel"
                           otherButtonTitles:nil]){
        self.caller = _caller;
        self.context = _context;
        self.data = _data;
        [self prepare];
    }
}
```

```
    return self;
}
```

The method performs three tasks. First, it calculates the height of the window by adjusting the dummy alert view message based on the size of the elements to be selected. The details of the adjustment are not that important as it is a hack. Next, the `UIAlertView` initializer is called to create the container view. Finally, a call to the `prepare` method is issued in order to create and lay out the table view with the items.

The `prepare` method is shown in Listing 16.6. It creates a table view with dimensions to fit an alert view container, enables scrolling only if we have scrollable content, and sets the table view's delegate and data source to be the `TableAlertView` instance.

Listing 16.6 The `prepare` method for layout of the table view inside an alert view.

```
- (void)prepare{
    myTableView =
        [[UITableView alloc]
            initWithFrame:CGRectMake(15, 35, 255, tableHeight)
            style:UITableViewStyleGrouped];
    myTableView.backgroundColor = [UIColor clearColor];
    if ([data count] < MAX_VISIBLE_ROWS){
        myTableView.scrollEnabled = NO;
    }
    myTableView.delegate = self;
    myTableView.dataSource = self;
    [self addSubview:myTableView];
}
```

A caller performs two steps in initiating the table alert view similar to the following:

```
TableAlertView *alert =
    [[[TableAlertView alloc] initWithCaller:self data:data
        title:@"Did you mean..." andContext:nil] autorelease];
[alert show];
```

The `show` method of the component is shown below. What it does is that it hides itself, schedules a timer, and cascades the `show` call to the `UIAlertView` `show` method. The first two steps are not necessary; they just accomplish better user experience vis-à-vis the rendering of the table view.

```
- (void)show{
    self.hidden = YES;
    [NSTimer scheduledTimerWithTimeInterval:.5 target:self
        selector:@selector(myTimer:) userInfo:nil repeats:NO];
    [super show];
}
```

The timer is scheduled to fire in 0.5 seconds and, when it does, it sets the alert view's hidden property to NO and flashes the table view scroll indicators, but only when we have enough scrollable content. The method is shown below.

```
- (void)myTimer: (NSTimer*)_timer{
    self.hidden = NO;
    if ([data count] > MAX_VISIBLE_ROWS) {
        [myTableView flashScrollIndicator];
    }
}
```

Since the TableAlertView is the delegate of the UIAlertView, we define the alertView:-clickedButtonAtIndex: method. The method simply informs the user that the action has been cancelled. Instead of requiring another method in the protocol, we use a negative index of the selected item to signal cancellation of the process.

```
- (void)alertView: (UIAlertView *)alertView
    clickedButtonAtIndex: (NSInteger)buttonIndex{
    [self.caller didSelectRowAtIndex:-1 withContext:self.context];
}
```

In addition to being a delegate of the alert view, the component is also the data source and delegate for the table view. The component defines the tableView:cellForRowAtIndexPath: shown in Listing 16.7. You have already seen plenty of this method! The cell text is retrieved from the description of the corresponding data item provided to the component by the user.

Listing 16.7 The tableView:cellForRowAtIndexPath: method for the TableAlertView component.

```
- (UITableViewCell *)tableView: (UITableView *)tableView
    cellForRowAtIndexPath: (NSIndexPath *)indexPath{
    static NSString *cellID = @"ABC";
    UITableViewCell *cell =
        (UITableViewCell*)
            [tableView dequeueReusableCellWithIdentifier:cellID];
    if (cell == nil) {
        cell = [[[UITableViewCell alloc]
                  initWithStyle:UITableViewCellStyleDefault
                  reuseIdentifier:cellID] autorelease];
        cell.selectionStyle = UITableViewCellStyleBlue;
    }
    cell.textLabel.text =
        [[data objectAtIndex:indexPath.row] description];
    return cell;
}
```

The tableView:didSelectRowAtIndexPath: delegate method simply dismisses the alert view and calls back the caller passing in the index of the selected row and the token (context). This method is shown below.

```
- (void)tableView:(UITableView *)tableView  
    didSelectRowAtIndexPath:(NSIndexPath *)indexPath{  
    [self dismissWithClickedButtonIndex:0 animated:YES];  
    [self.caller didSelectRowAtIndexPath:indexPath.row  
        withContext:self.context];  
}
```

For more information, consult the `TableAlertView` project in the source downloads; this gives a complete application utilizing this component.

16.3 Progress Alert View

Often, you would like to perform a task, show the user the progress of this task while allowing the user the option of canceling this task. Examples include uploading a file for processing or performing image analysis. In this section, we will develop a UI component that does just that. Figure 16.5 shows how this UI component looks.



Figure 16.5 The progress alert view UI component.

Let's start with the interface. Listing 16.8 shows the interface for the `ProgressAlertView` UI component.

Listing 16.8 The interface for the ProgressAlertView UI component.

```

@interface ProgressAlertView : NSObject {
    UIPercentProgressView *progressView;
    UILabel *statusLabel;
    NSThread *thread;
    UIAlertView *alertView;
    SEL task;
    id delegate;
}
@property SEL task;
@property(nonatomic, retain) id delegate;

- (void)start;
- (BOOL)isCancelled;
- (void)updateProgress:(NSDictionary*)_progressData;
@end

```

The interface is simple. You create an instance of `ProgressAlertView` and set its `task` property to the task you would like to perform, the `delegate` to your reference, and you send a `start` message to the component.

Immediately, the progress alert view appears and your task method is invoked. At any time, you can update the progress bar and the message beneath it using the `updateProgress:` method passing a dictionary with two values: an `NSNumber` encapsulating a float and a `NSString` object encapsulating the message.

Since your task is running on its own thread, the user can interact with the progress alert view. If the user taps Cancel, the progress alert view object becomes tainted. You can, at any time, check for this state using the `isCancelled` method. Just returning from the task method you've supplied, removes the progress alert view.

Listing 16.9 shows the implementation of the `start` method. It creates the `UIAlertView`, `UIProgressView`, and `UILabel` instances, adds the progress and label views to the alert view, shows the alert view, and starts a new thread.

Listing 16.9 The start method for the ProgressAlertView UI component.

```

- (void)start{
    if(thread) {
        return;
    }
    alertView = [[UIAlertView alloc]
        initWithTitle:nil message:@"\n"
        delegate:self cancelButtonTitle:@"Cancel"
        otherButtonTitles:nil];
    progressView =
        [[UIProgressView alloc]
            initWithFrame:CGRectMake(0, 0, 100, 100)];
    progressView.progress = 0.0;
    progressView.hidden = NO;
    [alertView addSubview:progressView];
    [alertView addSubview:statusLabel];
    [alertView show];
    [NSThread detachNewThreadSelector:@selector(runTask)
        toTarget:self withObject:nil];
}

```

```
[progressView setBackgroundColor:[UIColor clearColor]];
progressView.frame = CGRectMake(12.0, 20, 260.0, 20.0);
[alertView addSubview:progressView];
statusLabel = [[UILabel alloc]
    initWithFrame:CGRectMake(12.0, 30, 260.0, 20.0)];
statusLabel.backgroundColor = [UIColor clearColor];
statusLabel.textColor = [UIColor whiteColor];
statusLabel.textAlignment = UITextAlignmentCenter;
[alertView addSubview:statusLabel];
[alertView show];
thread = [[NSThread alloc]
    initWithTarget:self selector:@selector(performTask)
    object:nil];
[thread start];
}
```

The `performTask` method is the new thread body. It creates a new autorelease pool and performs the task method. The method is shown below.

```
- (void)performTask{
    NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
    [delegate performSelector:task];
    [self stop];
    [pool release];
}
```

The `stop` method simply dismisses the alert view and is shown below.

```
- (void)stop{
    [alertView dismissWithClickedButtonIndex:0 animated:YES];
}
```

The `updateProgress:` method updates the UI. You should always perform UI updates from the main thread. The method simply routes the call to an internal method that updates the progress bar and the message label. It achieves that by sending a `performSelectorOnMainThread:withObject:waitUntilDone:` message to `self`. The two methods are shown below.

```
- (void)safeUpdate:(NSDictionary*)_progressData{
    progressView.progress +=
        [_progressData objectForKey:PROGRESS_PERCENTAGE_KEY] floatValue];
    statusLabel.text =
        [_progressData objectForKey:PROGRESS_MESSAGE_KEY];
}

- (void)updateProgress:(NSDictionary*)_progressData{
    [self performSelectorOnMainThread:@selector(safeUpdate:)
        withObject:_progressData waitUntilDone:NO];
}
```

Since the UI component instance is the delegate of the alert view, it defines the `alertView:clickedButtonAtIndex:`. We simply cancel the thread by sending a `cancel` message to it.

```
- (void)alertView: (UIAlertView *)alertView
    clickedButtonAtIndex: (NSInteger)buttonIndex{
    [thread cancel];
}
```

The `isCancelled` simply returns the cancellation status of the thread.

```
- (BOOL)isCancelled{
    return [thread isCancelled];
}
```

Using this UI component is simple. The following code fragment creates the `ProgressAlertView` instance, sets its `delegate` to `self`, sets its `task` to the method `compute` and sends it a `start` message.

```
self.progress = [[[ProgressAlertView alloc] init] autorelease];
progress.delegate = self;
progress.task = @selector(compute);
[progress start];
```

Our demo `compute` method (shown in Listing 16.10) doesn't do anything useful. It simply fakes several computation phases and updates the view at the end of each phase. The delay is achieved using the `sleepForTimeInterval:` `NSThread` class method. When this method returns, the progress alert view disappears.

Listing 16.10 The `compute` method used in demonstrating the usage of the `ProgressAlertView` component.

```
- (void)compute{
    [self updateUIWithProgress:0.0 andMessage:@"Initializing..."];
    [NSThread sleepForTimeInterval:1];
    if([progress isCancelled]){
        self.progress = nil;
        return;
    }
    [self updateUIWithProgress:0.2 andMessage:@"Preparing data..."];
    [NSThread sleepForTimeInterval:2];
    if([progress isCancelled]){
        self.progress = nil;
        return;
    }
    [self updateUIWithProgress:0.4 andMessage:@"Crunching numbers..."];
    [NSThread sleepForTimeInterval:1];
    if([progress isCancelled]){
        self.progress = nil;
```

```
    return;
}
[self updateUIWithProgress:0.8 andMessage:@"Almost done!"];
[NSThread sleepForTimeInterval:2];
if ([progress isCancelled]){
    self.progress = nil;
    return;
}
[self updateUIWithProgress:1.0 andMessage:@"Done!"];
}
```

The following is a convenience method for updating the UI.

```
- (void)updateUIWithProgress:(float)_progress
    andMessage:(NSString*)_message{
    NSMutableDictionary *_progressData =
        [NSMutableDictionary dictionary];
    [_progressData setObject:[NSNumber numberWithFloat:_progress]
        forKey:PROGRESS_PERCENTAGE_KEY];
    [_progressData setObject:_message
        forKey:PROGRESS_MESSAGE_KEY];
    [progress updateProgress:_progressData];
}
```

See the `ProgressAlertView` project in the source downloads for a complete application utilizing this component.

16.4 Summary

The SDK provides basic UI components for everyday use. Sometimes during the developments of your projects, you need a UI component that is not provided by the SDK. In this chapter, we showed how to marry various UI components and build custom reusable ones.

First, we showed how to build an alert view with a text field in it, in Section 16.1. Next, Section 16.2 presented a table view inside an alert view. Finally, Section 16.3 showed how to build a progress alert view.

Problems

- (1) Build a tabbed control UI component. For each tab, the user should be able to provide just the title and the view. In addition, an optional title for the control should be accommodated. The UI component manages the switching from one view to the other. The UI component should support a variable number of tabs and variable length of the titles. The UI component

should support scrolling if a given view has a height that exceeds the available space for it. See Figure 16.6 for an example.



Figure 16.6 The tabbed control UI component.

17

Advanced Networking

This chapter addresses several advanced networking topics. We start by looking in Section 17.1 at how we can determine the network connectivity of the device. This is important for several reasons. First, your application needs to determine the status of network connectivity and alert the user of connectivity problems instead of presenting an empty view to the user. In addition, some applications require WiFi connection for specific services (e.g., downloading large files). You should be able to enable such services dynamically, based on the connectivity of the device.

After that, we tackle the issue of uploading multimedia content (e.g., photos) to remote servers, in Section 17.2. Next, In Section 17.3, 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. Section 17.4 then shows you how to present a responsive table view whose data rows are fed from the Internet without sacrificing the user experience. Next, Section 17.5 addresses the topic of push notification. Section 17.6 discusses sending email from within your iPhone application. Finally, Section 17.7 summarizes the chapter.

17.1 Determining Network Connectivity

In this section, we look at a mechanism that allows you to determine the network connectivity of the device. We develop the following three methods in a category on `UIDevice` class:

- `cellularConnected`. This method is used to determine whether the device is connected to the network via EDGE or GPRS.
- `wiFiConnected`. This method is used to determine whether the device is connected to the network on a WiFi.
- `networkConnected`. This method is used to determine network connectivity in general.

Listing 17.1 shows the declaration of the category.

Listing 17.1 A category on UIDevice for network connectivity.

```
@interface UIDevice (DeviceConnectivity)

+(BOOL)cellularConnected;
+(BOOL)wiFiConnected;
+(BOOL)networkConnected;

@end
```

In order to use the methods in this section, you need to add the `SystemConfiguration` framework as explained in Section D.4. In addition, you need to add the following import statement to your code:

```
#import <SystemConfiguration/SCNetworkReachability.h>
```

17.1.1 Determining network connectivity via EDGE or GPRS

Listing 17.2 shows the `cellularConnected` method which determines whether the device is connected via EDGE or GPRS.

Listing 17.2 The `cellularConnected` method for determining connectivity to the network via EDGE or GPRS.

```
+ (BOOL)cellularConnected{ // EDGE or GPRS
    SCNetworkReachabilityFlags      flags = 0;
    SCNetworkReachabilityRef        netReachability;
    netReachability     = SCNetworkReachabilityCreateWithName
        (CFAllocatorGetDefault(), [EXTERNAL_HOST UTF8String]);
    if (netReachability) {
        SCNetworkReachabilityGetFlags(netReachability, &flags);
        CFRelease(netReachability);
    }
    if (flags & kSCNetworkReachabilityFlagsIsWWAN) {
        return YES;
    }
    return NO;
}
```

The method first creates a network reachability object using the function `SCNetworkReachabilityCreateWithName()`. This function is declared as follows:

```
SCNetworkReachabilityRef SCNetworkReachabilityCreateWithName (
    CFAllocatorRef allocator,
    const char *nodename
);
```

You pass in the allocator in the first argument. An allocator is used throughout Core Foundation for allocating and deallocating Core Foundation objects. In our case, we just use the default allocator by obtaining it using the `CFAlocatorGetDefault()` function. The second parameter is the node name (e.g., `google.com`) that you want to test reachability to.

After obtaining the reachability reference, the method determines network connectivity to the host by calling the `SCNetworkReachabilityGetFlags()` function. You pass in the network reference and a reference to the `flags` local variable (32-bit number). The method checks the `flags` by looking for a 1 in bit 18. If it is 1, that means the device is reachable via a cellular connection, such as EDGE or GPRS.

17.1.2 Determining network connectivity in general

Listing 17.3 shows a method that determines network connectivity in general.

Listing 17.3 The method `networkConnected` that determines network connectivity.

```
+ (BOOL)networkConnected{
    SCNetworkReachabilityFlags      flags = 0;
    SCNetworkReachabilityRef        netReachability;
    BOOL                           retrievedFlags = NO;
    netReachability     = SCNetworkReachabilityCreateWithName(
        CFAllocatorGetDefault(), [EXTERNAL_HOST UTF8String]);
    if(netReachability){
        retrievedFlags =
            SCNetworkReachabilityGetFlags(netReachability, &flags);
        CFRelease(netReachability);
    }
    if (!retrievedFlags || !flags) {
        return NO;
    }
    return YES;
}
```

It uses the same procedure above, except that we simply check that the return value is `YES` and `flags` is not 0. If that is the case, we report network connectivity by returning `YES`; otherwise, we return `NO`.

17.1.3 Determining network connectivity via WiFi

Finally, the following method determines WiFi connectivity by checking for network connectivity via a transport other than EDGE/GPRS.

```
+ (BOOL)wiFiConnected{
    if([self cellularConnected]) {
```

```
    return NO;
}
return [self networkConnected];
}
```

17.2 Uploading Multimedia Content

In this section, we will see how we can use the `NSURLConnection` class to upload multimedia content to a remote server. For demonstration purposes, we will use the example of uploading a photo along with several other parameters to a remote server. The procedure presented here also applies to uploading other types of multimedia content (e.g., audio).

To communicate with a server, you follow these steps:

1. Create a request (instance of `NSURLRequest` class or its subclasses).
2. Configure that request with the url (an instance of `NSURL` class).
3. Specify the HTTP method (`Post`, `Get`, etc.).
4. Set the values of some of the request headers.
5. Build the request body (instance of `NSData` class) and assign it to the request.
6. Use either a synchronous or asynchronous version of the `NSURLConnection` to send the request to the server.
7. Obtain the response from the server and act according to the HTTP status code and/or application-level return values.

Listing 17.4 shows a method that posts a photo to a server.

Listing 17.4 A method that posts a photo to a server.

```
- (void)postPhoto:(UIImage *)_photo withLat:(float)_lat
           withLng:(float)_lng andCaption:(NSString*)_caption{
NSMutableURLRequest *req =
[NSMutableURLRequest requestWithURL:
[NSURL URLWithString:@"http://192.168.1.100:3000/photos"]];
[req setHTTPMethod:@"POST"];
NSString *contentType = [NSString stringWithFormat:
@'"multipart/form-data; boundary=%@", boundary];
[req setValue:contentType forHTTPHeaderField:@"Content-type"];
NSMutableData *postBody = [NSMutableData data];
[postBody appendData:[NSString stringWithFormat:
@"--%@\r\n", boundary] dataUsingEncoding:NSUTF8StringEncoding];
[self appendPhoto:_photo
      withParamName:@"photo[uploaded_data]"
      toData:postBody];
[self appendParamValue:_caption
      withParamName:@"photo[caption]"
```

```

        toData:postBody];
[self appendParamValue: [NSNumber numberWithFloat:_lat]
    withParamName:@"photo[lat]" toData:postBody];
[self appendParamValue: [NSNumber numberWithFloat:_lng]
    withParamName:@"photo[lng]" toData:postBody];
[postBody appendData:[NSString stringWithFormat:
    @"%r\n--%r\n", boundary] dataUsingEncoding:NSUTF8StringEncoding]];
[req setHTTPBody:postBody];
NSHTTPURLResponse * returnResponse = nil;
NSError * returnError = nil;
NSData *returnData =
    [NSURLConnection sendSynchronousRequest:req
                                         returningResponse:&returnResponse
                                         error:&returnError];
int statusCode = returnResponse.statusCode;
NSString *str = [[NSString alloc]
                  initWithData:returnData
                  encoding:NSUTF8StringEncoding] autorelease];
if([str isEqualToString:@"OK"] &&(statusCode == 200) && !returnError){
    NSLog(@"Photo uploaded successfully! Status code: 200");
}
else{
    NSLog(@"Failed to upload photo error: %@. Status code: %d. Error:%@",
          str, statusCode, [returnError localizedDescription]);
}
}

```

The first argument is the photo in a `UIImage` instance. The second and third arguments are the latitude and longitude, respectively. The fourth and last argument is the caption for this photo.

First, the method creates a mutable request and initializes it with an `NSURL` instance representing the post address. In this example, we are posting to a Rails server available from the source downloads. Nevertheless, this method should generally work with any other service (such as Flickr) with minimal changes to accommodate the service.

Next, we set the HTTP method type to Post and the Content-type to:

multipart/form-data; boundary=-----75023658052007

The value for the boundary should be a unique pattern that does not occur within the post data.¹

After that, we add the parts of this post one after the other to a mutable `NSData` object. The separators are needed between these parameters and should be used literally, otherwise the post will be invalid.

Listing 17.5 shows the method used to add the caption, and the geo-data to a post body by the `postPhoto:withLat:withLng:andCaption:` method.

¹RFC1867 – Form-based File Upload in HTML, <http://www.faqs.org/rfcs/rfc1867.html>

Listing 17.5 A method that adds a parameter to a post data.

```
- (void)appendParamValue: (id)_value withParamName: (NSString*)_param
    toData: (NSMutableData*)_data{
    NSString *_tmp = [NSString stringWithFormat:
        @"Content-Disposition: form-data; name=\"%@\"\r\n\r\n", _param];
    [_data appendData: [[NSString stringWithFormat:
        @"\r\n--%@\r\n", boundary] dataUsingEncoding:NSUTF8StringEncoding]];
    [_data appendData: [_tmp dataUsingEncoding:NSUTF8StringEncoding]];
    [_data appendData: [[[[_value description] urlEncodedVersion]
        dataUsingEncoding:NSUTF8StringEncoding]]];
}
```

Again, the separator is defined by the RFC and should be used as is. The `NSNumber` and `NSString` classes define the `description` method in a way suitable for our purpose. If you would like to use this method to add a parameter of different type, make sure that its `description` method is defined in the correct way.

Listing 17.6 shows the method for adding a photo parameter to the post body.

Listing 17.6 Appending a photo to a post body after compression.

```
- (void)appendPhoto: (UIImage*)_photo withParamName: (NSString*)_param
    toData: (NSMutableData*)_data{
    NSData *_photoData = UIImageJPEGRepresentation(_photo, 0.6);
    NSString *_tmp = [NSString stringWithFormat:
        @"Content-Disposition: form-data; name=\"%@\"; filename=\"p.jpg\"\r\n",
        _param];
    [_data appendData: [_tmp dataUsingEncoding:NSUTF8StringEncoding]];
    [_data appendData: [@["Content-Type: image/jpeg\r\n\r\n"
        dataUsingEncoding:NSUTF8StringEncoding]];
    [_data appendData:_photoData];
}
```

The method first compresses the image to a reasonable size; the post of an iPhone 320×320 photo should take around 10 seconds over EDGE. The compressed data is then appended to the post body (after the headers, of course).

One last comment about communicating with a server. You need to encode the data. Listing 17.7 shows a category on `NSString` to allow strings to produce encoded versions of their content. The method `urlEncodedVersion` simply replaces all occurrences of an encodable character with the encoded version of that character.

Listing 17.7 A category on `NSString` to extend strings with the ability to produce encoded versions of themselves.

```
@interface NSString (URL_ENCODE)
- (NSString *)urlEncodedVersion;
@end
```

```

@implementation NSString (URL_ENCODE)

- (NSString *)urlEncodedVersion{
    NSArray *escapeChars = [NSArray arrayWithObjects:
        @"/", @";", @"?", @":", @"@",
        @"&", @"=", @"+", @"$", @"",
        @"[", @"]", @"#", @"!", @"'", @"(", @""
        @")", @"*", nil];
    NSArray *replaceChars = [NSArray arrayWithObjects:
        @"%20", @"%3B", @"%2F", @"%3F", @"%3A",
        @"%40", @"%26", @"%3D",
        @"%2B", @"%24", @"%2C", @"%5B", @"%5D",
        @"%23", @"%21", @"%27",
        @"%28", @"%29", @"%2A", nil];
    NSMutableString *tempStr = [[self mutableCopy] autorelease];
    for(int i = 0; i < [escapeChars count]; i++) {
        [tempStr replaceOccurrencesOfString:[escapeChars objectAtIndex:i]
            withString:[replaceChars objectAtIndex:i]
            options:NSLiteralSearch
            range:NSMakeRange(0, [tempStr length])];
    }
    return [[tempStr copy] autorelease];
}
@end

```

You can simply post a photo as follows:

```

[self postPhoto:[UIImage imageNamed:@"clouds.jpg"]
    withLat:38.44 withLng:-97.76
    andCaption:@"This is a nice photo!"];

```

Consult the `upload_image` project files for a complete iPhone client and Rails server source code. These projects are available from the source downloads.

17.3 Computing MD5 Hash Value

MD5 is an algorithm which generates a 128-bit hash value for a given string. MD5 is often used to check the integrity of files downloaded from the Internet. MD5 is also used by some web services such as Flickr. This section presents a category on `NSString` to allow a string to produce an MD5 digest of its content.

Listing 17.8 shows a category on `NSString` defining the `md5` method which generates a 128-bit digest on the value stored in the instance. The `md5` method uses the `CC_MD5` function to compute the digest, and it then outputs the hexadecimal representation of the result.

Listing 17.8 A category on `NSString` defining the `md5` method which generates a 128-bit digest from the value stored in the instance.

```
#import <CommonCrypto/CommonDigest.h>

@interface NSString (MD5)
- (NSString*) md5;
@end

@implementation NSString (MD5)
- (NSString*) md5{
    const char *cStrValue = [self UTF8String];
    unsigned char theResult[CC_MD5_DIGEST_LENGTH];
    CC_MD5(cStrValue, strlen(cStrValue), theResult);
    return [NSString stringWithFormat:
            @"%02X%02X%02X%02X%02X%02X%02X%02X"
            @"%02X%02X%02X%02X%02X%02X%02X%02X",
            theResult[0], theResult[1], theResult[2],
            theResult[3], theResult[4], theResult[5],
            theResult[6], theResult[7], theResult[8],
            theResult[9], theResult[10], theResult[11],
            theResult[12], theResult[13], theResult[14],
            theResult[15]
        ];
}
@end
```

The following code fragment shows a demonstration of the usage of this category:

```
NSString *value1 = @"The quick brown fox jumps over the lazy dog";
NSString *value2 = @"The quick brown fox jumps over the lazy dog.";
NSLog(@"%@", [value1 md5]);
NSLog(@"%@", [value1 md5]);
NSLog(@"%@", [value2 md5]);
```

The output (after removing extra logging information) is as follows:

```
MD5 of zero-length string is D41D8CD98F00B204E9800998ECF8427E
MD5(The quick brown fox jumps over the lazy dog) = \
9E107D9D372BB6826BD81D3542A419D6
MD5(The quick brown fox jumps over the lazy dog.) = \
E4D909C290D0FB1CA068FFADDFF22CBD0
```

Notice how just adding a “.” to the end of the text completely changes the digest. MD5 has its weaknesses, but if a service requires it, then you need to use it.

Please see the MD5 project in the source downloads for a complete application.

17.4 Multithreaded Downloads

In this section, we develop an application that presents a table view with downloadable resources. The download of a resource will not start until the corresponding cell hosting that resource becomes visible. If the resource has been successfully downloaded, that resource is used to decorate the cell. If, on the other hand, that resource has not been downloaded yet, we ask the resource to download itself in the background. If the resource cannot be download due to network or application failure, we signal failure to the user by using a bundled image (a red X) instead.

17.4.1 The application

In the following section, we develop the Multithreaded Download application. The source code of the complete application can be found in the `MThreadedDownloads` project available from the source downloads.

Figure 17.1 shows a screenshot of the application.



Figure 17.1 Screenshot of the Multithreaded Downloads application.

At the heart of our application is the `InternetResource` class; a class that encapsulates the download of the resource in a new thread. We start by developing this class and then write a table view controller that uses it.

The Internet Resource class

The `InternetResource` class encapsulates an Internet resource that is downloaded, on demand, in a separate thread (i.e., without locking the UI of the user). Listing 17.9 shows the interface for this class.

Listing 17.9 The interface for the `InternetResource` class.

```
#define FinishedLoading @"FinishedLoading"

typedef enum {
    NEW,
    FETCHING,
    FAILED,
    COMPLETE
} STATUS;

@interface InternetResource : NSObject {
    NSString          *url, *title;
    UIImage           *image;
    STATUS            status;
    NSMutableData     *receivedData;
}
-(void)start;
-(id)initWithTitle:(NSString*)_title andURL:(NSString*)_url;
@property(nonatomic, retain) NSString      *url;
@property(nonatomic, retain) NSString      *title;
@property(nonatomic, retain) UIImage       *image;
@property(nonatomic, assign) STATUS        status;
@end
```

An object of this class is initialized with the title of the resource and its URL. An `InternetResource` object can be in one of the following four states:

- NEW. It has just been created.
- FETCHING. It has received a `start` message and is currently fetching the resource from the Internet.
- COMPLETE. It has successfully downloaded the resource.
- FAILED. A network or application-level failure has occurred.

To access the state of the resource, objects should use the `status` property. If the object is in `COMPLETE` state, the picture can be retrieved from the `image` property.

The following shows the implementation of the initializer.

```
- (id)initWithTitle:(NSString*)_title andURL:(NSString*)_url{
```

```

if(self = [super init]) {
    self.title = _title;
    self.url = _url;
    self.status = NEW;
}
return self;
}

```

The `start` method simply sets the `status` to `FETCHING` and initializes the `receivedData` instance variable. `receivedData` will hold the downloaded image data as we get chunks of it over time. After that, the method starts a new thread to proceed with the download. It uses the `NSThread` class method `detachNewThreadSelector:toTarget:withObject:` which is declared as follows:

```
+ (void)detachNewThreadSelector:(SEL)selector
                           toTarget:(id)target withObject:(id)argument;
```

The method to host the thread is `fetchURL`, the target is `self`, and `nil` is passed for the argument.

```

- (void)start{
    self.status = FETCHING;
    receivedData = [[NSMutableData data] retain];
    [NSThread detachNewThreadSelector:@selector(fetchURL)
                                toTarget:self withObject:nil];
}

```

The `fetchURL` method starts by creating an `autorelease` pool.² After that, an `NSURLRequest` object is created and initialized with the `url` property (which was set by the user of the object).

We have been discussing synchronous `NSURLConnection` networking up to now. In this example, however, we will use the other kind of `NSURLConnection` networking: *asynchronous* networking. To download asynchronously, the instance of `NSURLConnection` is created and initialized with the `NSURLRequest` object and the delegate as `self`. Download starts immediately after that. Since the download is asynchronous, we need to keep the thread running. To achieve that, we tell the run-loop to keep running for 60 seconds. The `runUntilDate:` method of `NSRunLoop` keeps checking for input sources for 60 seconds. Whenever 60 seconds have passed or no input sources are scheduled on this run-loop, it quits; thus freeing the pool and ending the download process. Since `NSURLConnection` instance is considered an input source, we achieve what we want.

```

- (void)fetchURL {
    NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
    NSMutableURLRequest *theRequest =
        [NSMutableURLRequest requestWithURL:[NSURL URLWithString:self.url]];
    [NSURLConnection alloc] initWithRequest:theRequest delegate:self];
    [NSRunLoop currentRunLoop]
    runUntilDate:[NSDate dateWithTimeIntervalSinceNow:60]];
}

```

²Remember, every thread needs its own `autorelease` pool.

```
[pool release];
}
```

The delegate of `NSURLConnection` will receive calls during the lifetime of the download. We implement the methods that interest us and leave the rest for you to explore.

The first method we implement is `connection:didFailWithError:`: This is the last message the delegate will receive regarding this connection. It informs the delegate that the connection has failed. You should release the connection and any opened resource. The following shows our implementation of this method. In addition to freeing resources, we set the `status` of this resource to `FAILED`. Since other objects might access this property, we synchronize to prevent corrupted data. It's always a good idea to synchronize.

```
- (void)connection:(NSURLConnection *)connection
    didFailWithError:(NSError *)error {
    [connection release];
    if(receivedData) {
        [receivedData release];
        receivedData = nil;
    }
    @synchronized(self) {
        self.status = FAILED;
    }
}
```

The second method we implement is `connection:didReceiveResponse:`:. This method is declared as follows:

```
- (void)connection:(NSURLConnection *)connection
    didReceiveResponse:(NSURLResponse *)response;
```

This method is called when the system has enough information to construct a response. You usually check for connection success and initialize your buffer. You can also check for the HTTP status code, and flag the resource as `FAILED` if it is different than 200. It all depends on your application.

```
- (void)connection:(NSURLConnection *)connection
    didReceiveResponse:(NSURLResponse *)response {
    int statusCode = ((NSHTTPURLResponse*) response).statusCode;
    if(statusCode != 200) {
        @synchronized(self) {
            self.status = FAILED;
        }
    }
    [receivedData setLength:0];
}
```

In asynchronous networking, you receive chunks of data over time. The method `connection:didReceiveData:` is called multiple times with these chunks. You need to append each chunk to the end of the accumulated data. The following shows our implementation of this delegate method.

```
- (void)connection:(NSURLConnection *)connection
    didReceiveData:(NSData *)data {
    [receivedData appendData:data];
}
```

When the download is complete, `connectionDidFinishLoading:` is called. This method sets the `status` instance variable to `COMPLETE`, frees resources, and builds the image from the data. The method used is `imageWithData:` of the `UIImage` class method. We also need to inform the object using this resource that the image is ready. We do that by posting a notification with the name `FinishedLoading`. In our case, our table view controller listens to this event and reloads its data. If the cell corresponding to this resource is visible, the user sees it immediately. The following shows our implementation of the method.

```
- (void)connectionDidFinishLoading:(NSURLConnection *)connection {
    @synchronized(self) {
        if(self.status != FAILED) {
            self.status = COMPLETE;
            self.image = [UIImage imageWithData:receivedData];
            [receivedData release];
            receivedData = nil;
        }
    }
    [[NSNotificationCenter defaultCenter]
        postNotificationName:FinishedLoading object:self];
    [connection release];
}
```

The Table View controller

Now that we have multithreaded downloads, we can build a simple table view controller, populate it with Internet resources, and show it to the user.

Listing 17.10 shows the initializer of the table view controller.

Listing 17.10 The initializer of the table view controller used in the Multithread Downloads application.

```
- (id)initWithStyle:(UITableViewStyle)style {
    if (self = [super initWithStyle:style]) {
        [[NSNotificationCenter defaultCenter]
            addObserver:self
            selector:@selector(handleFinishedLoading:)
            name:FinishedLoading object:nil];
        self.iResources = [NSArray arrayWithObjects:
            [[[InternetResource alloc] initWithTitle:@"First pic"
                andURL:BAD_RESOURCE_URL2] autorelease],
            [[[InternetResource alloc] initWithTitle:@"Second pic"
                andURL:SOME_RESOURCE_URL] autorelease],
            [[[InternetResource alloc] initWithTitle:@"Third pic"
                andURL:SOME_RESOURCE_URL] autorelease]];
    }
}
```

```
        [[[InternetResource alloc] initWithTitle:@"Third pic"
                                         andURL:SOME_RESOURCE_URL] autorelease],
        [[[InternetResource alloc] initWithTitle:@"Fourth pic"
                                         andURL:SOME_RESOURCE_URL] autorelease],
        [[[InternetResource alloc] initWithTitle:@"Fifth pic"
                                         andURL:SOME_RESOURCE_URL] autorelease],
        [[[InternetResource alloc] initWithTitle:@"Sixth pic"
                                         andURL:SOME_RESOURCE_URL] autorelease],
        nil];
    }
    return self;
}
```

We first add the controller as an observer for the notification `FinishedLoading`. After that, an array of `InternetResource` objects are created and put in a array.

The table view controller adds a delegate and a data source to the table view. Listing 17.11 shows the `tableView:cellForRowAtIndexPath:` for the table view controller. The method obtains the `InternetResource` object corresponding to the cell. After that, it displays the appropriate image depending on the state of the resource.

Listing 17.11 The `tableView:cellForRowAtIndexPath:` for the table view controller demonstrating multithreaded downloading.

```
- (UITableViewCell *)tableView:(UITableView *)tableView
    cellForRowAtIndexPath:(NSIndexPath *)indexPath {
    static NSString *CellIdentifier = @"Cell";
    UITableViewCell *cell =
        [tableView dequeueReusableCellWithIdentifier:CellIdentifier];
    if (cell == nil) {
        cell = [[UITableViewCell alloc]
                initWithStyle:UITableViewCellStyleDefault
                reuseIdentifier:CellIdentifier] autorelease];
    }
    InternetResource *iResource =
        [self.iResources objectAtIndex:indexPath.row];
    cell.textLabel.text = iResource.title;
    cell.imageView.image = nil;
    @synchronized(iResource) {
        switch (iResource.status) {
            case NEW:
                cell.imageView.image = [UIImage imageNamed:@"loading.png"];
                [iResource start];
                break;
            case COMPLETE:
                cell.imageView.image = iResource.image;
                break;
        }
    }
}
```

```

    case FAILED:
        cell.imageView.image = [UIImage imageNamed:@"failed.png"];
        break;
    case FETCHING:
        cell.imageView.image = [UIImage imageNamed:@"loading.png"];
        break;
    default:
        cell.imageView.image = nil;
        break;
    }
}
return cell;
}

```

When a resource posts a notification, the method `handleFinishedLoading:` gets called immediately. The following method simply invokes the method `reloadTheData:` on the main thread. It is *always* a good idea to change the UI from the *main* thread.

```

- (void)handleFinishedLoading:(NSNotification*)notification{
    [self performSelectorOnMainThread:@selector(reloadTheData:)
        withObject:notification.object waitUntilDone:NO];
}

```

The `reloadTheData:` is shown below. It simply asks the table view to reload its data, thus calling the `tableView:cellForRowAtIndexPath:` method.

```

- (void)reloadTheData:(InternetResource*)_resource{
    [self.tableView reloadData];
}

```

It's worth noting that in the `handleFinishedLoading:` method we did not need to pass in `NO` for the `waitUntilDone` parameter. The table view's `reloadData` method does not block until the table refreshes; it simply sets the table as requiring refresh. When the run-loop of the main thread takes control, it refreshes the table view.

Finally, the `dealloc` method of the controller frees the resources and removes itself from being an observer to any notification.

```

- (void)dealloc {
    [[NSNotificationCenter defaultCenter] removeObserver:self];
    self.iResources = nil;
    [super dealloc];
}

```

17.5 Push Notification

Push notification is a mechanism that allows a machine (server) on the Internet to notify a specific iPhone application installed on an iPhone OS device about an event.

The server prepares a small message and communicates this message to an Apple's server using an SSL certificate for authentication. The iPhone OS device, in turn, registers itself with an Apple's server every time it boots up.

The message sent by the server to Apple to be delivered to a specific application is tagged with a device token. This device token is computed by the iPhone application and communicated to the server. This token is usually communicated to the server once and saved on the server thereafter.

When a push notification message is received by the device, the operating system checks to see if the targeted application is running. If that is the case, the application's delegate of the application is sent the message. If the application is not running, an alert is shown to the user with the option to launch the target application.

Development of a push notification involves coding for the server and the client. In addition, an SSL certificate must be generated for each application provisioned for push notification. This SSL certificate must be installed on the server. The client does use SSL authentication, but you do not have to manage that.

17.5.1 *Configuring push notification on the server*

In this section, we outline the major steps needed to set up a server application that can send push notifications to our iPhone application. Some of the steps here are needed for the client side as well.

Configuring the App ID

Click on the iPhone Developer Program Portal in the iPhone Dev Center. Select App IDs from the menu as shown in Figure 17.2.

Click on the Add ID button as shown in Figure 17.3.

An App ID is needed so that the notification server and the iPhone OS can know how to deliver the message that your server sends to a given application. An App ID consists of two parts:

- **Bundle seed ID.** This is a 10-digit number that Apple automatically generates for you during the App ID creation process.
- **Bundle identifier.** This part is determined by you the developer. Usually, it is a string in reverse-DNS format such as `com.mycompany.appname`.

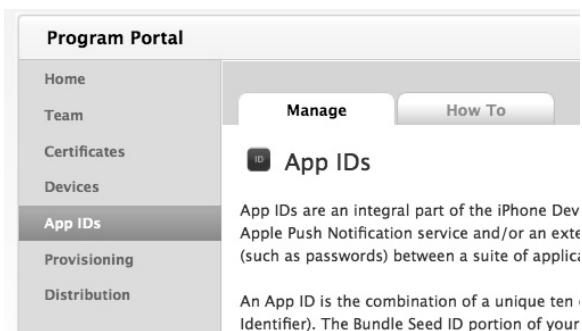


Figure 17.2 Selecting the App IDs from the menu.

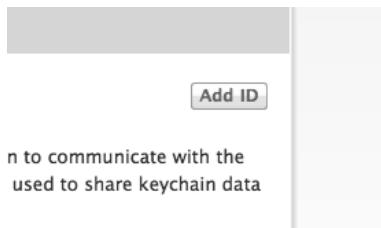


Figure 17.3 The Add ID button.

Under the Manage tab, you will see two text boxes that you need to fill in. In the first field, you enter a distinguishable name for this App ID. This is used for display purposes only and does not affect the App ID.

In the second text field, you enter the Bundle Identifier. Figure 17.4 shows an example.

App ID Name	App ID (Bundle Seed ID + Bundle Identifier)
My ID Name	#####.com.maher.push.third

Figure 17.4 Creating the App ID in the program portal.

After filling in the two required fields, you hit Submit. The App ID will be generated and you will be returned to the page where all your App IDs are listed. You should see your App ID as one of the items listed as shown in Figure 17.5.

ID	My ID Name	Q8DP4CN6MJ.com.maher.push.third	Available	Configure
----	------------	---------------------------------	-----------	-----------

Figure 17.5 The newly-created App ID.

Under the ID column, you will see the App ID which is composed of the 10-digit random number and your bundle identifier. You will also notice that under the Apple Push Notification column it says that the service is Available and the icon is in orange color.

Configuring the App ID for notification

We need to configure the App ID for notification. Click on the Configure button. The Configure App ID page will appear. You will need to enable Push by checking the Enable Push Notification Services shown in Figure 17.6.



Figure 17.6 The Enable Push Notification Services check box.

Once you have checked the box, the Configure button (see Figure 17.7) becomes enabled, so click it.



Figure 17.7 The Configure button.

Once you have clicked the Configure button, a pop-up window appears with a new workflow. This wizard will guide you through the process of generating an SSL certificate to be used by the server. Figure 17.8 shows that window.



Figure 17.8 The first window in the wizard for generating the SSL certificate for push notification.

Generating the SSL certificate

The first step in this process is the generation of the certificate signing request (CSR) using the Keychain Access application. Launch the Keychain Access application and select from the menu Keychain Access > Certificate Assistant > Request a Certificate from a Certificate Authority. Fill in the request similar to the one shown in Figure 17.9 and hit Continue.

Once you clicked on Continue, a dialog box appears asking you for the location of the CSR file. Choose a location such as the Desktop and hit Save as shown in Figure 17.10.

After saving the file, hit Done. Now, go back to the wizard and hit Continue.

You need to upload this CSR file to Apple's server. Click on the Browse and locate the file on the Desktop. Click on Generate. See Figure 17.11.

After a few seconds, the Apple Push Service (APS) certificate will be generated. See Figure 17.12.

Now we need to download it so that we install the certificate on our server. Click on Download Now as shown in Figure 17.13.

Now, hit Done. You'll see that the Apple Push Notification service for the App ID says Enabled and it is green. See Figure 17.14.



Figure 17.9 Filling in the certificate information.

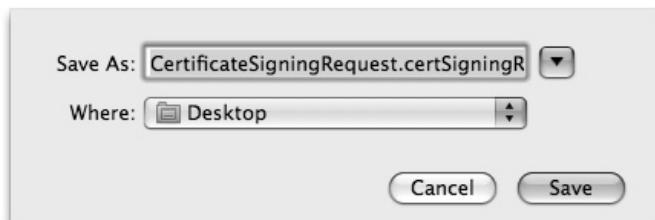


Figure 17.10 Saving the certificate signing request file.

Select the Certificate Signing request (CSR) file that you saved to your disk.

/Users/ali/Desktop/Certific

Figure 17.11 Locating the certificate signing request file.

Installing the SSL certificate on the server

Now that we have the SSL certificate, we need to install it on the server. In addition, we need to configure the server application so that it uses this certificate when talking with Apple's notification servers.

Certificate Name: Maher Ali



Your APS Certificate has been generated.
Please continue to the next step.

Figure 17.12 Successfully generating the SSL certificate.



Figure 17.13 Downloading the SSL certificate.



Figure 17.14 An App ID enabled for APS.

Double-click on the SSL certificate and install it on the server as shown in Figure 17.15.



Figure 17.15 Installing the SSL certificate on the server.

Now that the SSL certificate is installed on the server, we need to tell the server about this certificate.

It all depends on the environment in which you wrote the server. Here, we are using a simple server written in Objective-C that runs on a Mac. You will find this server in the PushMeBaby project available from the source downloads.

Rename the SSL .cer file to apns.cer and drag and drop it in the bundle of the PushMeBaby project as shown in Figure 17.16.

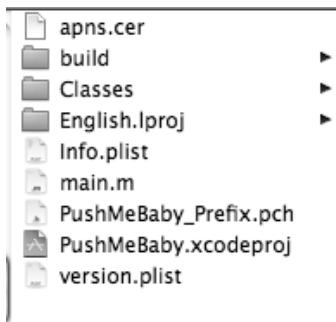


Figure 17.16 The apns.cer file referenced in the bundle of the server application.

This completes the server configuration. One more thing that you need to take care of. The first time you launch the PushMeBaby server application, the Mac OS asks you for permission to sign using your key. You should choose Always Allow as shown in Figure 17.17.



Figure 17.17 Giving permission to the server to use the key.

17.5.2 Configuring the client

Now that we have configured the server, we need to configure the client.

Creating a provisioning profile

We need to create a provisioning profile for our application. Go back to the Program Portal and choose the Provisioning menu as shown in Figure 17.18.

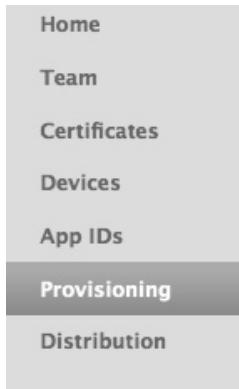


Figure 17.18 The Provisioning menu in the Program Portal.

Click on Add Profile as shown in Figure 17.19.



Figure 17.19 The Add Profile button.

Now, you need to fill in a form so that the provisioning profile can be created. Choose a name for this profile, select the certificate, choose the push notification App ID you created and the devices you want to install this profile on. Click Submit. See Figure 17.20.

After creating the profile, you will see it available for download and listed under Development Provisioning Profiles as shown in Figure 17.21.

Create iPhone Development Provisioning Profile

Generate provisioning profiles here. To learn more, visit the How To section.

Profile Name	Third Push Profile
Certificates	<input checked="" type="checkbox"/> Maher Ali
App ID	My ID Name
Devices	<input type="checkbox"/> Select All <input checked="" type="checkbox"/> Ali iPhone <input type="checkbox"/> Burin Asavesna <input checked="" type="checkbox"/> First iPhone <input type="checkbox"/> Johnathan Conley <input type="checkbox"/> Josh Taylor

Figure 17.20 Creation of the iPhone development provisioning profile.



Figure 17.21 A ready-to-download iPhone development profile.

Installing the provisioning profile on the device and XCode

Now, we need to install the provisioning profile to the device(s) and make XCode aware of it. Click on Download and save the profile on your computer. In XCode, choose Windows > Organizer. Select the device you want to install the profile on as shown in Figure 17.22.



Figure 17.22 Selecting the device in Organizer.

Drag and drop the provisioning profile to the Provisioning section in Organizer as shown in Figure 17.23.

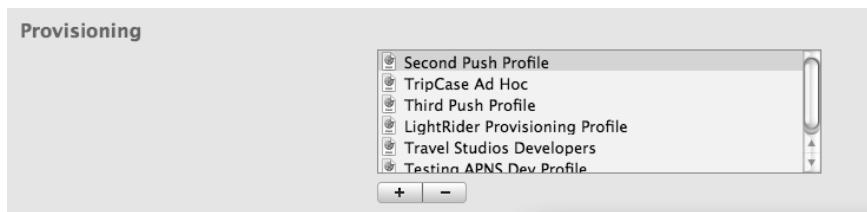


Figure 17.23 The Provisioning section of the device info in Organizer.

Double-click the provisioning profile file in Finder and choose XCode to open it. This will make XCode aware of this profile.

Configuring the XCode application

In XCode, change the Bundle Identifier of the application (in the .plist file) to the one you used in generating the App ID as shown in Figure 17.24.



Figure 17.24 Specifying the Bundle ID of the application in the plist file.

Now, we need to configure the target so that XCode builds the application with the correct profile. Double-click on the target as shown in Figure 17.25.



Figure 17.25 Specifying the provisioning profile in the target.

Select the Build tab and choose the provisioning profile in the Code Signing section as shown in Figure 17.26.

Now, you should be able to build and install the application on the device. Make sure that you are targeting the device as shown in Figure 17.27.

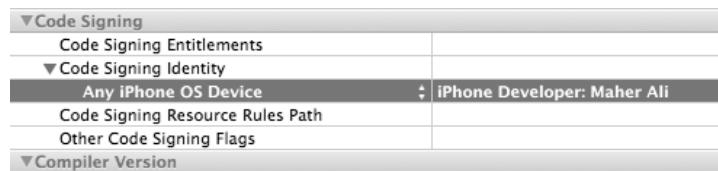


Figure 17.26 Specifying the provisioning profile in the target.



Figure 17.27 Targeting the device from XCode.

17.5.3 Coding the client

Coding the client involves registering for push notification, sending the device token to the server, and responding to notification messages.

Registering for push notification

The push-enabled application is required to register for remote notification on startup. You usually do that in the `applicationDidFinishLaunching:` method as shown below:

```
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    [[UIApplication sharedApplication] registerForRemoteNotificationTypes:
        UIRemoteNotificationTypeBadge |
        UIRemoteNotificationTypeSound |
        UIRemoteNotificationTypeAlert];
}
```

The `registerForRemoteNotificationTypes:` method takes an integer whose bits specify the request for accepting a given notification type. This method is declared as follows:

```
- (void)registerForRemoteNotificationTypes: (UIRemoteNotificationType) types
```

The `UIRemoteNotificationType` is declared as follows:

```
typedef enum {
    UIRemoteNotificationTypeNone      = 0,
    UIRemoteNotificationTypeBadge    = 1 << 0,
    UIRemoteNotificationTypeSound   = 1 << 1,
    UIRemoteNotificationTypeAlert   = 1 << 2
} UIRemoteNotificationType;
```

When your application registers for receiving notifications, the user sees an alert view as shown in Figure 17.28.

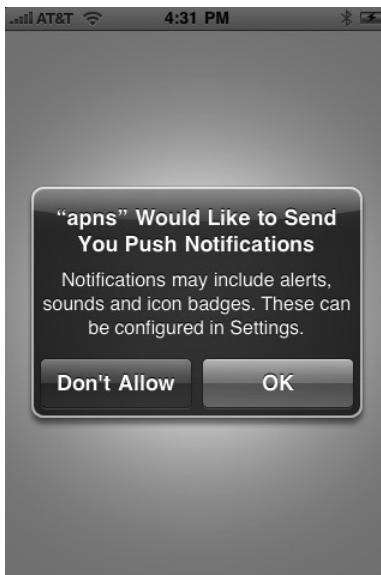


Figure 17.28 An alert view asking the user to approve notifications for a given application.

If the user approves the action and the registration is successful, the method `application:didRegisterForRemoteNotificationsWithDeviceToken:` gets called.

You get the device token in the second parameter. The following shows a sample implementation that just logs the token:

```
- (void)application:(UIApplication *)application  
    didRegisterForRemoteNotificationsWithDeviceToken:(NSData *)token{  
    NSLog(@"Inform the server of this device token: %@", token);  
}
```

The device token remains constant for a given application. Your application should send the token to the server so that the device can be targeted for future notifications.

If the registration fails, the method `application:didFailToRegisterForRemoteNotificationsWithError:` gets called with the error. The method is declared as follows:

```
- (void)application:(UIApplication *)application  
    didFailToRegisterForRemoteNotificationsWithError:(NSError *)error
```

Receiving notifications

If the device receives a notification for an application, and that application is running, the `application:didReceiveRemoteNotification:` method of the application delegate is called. The following shows an example implementation:

```
- (void)application:(UIApplication *)application  
    didReceiveRemoteNotification:(NSDictionary *)userInfo{  
    NSLog(@"The user info: %@", userInfo);  
}
```

For example, if the server sends the following message:

```
{"aps": {"alert": "This is message.", "badge": 1, "sound": "beep.aif"}}
```

The contents of the `userInfo` dictionary will be as follows:

```
2009-04-12 21:02:29.870 TestingAPNS[92:107] The user info: {  
    aps = {  
        alert = "This is message.";  
        badge = 1;  
        sound = "beep.aif";  
    };  
}
```

If, on the other hand, the application is not running, an alert is shown to the user with a message similar to Figure 17.29.



Figure 17.29 An alert displaying a notification message.

17.5.4 Coding the server

The server is required to generate a JSON dictionary with information about what message to be sent, what the number is that should be stored as a badge on the application icon, and the name of the sound that needs to play should the application happen to be inactive.

Coding for the server is beyond the scope of this text. You can look at an example in the PushMeBaby project available in the source downloads.

17.6 Sending Email

To send email from within your iPhone application, you can choose one of the following four approaches:

- **Use the standard email interface.** This approach allows you to set up the initial configuration of a new email message. You can pre-fill the recipients, the subject, and any attachments you want. After that, you present the standard email interface to the user. The user can edit the email fields and possibly change your initial values. The user can then send or cancel the email altogether.
- **Use a back-end service.** Using this approach, you send the email fields to the server and the server then sends the email.

- **Use the** `UIApplication openURL:` **method.** You can set up a URL with the encoded email message and invoke the `openURL:` static method of the `UIApplication` class. Using this approach will result in your application quitting and the `Mail.app` application being launched with a new message. This approach does not allow for file attachment.
- **Use an SMTP library.** Simple Mail Transfer Protocol (SMTP) is a protocol used to send email over the Internet. Using this approach you utilize SMTP to send the email from the iPhone without the user's intervention.

In this section, we discuss the first approach.

17.6.1 Using the mail composition view controller

The class `MFMailComposeViewController` is used to show an email interface that the user can interact with. You create an instance of this controller, initialize it, configure the different email fields and present it to the user modally.

Checking email capability

Before you do all that, you need to check whether your application can send the email. You check that by using the following static method:

+ (BOOL) canSendMail

Creating the email composition controller

If you can send the email, you can proceed to create the mail controller as shown below:

```
MFMailComposeViewController *mailCtrl =  
    [[[MFMailComposeViewController alloc] init] autorelease];
```

Adding the subject line

Once it is created, you can add a subject line using the `setSubject:` method which is declared as follows:

- (**void**) `setSubject:(NSString *)subject`

This method takes a string as an argument and uses that string to set the `Subject` header of the email message. The user can later modify this value.

Adding the recipients

To set the recipients of the message, you use the `setToRecipients:` method which is declared as follows:

```
- (void)setToRecipients:(NSArray *)toRecipients
```

You pass in an array of string values where each value is a valid email address. The method uses this array to set the `To` message header.

Adding the other recipients

To add a `Cc` header, you can use a similar method called `setCcRecipients:`. To set the `Bcc` header, use the `setBccRecipients:` method. Both methods take an array of strings.

Setting up the message body

To set the message body, you can use the following method:

```
- (void)setMessageBody:(NSString *)body isHTML:(BOOL)isHTML
```

You pass in the email body as a string in the first argument and `YES` in the second argument if and only if the message is in HTML format.

Adding attachments

If you want to attach any files, you can use the following method:

```
- (void)addAttachmentData:(NSData *)attachment  
    mimeType:(NSString *)mimeType  
    fileName:(NSString *)filename
```

You pass in the attachment data in the first argument, and its MIME type in the second argument. The file name is passed in the last argument. For example, to attach an image from the bundle called `Flower1.jpg`, you can write something like the following:

```
[mailCtrl addAttachmentData:  
    UIImageJPEGRepresentation([UIImage imageNamed:@"Flower1.jpg"], 0.6)  
    mimeType:@"image/jpeg" fileName:@"Flower1.jpg"];
```

Here, we obtain a compressed data representation of the image with 60% compression rate. The compressed data is then used to add the attachment of MIME type `image/jpeg`.

The delegate

After setting up the email message, you need to assign the delegate of the mail view controller using the `mailComposeDelegate` property. Finally, you can present the mail message controller as you present any other controller.

The delegate object should (and is expected to) implement the following method:

```
- (void)mailComposeController:(MFMailComposeViewController *)controller  
didFinishWithResult:(MFMailComposeResult)result  
error:(NSError *)error
```

You receive the result of the user's decision and any queuing error. The following are potential result values:

- `MFMailComposeResultCancelled`. This value indicates that the email message composition was cancelled by the user.
- `MFMailComposeResultSaved`. This value indicates that the email message composition was saved by the user.
- `MFMailComposeResultSent`. This value indicates that the email message was queued in the Mail.app program.
- `MFMailComposeResultFailed`. This value indicates that there was an error in the user's action. The message is neither queued nor saved.

In all cases, you should dismiss the mail composition controller.

The project `Email` (available from the source downloads) contains a complete application for email composition demonstrating the concepts in this section. A screenshot of the application is shown in Figure 17.30.

17.7 Summary

In this chapter, we addressed several advanced networking topics. We started by looking in Section 17.1 at how we can determine network connectivity of the device. After that, we tackled the issue of uploading multimedia content to remote servers in Section 17.2. Next, In Section 17.3, we presented a category on `NSString` that allows us to easily compute the MD5 digest of a string. After that, Section 17.4 showed you how to present a responsive table view whose data rows are fed from the Internet without sacrificing the user experience. Next, Section 17.5 addressed the topic of push notification. Finally, Section 17.6 discussed sending email from with your iPhone application.



Figure 17.30 A screenshot showing email composition.

Problems

- (1) The application presented in Section 17.4 will start downloading the Internet resource as soon as the corresponding cell becomes visible. Improve on this behavior so that downloading starts only when the user stops the scrolling. This is a more efficient behavior and is used by the App Store application.
- (2) Write an application that uploads images to Flickr.

18

Working with the Address Book Database

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.

In Section 18.1, we provide a brief introduction to the subject. Next, Section 18.2 discusses property types. After that, Sections 18.3 and 18.4 show how to access single- and multi-value properties, respectively. Next, Sections 18.5 and 18.6 go into the details of the person record and the address book, respectively. Issues related to multithreading and identifiers are addressed in Section 18.7.

After covering the foundation of the address book API, we provide several sample applications. Section 18.8 shows how to use a query to retrieve the photo of a given record. Next, Section 18.9 shows how to use the `ABUnknownPersonViewController` class. After that, Section 18.10 covers the `ABPeoplePickerNavigationController` class. The `ABPersonViewController` class is covered in Section 18.11. Section 18.12 covers the `ABNewPersonViewController` class. Finally, we summarize the chapter in Section 18.13.

18.1 Introduction

The iPhone SDK supports full access to the user’s address book. The address book API provides a simple interface to query the address book, create new records, modify records, and delete records. To use this API, you need to add the following import statement:

```
#import <AddressBook/AddressBook.h>
```

You also need to add the `AddressBook` framework to your project as explained in Section D.4.

The address book consists of a set of records. A record can be either a *person* record or a *group* record. A group is a container with a name and zero or more references to group and/or person records.

Every record has *properties*. A property can be a *single-value* property or a *multi-value* property. An example of a single-value property is the last name of a person. An example of a multi-value property is the person's address; which consists of street, city, zip, country, etc.

You can determine the type of a record using the `ABRecordGetRecordType` function. The properties (whether single- or multi-value) of person and group records are accessed using the same functions but with different property identifiers. You can set the value of a property using `ABRecordSetValue` function. You can retrieve the value of a property using the `ABRecordCopyValue` function. You can remove a property altogether using the `ABRecordRemoveValue` function.

To access the address book database, you create an address book object. This will result in creating a reference to the address book database in memory. The address book reference is only valid within the thread that created it.

You can modify the address book by adding, removing, and updating records. These modifications remain in memory until you save the address book. You can also revert changes that you've made.

18.2 Property Types

There are ten record property types available to you. Five of those are for single-value properties and the other five are for multi-value properties.

- **String.** The single-value property type is defined as `kABStringPropertyType` while the multi-value property type is defined as `kABMultiStringPropertyType`. The value retrieved from a single-value property is of type `CFStringRef` which is equivalent to `NSString*`. The values retrieved from multi-value property are all of type `CFStringRef`.
- **Integer.** The single-value is referred to using `kABIIntegerPropertyType` while the multi-value is referred to using `kABMultiIntegerPropertyType`. The value retrieved from a single-value property is of type `CFNumberRef` which is equivalent to `NSNumber*`. The values retrieved from multi-value property are all of type `NSNumber*`.
- **Date.** `kABDateTimePropertyType` is used for single-value and `kABMultiDateTimePropertyType` is used for multi-value. The values are of type `CFDateRef` or `NSDate*`.
- **Real.** `kABRealPropertyType` is used for single-value and `kABMultiRealPropertyType` for multi-value properties. The values are of type `CFNumberRef` or `NSNumber*`.
- **Dictionary.** `kABDictionaryPropertyType` is used for single-value and `kABMultiDictionaryPropertyType` for multi-value properties. The values are of type `CFDictionaryRef` or `NSDictionary*`.

18.3 Accessing Single-Value Properties

In this section, we discuss the functions used to manipulate single-value properties for person and group records.

18.3.1 Retrieving single-value properties

To retrieve the value for a single-value property, you need to copy that value from a record. The function `ABRecordCopyValue` is used for this purpose. The function is declared as follows:

```
CFTypeRef ABRecordCopyValue(ABRecordRef record, ABPropertyID property);
```

The first parameter of this function is the record you want to retrieve the specific property value from, and the second parameter is the property identifier. In the documentation, you can find out what predefined constant identifiers exist for a given property. For example, the first name of a person has the property identifier `kABPersonFirstNameProperty`. The return value depends on the property being retrieved. The core foundation (hence the CF prefix) framework uses the `CFTypeRef` generic reference as a pointer to any core foundation object. As you might have guessed, it's declared as follows:

```
typedef const void * CFTypeRef;
```

The value retrieved is copied. Which means that you are responsible for its release. You release this value using `CFRelease` function. You can also release it by assigning the value to a Cocoa variable with an equivalent type and sending a `release` message to it. If you would rather work with the Foundation Framework (classes prefixed by `NS`), you can cast the retrieved object to the Cocoa type to disable warnings.

Enough talk. Let's see how we can retrieve the first name of a person. The following retrieves that value and stores it in the variable `firstName`.

```
NSString *firstName =  
    (NSString*)ABRecordCopyValue(person, kABPersonFirstNameProperty);
```

To see a list of property identifiers for a person record, command-double-click in XCode the `kABPersonFirstNameProperty` token.

Let's see another example. Suppose we have a group object and we want to retrieve the name of the representative group. The following shows how we can do that:

```
NSString *groupName =  
    (NSString*)ABRecordCopyValue(group, kABGroupNameProperty);
```

Again, command-double-click the `kABGroupNameProperty` to see other property identifiers for a group record. You will find none. The `kABGroupNameProperty` is the only predefined property for a group.

The following are some of the single-value property identifiers defined for a person record:

- `kABPersonLastNameProperty`. Returns a string value representing the last name of the person.
- `kABPersonMiddleNameProperty`. Returns a string value representing the middle name of the person.

- `kABPersonNicknameProperty`. Returns a string value representing the nickname of the person.
- `kABPersonBirthdayProperty`. Returns a date value representing the birthday of the person.
- `kABPersonNoteProperty`. Returns a string value for the note associated with the person.

18.3.2 Setting single-value properties

To change the value for a given property, you use the `ABRecordSetValue` function. The function is declared as follows:

```
bool ABRecordSetValue(ABRecordRef record, ABPropertyID property,
                      CFTypeRef value, CFErrorRef* error
                    ) ;
```

You pass in the record object, the property identifier you want to change, the value you want to set, and a reference to an `NSError` object. The function returns YES if successful and NO, otherwise.

For example, to change the first name of the record in `person` to `Barack`, use:

```
ABRecordSetValue(person, kABPersonFirstNameProperty, @"Barack", NULL) ;
```

Here, we are passing `NULL` for the `NSError` reference as we are not interested in dealing with errors. Of course, you should always write code that does deal with potential errors.

To set the group name for a group record, you can write something like the following:

```
ABRecordSetValue(group, kABGroupNameProperty, @"Presidents", NULL) ;
```

Again, notice that we are using the same function in dealing with group and person records.

18.4 Accessing Multi-Value Properties

In this section, we talk about the manipulation of multi-value properties.

18.4.1 Retrieving multi-value properties

To retrieve the value of a multi-value property, you use the same function you used to retrieve a single-value property, `ABRecordCopyValue`. The value returned is of type `ABMultiValueRef` which is declared as an alias to the generic `CFTypeRef` type.

The following shows how to retrieve the person's emails:

```
ABMultiValueRef emailsProperty =  
    ABRecordCopyValue(person, kABPersonEmailProperty);
```

Once we have the multi-value object, we can retrieve its values (in this case, the strings of emails), using the function `ABMultiValueCopyArrayOfAllValues`, which is declared as follows:

```
CFArrayRef ABMultiValueCopyArrayOfAllValues(ABMultiValueRef multiValue);
```

The function returns the values in an `NSArray` object. You can then iterate through this array and access the values.

Each value stored for a multi-value property has a label identifying this value and a unique identifier. The label can be any string value, and several values can have the same label. Some of the generic labels defined are: `kABWorkLabel`, `kABHomeLabel`, and `kABOtherLabel`.

To retrieve the label for a given value, you can use the `ABMultiValueCopyLabelAtIndex` function. It returns an `NSString` object with the label of a given value. The function is declared as follows:

```
CFStringRef ABMultiValueCopyLabelAtIndex(  
    ABMultiValueRef multiValue, CFIIndex index);
```

The first parameter is the multi-value object and the second is the index of the value whose label you want to retrieve. For example, the following retrieves the label value for the email at `index`:

```
NSString *emailLabel =  
    (NSString*)ABMultiValueCopyLabelAtIndex(emailsProperty, index);
```

As usual, since the function has a “copy” in it, you are responsible for the object’s memory.

The following are some of the multi-value property identifiers defined for the person record:

- `kABPersonAddressProperty`. This identifier is used to access the person’s address multi-value property. The property type is `kABMultiDictionaryPropertyType`, which means that each value of this property is an `NSDictionary` instance.
- `kABPersonDateProperty`. This identifier is used to access all the dates associated with this person. Each value is an `NSDate` instance.
- `kABPersonPhoneProperty`. This identifier is used to retrieve all phone numbers associated with the person. Each value is an `NSString` instance.
- `kABPersonURLProperty`. This identifies all the URLs associated with this person. Each value is an `NSString` object.

Listing 18.1 shows a code fragment that retrieves all the emails of a given person and logs them labelled.

Listing 18.1 Logging all the emails associated with a given person record.

```
//Access emails
ABMultiValueRef emailsProperty =
    ABRecordCopyValue(person, kABPersonEmailProperty);
NSArray* emailsArray =
    (NSArray*)ABMultiValueCopyArrayOfAllValues(emailsProperty);
NSLog(@"Emails:");
for(int index = 0; index< [emailsArray count]; index++){
    NSString *email = [emailsArray objectAtIndex:index];
    NSString *emailLabel =
        (NSString*)ABMultiValueCopyLabelAtIndex(emailsProperty, index);
    NSLog(@"%@", [emailLabel isEqualToString:(NSString*)kABWorkLabel] ?@"Work" :
        [emailLabel isEqualToString:(NSString*)kABHomeLabel] ?
            @"Home":@"Other", email);
    [emailLabel release];
}
CFRelease(emailsProperty);
[emailsArray release];
```

Listing 18.2 shows a code fragment that retrieves all the phone numbers of a given person and logs them labelled.

Listing 18.2 Logging all the phone numbers associated with a given person record.

```
// Access phones
ABMultiValueRef phonesProperty =
    ABRecordCopyValue(person, kABPersonPhoneProperty);
NSArray* phonesArray =
    (NSArray*)ABMultiValueCopyArrayOfAllValues(phonesProperty);
NSLog(@"Phones:");
for(int index = 0; index< [phonesArray count]; index++){
    NSString *aPhone = [phonesArray objectAtIndex:index];
    NSString *phoneLabel =
        (NSString*)ABMultiValueCopyLabelAtIndex(phonesProperty, index);
    NSLog(@"%@", [phoneLabel isEqualToString:(NSString*)kABPersonPhoneMobileLabel] ?
        @"Mobile":@"Phone", aPhone);
    [phoneLabel release];
}
CFRelease(phonesProperty);
[phonesArray release];
}
```

18.4.2 Setting multi-value properties

To modify a multi-value property, you need a mutable version of that property. If you want to create a brand new value, you use `ABMultiValueCreateMutable` function, add the values and labels to it and set the corresponding property with the new value. If, on the other hand, you want to modify an existing multi-value, you retrieve this value, create a mutable copy of it using the function `ABMultiValueCreateMutableCopy`, add to or delete from it, and set the value in the record.

Let's make these steps concrete through some examples. First, let's us look at creating a brand new multi-value.

We want to set a person's record with one work address. First, we create a mutable multi-value as follows:

```
ABMutableMultiValueRef multiValueAddress =
    ABMultiValueCreateMutable(kABMultiDictionaryPropertyType);
```

Here, we are asking the address book framework to create a new multi-value object of `kABMultiDictionaryPropertyType` type. As we mentioned before, this is the type of the street address property (a person can have multiple addresses and each address is a dictionary).

After that, we create one address and store its parts in a dictionary as follows:

```
NSMutableDictionary *theAddress =
    [ [NSMutableDictionary alloc] init] autorelease];
[theAddress setValue:@"1600 Pennsylvania Avenue NW"
    forKey:(NSString *)kABPersonAddressStreetKey];
[theAddress setValue:@"Washington"
    forKey:(NSString *)kABPersonAddressCityKey];
[theAddress setValue:@"DC"
    forKey:(NSString *)kABPersonAddressStateKey];
[theAddress setValue:@"20500"
    forKey:(NSString *)kABPersonAddressZIPKey];
[theAddress setValue:@"us"
    forKey:(NSString *)kABPersonAddressCountryCodeKey];
```

This is pretty straight-forward dictionary creation. The keys used are defined by the framework. You can set any or all of them as they are all optional.

Now that we have a new value, we need to add it to the multi-value and give it a label. The function to use is `ABMultiValueAddValueAndLabel`. The first parameter of this function is the multi-value object, the second is the value to add, and the third is the label. You can pass a reference to an `NSError` object if you want to in the fourth parameter. The following shows the addition of the new address to the multi-value object:

```
ABMultiValueAddValueAndLabel(multiValueAddress, theAddress,
    kABWorkLabel, NULL);
```

You can repeat these steps for each additional address. Once you have what you want, you set the multi-value property with the new value using our old friend `ABRecordSetValue` as follows:

```
ABRecordSetValue(person, kABPersonAddressProperty, multiValueAddress, NULL);
```

If, on the other hand, you want to modify an existing multi-value, you need to retrieve it, create a mutable copy of it, add to the mutable copy, and set it back to the record. The following code fragment shows exactly that:

```
ABMultiValueRef streetAddressProperty =
    ABRecordCopyValue(person, kABPersonAddressProperty);
ABMutableMultiValueRef mutableStreetAddressProperty =
    ABMultiValueCreateMutableCopy(streetAddressProperty);
CFRelease(streetAddressProperty);
NSMutableDictionary *theAddress =
    [[[NSMutableDictionary alloc] init] autorelease];
[theAddress setValue:@"1600 Pennsylvania Avenue NW"
    forKey:(NSString *)kABPersonAddressStreetKey];
[theAddress setValue:@"Washington"
    forKey:(NSString *)kABPersonAddressCityKey];
[theAddress setValue:@"DC"
    forKey:(NSString *)kABPersonAddressStateKey];
[theAddress setValue:@"20500"
    forKey:(NSString *)kABPersonAddressZIPKey];
[theAddress setValue:@"us"
    forKey:(NSString *)kABPersonAddressCountryCodeKey];
ABMultiValueAddValueAndLabel(mutableStreetAddressProperty,
    theAddress, kABHomeLabel, NULL);
ABRecordSetValue(person, kABPersonAddressProperty,
    mutableStreetAddressProperty, NULL);
CFRelease(mutableStreetAddressProperty);
```

18.5 Person and Group Records

Creating a new person record is simple. You use the function `ABPersonCreate` to create a new `ABRecordRef`. After that, you set its properties and add it to the address book object using `ABAddressBookAddRecord` function which we will discuss shortly.

To create a group, you use the `ABGroupCreate` function. You set its properties (only one is defined) and add it to the address book object as you would add any record using the `ABAddressBookAddRecord` function. You can add a person as a member to this group by using the `ABGroupAddMember` function. This function is declared as follows:

```
bool
ABGroupAddMember(ABRecordRef group, ABRecordRef person, CFErrorRef* error)
```

You can retrieve all members of a given group using the function `ABGroupCopyArrayOfAllMembers` which is declared as follows:

```
CFArrayRef ABGroupCopyArrayOfAllMembers(ABRecordRef group)
```

Each person has an image. You can retrieve that image using the function `ABPersonCopyImageData` which is declared as follows:

```
CFDataRef ABPersonCopyImageData(ABRecordRef person);
```

The previous function returns an `NSData` object containing the image data. You can then use the `UIImage imageWithData:` method to build a `UIImage` object from it.

To set the photo of a person, use the `ABPersonSetImageData` function which is declared as follows:

```
bool ABPersonSetImageData(ABRecordRef person, CFDataRef imageData,
                         CFErrorRef* error);
```

18.6 Address Book

In the previous sections, we mostly covered records. In order to modify the actual database, however, you need to use the address book.

You usually start by creating an address book and initialize it with references to existing records. You modify, add, and delete records. After that, you save the address book.

To create an address book object, you use the function `ABAddressBookCreate`. This will return a reference to an address book, `ABAddressBookRef`, which we will discuss shortly.

```
ABAddressBookRef addressBook = ABAddressBookCreate();
```

To save an address book back to the database, you use the `ABAddressBookSave` function as shown below.

```
ABAddressBookSave(addressBook, NULL);
```

After finishing with an address book, you need to release it as follows:

```
CFRelease(addressBook);
```

Remember that all your changes to the records are in memory. To persist these changes, you'll need to save the address book object.

The following are some of the useful functions that operate on an address book object:

- `ABAddressBookGetPersonCount`. This function returns the number of person records in the address book. The function is declared as follows:

```
CFIndex ABAddressBookGetPersonCount (ABAddressBookRef addressBook) ;
```

CFIndex is basically a **signed long**.

- ABAddressBookGetGroupCount. This function returns the number of groups in the address book and it is declared as follows:

```
CFIndex ABAddressBookGetGroupCount (ABAddressBookRef addressBook) ;
```

- ABAddressBookCopyArrayOfAllPeople. This function returns an array of all person records. The function is declared as follows:

```
CFArrayRef  
ABAddressBookCopyArrayOfAllPeople (ABAddressBookRef addressBook) ;
```

Again, you need to release this array after you are finished with it.

- ABAddressBookCopyArrayOfAllGroups. This function returns an array of all groups in the address book and is declared as follows:

```
CFArrayRef  
ABAddressBookCopyArrayOfAllGroups (ABAddressBookRef addressBook) ;
```

- ABAddressBookCopyPeopleWithName. This function is actually pretty useful. You specify a query string and it will return all person records matching this query. The function is declared as follows:

```
CFArrayRef  
ABAddressBookCopyPeopleWithName (ABAddressBookRef addressBook,  
CFStringRef name) ;
```

We will talk about this function later in this chapter.

- ABAddressBookHasUnsavedChanges. This function will return YES if and only if there are changes to the address book that need saving. The function is declared as follows:

```
bool ABAddressBookHasUnsavedChanges (ABAddressBookRef addressBook) ;
```

- ABAddressBookAddRecord. This function is used to add a record (either person or group record) to the address book. The function is declared as follows:

```
bool ABAddressBookAddRecord (ABAddressBookRef addressBook,  
ABRecordRef record, CFErrorRef* error) ;
```

- ABAddressBookRemoveRecord. This function is used to remove a record from the address book database. The function is declared as follows:

```
bool ABAddressBookRemoveRecord (ABAddressBookRef addressBook,  
ABRecordRef record, CFErrorRef *error)
```

- **ABAddressBookRevert**. Using this function will discard all your modifications to the address book. After calling this function, the address book will be refreshed from the database. Also, after calling this function, you can see the changes that other threads have committed after your last save. The function is declared as follows:

```
ABAddressBookRevert (ABAddressBookRef addressBook) ;
```

If a record has been removed from the database before reverting, all properties of this record will return **NULL**.

18.7 Multithreading and Identifiers

Every record has a unique identifier. This identifier should be used to communicate records between threads. To retrieve the identifier of a person or a group record, use the function **ABRecordGetRecordID** which is declared as follows:

```
ABRecordID ABRecordGetRecordID (ABRecordRef record) ;
```

We mentioned before that, in multi-value properties, each value has a unique identifier. You retrieve these values using an index. Moreover, if you need to store references to specific entries, you need to store the unique identifier of that value rather than its index. The function **ABMultiValueGetIndexForIdentifier** is used to retrieve the index for the value using its unique identifier. This function is declared as follows:

```
CFIndex ABMultiValueGetIndexForIdentifier (ABMultiValueRef multiValue,  
                                         ABMultiValueIdentifier identifier) ;
```

To retrieve the unique identifier of a value using its index, use the function **ABMultiValueGetIdentifierAtIndex**, which is declared as follows:

```
ABMultiValueIdentifier  
ABMultiValueGetIdentifierAtIndex (ABMultiValueRef multiValue,  
                                 CFIndex index)
```

We will see the use of identifiers when we discuss some applications later in this chapter.

18.8 Person Photo Retriever Application

In this section, we present a sample application that prompts the user to enter a query for a person. This query is used to retrieve a person with a photo and display it on the screen as shown in Figure 18.1

The source code for this application can be found in the **PersonPhotoRetriever** project available from the source downloads.

Listing 18.3 shows a category on **UIImage** to return the photo of the first person in the address book whose name matches a given query.



Figure 18.1 The photo retriever application.

Listing 18.3 A category on UIImage to return the photo of the first person in the address book whose name matches a given query.

```
@interface UIImage (AddressBook)
+(UIImage*)photoForAperson:(NSString*)_name;
@end

@implementation UIImage (AddressBook)
// returns the image of the first person give a query
+(UIImage*)photoForAperson:(NSString*)_name{
    UIImage *_image = nil;
    ABAddressBookRef addressBook = ABAddressBookCreate();
    NSArray *people = (NSArray*)
        ABAddressBookCopyPeopleWithName(addressBook, (CFStringRef)_name);
    int index = 0;
    while (index < [people count]){
        ABRecordRef person = (ABRecordRef)[people objectAtIndex:index++];
        NSData *photoData = (NSData*) ABPersonCopyImageData(person);
        if(photoData){
            _image = [UIImage imageWithData:photoData];
        }
    }
}
```

```

        [photoData release];
    break;
}
}
[people release];
CFRelease(addressBook);
return _image;
}
@end

```

The `photoForAperson:` method takes the query text as an argument and returns the photo. It starts by creating an address book object. After that, the method `ABAddressBookCopyPeopleWithName` is used to perform a prefix search using the given query. The function returns an array of person records that match this query. The method then iterates through this array retrieving the image data of each person record using `ABPersonCopyImageData` function. If the photo data is not nil, a `UIImage` instance is created from this data and the image is returned.

Listing 18.4 shows the method triggered when the user taps the `Retrieve Photo` button. It simply retrieves the image view and sets it to the image if an image with the query exists. Otherwise, it displays an alert view.

Listing 18.4 The method triggered when the user taps the `Retrieve Photo` button.

```

-(void)buttonPushed{
    NSString *name = [(UITextField*)[self.view viewWithTag:999] text];
    UIImageView *imageView = (UIImageView*)[self.view viewWithTag:1234];
    UIImage *image = [UIImage photoForAperson:name];
    if(image){
        imageView.image = image;
        [[self.view viewWithTag:999] resignFirstResponder];
    }
    else{
        [[[UIAlertView alloc] initWithTitle:@"No Records!"
            message:[NSString stringWithFormat:@"%@ photo not found", name]
            delegate:self
            cancelButtonTitle:nil
            otherButtonTitles:@"OK", nil] show];
    }
}

```

18.9 Using the `ABUnknownPersonViewController` Class

Often, you want to present to the user a partial record and allow them to use this partial information to create a new record or add this information to an existing record. The `ABUnknownPersonViewController` is used for this purpose. In addition to the `AddressBook` framework, you will need

to add the AddressBookUI framework as explained in Section D.4. Also, don't forget to add the following import statement:

```
#import <AddressBookUI/AddressBookUI.h>
```

To use this controller, you first allocate it and initialize it. Next, you set its `displayedPerson` property to a person record with its relevant properties filled in. After that, you set the delegate property `unknownPersonViewController` to an object that implements the `ABUnknownPersonViewControllerDelegate` protocol. If you want the user to change the address book database, you set the `allowsAddingToAddressBook` property to YES. Finally, you push the controller on the stack.

The delegate needs to implement the method `unknownPersonViewController:didResolveToPerson:` which is declared as follows:

```
- (void)unknownPersonViewController:(ABUnknownPersonViewController *)  
    unknownCardViewController didResolveToPerson:(ABRecordRef)person;
```

If the user cancelled the controller, `person` will have the value `NULL`. Otherwise, you receive the `person` object with the user's modifications. The `person` record would have been added to the database by this time. You will need to pop the controller in this method.

Listing 18.5 shows the method that pushes an `ABUnknownPersonViewController` instance and the delegate method that pops it. The delegate method does not inspect the person returned. Depending on your application, you may want to use this object. The complete application can be found in the `VisuallyAddingContact` project available from the source downloads.

Listing 18.5 Utilizing an `ABUnknownPersonViewController` class to add/modifies a person record visually by the user.

```
- (void)buttonPushed{  
    ABUnknownPersonViewController *unknownPersonViewController =  
        [[ABUnknownPersonViewController alloc] init] autorelease];  
    ABRecordRef person = ABPersonCreate();  
    ABRecordSetValue(person, kABPersonFirstNameProperty, @"Barack", NULL);  
    ABRecordSetValue(person, kABPersonLastNameProperty, @"Obama", NULL);  
    unknownPersonViewController.displayedPerson = person;  
    CFRelease(person);  
    unknownPersonViewController.allowsAddingToAddressBook = YES;  
    unknownPersonViewController.unknownPersonViewDelegate = self;  
    [self.navigationController  
        pushViewController:unknownPersonViewController animated:YES];  
}  
  
- (void)unknownPersonViewController:(ABUnknownPersonViewController *)  
    unknownCardViewController didResolveToPerson:(ABRecordRef)person{  
    [self.navigationController popViewControllerAnimated:YES];  
}
```

18.10 Using the ABPeoplePickerNavigationController Class

If you want to ask the user to choose a person record or, say, a phone number from the address book, then the `ABPeoplePickerNavigationController` class is your friend.

To use this class, you allocate it, initialize it, set its delegate to an object implementing its delegate, optionally specifying the properties (emails, phone numbers, etc.) that should be displayed when the user peeks into a specific record, and finally present it modally. The following code fragment shows a people picker that only shows the phone numbers of records:

```
ABPeoplePickerNavigationController *peoplePickerController =
    [[[ABPeoplePickerNavigationController alloc] init] autorelease];
peoplePickerController.peoplePickerDelegate = self;
peoplePickerController.displayedProperties =
    [NSArray arrayWithObject:
        [NSNumber numberWithInt:kABPersonPhoneProperty]];
[self presentModalViewController:peoplePickerController
    animated:YES];
```

The `displayedProperties` property uses an array of `ABPropertyIDs` of the properties you want to show. Notice that we did not *push* the controller but rather we presented it.

The delegate should implement the following three methods:

- `(void)peoplePickerControllerDidCancel:`
`(ABPeoplePickerNavigationController *)peoplePicker;`

This method is called when the user cancels the operation. You should dismiss the controller as follows:

```
[self dismissModalViewControllerAnimated:YES];
```

The second method is the following:

- `(BOOL)`
`peoplePickerController:(ABPeoplePickerNavigationController *)`
`peoplePicker shouldContinueAfterSelectingPerson:(ABRecordRef)person;`

This method is called when the user selects a person record wanting to see its details or confirming that this is the record they are interested in. Depending on the purpose of the people picker, you should either return YES to allow showing of the selected properties, or return NO and dismiss the controller as above.

Finally, the following method is called when the user selects a specific property (see Figure 18.2):

- `(BOOL)`
`peoplePickerController:`
`(ABPeoplePickerNavigationController *)peoplePicker`
`shouldContinueAfterSelectingPerson:(ABRecordRef)person`
`property:(ABPropertyID)property`
`identifier:(ABMultiValueIdentifier)identifier;`



Figure 18.2 People picker controller showing a record details.

If you want the default action to be performed (e.g., dialing a phone number), you should return YES and possibly dismiss the controller. If, on the other hand, you're just interested in the value the user has selected, you should return NO and dismiss the controller.

The method is passed the person record and the value identifier in a multi-value property that was selected. For example, if you show phone numbers, and the person record contains three phone numbers, you get to know which of these phone numbers was selected (by its unique identifier).

The following shows a possible implementation.

```
ABMultiValueRef phoneProperty = ABRecordCopyValue(person, property);
NSInteger phoneIndex =
    ABMultiValueGetIndexForIdentifier(phoneProperty, identifier);
NSString *phone =
    (NSString *)ABMultiValueCopyValueAtIndex(phoneProperty, phoneIndex);
NSLog(@"%@", "The phone number selected is %@", phone);
CFRelease(phoneProperty);
[phone release];
[self dismissModalViewControllerAnimated:YES];
return NO;
```

In the above method, we retrieve the value of the property. Since this property is multi-value, we retrieve its index. After that, we retrieve the value chosen by the user using this index. We release memory, as we have learned before, and dismiss the controller.

The project PersonPicker, available from the source downloads, contains a complete application using the people picker.

18.11 Using the ABPersonViewController Class

The `ABPersonViewController` class allows you to present the details of a specific record to the user. As with its other sisters, you need to create it and initialize it. Next, you set its delegate (one method to implement). After that, you configure some of its options. The `allowsEditing` property is set to `YES` if you want the user to edit the record. `NO` is the default. The `displayedPerson` must be set to the person record you want to show. The `displayedProperties` is an array of all properties you want to show. If you allow editing, then the other properties will show as well while editing.

If you want to highlight a given property, use the `setHighlightedItemForProperty:withIdentifier:` method which is declared as follows:

```
- (void)setHighlightedItemForProperty: (ABPropertyID)property  
    withIdentifier: (ABMultiValueIdentifier)identifier;
```

The `property` parameter specifies the property identifier you want to highlight. If the property is single-value, the second parameter is ignored. If, on the other hand, the property is multi-value (e.g., phone), the `identifier` specifies which value to highlight. You can highlight as many values as you want.

Listing 18.6 shows how one can setup and invoke a person view controller. In this example, we retrieve the first person record and show it. The displayed properties are the phone and email properties. The method also highlights the phone value with identifier 0.

Listing 18.6 Showing a person record using the `ABPersonViewController` class.

```
- (void)buttonPushed{  
    ABAddressBookRef addressBook = ABAddressBookCreate();  
    NSArray *allPeople =  
        (NSArray*) ABAddressBookCopyArrayOfAllPeople(addressBook);  
    if(allPeople.count){  
        ABRecordRef person = (ABRecordRef) [allPeople objectAtIndex:0];  
        ABPersonViewController *personViewController =  
            [[[ABPersonViewController alloc] init] autorelease];  
        personViewController.personViewDelegate = self;  
        personViewController.displayedPerson = person;  
        personViewController.displayedProperties =  
            [NSArray arrayWithObjects:  
                [NSNumber numberWithInt:kABPersonEmailProperty],
```

```
[NSNumber numberWithInt:kABPersonPhoneProperty], nil];
[personViewController
    setHighlightedItemForProperty:kABPersonPhoneProperty
    withIdentifier:0];
[self presentModalViewController:personViewController animated:YES];
}
[allPeople release];
CFRelease(addressBook);
}
```

Listing 18.7 shows the delegate method of the person view controller. If the property selected by the user is an email property, we log it, disallow default action, and dismiss the controller. Otherwise, we dismiss the controller and allow default action to occur.

Listing 18.7 The delegate method of a person view controller.

```
- (BOOL)
personViewController:(ABPersonViewController *)personViewController
shouldPerformDefaultActionForPerson:(ABRecordRef)person
property:(ABPropertyID)property
identifier:(ABMultiValueIdentifier)identifierForValue{
if(property == kABPersonEmailProperty){
    ABMultiValueRef emailProperty = ABRecordCopyValue(person, property);
    NSInteger emailIndex =
        ABMultiValueGetIndexForIdentifier(emailProperty, identifierForValue);
    NSString *email =
        (NSString *)ABMultiValueCopyValueAtIndex(emailProperty, emailIndex);
    NSLog(@"The email selected is %@", email);
    CFRelease(emailProperty);
    [email release];
    [self dismissModalViewControllerAnimated:YES];
    return NO;
}
else{
    [self dismissModalViewControllerAnimated:YES];
    return YES;
}
}
```

Figure 18.3 shows a view from the person view controller.

18.12 Using the ABNewPersonViewController Class

If you want the user to create a new person record, you can use the `ABNewPersonViewController` controller. You create and initialize the controller and set the delegate. The controller is then pushed on the stack. The following shows a typical invocation:



Figure 18.3 A view from a person view controller.

```
ABNewPersonViewController *newPersonViewController =  
    [[[ABNewPersonViewController alloc] init] autorelease];  
newPersonViewController.newPersonViewDelegate = self;  
[self.navigationController  
    pushViewController:newPersonViewController animated:YES];
```

The only delegate method is `newPersonViewController:didCompleteWithNewPerson:`. You should dismiss the controller and inspect the new person record. Note that the person will be added to the address book by the time this method is called. If the user cancelled, the `person` parameter is `NULL`.

```
- (void)  
newPersonViewController:(ABNewPersonViewController *)newPersonView  
    didCompleteWithNewPerson:(ABRecordRef)person{  
    [self.navigationController popViewControllerAnimated:YES];  
}
```

Figure 18.4 shows the view of `ABNewPersonViewController` controller.



Figure 18.4 Adding a new contact using the `ABNewPersonViewController` class.

18.13 Summary

In this chapter, we discussed the foundation of the address book API and several UI elements that can be used to modify the contacts database.

In Section 18.1, we provided a brief introduction to the subject. Next, Section 18.2 discussed property types. After that, Sections 18.3 and 18.4 showed how to access single- and multi-value properties, respectively. Next, Sections 18.5 and 18.6 went into the details of the person record and the address book, respectively. Issues related to multithreading and identifiers were addressed in Section 18.7.

After covering the foundation of the address book API, we provided several sample applications. Section 18.8 showed how to use a query to retrieve the photo of a given record. Next, Section 18.9 showed how to use the `ABUnknownPersonViewController` class. After that, Section 18.10 covered the `ABPeoplePickerNavigationController` class. The `ABPersonViewController` class was covered in Section 18.11. Finally, Section 18.12 covered the `ABNewPersonViewController` class.

Problems

- (1) Study the `ABRecordRef` type in the `ABRecordRef.h` header file and the documentation.
- (2) Write a view controller that lists the contacts in the address book and allows the user to perform multiple selections of person records.
- (3) Enhance the controller in (2) by adding search capability.

19

Core Data

In this chapter, you learn how to use the Core Data framework in your application. In Section 19.1, you learn about the main components in the Core Data application. Next, in Section 19.2, we talk about the major classes in the Core Data framework. In Section 19.3, you learn how to use the graphical modeling tool to build a data model. After that, Section 19.4 addresses the basic operations in persistence storage using Core Data. Next, Section 19.5 shows how to use relationships in the Core Data model. After that, Section 19.6 presents a search application that utilizes Core Data for storage. Finally, we summarize the chapter in Section 19.7.

19.1 Core Data Application Components

Data models in a Core Data application are represented by *entities*. Entities are composed of *attributes* (such as `salary`) and *relationships* (such as `manager`). Attributes and relationships are called *properties*.

For entities to come to life, they need to be represented by a *managed object*. In the relational database world, an entity can be thought of as a table and a managed object as a specific row in that table. In the object world, an entity can be thought of as a class, and a managed object as an instance of that class.

A collection of entities with their attributes and relationships represents a *schema* in a Core Data application. This schema is represented by a *managed object model*. You can create the model using Objective-C code (not recommended) or using the more convenient graphical modeling tool within XCode.

In addition to an entity, a managed object needs a *managed object context*. Object contexts manage the life cycle of a collection of managed objects. A managed object context needs a *persistence store coordinator* to manage the persistence of managed objects as well as their retrieval from the store. A store can be a SQLite database, in-memory, or binary file storage.

19.2 Key Players

In this section, we talk about the major classes in the Core Data framework. In essence, we present the Core Data stack.

19.2.1 Entity

Entities are represented by an instance of the `NSEntityDescription` class. As a minimum, this instance needs a name. The following code fragment shows how to create an instance of this class:

```
NSEntityDescription *userEntity =
    [[[NSEntityDescription alloc] init] autorelease];
[userEntity setName:@"User"];
```

Attributes are represented by the `NSAttributeDescription` class. To add an attribute, such as name, to an entity, you first create it as follows:

```
NSAttributeDescription *nameAttribute;
nameAttribute = [[[NSAttributeDescription alloc] init] autorelease];
[nameAttribute setName:@"name"];
[nameAttribute setAttributeType:NSStringAttributeType];
[nameAttribute setOptional:NO];
```

In the above code fragment, we set the name of this attribute, provide its type (a string), and specify that is mandatory. After creating the attribute(s), the properties are added as follows:

```
[userEntity setProperties:
    [NSArray arrayWithObjects: dobAttribute, nameAttribute, nil]];
```

In the above code, we set the properties of the `User` entity to two attributes.

19.2.2 Managed object model

A managed object model is an instance of the `NSManagedObjectModel` class. There are two options available to create an instance of this class:

- **Objective-C code.** You start by creating entities and then adding these entities to an instance of `NSManagedObjectModel` using the `setEntities:` method.
- **Data modeling.** You use a data modeling tool in XCode to graphically build your data model, save it to a file, and load it at run time into an instance of `NSManagedObjectModel` class. The easiest initializer is the `mergedModelFromBundles:` method. If you pass in `nil` as the argument, all models in the main bundle are loaded and used to initialize the instance as shown below:

```
NSManagedObjectModel *managedObjectModel =
    [[NSManagedObjectModel mergedModelFromBundles:nil] retain];
```

19.2.3 Persistent store coordinator

A persistence store coordinator is an instance of the `NSPersistentStoreCoordinator` class. You first create an instance of this class and then initialize it with the managed object model instance. After that, you add a persistence store to it. The following code shows a typical setup:

```
NSURL *storeUrl = [NSURL fileURLWithPath:[NSHomeDirectory()
    stringByAppendingPathComponent:@"Documents/database.sqlite"]];
NSError *error;
NSPersistentStoreCoordinator *persistentStoreCoordinator =
    [[NSPersistentStoreCoordinator alloc]
        initWithManagedObjectModel:self.managedObjectModel];
if (! [persistentStoreCoordinator
    addPersistentStoreWithType:NSSQLiteStoreType
    configuration:nil URL:storeUrl options:nil error:&error]) {
    NSLog(@"error");
}
```

In the above code, we specify the SQLite store type and the location of the database file in the home directory of the application.

19.2.4 Managed object context

Managed object contexts are instances of the `NSManagedObjectContext` class. The following code fragment shows the setup of an instance of this class:

```
managedObjectContext = [[NSManagedObjectContext alloc] init];
[managedObjectContext
    setPersistentStoreCoordinator:persistentStoreCoordinator];
```

Notice how a managed object context needs a persistence store coordinator in order to retrieve and persist the managed objects it manages.

19.2.5 Managed object

In an MVC Core Data application, the model is captured by the managed object; an instance of `NSManagedObject`. To create a managed object, you can use the following class method of `NSEntityDescription`:

```
+ (id)insertNewObjectForEntityForName:(NSString *)entityName
    inManagedObjectContext:(NSManagedObjectContext *)context;
```

Here, you attach a managed object instance configured to work with a specific entity to a managed object context. The method returns the managed object autoreleased.

The following shows a typical example:

```
User *user = (User *) [NSEntityDescription
    insertNewObjectForEntityForName:@"User"
    inManagedObjectContext:self.managedObjectContext];
user.dob      = [NSDate date];
user.name     = @"Kate";
user.social   = @"555-12-9898";
```

To save this object into the persistence store (e.g., a database table), you must send its context a `save:` message passing a reference to an `NSError` object, or `NULL` if you are not interested in receiving potential error messages.

19.2.6 Summary

If the previous description seems somewhat abstract, this section will make things concrete by giving a complete Core Data wrapper class that you can find in the `CoreDataBasic1` project which can be found in the source downloads. The class interface is shown in Listing 19.1.

An application needs one instance of this class. It provides a basic Core Data stack that can be used. The three needed main objects (context, coordinator, and model) are created and initialized for you as we shall see shortly. In addition, it provides a `save` method for saving all managed objects to the store.

Listing 19.1 Interface for the Core Data wrapper.

```
#import <CoreData/CoreData.h>
#import "User.h"
@interface CoreDataWrapper : NSObject {
    NSPersistentStoreCoordinator *persistentStoreCoordinator;
    NSManagedObjectModel         *managedObjectModel;
    NSManagedObjectContext       *managedObjectContext;
}
@property(nonatomic, readonly, retain)
    NSPersistentStoreCoordinator *persistentStoreCoordinator;
@property(nonatomic, readonly, retain)
    NSManagedObjectModel        *managedObjectModel;
@property(nonatomic, readonly, retain)
    NSManagedObjectContext       *managedObjectContext;
- (id)init;
- (BOOL)save;
@end
```

Listing 19.2 shows some of the implementation of the wrapper class. We've talked about most of these methods. The `init` method simply starts the stack build process by retrieving the value of the context. The method `managedObjectContext` gets called and it checks to see if the object was initialized before. Since all instance variables are initialized to `nil`, the method proceeds by retrieving the persistence coordinator and attaching this coordinator to the context.

The `persistentStoreCoordinator` method checks to see if the coordinator was created before. If not, it creates it and initializes it as we saw before in Section 19.2.3. The initialization uses a managed object model instance.

The `managedObjectModel` checks to see if the model was created before. If not, it creates from either code (shown in Listing 19.3) or loading it from file.

Listing 19.2 Some of the implementation of the wrapper class.

```
#import "CoreDataWrapper.h"
@implementation CoreDataWrapper
- (id)init{
    if(self = [super init]){
        self.managedObjectContext;
    }
    return self;
}
- (BOOL)save{
    NSError *error;
    if ([self.managedObjectContext save:&error]) {
        return YES;
    }
    return NO;
}
- (NSManagedObjectContext *)managedObjectContext {
    if (managedObjectContext) {
        return managedObjectContext;
    }
    NSPersistentStoreCoordinator *coordinator =
        self.persistentStoreCoordinator;
    if (coordinator) {
        managedObjectContext = [[NSManagedObjectContext alloc] init];
        [managedObjectContext setPersistentStoreCoordinator:coordinator];
    }
    return managedObjectContext;
}
- (NSManagedObjectModel*) managedObjectModel{
#ifndef FALSE
    return [self managedObjectModelFromCode];
#else
    if(managedObjectModel){
        return managedObjectModel;
    }

```

```
managedObjectModel =
    [[NSManagedObjectModel mergedModelFromBundles:nil] retain];
    return managedObjectModel;
#endif
}
- (NSPersistentStoreCoordinator*) persistentStoreCoordinator{
    if (persistentStoreCoordinator) {
        return persistentStoreCoordinator;
    }
    NSURL *storeUrl =
        [NSURL fileURLWithPath: [NSHomeDirectory()
            stringByAppendingPathComponent:@"Documents/database.sqlite"]];
    NSError *error;
    persistentStoreCoordinator =
        [[NSPersistentStoreCoordinator alloc]
            initWithManagedObjectModel:self.managedObjectModel];
    if (![persistentStoreCoordinator
        addPersistentStoreWithType:NSSQLiteStoreType configuration:nil
        URL:storeUrl options:nil error:&error]){
        NSLog(@"error");
    }
    return persistentStoreCoordinator;
}
- (void)dealloc{
    [persistentStoreCoordinator release];
    [managedObjectModel release];
    [managedObjectContext release];
    [super dealloc];
}
@end
```

Listing 19.3 Creating a managed object model with a User entity from code.

```
- (NSManagedObjectModel*) managedObjectModelFromCode{
    if (managedObjectModel) {
        return managedObjectModel;
    }
    managedObjectModel = [[NSManagedObjectModel alloc] init];
    NSEntityDescription *userEntity = [[[NSEntityDescription alloc] init]
        autorelease];
    [userEntity setName:@"User"];
    [userEntity setManagedObjectClassName:@"User"];
    [managedObjectModel setEntities:[NSArray arrayWithObject:userEntity]];
    NSAttributeDescription *dobAttribute;
    dobAttribute = [[NSAttributeDescription alloc] init] autorelease];
    [dobAttribute setName:@"dob"];
    [dobAttribute setAttributeType:NSDateAttributeType];
    [dobAttribute setOptional:NO];
```

```

NSAttributeDescription *nameAttribute;
nameAttribute = [[[NSAttributeDescription alloc] init] autorelease];
[nameAttribute setName:@"name"];
[nameAttribute setAttributeType:NSStringAttributeType];
[nameAttribute setOptional:NO];
NSAttributeDescription *socialAttribute;
socialAttribute = [[[NSAttributeDescription alloc] init] autorelease];
[socialAttribute setName:@"social"];
[socialAttribute setAttributeType:NSStringAttributeType];
[socialAttribute setOptional:NO];
[userEntity setProperties:
[NSArray arrayWithObjects:dobAttribute, nameAttribute,
socialAttribute, nil]];
return managedObjectModel;
}

```

In Listing 19.3, we associated the `User` entity with the Objective-C class `User` using the following statement:

```
[userEntity setManagedObjectClassName:@"User"];
```

The `User` class is shown in Listing 19.4. It simply inherits all the behavior from `NSManagedObject` class and declares three attributes. Since the Core Data framework will generate the accessor methods, you are encouraged to use the `@dynamic` directive. This directive will simply stop compiler warnings.

Listing 19.4 The `User` managed object class.

```

#import <CoreData/CoreData.h>
@interface User : NSManagedObject {
}
@property (retain) NSString *social;
@property (retain) NSString *name;
@property (retain) NSDate *dob;
@end

@implementation User
@dynamic dob, social, name;
@end

```

19.3 Using the Modeling Tool

In this section, we show how to build a simple model using the graphical modeling tool. The model will consist of two entities: `User` and `Comment`. A user can have many comments, and every comment belongs to a specific user.

The model resides in a file in the bundle. To create the model, start by creating this file.

1. Right-click on the Resources group and choose Add and then choose New File. Select Resource, choose Data Model and hit Next (see Figure 19.1).



Figure 19.1 Selecting a data model resource.

2. Choose the model name and hit Next (see Figure 19.2). Hit Finish.
3. On the diagram window, right-click and choose Add Entity (Figure 19.3).
4. Enter the name of the entity and the name of its class as shown in Figure 19.4.
5. Select the User entity and click on the + icon to add an attribute as shown in Figure 19.5.
6. Name the attribute name and choose the type to be String as shown in Figure 19.6.
7. Repeat the process and add a dob attribute of type Date, and a social attribute of type String.

The state of the User entity at this stage is shown in Figure 19.7.

8. Now, go ahead and add another model, Comment. Comment has a lat attribute of type Double, a lon attribute of type Double, and a text attribute of type String. All are mandatory.

Our data model declares that a user has many comments and each comment belongs to one user. Let's declare these relationships using the tool.

Select the User entity and choose Add Relationship as shown in Figure 19.8.

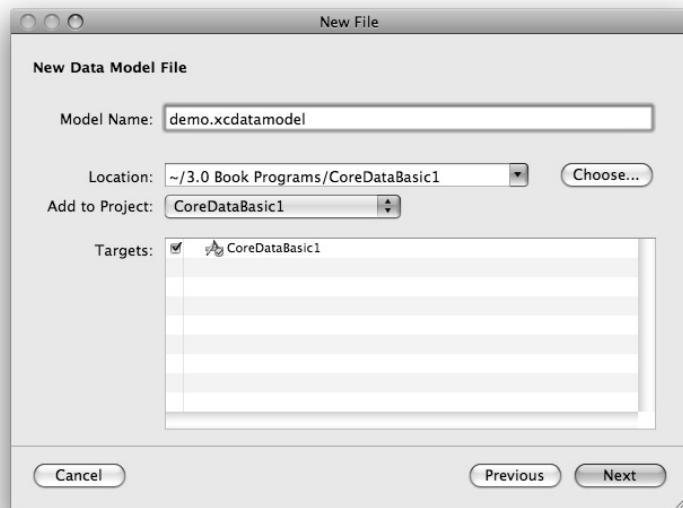


Figure 19.2 Naming the data model.

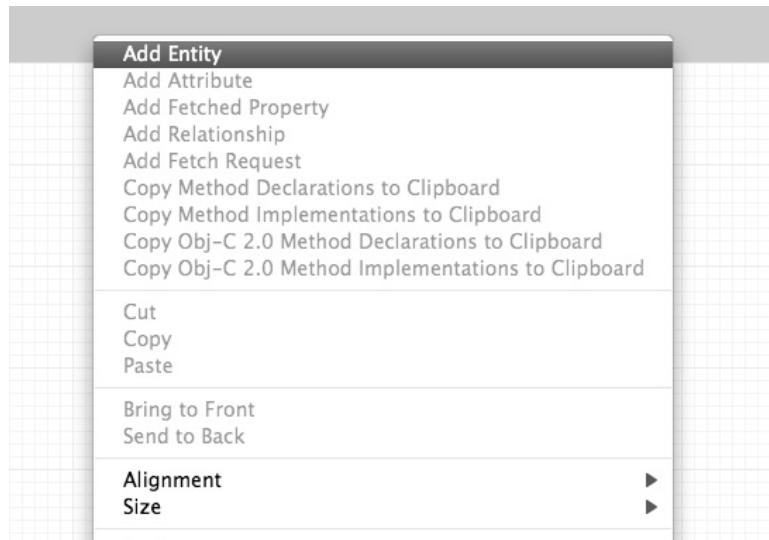


Figure 19.3 Adding a new entity to the model.

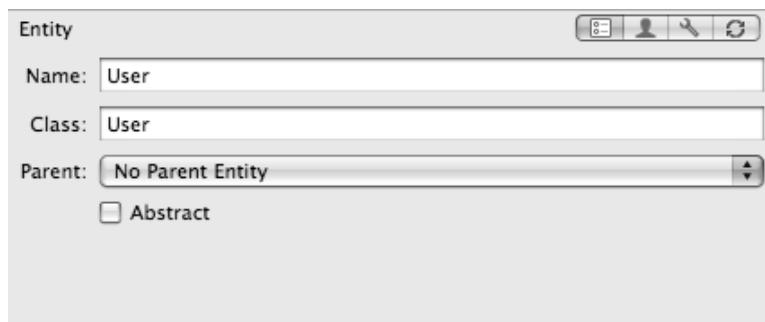


Figure 19.4 Configuring the new User entity.

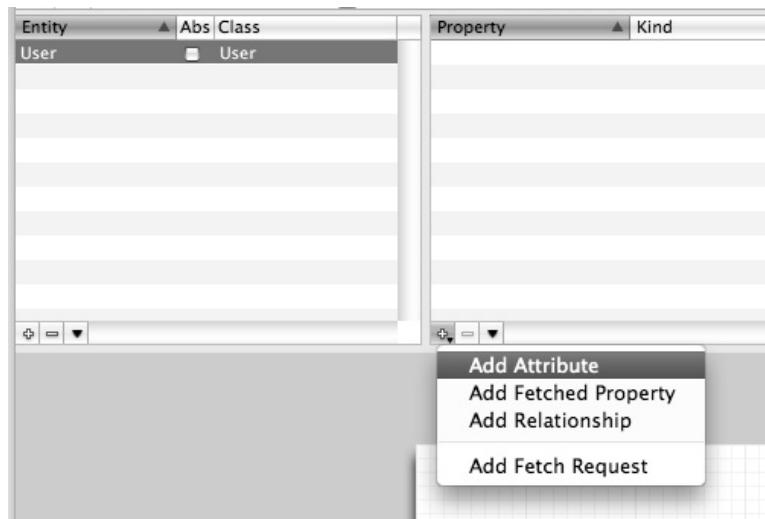


Figure 19.5 Adding a new attribute to the User entity.

9. Name the relationship `comments`, pick the destination to be the `Comment` entity. Choose a `To-Many` relationship (meaning the user will have many comments) and make the delete rule `Cascade`; this way, all comments that belong to a user will be deleted when that user is deleted. See Figure 19.9.
10. Select the `Comment` entity and add a relationship as shown in Figure 19.10.

Notice that we choose the inverse to be `comments` and the delete rule to be `No Action`.

The resulting model diagram is shown in Figure 19.11.

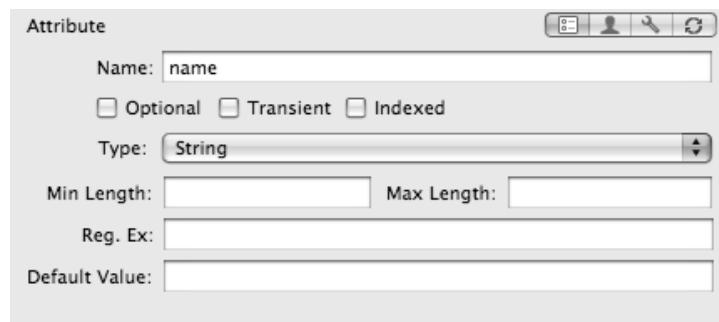


Figure 19.6 Specifying the parameters for the name attribute of the User entity.

Entity	Abs Class	Property	Kind	Type or Destination
User	User	dob	Attribute	Date
		name	Attribute	String
		social	Attribute	String

Figure 19.7 The User entity with three attributes.

Entity	Abs Class	Property	Kind	Type or Destination
Comment	Comment	dob	Attribute	Date
User	User	name	Attribute	String
		social	Attribute	String

At the bottom left, there are buttons for adding (+), deleting (-), and editing (=). A context menu is open at the bottom right, listing options: 'Add Attribute', 'Add Fetched Property', 'Add Relationship' (which is highlighted in dark grey), and 'Add Fetch Request'.

Figure 19.8 Adding a relationship in the User model.

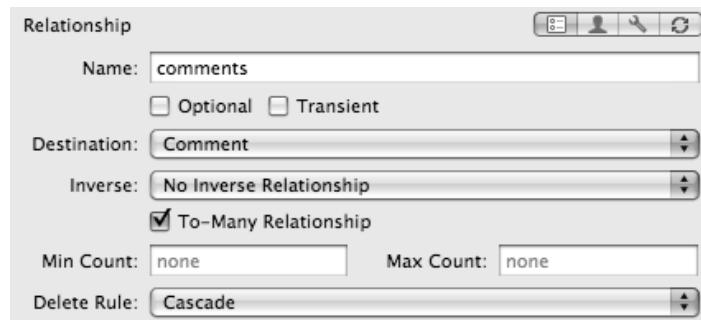


Figure 19.9 The comments relationship in the User model.

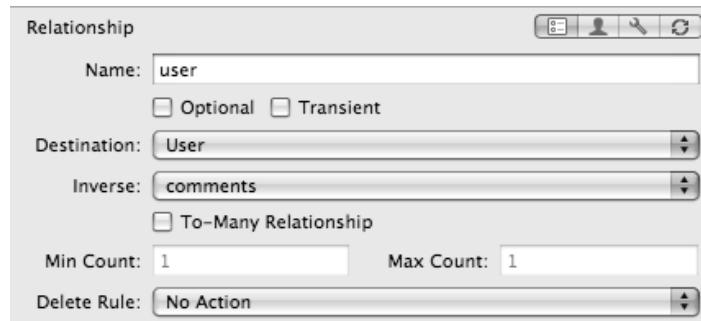


Figure 19.10 The user relationship in the Comment model.

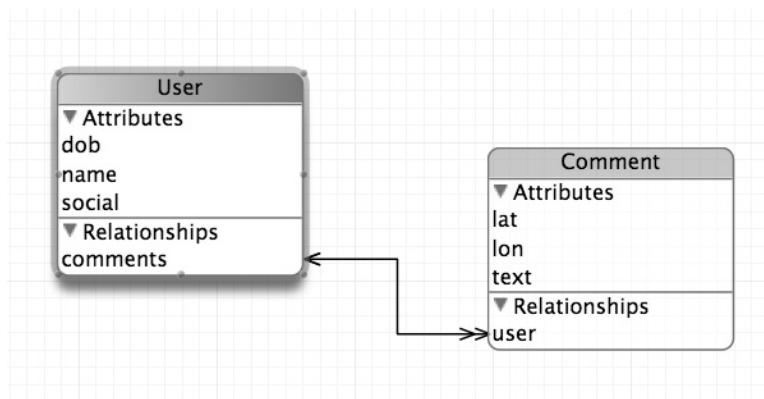


Figure 19.11 The data model consisting of User and Comment entities with relationships. Double arrows indicate To-Many relationship.

19.4 Create, Read, Update and Delete (CRUD)

In this section, we address the basic operations in persistence storage using Core Data.

19.4.1 Create

Creating a new managed object and saving it to the store is pretty straight forward. You use `NSEntityDescription`'s class method `insertNewObjectForEntityForName:inManagedObjectContext:` to obtain a fresh managed object for a given entity in a given context. After that, you simply assign values to its attributes and send a `save:` message to its context.

The following method creates a new record in the persistence store for a user with name, date of birth, and social security number.

```
- (BOOL) addUser: (NSString*) _userName dateOfBirth: (NSDate*) _dob
    andSocial: (NSString*) _social{
    User *user = (User *) [NSEntityDescription
        insertNewObjectForEntityForName:@"User"
        inManagedObjectContext:self.managedObjectContext];
    user.dob = _dob;
    user.name = _userName;
    user.social = _social;
    return [self.managedObjectContext save:NULL];
}
```

19.4.2 Delete

Deleting a record is simple. Given a managed object, you send a `deleteObject:` message to the context with that object as an argument. After that, you send the context a `save:` message to persist the change. The following shows a code fragment that accomplishes that.

```
[self.managedObjectContext deleteObject:user];
[self.managedObjectContext save:NULL];
```

19.4.3 Read and update

To update a record, you retrieve it (Read), change its attributes and save its context.

Let's turn our attention to retrieval in Core Data. To retrieve managed objects from the persistence store, you execute *fetch requests*. A fetch request is an instance of the `NSFetchRequest` class. An instance of this class can be configured with three pieces of information:

- **The name of the entity.** The fetch request must be associated with an entity. To set the entity of a fetch request instance, you use the method `setEntity:` which takes an instance of `NSEntityDescription` class as an argument.
- **The conditions of the search.** You specify the conditions using a *predicate*. A predicate is an instance of the class `NSPredicate`. This is optional.
- **The sort criteria.** You specify the sort criteria by using the method `setSortDescriptors:` passing in an array of `NSSortDescriptor` instances. Sort descriptors with lower indices in this array are given higher precedence in the sorting algorithm. Sorting is optional.

Once you have configured the fetch request object, you use the following instance method of the `NSManagedObjectContext` class to retrieve the managed objects:

```
- (NSArray *)  
executeFetchRequest:(NSFetchRequest *)request error:(NSError **)error
```

Unconditional fetch

The following method shows how to retrieve all `User`'s managed objects:

```
- (NSArray*)allUsers{  
    NSFetchedResultsController *request =  
        [[[NSFetchRequest alloc] init] autorelease];  
    NSEntityDescription *entity =  
        [NSEntityDescription entityForName:@"User"  
            inManagedObjectContext:self.managedObjectContext];  
    [request setEntity:entity];  
    return [self.managedObjectContext  
        executeFetchRequest:request error:NULL];  
}
```

The method simply specifies the name of the entity whose managed objects are being retrieved and executes the fetch. No sorting or conditions are specified (i.e., in the case of a SQL table, all rows are retrieved with no ordering).

Conditional fetch

As an example of specifying fetch conditions, the following method searches for all `User` records where the `name` attribute matches a query:

```
- (NSArray*)usersWithNameQuery:(NSString*)_query{  
    NSFetchedResultsController *request = [[[NSFetchRequest alloc] init] autorelease];  
    NSEntityDescription *entity =  
        [NSEntityDescription  
            entityForName:@"User"]
```

```

        inManagedObjectContext:self.managedObjectContext];
[request setEntity:entity];
NSPredicate *predicate =
[NSPredicate predicateWithFormat:
@"name like[cd] %@", [NSString stringWithFormat:@"*%@*", _query]];
[request setPredicate:predicate];
return [self.managedObjectContext
executeFetchRequest:request error:NULL];
}

```

To specify the condition, a new `NSPredicate` object is generated using the `predicateWithFormat:` class method. Here, we are saying that the `name` attribute must contain the query string in it. The `[cd]` means case- and diacritic-insensitive and the `*` is used to denote zero or more characters. The `predicateWithFormat:` method does add quotes to the query. After setting the predicate, the context is asked to execute the fetch.

Another example of using a predicate is retrieval of older users. If you set the predicate to something like `dob < some_date`, you can retrieve all users older than that given date. The following method does just that:

```

- (NSArray*)olderUsers:(NSDate*)_date{
NSFetchRequest *request = [[[NSFetchRequest alloc] init] autorelease];
NSEntityDescription *entity =
[NSEntityDescription entityForName:@"User"
inManagedObjectContext:self.managedObjectContext];
[request setEntity:entity];
NSPredicate *predicate =
[NSPredicate predicateWithFormat:@"dob < %@", _date];
[request setPredicate:predicate];
return [self.managedObjectContext
executeFetchRequest:request error:NULL];
}

```

Sorted fetch

To generate a sorted result set, you use `NSSortDescriptor` class. You create a new `NSSortDescriptor` instance and initialize it with the `initWithKey:ascending:` initializer. After that, you set the sort descriptors array of the fetch request object using the `setSortDescriptors:` method. The following example shows how you can retrieve all users, sorted according to their date of birth (descending).

```

- (NSArray*)allUsersSorted{
NSFetchRequest *request = [[[NSFetchRequest alloc] init] autorelease];
NSEntityDescription *entity =
[NSEntityDescription entityForName:@"User"
inManagedObjectContext:self.managedObjectContext];

```

```
[request setEntity:entity];
NSSortDescriptor *sortDescriptor =
[[[NSSortDescriptor alloc] initWithKey:@"dob" ascending:NO]
autorelease];
[request setSortDescriptors:
[NSArray arrayWithObject:sortDescriptor]];
return [self.managedObjectContext
executeFetchRequest:request error:NULL];
}
```

19.5 Working with Relationships

Relationships in Core Data are easy. In the class representing a To-Many relationship, you declare a property of type reference to an NSSet class. For example, in the User class, you can declare the relationship with Comment as follows:

```
@property (retain) NSSet *comments;
```

In the Comment class, you declare the Belongs-To relationship with User as follows:

```
@property (retain) User *user;
```

In an inverse relationship, you can change one side of the relationship, and the other side will change automatically. For example, if you want to create a new comment for a given user, you can simply create the comment managed object, configure it with the text, latitude, longitude, and set its user property to the user managed object and save the context. Now, the user's comments property (represented by an instance of NSSet in the User class) has a new member.

The following method adds a new comment to an existing user:

```
- (BOOL)addCommentByUser: (User*)user withText: (NSString*)text
lat: (float)lat andLon: (float)lon{
Comment *comment = (Comment *) [NSEntityDescription
insertNewObjectForEntityForName:@"Comment"
inManagedObjectContext:self.managedObjectContext];
comment.user = user;
comment.text = text;
comment.lat = [NSNumber numberWithDouble:lat];
comment.lon = [NSNumber numberWithDouble:lon];
return [self.managedObjectContext save:NULL];
}
```

19.6 A Search Application

In this section, we present a search application that uses a search display controller to search for stars of TV series. The data store is an SQLite database managed by Core Data. The records (instances of `Star` managed object class) are presented in a table view.

In order to use the Core Data framework, you need to add the `CoreData.framework` to your project as explained in Section D.4. In addition, you need to add the following import statement to your code:

```
#import <CoreData/CoreData.h>
```

First, we discuss the `UISearchDisplayController` class and how it is used for managing a search bar and displaying the results of the search. Next, we present the main pieces of the application.

19.6.1 *The UISearchDisplayController class*

The `UISearchDisplayController` class is used to manage a search bar as well as providing an overlay table view for search results. When the user starts entering text in the search bar text field, the search display controller displays an overlay table view. The table view, whose data source and delegate are configured using properties of the search display controller, is then populated with records corresponding to the search. As the user changes the search text, the contents of the overlay table view is conditionally updated. If the user taps on one of the search results rows, the delegate of the overlay table view gets notified which can result in, for example, the details of this record to be shown by pushing a new view controller. Figure 19.12 shows the search display controller in action.

When the user taps the `Cancel` button, the overlay table view is removed from the display. In addition, the navigation bar reappears and the search bar is brought down.

To use the search display view controller, you need to do the following:

1. **Create and initialize it.** The controller is initialized by the following method:

```
- (instancetype)initWithSearchBar:(UISearchBar *)searchBar
                           contentsController:(UIViewController *)viewController;
```

The initializer takes as the first argument the search bar (an instance of `UISearchBar` class). The second argument should be the view controller that manages the display of the original content.

A search bar is a view that displays a text field, and cancel and bookmark buttons. In addition, you can add different scope buttons beneath it.

2. **Specify the data source for the search results.** You need to specify a value for the data source of the search results using the `searchResultsDataSource` property. This property is declared as follows:



Figure 19.12 A search display controller overlaying a table view with results from a text query in a search bar.

```
@property (nonatomic, assign)  
    id<UITableViewDataSource>    searchResultsDataSource;
```

The object should adopt the `UITableViewDataSource` protocol and usually this object is the same as the view controller used in the initialization of the search display controller.

3. **Specify the delegate of the search results.** The delegate of the overlay table view is specified using the `searchResultsDelegate` property. The object should implement the `UITableViewDelegate` protocol. As in the case of the data source, the view controller used to initialize the search display controller is usually used as the delegate of the search results table view.
4. **Specify the search display view controller delegate.** You also need to specify a delegate for the search display view controller. All methods are optional. The following two delegate methods are used to specify if the search results in the overlay table view should be reloaded when the user changes the text in the search bar text field or changes the scope of the search:

- `searchDisplayController:shouldReloadTableForSearchString:`

This method is called when the user changes the text in the text field of the search bar. The method is declared as follows:

```
- (BOOL)
searchDisplayController:(UISearchDisplayController *)controller
shouldReloadTableForSearchString:(NSString *)searchString;
```

If you return YES, the results table view is reloaded. If you determine that the search will take a long time, you may want to fire up a thread to do the actual search and return NO. When the search is finished, you can reload the table. You can access the table view of the results via the `searchResultsTableView` property which is declared as follows:

```
@property(nonatomic,readonly) UITableView *searchResultsTableView
```

- `searchDisplayController:shouldReloadTableForSearchScope::`

This method is called when the search scope of the search bar is changed. The method is declared as follows:

```
- (BOOL)
searchDisplayController:(UISearchDisplayController *)controller
shouldReloadTableForSearchScope:(NSInteger)searchOption;
```

The `searchOption` is used to pass in the index of the scope. The same logic used in the previous callback also applies here.

19.6.2 Main pieces

In the following, we present the main pieces of the application. We use a single table view controller as the data source and delegate for the main table view, the search results overlay table view, and the search display controller.

The application uses an instance of the table view controller `SearchTableViewController`. This instance is used as a root of the navigation controller of the application. The following code fragment shows the setup of the main display in the application delegate (see the `CoreDataBasic3` project in the source downloads for a complete listing).

```
navCtrl = [[UINavigationController alloc] initWithRootViewController:
[[[SearchTableViewController alloc]
initWithStyle:UITableViewStylePlain] autorelease]];
>window addSubview:navCtrl.view];
```

The initializer of the table view controller is shown below. It creates and initializes a `CoreDataWrapper` instance and uses it to retrieve all the stars records.

```
- (id)initWithStyle:(UITableViewStyle)style{
if(self = [super initWithStyle:style]){
self.cdw = [[[CoreDataWrapper alloc] init] autorelease];
self.allStars = [cdw allStars];
```

```
    self.title = @"Stars Info";
}
return self;
}
```

Listing 19.5 shows the `viewDidLoad` method of the table view controller.

Listing 19.5 The `viewDidLoad` method in the Core Data search application.

```
- (void)viewDidLoad {
[super viewDidLoad];
self.filteredListContent = [NSMutableArray array];
self.searchBar =
[[[UISearchBar alloc] initWithFrame:CGRectMake(0, 0, 320, 44)]
autorelease];
searchBar.scopeButtonTitles =
[NSArray arrayWithObjects:@"All", @"Lost", @"Simpsons", nil];
searchBar.autocorrectionType = UITextAutocorrectionTypeNo;
searchBar.autocapitalizationType = UITextAutocapitalizationTypeNone;
self.tableView.tableHeaderView = searchBar;
self.searchDisplayController =
[[[UISearchDisplayController alloc]
initWithSearchBar:searchBar contentsController:self] autorelease];
searchDisplayController.searchResultsDataSource = self;
searchDisplayController.searchResultsDelegate = self;
searchDisplayController.delegate = self;
}
```

The controller uses `filteredListContent` to store the search result records. The method creates a search bar and initializes its scope buttons with three titles. Here, we want the user to search for all stars, stars only in the Lost series, or stars only in the Simpsons series. The header view of the table view is set to be the search bar.

The search display controller is created and initialized with the search bar instance and `self` (the table view controller itself). The delegates and data source are set to be the table view controller instance. Figure 19.13 shows the main view of the search application.

As a data source for both the main table view displaying all the records and the search results table view, the following requirements must be met:

- **Specifying the number of rows in a table.** The data source method shown below checks the `tableView` argument. If it is the search results table, it returns the number of records obtained from executing the query. Otherwise, it returns the number of all records.

```
- (NSInteger) tableView:(UITableView *)tableView
 numberOfRowsInSection:(NSInteger)section {
if (tableView == searchDisplayController.searchResultsTableView) {
    return filteredListContent.count;
}
```

```
    }
    else{
        return allStars.count;
    }
}
```

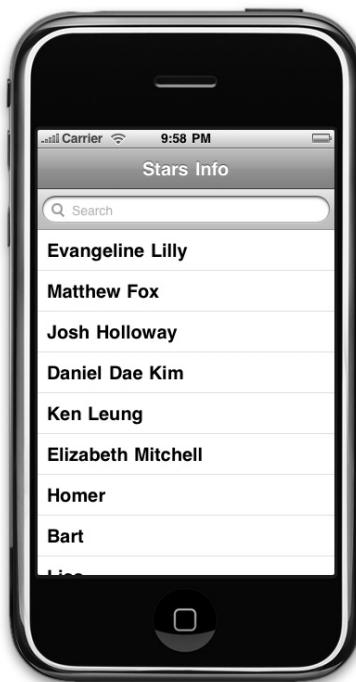


Figure 19.13 The main view in the Search app. The search bar is the table view's header.

- **Providing the cell.** If the table view is the search results table view, the cell is obtained from `filteredListContent` array. Otherwise, the `allStars` array is used. The method is shown below.

```
- (UITableViewCell *) tableView:(UITableView *)tableView
                     cellForRowAtIndexPath:(NSIndexPath *)indexPath{
    static NSString *CellIdentifier = @"Cell";
    UITableViewCell *cell =
        [tableView dequeueReusableCellWithIdentifier:CellIdentifier];
    if (cell == nil) {
        cell = [[[UITableViewCell alloc]
                  initWithStyle:UITableViewCellStyleDefault
                  reuseIdentifier:CellIdentifier] autorelease];
```

```
        }
    if (tableView == searchDisplayController.searchResultsTableView) {
        cell.textLabel.text =
            [[filteredListContent objectAtIndex:indexPath.row] name];
    }
    else {
        cell.textLabel.text =
            [[allStars objectAtIndex:indexPath.row] name];
    }
    return cell;
}
```

As we mentioned before, you can change the results table view's contents dynamically as the user types in the search bar (see Figures 19.14 and 19.15).



Figure 19.14 Searching in the Lost scope.



Figure 19.15 Searching in the Simpsons scope.

The following two methods are called by the search display controller. Both modify the `filteredListContent` array based on the new search and return YES (for reload).

```

- (BOOL)
    searchDisplayController:(UISearchDisplayController *)controller
    shouldReloadTableForSearchString:(NSString *)searchString {
    [self filterContentForSearchText:searchString
        scope:[[searchBar scopeButtonTitles]
            objectAtIndex:[searchBar selectedScopeButtonIndex]]];
    return YES;
}

- (BOOL)
    searchDisplayController:(UISearchDisplayController *)controller
    shouldReloadTableForSearchScope:(NSInteger)searchOption {
    [self filterContentForSearchText:[searchBar text]
        scope:[[searchBar scopeButtonTitles] objectAtIndex:searchOption]];
    return YES;
}

```

Both methods use the following custom method in the table view controller that does the actual search.

```

- (void)filterContentForSearchText:(NSString*)searchText
    scope:(NSString*)scope{
    [filteredListContent removeAllObjects];
    if([scope isEqualToString:@"All"]){
        [filteredListContent addObjectsFromArray:
            [self.cdw starsWithNameQuery:searchText]];
    }
    else{
        [filteredListContent addObjectsFromArray:
            [self.cdw starsWithNameQuery:searchText andSeries:scope]];
    }
}

```

The `starsWithNameQuery:` method retrieves all stars that have `searchText` in their names. This method is shown below.

```

- (NSArray*)starsWithNameQuery:(NSString*)_query{
    NSFetchedResultsController *request = [[[NSFetchedResultsController alloc] init] autorelease];
    NSEntityDescription *entity =
        [NSEntityDescription entityForName:@"Star"
            inManagedObjectContext:self.managedObjectContext];
    [request setEntity:entity];
    NSPredicate *predicate =
        [NSPredicate predicateWithFormat:@"name like[cd] %@", _query];
    [request setPredicate:predicate];
    return
        [self.managedObjectContext executeFetchRequest:request error:NULL];
}

```

The `starsWithNameQuery:andSeries:` method adds an equality condition to the above search condition and is shown below.

```
- (NSArray*)  
starsWithNameQuery: (NSString*)_query andSeries: (NSString*)_series{  
    NSFetchedResultsController *request = [[[NSFetchedResultsController alloc] init] autorelease];  
    NSEntityDescription *entity =  
        [NSEntityDescription entityForName:@"Star"  
            inManagedObjectContext:self.managedObjectContext];  
    [request setEntity:entity];  
    NSPredicate *predicate =  
        [NSPredicate predicateWithFormat:  
            @"name like[cd] %@ AND series = %@",  
            [NSString stringWithFormat:@"%@%@", _query], _series];  
    [request setPredicate:predicate];  
    return  
    [self.managedObjectContext executeFetchRequest:request error:NULL];  
}
```

19.7 Summary

In this chapter, you learned how to use the Core Data framework in your application. In Section 19.1, you learned the main components in the Core Data application. Next, in Section 19.2, we talked about the major classes in the Core Data framework. In Section 19.3, you learned how to use the graphical modeling tool to build a data model. After that, Section 19.4 addressed the basic operations in persistence storage using Core Data. Next, Section 19.5 showed how to use relationships in the Core Data model. Finally, Section 19.6 presented a search application that utilized Core Data for storage.

Problems

- (1) Read about the `NSManagedObjectModel` class in the `NSManagedObjectModel.h` header file and the documentation.
- (2) Write an application that manages users using Core Data. The application lists the users in a table view and allows the basic CRUD operations on the records. A user has a name, photo, and an address. Use SQLite for persistence.

20

Undo Management

In this chapter, you learn about undo management support in the iPhone OS. In Section 20.1, we discuss the basic steps needed to utilize undo management. After that, we present a detailed example that shows how to use undo management in Section 20.2. Next, we summarize the main rules in using the undo capabilities in an application in Section 20.3. Finally, we summarize the chapter in Section 20.4.

20.1 Understanding Undo Management

In this section, you learn the basic steps needed to add undo capabilities to your application. First, we discuss the basic idea in Section 20.1.1. After that, we talk about the undo manager in Section 20.1.2. Next, you learn in Section 20.1.3 how to register undo/redo operations. After that, you learn in Section 20.1.4 about the role that the first responder plays in the undo management. Section 20.1.4 covers the use of view controllers as first responders to undo requests. Finally, Section 20.1.5 shows what you need to do to enable shake-to-undo behavior.

20.1.1 Basic idea

Undo support provides a simple interface for managing undo/redo of user's actions. Whenever the user requests an operation that they expect to have the option of undoing, you ask an undo manager to record an action that reverts this operation.

Recording undo actions is performed on a stack. The user can shake the device to see the most recent action that can be reverted. If they select that action, the undo operation is executed. In addition, that undo operation can itself record its counterpart operation so that the user can redo the original operation. In essence, two stacks are maintained: one for undo and the other for redo.

You can invoke undo/redo operations from code if you choose to. In addition, you can disable the ability of the user to undo/redo operations by shaking the device.

If you want to utilize the undo capability in a text view, you can rely on the built-in support defined in that UI element. If, however, you want to implement this capability in, say, a view controller, you need to follow some basic rules.

20.1.2 Creating an undo manager

The undo/redo operations are managed by the `NSUndoManager` class. Any object that inherits from `UIResponder` (e.g., a `UIView`, a `UIViewController`, etc.), can create its own `NSUndoManager` instance.

Once created, the responder object can use it to store callback operations that undo other operations. When the `NSUndoManager` is asked to undo, it pops the top-most operation from the stack and calls the callback registered to undo it.

When the undo callback is executed, it can register yet another undo operation that will redo the original operation. The registration process is similar to the one that registered the undo action. The undo manager is smart enough so that it registers an operation as a redo when it is currently undoing that operation.

20.1.3 Registering an undo operation

There are two types of undo operations that can be registered:

- Simple undo
- Invocation-based undo

In simple undo, the undo operation is a selector that takes one argument. To register a simple undo operation, you send the undo manager instance a `registerUndoWithTarget:selector:-object:` message. This method is declared as follows:

```
- (void)registerUndoWithTarget:(id)target selector:(SEL)selector  
object:(id)anObject;
```

The `target` argument is the object that will receive the undo/redo message when the undo/redo operation is invoked. That message is basically the second and third argument. For example, an undo manager that is sent the following message:

```
[undoManager registerUndoWithTarget:aTarget  
selector:@selector(addValue:)  
object:@"Original"];
```

will send a `addValue:@"Original"` message to `aTarget` when an undo operation is requested.

If, however, your undo operation takes more than one argument, you need to use invocation-based undo. This is a two-step process. First, you need to prepare the undo manager by sending it a

`prepareWithInvocationTarget:` message, passing in the object that should receive the undo message. After that, you send the undo manager a message that the target object you passed in the first step should receive when the undo operation is requested. For example, the following statement:

```
[undoManager prepareWithInvocationTarget:anObject]
    setFather:@"Homer" mother:@"Marge" spouse:nil];
```

will result in the undo manager sending `anObject` the following message when undo is requested:

```
setFather:@"Homer" mother:@"Marge" spouse:nil
```

The `NSUndoManager` object implements this behavior using the concepts behind the `forwardInvocation:` method and the `NSInvocation` class. Refer to Section 2.11 for more information.

Note that, after registering an undo operation, the redo stack is cleared.

20.1.4 Hooking into the undo management mechanism

Whenever the user shakes the device, a call to retrieve the value of the property `undoManager` is sent to the first responder. This property is defined in the `UIResponder` class as follows:

```
@property(nonatomic) NSUndoManager *undoManager
```

If the first responder object has its own undo manager, that undo manager object is returned to the system and the appropriate options are displayed to the user (see Figure 20.1).

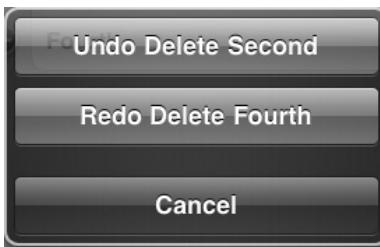


Figure 20.1 Undo menu appearing in the middle of undo/redo session after a device shake.

When the user makes a selection, that selection, whether undo or redo, is sent to the undo manager of the first responder in the form of either an `undo` or `redo` message. The corresponding operation is executed on the target of the registered undo message that is on top of the stack. If the first responder object is the target of the undo/redo message, it can reflect that change in its data as well as in the UI. If, on the other hand, the target is different, and the object responsible for maintaining the UI has previously registered to receive undo/redo notifications, then it will receive such notifications and can update the UI accordingly. Examples of notifications include:

- `NSUndoManagerWillUndoChangeNotification`. Posted just before an `NSUndoManager` object performs an undo operation.
- `NSUndoManagerDidUndoChangeNotification`. Posted just after an `NSUndoManager` object performs an undo operation.
- `NSUndoManagerWillRedoChangeNotification`. Posted just before an `NSUndoManager` object performs a redo operation.
- `NSUndoManagerDidRedoChangeNotification`. Posted just after an `NSUndoManager` object performs a redo operation.

Using undo with view controllers

View controllers are subclasses of the `UIResponder` class. To be able to interact with the user using the Undo menu, a view controller needs to follow simple rules:

- **Become first responder while its view is showing.** The view controller needs to be the first responder so that it receives actions from the Undo menu. To achieve that, the view controller needs to do two things:
 - Override `canBecomeFirstResponder` method and return YES.
 - Override `viewDidAppear:` and send itself a `becomeFirstResponder` message.
- **Resign first responder when the view it is managing disappears.** The controller needs to override `viewWillDisappear:` method and send itself a `resignFirstResponder` message.
- **Define an NSUndoManager property.** To be hooked into the undo mechanism, the view controller needs to declare a property similar to the following:

```
@property(nonatomic, retain) NSUndoManager *undoManager;
```

The `undoManager` name must be used exactly as it is shown. It is not enough to declare a property of type `NSUndoManager*`; it has to be called `undoManager`.

- **Create an instance of NSUndoManager when the user requests editing.** Once the user hits Done, the `NSUndoManager` instance should be deleted.

20.1.5 Enabling shake to edit behavior

To enable the Undo menu, the `UIApplication` instance must be configured so that shaking the device displays that menu. This can be done in the delegate method `applicationDidFinishLaunching:` as follows:

```
application.applicationSupportsShakeToEdit = YES;
```

20.2 Detailed Example

In this section, we present an application that supports undo management. The application uses a table view to show a list of items. If the user chooses to edit the table by tapping on the `Edit` button, the table view enters editing mode where the user can delete specific rows. When the user asks for a row to be deleted, the table view controller registers the value stored in this row to be added as an undo operation. After that, the row is deleted and the UI is updated.

When the user shakes the device and selects to undo the top-most operation, the method for adding a row is called with the old value of that row passed in as an argument. The method adds a new row with the value passed as its content, registers an undo event with the old value, and updates the UI. Since the undo manager is undoing while the undo registration is requested, it interprets that operation as a redo operation.

20.2.1 The view controller class

The view controller is declared in Listing 20.1.

Listing 20.1 The view controller used in demonstrating undo management.

```
@interface MyTableViewController : UITableViewController {
    NSUndoManager *undoManager;
    NSMutableArray *data;
}
@property(nonatomic, retain) NSUndoManager *undoManager;
@property(nonatomic, retain) NSMutableArray *data;
@end
```

The view controller maintains its own instance of `NSUndoManager` class. In addition, its data model is captured by a mutable array.

20.2.2 First responder status

The view controller maintains its responsibility as a first responder using the following method overrides:

```
- (BOOL)canBecomeFirstResponder {
    return YES;
}

- (void)viewDidAppear:(BOOL)animated {
    [super viewDidAppear:animated];
    [self becomeFirstResponder];
}
```

```
- (void)viewDidDisappear:(BOOL)animated{
    [super viewDidDisappear:animated];
    [self resignFirstResponder];
}
```

20.2.3 Editing mode and the NSUndoManager instance

To support editing, the view controller adds an Edit button in its viewDidLoad method as follows:

```
- (void)viewDidLoad {
    [super viewDidLoad];
    self.navigationItem.rightBarButtonItem = self.editButtonItem;
}
```

To respond to changes in the editing mode, the controller overrides setEditing:animated: method as follows:

```
- (void)setEditing:(BOOL)editing animated:(BOOL)animated {
    [super setEditing:editing animated:animated];
    if(editing) {
        self.undoManager = [[[NSUndoManager alloc] init] autorelease];
        [undoManager setLevelsOfUndo:10];
    }
    else{
        self.undoManager = nil;
    }
}
```

The undo manager is created and configured if the view controller is entering the editing mode. Since the undo stack capacity is defaulted to unlimited, the view controller sets appropriate stack capacity according to its needs and memory constraints. Here, it sets it to a maximum of 10 undo operations. If this limit is exceeded, the oldest undo operation is deleted first to make space. Note that setLevelsOfUndo:0 message will result in unlimited stack capacity.

If the view controller is leaving the editing mode, the undo manager is released. This event occurs when the user taps the Done button which means that they are expecting the changes to be permanent.

20.2.4 Registering undo actions

When the user requests the deletion of a row, the view controller deletes the row by calling the method deleteRowAtIndexPath:. This method is defined as follows:

```
- (void)deleteRowAtIndexPath:(NSInteger)index{
    NSString *item = [data objectAtIndex:index];
    [undoManager registerUndoWithTarget:self
```

```

        selector:@selector(addValue:)
        object:[data objectAtIndex:index]];
[data removeObjectAtIndex:index];
if (! [undoManager isUndoing]) {
    [undoManager
        setActionName:[NSString stringWithFormat:@"Delete %@", item]];
}
[self.tableView reloadData];
}

```

The method starts by retrieving the value of the item to be deleted. It then registers a simple undo action having a selector equal to `addValue:` and an object value equal to the item to be deleted. After that, it deletes the item from the data model. Next, the name of the undo/redo operation is set using the `setActionName:` method. Finally, the table view is reloaded to reflect the change in the data model. It's worth noting that the deleted item is retained by the `NSUndoManager` but the target (i.e., the view controller object) is not. Also, notice that the action name is only set if the `deleteRowAtIndexPath:` is invoked, while not in the process of undoing an operation.

When an undo operation is requested from the view controller, the method `addValue:` is invoked, passing in the original value of the item that was deleted. The method is defined as follows:

```

- (void)addValue:(NSString*)value{
    [undoManager registerUndoWithTarget:self
        selector:@selector(delete:)
        object:value];
    [data addObject:value];
    [self.tableView reloadData];
}

```

The method above starts by registering a redo operation but this time passing in the `delete:` selector and the object value that is about to be added to the data model. After adding the new item, the UI is refreshed by reloading the table view. Notice that the just registered operation is considered a redo as it was invoked while the undo manager is performing an undo.

The `delete:` method simply iterates over the elements in the mutable array looking for the item whose value is passed in. When found, the `deleteRowAtIndexPath:` method is called, passing in the index of that item. The method is shown below.

```

- (void)delete:(NSString*)value{
    for(int i=0; i< data.count; i++){
        if([[data objectAtIndex:i] isEqualToString:value]){
            [self deleteRowAtIndexPath:i];
            break;
        }
    }
}

```

The complete application can be found in the `UndoMgmt` project available from the source downloads.

20.3 Wrapping Up

To employ undo management in your application, you need to observe some simple rules.

If you use, as is mostly the case, a view controller to manage undo/redo operations, that view controller needs to become the first responder when its view appears, and resign as first responder when its view disappears.

The view controller needs to create a new instance of `NSUndoManager` when it enters editing mode. It also needs to delete that undo manager instance when it quits the editing mode.

The view controller needs to register undo callback operations as well as the action names. When the user requests an undo operation, the view controller should undo the operation and register a redo operation so that the user can redo the operation.

20.4 Summary

In this chapter, you learned about undo management support in the iPhone OS. In Section 20.1, we discussed the basic steps needed to utilize undo management. After that, we presented a detailed example that showed how to use undo management in Section 20.2. Finally, we summarized the main rules governing the use of the undo capabilities in an application in Section 20.3.

Problems

- (1) Study the `NSUndoManager` class in the `NSUndoManager.h` header file and the documentation.
- (2) Update the sample application described in this chapter to accommodate insertion of new rows.
- (3) In the example we presented, we did not need the receipt of notifications from the `NSUndoManager` instance. Read about what kind of notifications you can receive in the documentation.

21

Copy and Paste

This chapter examines the copy and paste capabilities of the iPhone OS and the supporting APIs. We start in Section 21.1 by discussing pasteboards. In Section 21.2, you learn about pasteboard items and the various methods available to you to manipulate them. In Section 21.3, we address the subject of the Editing Menu which is used by the user to issue editing commands. Section 21.4 puts all the ideas behind copy and paste together and presents a simple image editing application. Finally, we summarize the chapter in Section 21.5.

21.1 Pasteboards

Pasteboards are regions in memory that are shared among applications. The system can have an unlimited number of pasteboards where each pasteboard is uniquely identified by a name. A pasteboard can be configured to be persistent across application and device restarts.

21.1.1 *System pasteboards*

Two persistent system pasteboards are defined for you:

- **General pasteboard.** The General pasteboard, identified by the unique name `UIPasteboardNameGeneral`, can be used to store any type of information.
- **Find pasteboard.** The Find pasteboard, identified by the name `UIPasteboardNameFind`, is used to store the search text that the user enters in the search bar.

21.1.2 *Creating pasteboards*

A pasteboard is represented by the class `UIPasteboard`. You can obtain a reference to a system pasteboard using one of the methods of this class. For example, to obtain the shared instance of the

General pasteboard, you can use the `generalPasteboard` class method. To obtain a reference to the Find pasteboard, use `pasteboardWithName:create:` which is declared as follows:

```
+ (UIPasteboard *)pasteboardWithName:(NSString *)pasteboardName  
                           create:(BOOL)create;
```

You pass in `UIPasteboardNameFind` for the first argument and `NO` for the second.

To create a new pasteboard, you can use the method above by passing in a unique name for the first argument and `YES` for the second argument.

If, on the other hand, you want the system to create a pasteboard with a unique name, you can use the method `pasteboardWithUniqueName` which is declared as follows:

```
+ (UIPasteboard *)pasteboardWithUniqueName
```

21.1.3 Properties of a pasteboard

To access the name of a pasteboard, you can use the read-only `name` property which is declared as follows:

```
@property(nonatomic) NSString *name
```

To free the resources of a pasteboard, you can invalidate it by calling the method `removePasteboardWithName:` passing in the name of the pasteboard. Any messages to a pasteboard after sending it the previous message will be ignored.

The persistent status of a pasteboard is determined by the following property:

```
@property(nonatomic) BOOL persistent
```

A persistent application pasteboard remains persistent until the application that created it is uninstalled.

21.2 Pasteboard Items

A pasteboard is a collection of items. Each pasteboard item is a dictionary containing key/value pairs. The key is a string that identifies the type of the representation of the value. For example, the key `public.png` (`kUTTypePNG`) identifies a value as a `.png` image.

A pasteboard item can, and usually does, store more than one value. For example, an application might store three images as an item where each image represents the same picture in a specific format (e.g., `.png`, `.tiff`, `.jpeg`). Other applications can query this item for a format that they can use.

21.2.1 Pasteboard items

To find out how many items are stored in a given pasteboard, you can use the `numberOfItems` property which is declared as follows:

```
@property(nonatomic) NSInteger numberOfRowsInSection
```

To obtain an array of the items stored, you can use the `items` property declared as follows:

```
@property(nonatomic, copy) NSArray *items
```

You can use this property to set the items of a pasteboard by providing an array of dictionaries where each dictionary represents an item.

21.2.2 Manipulating pasteboard items

To overwrite a pasteboard with a given value for a specific type, you can use the `setValue:forPasteboardType:` method which is declared as follows:

```
- (void)setValue:(id)value forPasteboardType:(NSString *)pasteboardType
```

For example, to store a UTF8 string in the General pasteboard, you can write something like the following:

```
[UIPasteboard generalPasteboard]
    setValue:@"This is a text."
    forPasteboardType:@"public.utf8-plain-text"];
```

After executing the above statement, all items on the General pasteboard will be removed and the pasteboard will hold a single item.

Most of the time, a uniform type identifier (UTI) is used as the representation type of the a pasteboard item value. Applications can define their own UTI types, but for values to be communicated across applications, the type must be known to these applications.

The following shows some of the predefined UTI types:

- `public.jpeg` (`kUTTypeJPEG`). This UTI type represents a JPEG image.
- `public.mpeg` (`kUTTypeMPEG`). This UTI type represents a MPEG movie.
- `public.rtf` (`kUTTypeRTF`). This UTI type represents a rich text document.
- `public.html` (`kUTTypeHTML`). This UTI type represents an html content.

You use the `valueForPasteboardType:` method to retrieve the value of a given type from the first item in the pasteboard. All other items are ignored by this method. The method is declared as follows:

- (**id**)**valueForPasteboardType:** (**NSString** *)**pasteboardType**

The class of the returned object depends on the **pasteboardType** argument. If the value is not identified to be an instance of **NSString**, **NSArray**, **NSDictionary**, **NSDate**, **NSNumber**, or **NSURL**, an **NSData** instance representing the raw value is returned.

To retrieve the raw data, you use the **dataForPasteboardType:**. This method returns an **NSData** instance representing the value having the passed-in type. This method, too, works only on the first item in the pasteboard.

You use the **setValue:forPasteboardType:** method to store **NSString**, **NSArray**, **NSDictionary**, **NSDate**, **NSNumber**, or **NSURL** values. If you want to store the value of some other type, you use the **setData:forPasteboardType:** method which is declared as follows:

- (**void**)
 setData: (**NSData** *)**data** **forPasteboardType:** (**NSString** *)**pasteboardType**

You pass in the data in the first argument and the type in the second.

Convenient methods

The following are convenient properties that can be used to retrieve/set values of common types:

- **String(s).** To store/retrieve a string value, use the following property:

`@property(nonatomic, copy) NSString *string`

To store/retrieve an array of strings, use the **strings** property:

`@property(nonatomic, copy) NSArray *strings`

- **Image(s).** To store/retrieve an image value, use the following property:

`@property(nonatomic, copy) UIImage *image`

To store/retrieve an array of images, use the **images** property:

`@property(nonatomic, copy) NSArray *images`

- **Url(s).** To store/retrieve an **NSURL** value, use the following property:

`@property(nonatomic, copy) NSURL *URL`

To store/retrieve an array of **NSURL** values, use the **URLs** property:

`@property(nonatomic, copy) NSArray *URLs`

- **Color(s).** To store/retrieve a **UIColor** value, use the following property:

`@property(nonatomic, copy) UIColor *color`

To store/retrieve an array of **UIColor** values, use the **colors** property:

`@property(nonatomic, copy) NSArray *colors`

21.3 The Editing Menu

The Editing Menu is used to provide basic Copy, Cut, Paste, Select, and Select All commands. When you present the menu to the user, they can select the appropriate command. When your responder object (e.g., a view controller) receives that command, it needs to update the affected view and, if required by the command, update the pasteboard.

21.3.1 The standard editing actions

The `UIResponder.h` header file declares a category on `NSObject` that any responder that wishes to receive commands from the Editing Menu is expected to implement. This category is `UIResponderStandardEditActions` and is shown below:

```
@interface NSObject (UIResponderStandardEditActions)
- (void)cut:(id)sender;
- (void)copy:(id)sender;
- (void)paste:(id)sender;
- (void)select:(id)sender;
- (void)selectAll:(id)sender;
@end
```

The `sender` in the above methods is usually the singleton Editing Menu instance.

When the user taps on a command in the Editing Menu, the first responder is checked for the corresponding method. If that method is implemented, it will be invoked. Otherwise, the search continues along the responder chain.

The first responder can enable a subset of the editing commands, if it wishes to, by overriding the `UIResponder` method `canPerformAction:withSender:` which is declared as follows:

```
- (BOOL)canPerformAction:(SEL)action withSender:(id)sender
```

The above method allows you to provide meaningful commands that are appropriate for the current situation. For example, if there are no images in the pasteboard and the user can paste only images, the above method should return `NO` if `action` is equal to `@selector(paste:)`. Once there are images in the pasteboard, that method should return `YES`. You can force the Editing Menu to update itself (which will result in the above method getting called for each possible Editing Menu item) should you deem that necessary. All you have to do to force an update is to send an `update` message to the singleton Editing Menu instance.

21.3.2 The `UIMenuController` class

The Editing Menu is a singleton of the class `UIMenuController`. You can obtain this singleton by invoking the `sharedMenuController` class method. Once you have obtained this menu, you need

to set its *target rectangle*. The target rectangle conceptually defines the bounding box of the user's selection. However, it can be anything.

Once you have set up the menu, you can make it visible by sending the instance a `setMenuVisible:YES animated:YES` message. The menu will try to position itself above the target rectangle. If there is not enough space, the menu is positioned under the target rectangle. The menu has a pointer and that pointer is positioned at the center of the top or bottom of the target rectangle depending on the menu placement decision.

21.3.3 The role of the view controller

The view controller is usually the one responsible for displaying the Editing Menu and responding to its commands. In order for a view controller to work with the Editing Menu, a few rules must be observed:

- The view controller must override the `canBecomeFirstResponder` method and return YES as follows:

```
- (BOOL) canBecomeFirstResponder {  
    return YES;  
}
```

- The view controller must become the first responder when its view appears. This is usually done as follows:

```
- (void)viewDidAppear: (BOOL)animated{  
    [super viewDidAppear:animated];  
    [self becomeFirstResponder];  
}
```

- The view controller must resign as the first responder when its view disappears. This is usually done as follows:

```
- (void)viewDidDisappear: (BOOL)animated{  
    [super viewDidDisappear:animated];  
    [self resignFirstResponder];  
}
```

- The view controller should implement the appropriate action method declared in the `UIResponderStandardEditActions` category. In addition, it should implement the `canPerformAction:withSender:` method and return the appropriate value depending on the current state of the editing process.
- The view controller should show the menu at the appropriate time so that the user can perform editing actions.

21.4 Putting it Together

In this section, we present a complete editing application. The application presents to the user a number of small images. The user can select/unselect an image by tapping on it or by tapping on the area near it and choosing Select from the Editing Menu. In addition, the user can copy, cut, and paste some or all of the images. The complete application can be found in the `CopyPaste2` project available from the source downloads.

21.4.1 The image view

Each image is represented by the `MyImageView` class. This class is declared as follows:

```
@interface MyImageView : UIView {
    BOOL      selected;
    UIImage *image;
}
@property(assign)           BOOL selected;
@property(nonatomic, retain) UIImage *image;
@end
```

Each instance of this class maintains a reference to its image. In addition, the selected state of the image view is maintained by the `selected` instance variable.

The designated initializer `initWithImage:` is shown below:

```
- (id)initWithImage:(UIImage *)_image{
    if(self = [super init]){
        self.image = _image;
    }
    return self;
}
```

The method simply stores a reference to the image in its instance variable.

To enable selection when the image view is tapped, the following `UIResponder` method is overridden:

```
- (void)touchesEnded:(NSSet *)touches withEvent:(UIEvent *)event{
    self.selected = !selected;
}
```

The method simply toggles the selection state. The setter of the `selected` property is custom and is shown below:

```
- (void)setSelected:(BOOL)_selected{
    selected = _selected;
    [self setNeedsDisplay];
}
```

The method updates the instance variable with the new value and sends a message to its instance so that the view redraws itself. This will result in `drawRect:` getting invoked. The `drawRect:` method is shown below.

```
- (void)drawRect:(CGRect)rect{
    [super drawRect:rect];
    [self.image drawInRect:rect];
    if(selected){
        CGContextRef context = UIGraphicsGetCurrentContext();
        [[UIColor redColor] set];
        CGContextSetLineWidth(context, 7.0);
        CGContextMoveToPoint(context, 0, 0);
        CGContextAddLineToPoint(context, self.bounds.size.width, 0);
        CGContextAddLineToPoint(context, self.bounds.size.width,
                               self.bounds.size.height);
        CGContextAddLineToPoint(context, 0, self.bounds.size.height);
        CGContextAddLineToPoint(context, 0, 0);
        CGContextStrokePath(context);
    }
}
```

The `drawRect:` method simply draws the image in the view. After that, it draws a red rectangle around that image if the image view is selected.

21.4.2 The view controller

The view controller is responsible for the editing of its view. The `loadView` method is shown below.

```
- (void)loadView {
    MyView *theView =
    [[[MyView alloc] initWithFrame:CGRectMake(0, 0, 320, 480)]
     autorelease];
    theView.delegate = self;
    self.view = theView;
    self.view.backgroundColor = [UIColor grayColor];
    MyImageView *imgView =
    [[[MyImageView alloc]
      initWithImage:[UIImage imageNamed:@"Flower1.jpg"]]
     autorelease];
    imgView.frame = CGRectMake(50, 50, 70, 70);
    [self.view addSubview:imgView];

    imgView =
    [[[MyImageView alloc]
      initWithImage:[UIImage imageNamed:@"Flower2.jpg"]]
     autorelease];
    imgView.frame = CGRectMake(50, 150, 70, 70);
    [self.view addSubview:imgView];
}
```

The method simply creates the container view (an instance of `MyView` class) and adds two image views (instances of `MyImageView` class) as subviews.

The `MyView` class declaration is shown below:

```
@interface MyView : UIView {
    UIResponder *delegate;
}
@property(nonatomic, assign) UIResponder *delegate;
@end
```

It declares a `delegate` property that is required to be a responder.

The implementation of the class simply overrides one of the `UIResponder` methods and proxies that call to the delegate as shown below:

```
- (void)touchesEnded:(NSSet *)touches withEvent:(UIEvent *)event{
    [self.delegate touchesEnded:touches withEvent:event];
}
```

The view controller, acting as the delegate of its view, overrides that `UIResponder` method as shown below:

```
- (void)touchesEnded:(NSSet *)touches withEvent:(UIEvent *)event{
    UIMenuController *menu = [UIMenuController sharedMenuController];
    self.lastTouchRect =
        (CGRect){ [[touches anyObject] locationInView:self.view], CGSizeZero};
    [menu setTargetRect:lastTouchRect inView:self.view];
    [menu setMenuVisible:YES animated:YES];
}
```

The method above shows the Editing Menu near where the touch occurred.

All editing actions are implemented. However, not all actions are enabled all the time. Therefore, the `canPerformAction:` must be implemented. The method is shown below.

```
- (BOOL)canPerformAction:(SEL)action withSender:(id)sender{
    BOOL somethingSelected = [self selectedObjects].count;
    if((action == @selector(copy:)) && somethingSelected){
        return YES;
    }
    if((action == @selector(cut:)) && somethingSelected){
        return YES;
    }
    if(action == @selector(selectAll:)){
        return YES;
    }
    if(action == @selector(select:)){
        return YES;
    }
}
```

```
if( (action == @selector(paste:)) && [self pasteableItem]) {
    return YES;
}
return NO;
}
```

Copying and cutting are enabled only if at least one image is selected. Pasting is enabled if there is at least one image in the pasteboard. Selection is always enabled.

To determine if there is at least one image selected, the method `selectedObjects` is invoked to obtain all selected images. The method simply iterates over the subviews of the main view, checking for the selection state as shown below:

```
- (NSArray*)selectedObjects{
    NSMutableArray *arr = [NSMutableArray array];
    for(MyImageView *imgView in [self.view subviews]){
        if([imgView isKindOfClass:[MyImageView class]]){
            if(imgView.selected){
                [arr addObject:imgView];
            }
        }
    }
    return [[arr copy] autorelease];
}
```

Notice how the method uses the `isKindOfClass:` method to check if each subview is an instance of `MyImageView` before sending the `selected` message to that view. Of course, in our case, all subviews of the main view are instances of `MyImageView` class and this check is not needed. However, if in the future, not all subviews are instances of `MyImageView` class, this check becomes essential.

To enable pasting, the following method is used:

```
- (id)pasteableItem{
    return (id)([UIPasteboard generalPasteboard]
               valueForPasteboardType:@"public.png"] ||
               [UIPasteboard generalPasteboard]
               valueForPasteboardType:@"public.jpeg"]);
}
```

The method simply checks to see if there is an image in the pasteboard that is of type PNG or JPEG. It returns the `UIImage` instance if one is found. Otherwise, it returns `nil`. Notice that the method only checks the first pasteboard item. It's worth noting that images are treated as a special case and you do not need to convert them to `NSData`. An image is stored as a `UIImage` instance in the pasteboard.

The `cut:` and `copy:` methods are shown below:

```

- (void)cut:(id)sender {
    [self saveImagesInPasteboardAndDelete:YES];
}

- (void)copy:(id)sender{
    [self saveImagesInPasteboardAndDelete:NO];
}

```

These two methods invoke the same method passing a different value for its argument. The `saveImagesInPasteboardAndDelete:` method is shown below:

```

- (void)saveImagesInPasteboardAndDelete:(BOOL)alsoDelete{
    NSMutableArray *images = [NSMutableArray array];
    NSArray *selectedObjects = [self selectedObjects];
    for(MyImageView *imgView in selectedObjects){
        [images addObject:
            [NSDictionary dictionaryWithObject:imgView.image
                                         forKey:@"public.png"]];
        if(alsoDelete){
            [imgView removeFromSuperview];
        }
    }
    [UIPasteboard generalPasteboard].items = images;
}

```

The method first obtains all the image views that are selected. After that, it iterates over these objects and creates a pasteboard item for each image. If the `alsoDelete` argument is equal to YES, the corresponding image view is removed from the main view. After iterating over all selected views, the pasteboard items are used to set the `items` property of the General pasteboard. This, in effect, overwrites all items in the pasteboard with the selected images.

The `paste:` method is shown below:

```

- (void)paste:(id)sender {
    float xOffset = 0.0;
    float yOffset = 0.0;
    for(UIImage *image in [UIPasteboard generalPasteboard].images){
        MyImageView *imgView =
            [[[MyImageView alloc] initWithImage:image] autorelease];
        imgView.frame =
            CGRectMake(lastTouchRect.origin.x + xOffset,
                      lastTouchRect.origin.y + yOffset, 70, 70);
        [self.view addSubview:imgView];
        xOffset += 15;
        yOffset += 15;
    }
}

```

The method simply obtains all the images in the pasteboard, creates a `MyImageView` instance for each image, and adds that instance as a subview to the main view. To keep these images from overwriting each other in the case of multiple images, the frame of each view is adjusted.

The `selectAll:` method is shown below:

```
- (void)selectAll:(id)sender {
    for(MyImageView *imgView in [self.view subviews]){
        if([imgView isKindOfClass:[MyImageView class]]){
            imgView.selected = YES;
        }
    }
}
```

The method simply sets the `selected` property of every image view to YES;

The `select:` method is shown below:

```
- (void)select:(id)sender {
    for(MyImageView *imgView in [self.view subviews]){
        if([imgView isKindOfClass:[MyImageView class]]){
            if(CGRectContainsPoint(
                CGRectMake(0, imgView.frame.origin.y, 320,
                          imgView.frame.size.height),
                lastTouchRect.origin)){
                imgView.selected = YES;
            }
        }
    }
}
```

The method above simply iterates over all image views creating a virtual rectangle whose height is the height of the current image view and whose width is the width of the display (320). The y-coordinate of the origin of the imaginary rectangle is assumed to be the origin of the current image view.

After creating that imaginary rectangle, the last touch on the main view is checked to see if it lies inside this rectangle. If that is the case, that image view is selected. This algorithm is arbitrary. You can devise your own algorithm according to your needs.

Figure 21.1 shows a screenshot of the editing application. Refer to the `CopyPaste2` project, available from the source downloads, for a complete listing.

21.5 Summary

This chapter examined the copy and paste capabilities of the iPhone OS and the supporting APIs. We started in Section 21.1 by discussing pasteboards. In Section 21.2, you learned about pasteboard

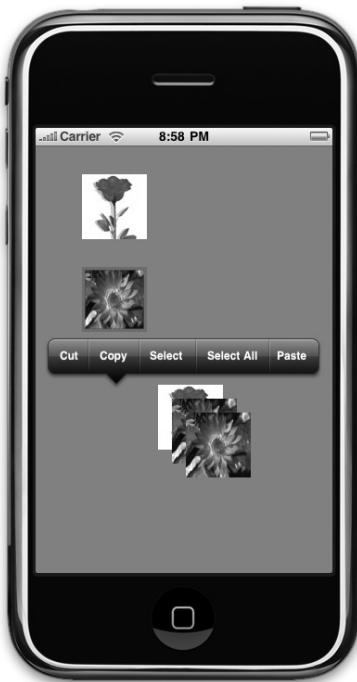


Figure 21.1 A screenshot of the editing application.

items and the various methods available to you to manipulate them. In Section 21.3, we addressed the subject of the Editing Menu which is used by the user to issue editing commands. Section 21.4 put all the ideas behind copy and paste together and presented a simple image editing application.

Problems

- (1) Add undo capabilities to the application presented in Section 21.4.
- (2) Study the `UIMenuController` class in the documentation and in the `UIMenuController.h` header file.
- (3) Study the `UIPasteboard` class in the documentation and in the `UIPasteboard.h` header file.

APPENDICES

A

Saving and Restoring App State

Since at most one application can run at a given time, your application should give the user the illusion of being active all the time even if the user presses the Home button. To achieve that, your application should save its current state (e.g., which level of hierarchy it is currently displaying, the current search term, etc.) when the application is terminated, and restore that state when it is relaunched.

There are several ways in which you can maintain this state information. You can, for example, use the `SQLite` database or flat-files. A Property List, however, is ideal for this situation and is the subject of this appendix.

To use Property Lists for capturing/restoring the state of an application, you need to follow the following guidelines:

- Represent the state in a dictionary or in an array.
- The state elements can be instances of `NSDictionary`, `NSArray`, `NSData`, `NSDate`, `NSNumber`, and `NSString`.
- Add the state elements to the dictionary or the array.
- Serialize the dictionary or the array into an `NSData` object using the `NSPropertyListSerialization` class method.
- The `NSData` object represents the state information in either an XML or a binary format. For efficiency, use binary format.
- Write the `NSData` object into a local file in the `Documents` directory.
- To restore the state, load the written file into an `NSData` object and use the `NSPropertyListSerialization` class method to obtain the dictionary or the array.

In the following, we give an example of saving/restoring an application state using Property Lists. The state of the application is assumed to be captured by a dictionary. This dictionary has five elements: two `NSStrings`, one `NSNumber`, one `NSArray`, and one `NSDate` value.

Listing A.1 shows the application delegate method that demonstrates the Property List concept. The method builds the state of the application (a dictionary) and invokes `saveAppState` to save the state and then `restoreState` to restore it.

Listing A.1 The delegate method used in building the app state, saving it, and then restoring it using Property Lists.

```
- (void) applicationDidFinishLaunching: (UIApplication *)application {
    // build app state
    state = [ [NSMutableDictionary alloc] initWithCapacity:5];
    [state setObject:@"http://www.thegoogle.com" forKey:@"URL"];
    [state setObject:@"smartphones" forKey:@"SEARCH_TERM"];
    [state setObject:[NSNumber numberWithFloat:3.14] forKey:@"PI"];
    [state setObject:
        [NSMutableArray arrayWithObjects:@"Apple iPhone 3G",
                                 @"Apple iPhone",
                                 @"HTC Touch Diamond",
                                 nil]
        forKey:@"RESULT"];
    [state setObject:[NSDate date] forKey:@"DATE"];
    // save state of app
    [self saveAppState];
    // restore state of app
    [self restoreState];
}
```

Of course, in a real app, you will restore the state of the app in the `applicationDidFinishLaunching:` method and save it in the `applicationWillTerminate:` method. The above example does both in the same method to keep things simple.

Listing A.2 shows the `saveAppState` method. The method uses the class method `dataFromPropertyList:format:errorDescription:` of the class `NSPropertyListSerialization` to obtain an `NSData` object of the serialized dictionary. There are two formats you can use: binary format specified using `NSPropertyListBinaryFormat_v1_0` or XML format specified using `NSPropertyListXMLFormat_v1_0`. You can also give a reference to an `NSString` object that can be used to signal back an error message. It is your responsibility to release that object if an error should occur. Once you have obtained the `NSData` object, you can write it to a local file.

Listing A.2 Saving the state of the application in a Property List.

```
- (void) saveAppState{
    NSString *theError;
    NSData *theData = [NSPropertyListSerialization
                      dataFromPropertyList:state
                      format:NSPropertyListXMLFormat_v1_0
                      errorDescription:&theError];

    if(theData){
        NSString *fileName = [NSHomeDirectory()
```

```

        stringByAppendingPathComponent:@"Documents/state.plist"];
    [theData writeToFile:fileName atomically:YES];
}
else{
    NSLog(@"Error saving app state: %@", theError);
    [theError release]; // need to release
}
}

```

Listing A.3 shows the contents of the XML file `state.plist` used to store the application's state. The number of bytes used to store the state in XML format is 543 while it is 204 when the binary format is used.

Listing A.3 The Property List in XML format.

```

<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN"
"http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
    <key>DATE</key>
    <date>2008-09-04T17:47:28Z</date>
    <key>PI</key>
    <real>3.1400001049041748</real>
    <key>RESULT</key>
    <array>
        <string>Apple iPhone 3G</string>
        <string>Apple iPhone</string>
        <string>HTC Touch Diamond</string>
    </array>
    <key>SEARCH_TERM</key>
    <string>smartphones</string>
    <key>URL</key>
    <string>http://www.thegoogle.com</string>
</dict>
</plist>

```

Listing A.4 shows the method used to restore the application's state. First, the file is read into an `NSData` object using the techniques in Chapter 10. After that, the class method `propertyListFromData:mutabilityOption:format:errorDescription:` is used to obtain the dictionary object. The parameter `mutabilityOption` is used to specify the mutability of the objects returned. If you specify `NSPropertyListImmutable`, then the dictionary, as well as all of its entries, will be returned as immutable. If you specify `NSPropertyListMutableContainersAndLeaves`, then the dictionary and all of its entries will be created as mutable objects. The option `NSPropertyListMutableContainers`, which we use here, generates mutable objects for arrays and dictionaries only.

Listing A.4 Restoring the state of the application in a Property List.

```
- (void) restoreState{
    NSString          *theError;
    NSPropertyListFormat  format;

    NSString *fileName = [NSHomeDirectory()
                           stringByAppendingPathComponent:@"Documents/state.plist"];
    NSData   *theData = [[NSData alloc] initWithContentsOfFile:fileName];
    if(theData) {
        [state release];
        state = [NSPropertyListSerialization
                  propertyListFromData:theData
                  mutabilityOption:NSPropertyListMutableContainers
                  format:&format errorDescription:&theError];
        if(state) {
            [state retain];
        }
        else{
            NSLog(@"Error retrieving app state: %@", theError);
            [theError release]; // need to release
        }
        [theData release];
    }
}
```

B

Invoking External Applications

Your iPhone application can programmatically invoke other iPhone applications. Moreover, you can open your iPhone application to be invoked by other iPhone applications. To accomplish that, you specify a new URL scheme in the application's bundle, and the system will register that new scheme once the application is installed.

To invoke another iPhone application, you use the `UIApplication` instance method `openURL:` and pass in the URL of that application. The following code fragment will open the `Maps` application and display a specific address.

```
NSString *address = @"http://maps.google.com/maps?q=plano,tx";
NSURL *myURL = [NSURL URLWithString:address];
[[UIApplication sharedApplication] openURL:myURL];
```

To register a new URL scheme, you need to add it to the `Info.plist` file. In Figure B.1, we show what needs to be added to register the new URL scheme `lookup`. The `URL identifier` can be any unique string.

▼ URL types	(1 item)
▼ Item 1	(2 items)
URL identifier	com.mycompany.lookup
▼ URL Schemes	(1 item)
Item 1	lookup

Figure B.1 Adding a new URL scheme in the `Info.plist` file.

To actually service the invocation, you need to implement the application delegate's method `application:handleOpenURL:`, which is declared as follows:

```
- (BOOL)
application:(UIApplication *)application handleOpenURL:(NSURL *)url
```

You receive an instance of NSURL encapsulating the URL used in the invocation. You can use the many methods of NSURL in order to retrieve queries, parameters, and fragments according to your needs. For example, our lookup scheme can be invoked by using either the ZIP code or the city. To look up based on the ZIP code, you invoke it as follows: `lookup://www?zip#68508`. To invoke it using the city, you use `lookup://www?city#Lincoln`.

Listing B.1 shows an implementation of the lookup URL scheme handling. To retrieve the query, we use the `query` method of NSURL. This can be either "city" or "zip". To retrieve the fragment, we use the `fragment` method. The implementation below, simply displays the important parts of the invocation URL. If you cannot process the request, you return NO. Otherwise, you service it and return YES.

Listing B.1 An implementation of the lookup URL scheme handling.

```
- (BOOL)
    application:(UIApplication *)application handleOpenURL:(NSURL *)url{
    NSString *query = [url query];
    NSString *fragment = [url fragment];
    NSMutableString *output;
    if ([query isEqualToString:@"zip"]){
        output = [NSMutableString
                  stringWithFormat:@"Looking up by zip code %@", fragment];
    }
    else if ([query isEqualToString:@"city"]){
        output = [NSMutableString
                  stringWithFormat:@"Looking up by city %@", fragment];
    }
    else return NO;
    textView.text = output;
    return YES;
}
```

C

App Store Distribution

The App Store submission process consists of the following steps:

1. The development team uses XCode to build a binary of the application with appropriate code signing. You use the iPhone Developer Program Portal to obtain the required certificates and profiles in order to prepare the application for distribution. Consult the Program Portal User Guide for step-by-step instructions.
2. Once the application has been successfully built and code signed, it needs to be compressed and uploaded to Apple's iTunes Connect site. In addition to the compressed binary, a 512 × 512 image representing the app on iTunes Store must be uploaded. A scaled-down (57 × 57) icon of the same image must be used by the application as an icon on the customer's Spring Board screen. An additional five snapshots of the app can be uploaded. These images will be used by users browsing the store to get a feeling of the application. Your app can choose to show a splash screen that is displayed for a second or so when the user launches the app. It's preferable to make the splash screen identical (scaled up to 320 × 480, of course) to the icon of the app. To add a splash screen, just name the image Default.png and put it in the main bundle of the app before code signing.
3. Description of the app (for every localization) is also required in this process. Ideally, it needs to be limited to 700 characters, but you can go up to 3000 characters. Marketing should work hard on producing the best app description. You may want initially to limit your claims, though. The reviewers do go over your claims while reviewing the app. Once the app has been approved, you can modify the description. But remember to always be truthful.
4. The price and geographic distribution (only US, global, etc.) is also required. This determines the App Stores where your application can be purchased.

After providing this information, the app can be submitted for review. Apple's Review Team usually responds within a week. If you're lucky, you don't hear from the review team at all. Instead, you will receive a wonderful message saying: "Dear John Doe, The status for the following application has changed to Ready for Sale." It takes several hours from the receipt of this email for the app to show on the iTunes Store.

If, on the other hand, the review team is not happy with some aspect of your app, you will receive a description of the problem (with possible screenshots of the offending feature) and a possible

reference to a section in the iPhone's Human Interface Guideline (HIG) document. For example, you might receive something like the following:

```
"Please review the Handling Common Tasks section of the
iPhone's Human Interface Guideline (HIG) here:
https://developer.apple.com/iphone/library/documentation/UserExperience/Conceptual/MobileHIG>"
```

You fix the problem, and submit a new binary again. You do not need to change other aspects of the submission if the problem is in the application itself. If the review team finds another problem, they respond back (within a week or so) with another screenshot and another section of the HIG to read.

This process repeats, until you give up, have a heart attack, or you receive a "Ready for Sale" email. Sorry, but you don't receive a list of issues in one go. One issue at a time!

One of the first things that a reviewer will do is to check your handling of network connectivity. Your application needs to detect network failure and display meaningful text explaining to the user the problem and how they can fix it (e.g., disable Airplane Mode). You cannot just display a white screen and a loading activity indicator that does not stop! Check out Section 17.1 for information on how you can detect network connectivity.

You can change the price of the app, its description, geographic distribution market, etc., any time after the app appears in the store. A new binary, however, requires that you go through the process again. Once a revision is approved, the old version is removed and is replaced by the new one. This swap is not instantaneous, though. This might result in lost sales for a few hours. Note that if you exclude a given market, which the previous version used to be distributed in, the customers in that market will not receive your app updates.

There are thousands and thousands of apps in 20 categories available for download. Marketing your app cannot be overemphasized.

D

Using XCode

XCode is a powerful IDE for Mac/iPhone development. In this appendix, we cover several topics related to using XCode. First, we show some useful shortcuts. Next, we talk about writing custom templates for your classes and after that we cover build configuration. Finally, we show you how to add references to other libraries (also known as frameworks).

D.1 XCode Shortcuts

The following are some of the common shortcuts in XCode:

- **Quick Open.** To open a file quickly, use Command-Shift-D.
- **Build Project.** To build your project, use Command-B.
- **Global Search.** To search for something in your project, use Shift-Command-F.
- **Spelling and Grammar.** To show spelling and grammar, use Command-:.
- **Shift Text.** To shift text to the right, use Command-]. To shift to the left, use Command-[. Select a block to shift it. No selection is needed for a single line.
- **Message Bubbles.** To show message bubbles, use Shift-Command-H. To hide message bubbles, use Option-Shift-Command-H.
- **Documentation.** To open documentation on something (e.g., class), Option-Double-Click it. To show its declaration, Command-Double-Click it.

D.2 Creating Custom Templates

File templates are widely used in XCode. For example, to create a `TableViewController`, you choose `File->New` and select the `TableViewController` under the `Cocoa Touch Class` category. This is very helpful as you do not want to write all the necessary delegate and data source method signatures, etc.

In this section, you learn how easy it is to create your own templates. All templates live under the "/Developer/Platforms/iPhone-OS.platform/Developer/Library/Xcode/-File Templates" directory. To create a template (XYZ) for a class, you create a directory with the name XYZ.pbfiletemplate and place class.h, class.m, and TemplateInfo.plist files in it. See Figure D.1 for an example of the directory structure of a template.

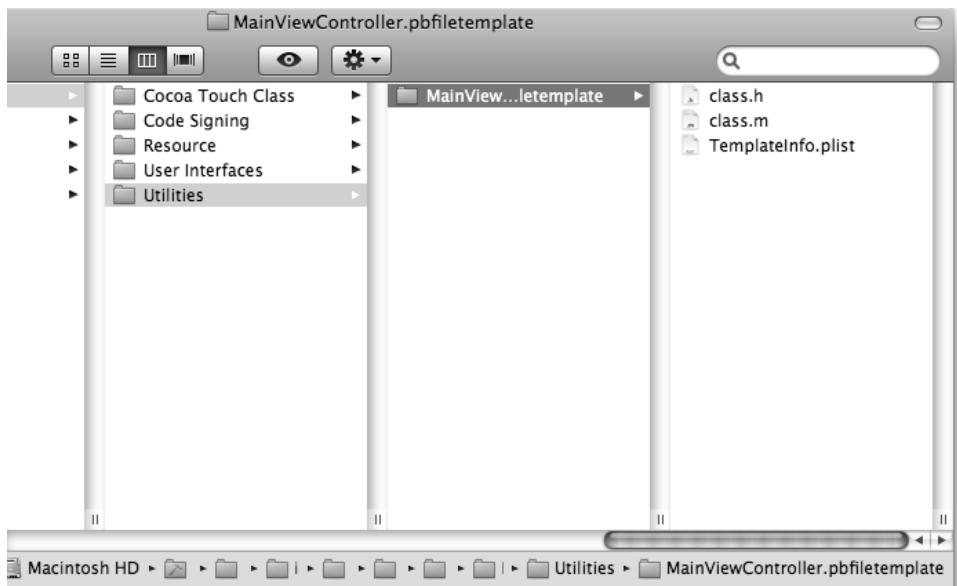


Figure D.1 The directory structure for a new class template. The template is for class MainViewController under a new category, Utilities.

Inside the `class.h` file, you put the interface template for this class. The implementation of the class goes into `class.m`. The `.pbfiletemplate` file has three key/value pairs. The `MainTemplateFile` key has the value `class.m`. The `CounterpartTemplateFile` key has the value `class.h`. The `Description` key has as its value the description of this template. Figure D.2 shows the contents of an example `.pbfiletemplate` file.

Key	Value
▼Information Property List	(3 items)
MainTemplateFile	class.m
CounterpartTemplateFile	class.h
Description	An Objective-C class which is a subclass of UIViewController, with an optional header file which

Figure D.2 The `.pbfiletemplate` file describing the file template.

Inside the `class.h` and `class.m` files, you write the template as if you are trying to write a class from scratch. Of course, you want to use *tags* in the template in order for it to be reusable. There are several tags you can put in the two files. These tags are all-caps and enclosed between « and »¹. The following are some of the tags you can use:

- «FILEBASENAMEASIDENTIFIER». This is the file name (without extension) that the user enters when they create a class based on your template. The file name will be fixed if it is not a valid C identifier. For example, if the user enters `Hello World` for the file name, you get `Hello_World` out of this tag.

You use this tag in your class interface and implementation. For example:

```
@interface «FILEBASENAMEASIDENTIFIER»: UIVViewController{
```

- «FULLUSERNAME». This tag provides the full name of the user. You can use it in the copyright header, etc.
- «TIME». This tag provides the current time.
- «PROJECTNAME». This tag provides the project's name.

Once you have these three files written inside the directory, you can start using them from XCode.

D.2.1 *Changing template macro definitions*

You can change the default values of most of the tags mentioned above by setting their values in the `PBXCustomTemplateMacroDefinitions` dictionary.

The easiest way to change these default values is to use the `defaults` command from the Terminal application. For example, the following command changes the organization to Alcatel-Lucent:

```
defaults write com.apple.Xcode PBXCustomTemplateMacroDefinitions \
'{ORGANIZATIONNAME = "Alcatel-Lucent";}'
```

You will need to restart XCode for the above command to take effect. From this point on, any file you create in XCode, will have a comment block at the top, whose copyright is similar to the following:

```
//
//  UntitledAppDelegate.m
//  CrossLight
//
//  Created by Maher Ali on 5/19/09.
//  Copyright Alcatel-Lucent 2009. All rights reserved.
//
```

¹To get a «, use Option-\. To get a », use Shift-Option-\.

D.3 Build-Based Configurations

You are building an iPhone app that uses an application server. During testing on the simulator, you want the application to hit the server running on your local machine. During testing on the device, you want to hit a beta external server. When you build for the App Store, you want to hit a secured production server. You do not want to change your code based on the build. You would rather have the server name as part of the build.

In this section, we show how easy it is to accomplish this task. Let's build a project in XCode with the following simple main function:

```
int main(int argc, char *argv[]) {
    NSAutoreleasePool * pool = [[NSAutoreleasePool alloc] init];
    NSLog([NSBundle mainBundle] objectForKey:@"Server"]);
    [pool release];
}
```

In `main`, we retrieve from the `.plist` file of the app the value for the key `Server`. The value can be retrieved using the method `objectForInfoDictionaryKey:` of the main bundle instance.

In XCode, locate your `.plist` file in the Resources group and click on it. Right-click to add a new row as shown in Figure D.3.

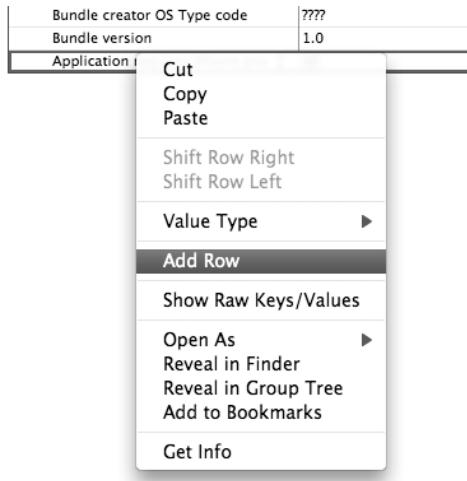


Figure D.3 Adding a new row in the `.plist`.

Add the `Server/$AppServer` key/value pair in the `.plist` as shown in Figure D.4. This line will add a new key with the value of the variable `$AppServer`.

Bundle creator OS Type code	????
Bundle version	1.0
Application requires iPhone env	<input checked="" type="checkbox"/>
Server	\$AppServer

Figure D.4 Adding the Server/\$AppServer key/value in the .plist.

Now, we will specify the value for \$AppServer in the Debug and Release builds. Double-click on the target in the Targets group as shown in Figure D.5.

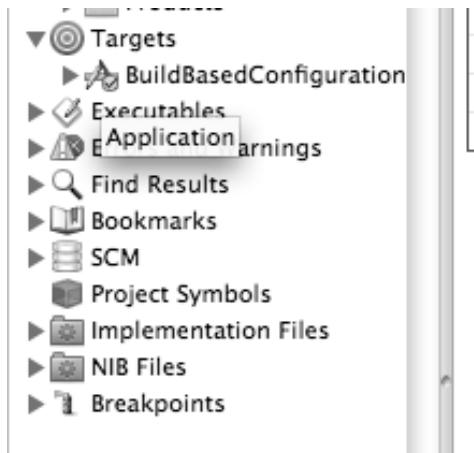


Figure D.5 Locating the target under Targets group.

Select the Debug configuration as shown in Figure D.6.

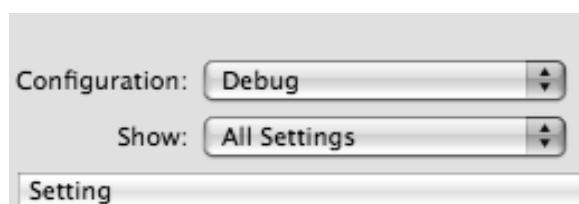


Figure D.6 Selecting the configuration (here, either Debug or Release).

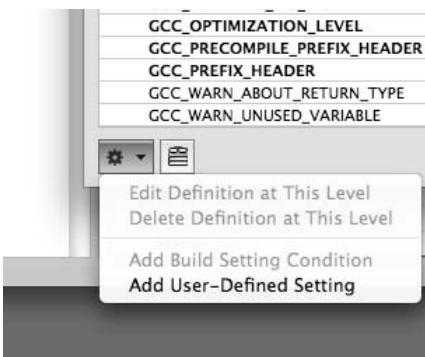


Figure D.7 Adding a user-defined setting for a specific configuration in a given target.

Add a user-defined setting as shown in Figure D.7.

Figure D.8 shows the highlighted key/value pair to enter for the Debug configuration.

SHOW WARNINGS	
Show Warnings	<input checked="" type="checkbox"/>
User-Defined	
AppServer	http://localhost:3000
GCC_C_LANGUAGE_STANDARD	c99
GCC_DYNAMIC_NO_PIC	NO
GCC_OPTIMIZATION_LEVEL	0

Figure D.8 The key/value pair for the Debug configuration.

Repeat this process and enter the key/value pair for the Release configuration as shown in Figure D.9.

SHOW WARNINGS	
Show Warnings	<input checked="" type="checkbox"/>
User-Defined	
AppServer	https://app.com
GCC_C_LANGUAGE_STANDARD	c99
GCC_PRECOMPILE_PREFIX_HEADER	YES
GCC_PREFIX_HEADER	

Figure D.9 The key/value pair for the Release configuration.

Now, when you change the configuration, the output of the `main()` function will change.

D.4 Using Frameworks

The iPhone SDK comes with a variety of frameworks that you can use. To use a framework, you need to `#import` its main header file and include a reference to that framework in the target.

When you create a new project, three frameworks are automatically added for you. These three frameworks are: Foundation, UIKit, and CoreGraphics. In addition, two import statements are added to the `xxx_prefix.pch` file, where `xxx` stands for the project's name entered by you. These two statements are:

```
#import <Foundation/Foundation.h>
#import <UIKit/UIKit.h>
```

In this section, we show how you can add other frameworks to your target. The Core Location framework is used here as an example.

First, you need to add a reference to the main header file by adding the following statement so that any code that references the Core Location classes is able to find them.

```
#import <CoreLocation/CoreLocation.h>
```

You can simply add this statement to the `xxx_prefix.pch` file. This way, all other files can benefit from this import.

In addition, you need to add the framework to the target. In XCode, select the `Project->Edit Active Target` menu as shown in Figure D.10.



Figure D.10 Project > Edit Active Target menu.



Figure D.11 Target Info window.

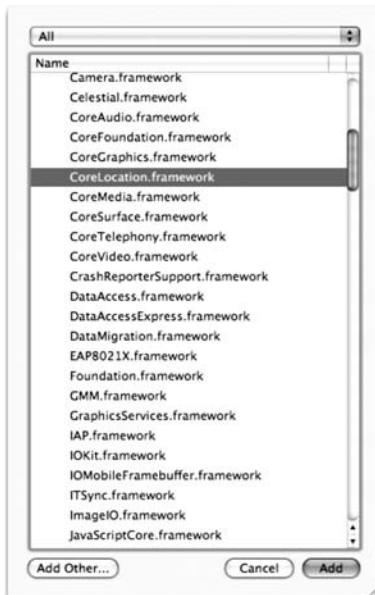


Figure D.12 The CoreLocation.framework library.



Figure D.13 The added Core Location library in the Linked Libraries section.

The Target Info window will appear as shown in Figure D.11. Click on the “+” button located at the bottom left-hand side. A list of libraries will be shown. Scroll down and locate the CoreLocation.framework as shown in Figure D.12. Select it and click “Add”. Figure D.13 shows the added Core Location library in the Linked Libraries section.

E

Unit Testing

In this appendix, we show you how to add unit tests to your project. By adding unit testing support, you'll be able to write tests for your methods. These tests will be added as a dependency on the building of your application. This will result in the tests being run before actually building your application.

In the following, we walk you through a step-by-step process for adding unit testing. We use a simple Employee class for demonstration purposes.

E.1 Adding a Unit Test Target

In this section, we show you how to create a unit test target in your project. Later, we will make our main target dependent on this unit test target, thus making sure that the unit tests are executed before building our target.

Right-click on Targets node in Groups & Files. Select Add > New Target as shown in Figure E.1.

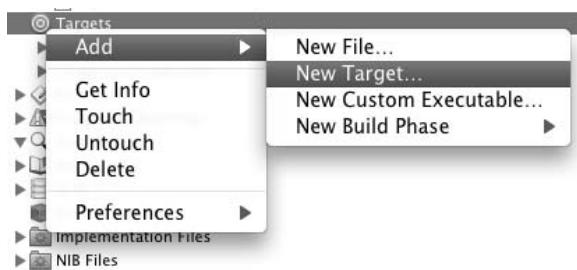


Figure E.1 Selecting Add New Target from the context menu.

Select Cocoa under the Mac OS X category. Scroll down and double-click on Unit Test Bundle as shown in Figure E.2.

Enter the name of the target, such as `MyUnitTestBundle`, as shown in Figure E.3.



Figure E.2 Choosing Unit Test Bundle for the new target.

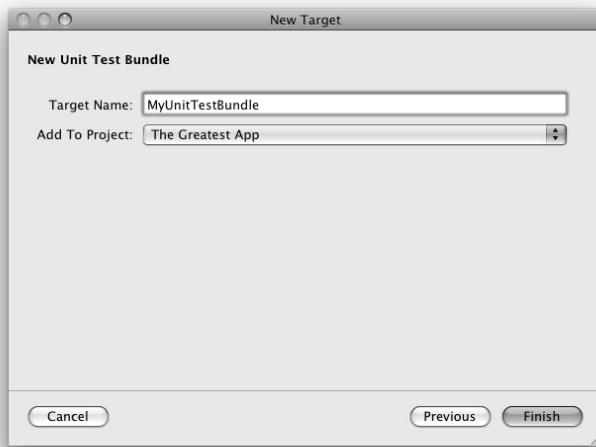


Figure E.3 Naming the Unit Test Bundle.

E.2 Adapting to Foundation

The target we just added in the previous section needs to be configured for use with the iPhone SDK instead of Mac OS X.

Double-click on the unit test target. Choose All Configurations as shown in Figure E.4.

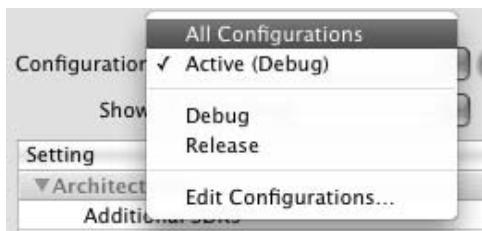


Figure E.4 Choosing All Configurations in the Build tab of the Target Info window.

Search for Other Linker Flags by entering “other linker” in the search box as shown in Figure E.5.

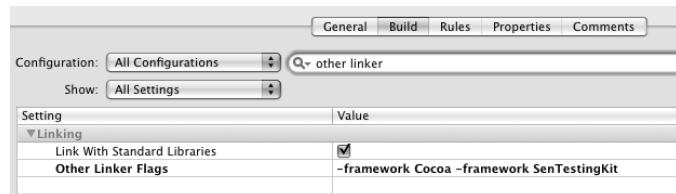


Figure E.5 Searching for the Other Linker Flags.

Double-click on the value and change Cocoa to Foundation as shown in Figure E.6.

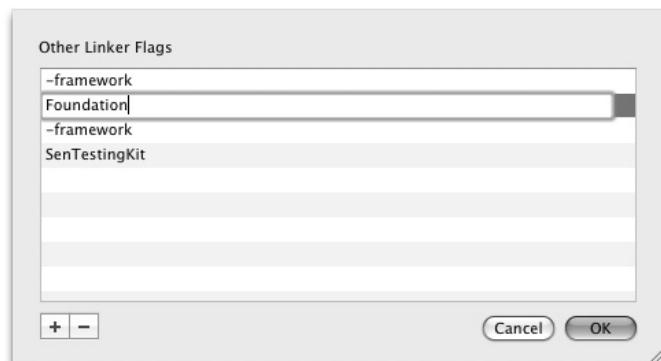


Figure E.6 Changing from Cocoa configuration to Foundation.

Search for `GCC_PREFIX_HEADER` as shown in Figure E.7.

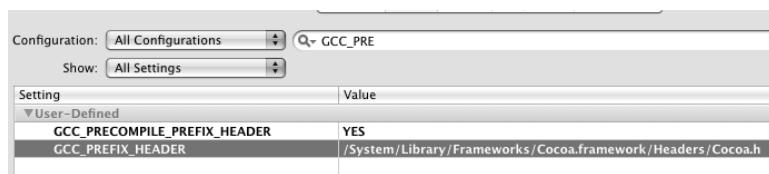


Figure E.7 Searching for the `GCC_PREFIX_HEADER` setting.

Double-click on the value field and clear the content as shown in Figure E.8.

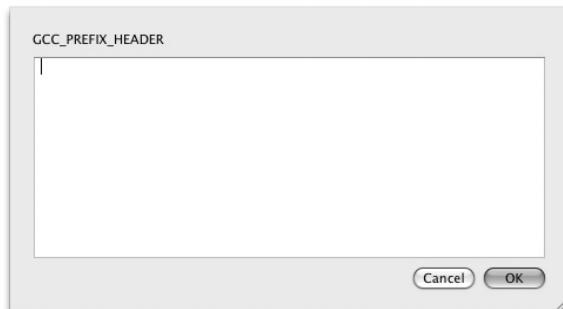


Figure E.8 Removing the `GCC_PREFIX_HEADER` setting.

Hit OK. Close the target Info window.

E.3 The Model

For demonstration purposes, we will use the `Employee` class as an example. Let's first add it to our targets.

Right-click on the Classes group. Select Add > New File. Select the NSObject subclass. Name the class `Employee` as shown in Figure E.9. Make sure that you select both targets.

Replace the `Employee.h` header file with the contents shown in Listing E.1.

Listing E.1 The `Employee.h` header file.

```
#import <Foundation/Foundation.h>
#import <UIKit/UIKit.h>
```

```
@interface Employee : NSObject {
    NSString      *firstName, *lastName;
    NSInteger     salary;
    Employee      *manager;
}

@property(nonatomic, retain) NSString      *firstName;
@property(nonatomic, retain) NSString      *lastName;
@property(assign)           NSInteger     salary;
@property(nonatomic, retain) Employee     *manager;
@end
```

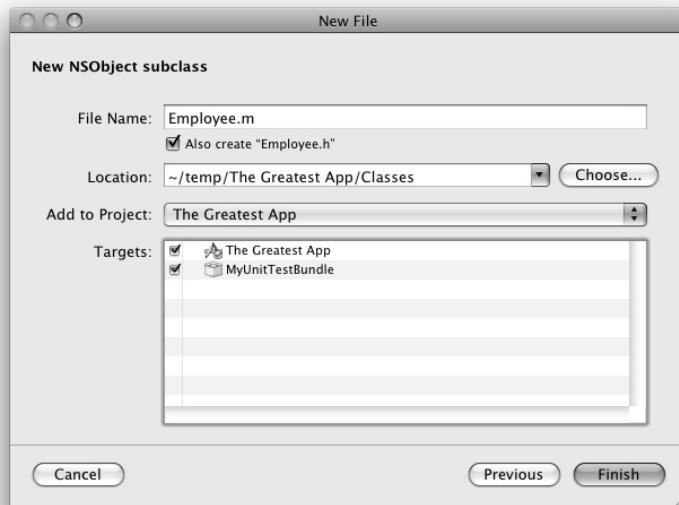


Figure E.9 Creating a new class and adding it to the two targets.

Replace the `Employee.m` implementation file with the contents shown in Listing E.2.

Listing E.2 The `Employee.m` implementation file.

```
#import "Employee.h"

@implementation Employee

@synthesize firstName, lastName, salary, manager;
- (void)setSalary:(NSInteger)theSalary{
```

```
if(theSalary > 0){  
    salary = theSalary;  
}  
}  
  
- (void)dealloc{  
    self.manager = nil;  
    self.firstName = nil;  
    self.lastName = nil;  
    [super dealloc];  
}  
@end
```

E.4 Writing Unit Tests for the Employee Class

In this section, we show you how to write a unit test for the `Employee` class.

Create a new group in your project and call it something like `Unit Testing`. Right-click on the new group and select `Add > New File`. Select `Cocoa` and double-click on `Objective-C test case class` as shown in Figure E.10.

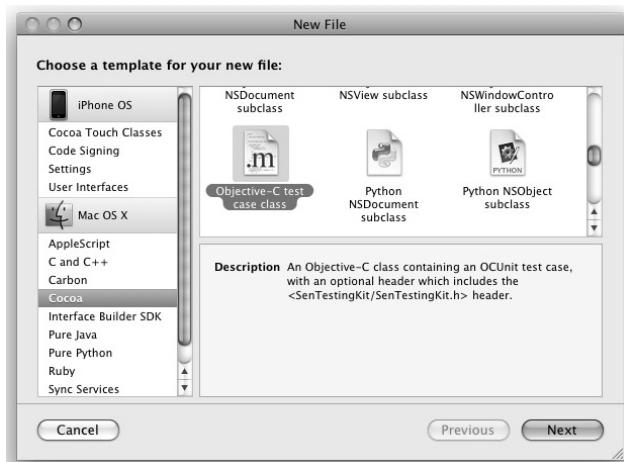


Figure E.10 Creating a new Objective-C test case class.

Type the name of the new test case. The name should end with `TestCase`. See Figure E.11.

Edit the `SampleTestCase.h` file and make it look like the following:

```
#import <SenTestingKit/SenTestingKit.h>  
#import "Employee.h"
```

```
@interface SampleTestCase : SenTestCase {  
}  
@end
```

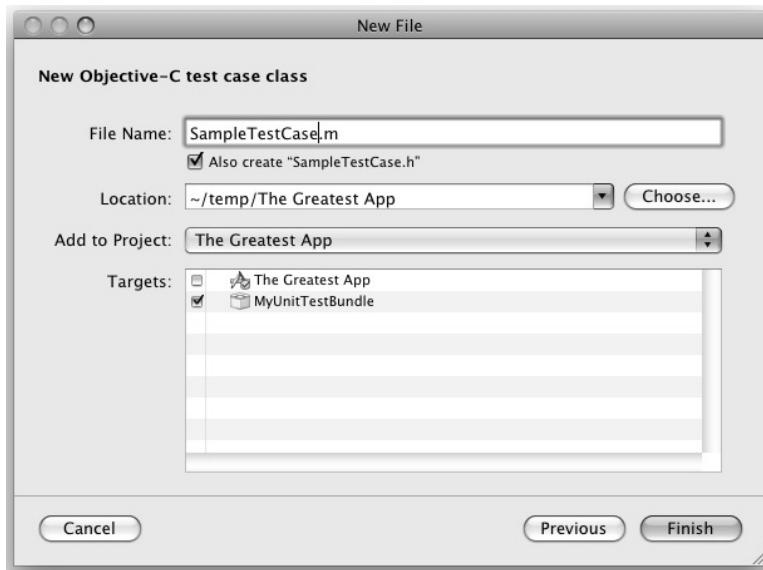


Figure E.11 Naming the test case. Name must end with `TestCase`.

E.4.1 The `setUp` and `tearDown` methods

Every unit test case has a `setUp` and a `tearDown` method. In the `setUp` method, you put any initialization code you would like to be executed before executing the tests. In the `tearDown` method, you provide any cleaning code that needs to be executed before finishing the tests. This code is executed after all test have been executed.

In the example shown below, we have these methods as empty, but you are free to customize these as you see fit.

```
- (void) setUp{  
    //do any initialization here  
}  
- (void) tearDown{  
    // do any cleaning up here  
}
```

E.4.2 Testing for equality

To create a test, add a method in the test case class. The method's name needs to start with `test`.

The following method tests the `Employee` class initialization.

```
- (void)testSalaryShouldBeInitializedToZero{
    Employee *emp = [[[Employee alloc] init] autorelease];
    STAssertEquals(emp.salary, 0,
                   @"Salary should be initialized to zero");
}
```

The method starts by creating an `Employee` instance. After that it asserts that the employee's salary is initialized to 0.

The test uses the `STAssertEquals` macro. This macro takes for the first two arguments C scalars, structs, or unions and an `NSString` instance for the third argument. If the first two arguments are not equal, the test fails.

The following test tries to assign a negative value for the salary. Since the `Employee` class rejects negative values, the existing value for salary remains unchanged. The test checks for that.

```
- (void)testSalaryCannotBeNegative{
    Employee *emp = [[[Employee alloc] init] autorelease];
    NSInteger salary = emp.salary;
    [emp setSalary:-100];
    STAssertEquals(emp.salary, salary,
                   @"Setting salary to a negative value should be ignored");
}
```

E.4.3 Testing for nullity

You can use the `STAssertNil` macro to test for expected `nil` values.

The following test asserts that the manager property is set to `nil`.

```
- (void)testNullifyingManager{
    Employee *emp = [[[Employee alloc] init] autorelease];
    Employee *manager = [[[Employee alloc] init] autorelease];
    emp.manager = manager;
    emp.manager = nil;
    STAssertNil(emp.manager, @"Should be able to nullify manager");
}
```

E.5 Adding a Build Dependency

If you would like the unit tests to be executed and the success of the unit testing to be a condition to the successful building of your application, you can add a build dependency.

Edit the info of the main target of your application. Click on the “+” icon to add a dependency, and add the unit test target as that dependency as shown in Figure E.12.

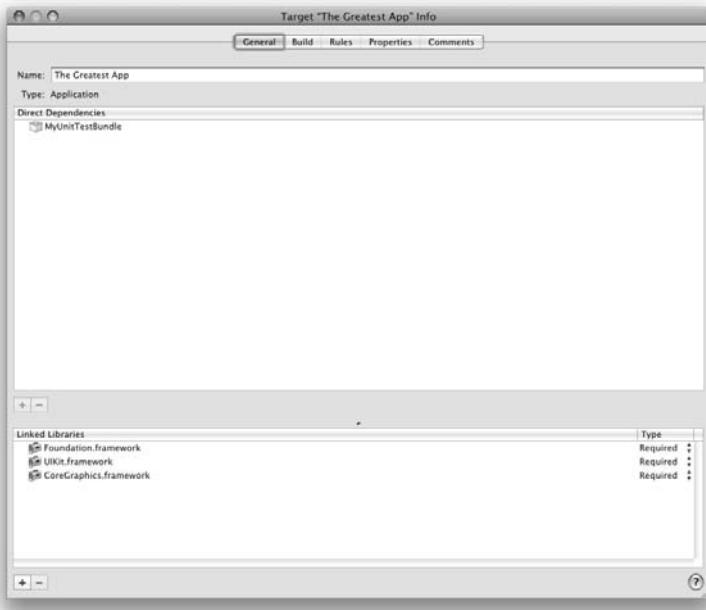


Figure E.12 Adding a build dependency for the main target on the unit test target.

E.6 Running the Tests

When you add the test target as a dependency for the main target of your application, running the test becomes an automatic task. Every time you build your application, the tests are run.

Suppose someone, for some reason, removed the `setSalary:` method of the `Employee` class thinking that the `@synthesize` directive would generate one for us and there is no need for a custom setter.

Now, the `testSalaryCannotBeNegative` test will fail with errors shown in the build console as shown in Figure E.13.

```
▼ ⓘ Building target "MyUnitTestBundle" of project "test unit test" with configuration "Debug" — (2 errors)
  ▼ ⓘ Running custom shell script (2 errors)
    note: Started tests for architectures 'i386'
    note: Running tests for architecture 'i386' (GC OFF)
    ✘ error: -[SampleTestCase testSalaryCannotBeNegative] : '-100' should be equal to '0': Setting salary to a negative value should be ignored
    ✘ error: Failed tests for architecture 'i386' (GC OFF)
    note: Completed tests for architectures 'i386'
  ⓘ Build failed (2 errors)
```

Figure E.13 Build failure due to test failure.

Seeing that the test `testSalaryCannotBeNegative` has failed, you can inspect it as well as inspect the `Employee` class and quickly come to the conclusion that the `setSalary:` method was removed by someone. You can then go to the version control software and pinpoint that person. What happens next is beyond the scope of this text!

F

Working with Interface Builder

In this appendix, we use Interface Builder to build a couple of iPhone applications. The techniques you learn from building these applications should prove to be useful in building similar iPhone applications.

F.1 National Debt Clock Application

In this section, we develop the National Debt Clock application. The application's UI is developed using Interface Builder. A screenshot of the completed product is shown in Figure F.1.

F.1.1 Creating the project

Launch XCode. Click on File > New Project. Click on the Application category under iPhone OS. Choose Window-based Application and click on Choose.

Name the project `NationalDebt` and click Save.

F.1.2 Creating the view controller class

Right-click on the Classes group and select Add > New File as shown in Figure F.2.

Select `UIViewController` subclass under the Cocoa Touch Class as shown in Figure F.3 and click on Next.

Name the file `DebtViewController.m`, make sure that the check box for generating the header file is checked, and click Finish.

As the screenshot of the application in Figure F.1 shows, there are four main UI elements:

- **A label.** An instance of `UILabel` is used to show the text `National Debt Clock`. This is a static text that our application need not change. No code in our controller needs to know about this UI element.



Figure F.1 A screenshot of the National Debt Clock application.

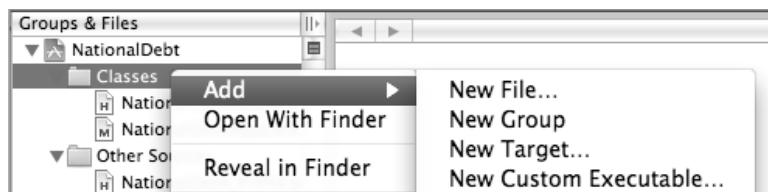


Figure F.2 Adding a new class.

- **An activity indicator.** An instance of the `UIActivityIndicatorView` class is used to indicate that we are busy fetching the image representing the national debt figure from the Internet. Our controller code needs to know about this UI element.

To connect an object in our controller's code with this UI element, we need to add an Interface Builder outlet property of type `UIActivityIndicatorView`. In addition, we need to add a link between the UI element and the outlet in Interface Builder.

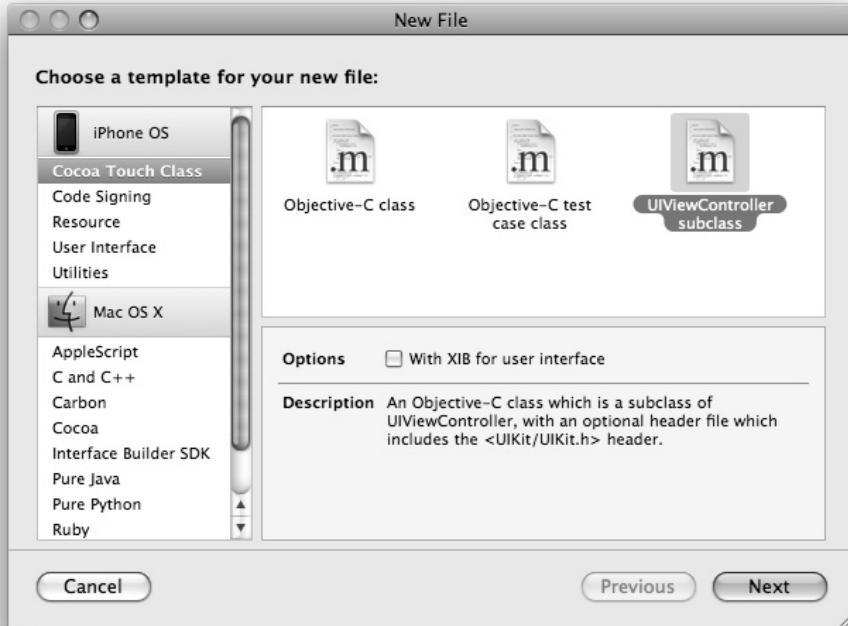


Figure F.3 Adding a subclass of the UIViewController class.

- **An image view.** The national debt clock is retrieved as an image from the Internet. We need to add an instance of UIImageView to the view of the view controller. In addition, we need to add an outlet in our view controller header file and connect it to the image view UI element. Whenever we retrieve the image from the Internet, we need to set the `image` property of the UIImageView object to the fetched image.
- **A refresh navigation item.** Whenever the user taps on the Refresh button, we need to bring a fresh image from the Internet. We need to add a method that is tagged with `IBAction` and connect it to the button.

The following shows the updated header file for the DebtViewController class.

```
@interface DebtViewController : UIViewController {
    UIImageView *imageView;
    UIActivityIndicatorView *busy;
}
@property(nonatomic, retain) IBOutlet UIImageView *imageView;
@property(nonatomic, retain) IBOutlet UIActivityIndicatorView *busy;
```

```
- (IBAction)refresh;  
@end
```

The `IBOutlet` tag is defined as empty as shown below:

```
#ifndef IBOutlet  
#define IBOutlet  
#endif
```

It is just used to facilitate the communication between XCode and Interface Builder. The `IBAction` is defined as `void`.

Now, our controller has an `imageView` instance variable holding a reference to the image view UI element. Also, we have a `busy` instance variable holding a reference to the activity indicator view UI element. We still need to create these UI elements in Interface Builder and make the connections.

We also need to update the .m file of the view controller and add the following statement:

```
@synthesize imageView, busy;
```

Also, we need to deallocate the objects in the `dealloc` method as shown below:

```
- (void)dealloc {  
    self.busy = nil;  
    self.imageView = nil;  
    [super dealloc];  
}
```

The `refresh` method is declared in the view controller class using the `IBAction` tag. This will help in connecting the button's action with our `refresh` method.

F.1.3 The application delegate class

Now, we turn our attention to the application delegate class. As you can see from the screenshot of our application in Figure F.1, we are using a navigation controller. The navigation controller will be created in Interface Builder. We still need a reference to it in the application delegate so that we can add its view (which is basically the view of its root view controller) as a subview to the main window when the application is launched.

Modify the `NationalDebtClockAppDelegate.h` header file by adding a new instance variable as shown below:

```
UINavigationController *navCtrl;
```

Add the property for this instance variable with an outlet tag as shown below:

```
@property (nonatomic, retain) IBOutlet UINavigationController *navCtrl;
```

We also need to synthesize the `navCtrl` property and release it in the `dealloc` method of the application delegate.

In the `applicationDidFinishLaunching:` method, we need to add the view property of the navigation controller as a subview to the main window.

The following shows the updated method:

```
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    [window addSubview:navCtrl.view];
    [window makeKeyAndVisible];
}
```

Notice that we did not create an instance of `UINavigationController`. This instance will be created by deserializing a file that we will populate in Interface Builder in the next section.

F.1.4 Building the UI

Now, we need to use Interface Builder to build the UI and connect it to our code through `IBOutlets` and `IBActions`.

Double-click on `MainWindow.xib` under the Resource group as shown in Figure F.4.

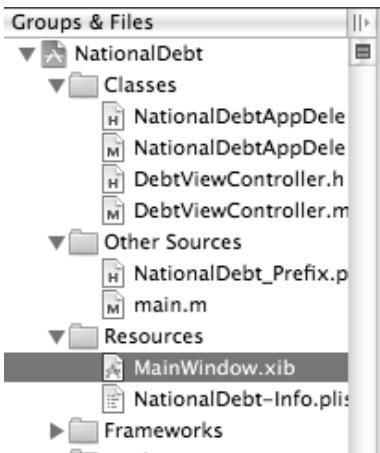


Figure F.4 Opening the `MainWindow.xib` file.

Interface Builder will be launched, and the `MainWindow.xib` document will be opened.

Choose the Browser mode to display the document's objects in a browser control while showing the parent-child relationships (see Figure F.5).

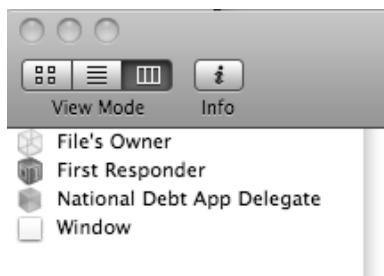


Figure F.5 The Browser display mode for objects in an XIB document.

Adding a navigation controller

Now, we would like to add a navigation controller. This navigation controller will manage the navigation between several views that can be represented hierarchically.

Although our application does not need to present views hierarchically, it does utilize a navigation controller for the placement of a refresh button on its navigation bar.

When you open the XIB document, several windows open in Interface Builder. One of these windows is the Library window. Inside the Library window, you are given a list of several categories of elements. You select an element from the list and drag and drop it onto the XIB document or another element.

Click on the Controllers category in the Library window and locate the Navigation Controller element from the list as shown in Figure F.6.



Figure F.6 The Controllers category in the Library window.

Click on the Navigation Controller object and drag and drop it onto the document as shown in Figure F.7.

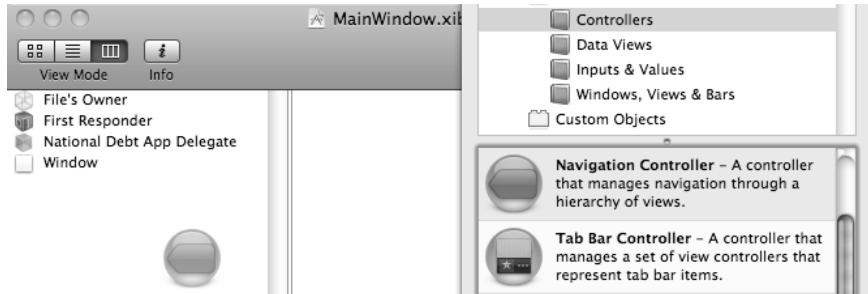


Figure F.7 Adding a navigation controller to our XIB document.

The document should look as shown in Figure F.8.

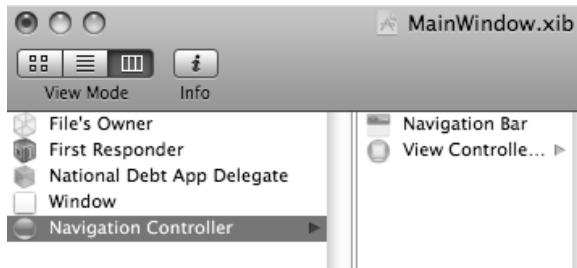


Figure F.8 The XIB document after adding a navigation controller.

Now, we would like to connect the navigation controller we've just added to the `navCtrl` property in the application delegate class. Control-click the application delegate object to show the Connections panel as shown in Figure F.9.

Click on the `navCtrl` connector and link this outlet to the navigation controller object as shown in Figure F.10.

The status of the application delegate outlets should look like the one in Figure F.11.



Figure F.9 The Connections panel of the application delegate.

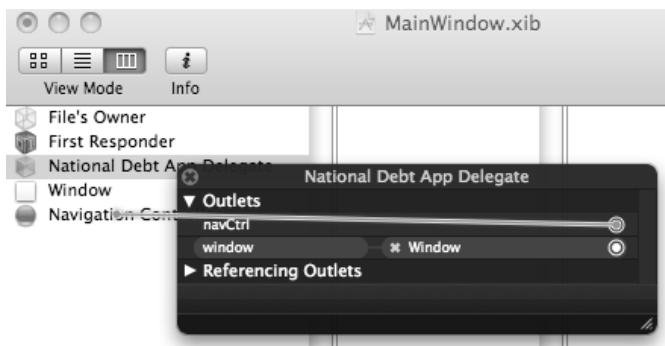


Figure F.10 Connecting the navCtrl property to the navigation controller component.

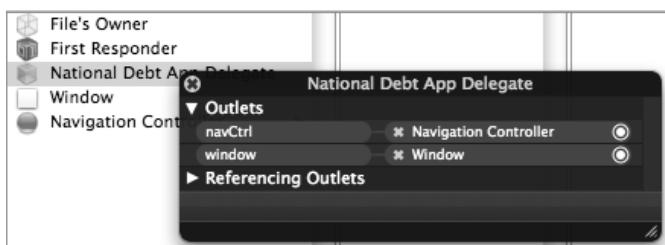


Figure F.11 The status of the application delegate connections after adding a connection to the navigation controller.

Adding a root view controller

A navigation controller must have at least one view controller. This view controller is referred to as the root view controller.

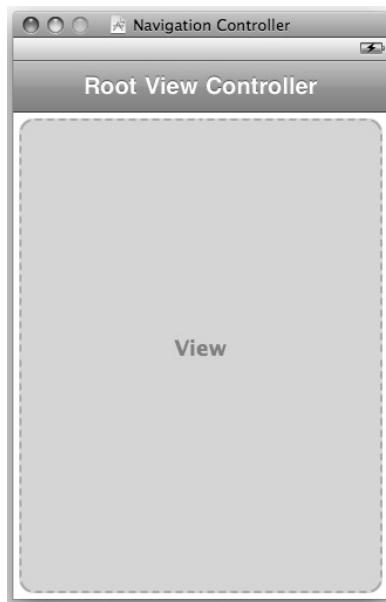


Figure F.12 The navigation controller window before adding the root view controller.

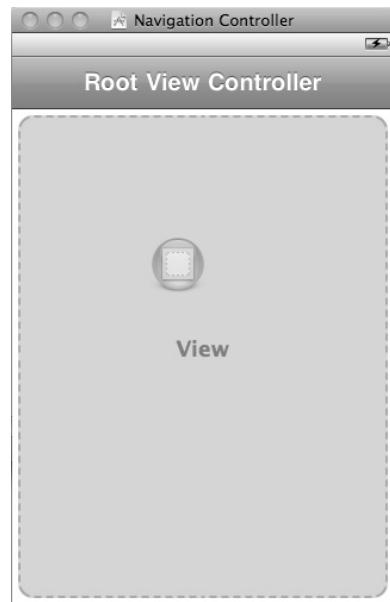


Figure F.13 Adding a root view controller to the navigation controller.

To add a root view controller, all we need to do is to drag and drop a view controller on the opened navigation controller element.

Make sure that the navigation controller is open (if it is not, double-click on it). It should look like the one in Figure F.12.

Drag and drop a view controller object from the Library on the navigation controller as shown in Figure F.13.

Once the view controller is dropped onto the navigation controller, you will be able to see this controller as a child element in the Browser view of the XIB document as shown in Figure F.14.

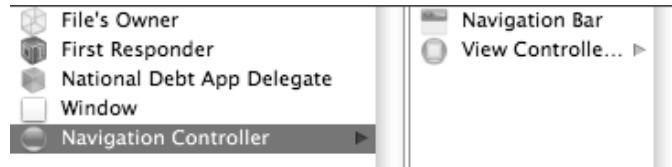


Figure F.14 A view controller added as a root controller of a navigation controller.

Building the main view of the root controller

Now, we want to build a view for the view controller. Select Windows, Views & Bars from the Library and drag and drop a View object onto the view controller window as shown in Figure F.15.



Figure F.15 Adding a View UI element to the root view controller.

Now, the view controller has a View object and a Navigation Item object as shown in Figure F.16.

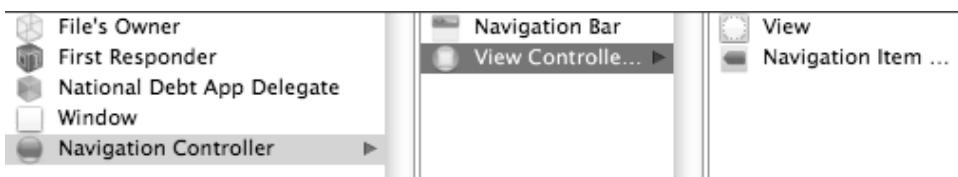


Figure F.16 The Browser view for the view controller after adding a View UI element.

Drag and drop a Label object (from the Inputs & Values category) onto the view as shown in Figure F.17.

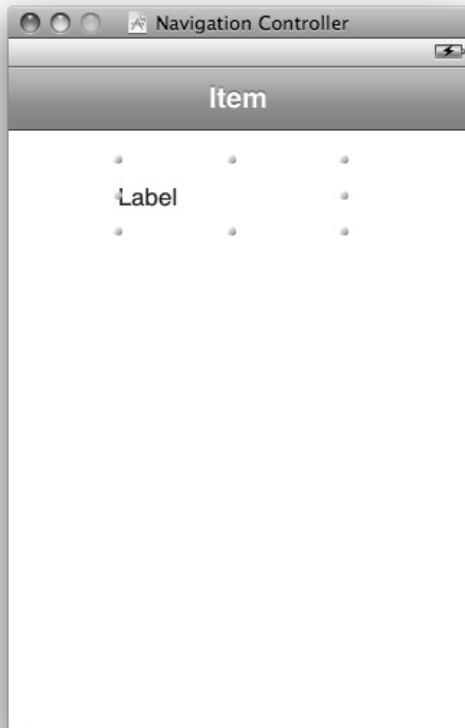


Figure F.17 Adding a Label UI element.

Double-click on the label object and change the label text as shown in Figure F.18. You also need to resize the label's frame.

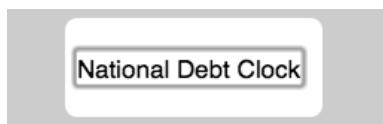


Figure F.18 Changing the text and dimension of the Label UI element.

Change the color and font size attributes of the label to red and 24 pts as shown in Figure F.19.

Drag and drop an Image View object (found under the Data Views category) as shown in Figure F.20.

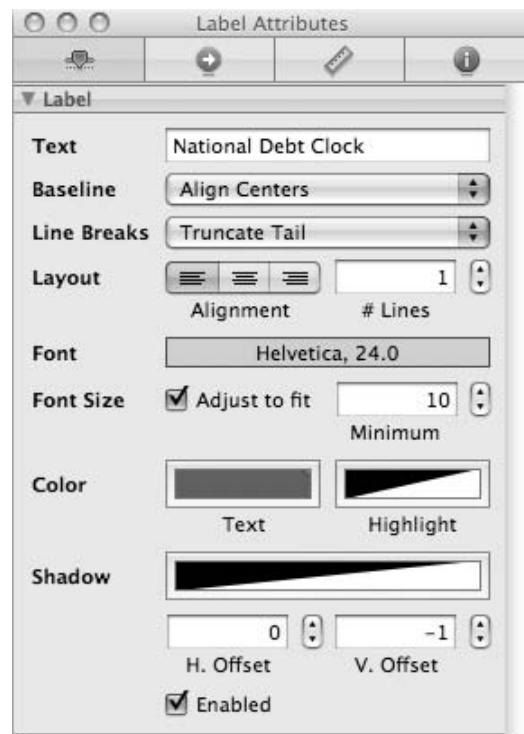


Figure F.19 Changing the color and font size of the Label UI element.



Figure F.20 Adding an Image View UI element to the view.

Resize the image view as shown in Figure F.21.

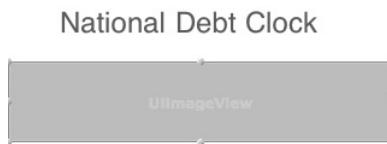


Figure F.21 Resizing the Image View UI element.

Select Aspect Fit Mode as shown in Figure F.22.

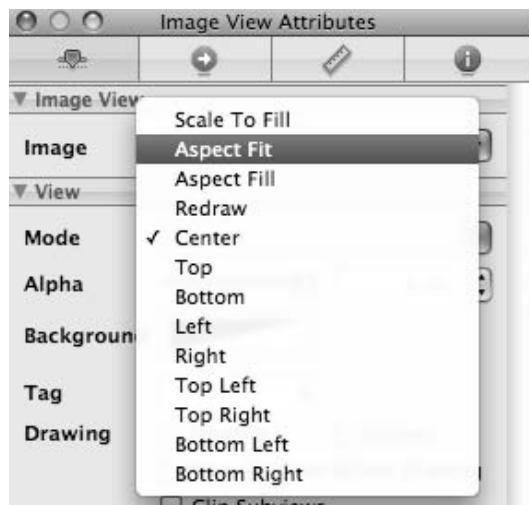


Figure F.22 Changing the view mode to Aspect Fit.

Drag and drop an Activity Indicator View as shown in Figure F.23.



Figure F.23 Adding an Activity Indicator View.

Click on it and configure it to Hide When Stopped as shown in Figure F.24.

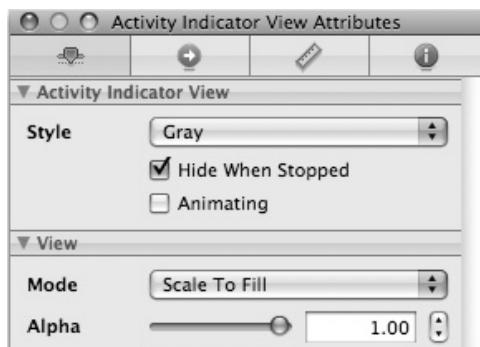


Figure F.24 Configuring the Activity Indicator View to Hide When Stopped.

Double-click on the Navigation Item title and enter National Debt Clock as shown in Figure F.25.



Figure F.25 Changing the navigation item title.

Linking the UI elements with the code

Now, we would like to link the view controller object with our code.

Make sure that the view controller object is selected and click on the Identity tab in the Inspector window as shown in Figure F.26.

Select the `DebtViewController` for the Class attribute.

Control-click the view controller and connect the `busy` property to the Activity Indicator View as shown in Figure F.27.

Connect the `imageView` property to the Image View as shown in Figure F.28.

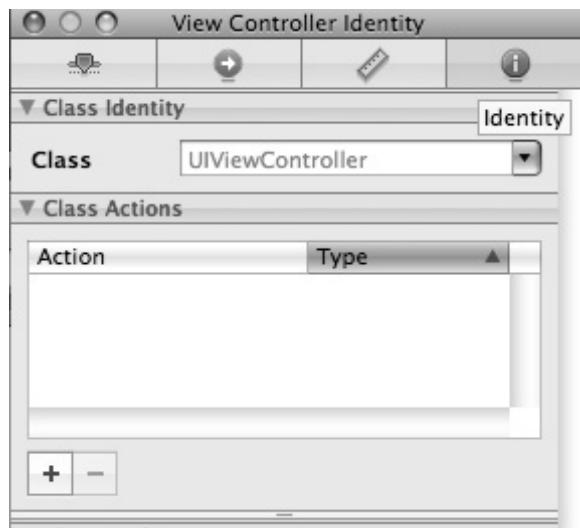


Figure F.26 The Identity tab in the Inspector window of the view controller.

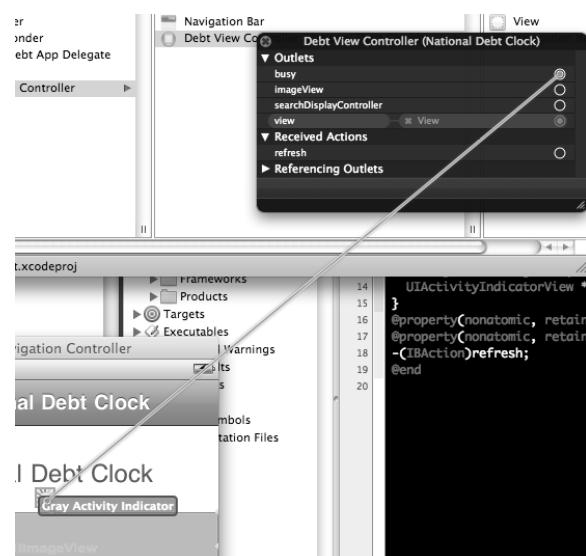


Figure F.27 Connecting the busy property to the Activity Indicator View.

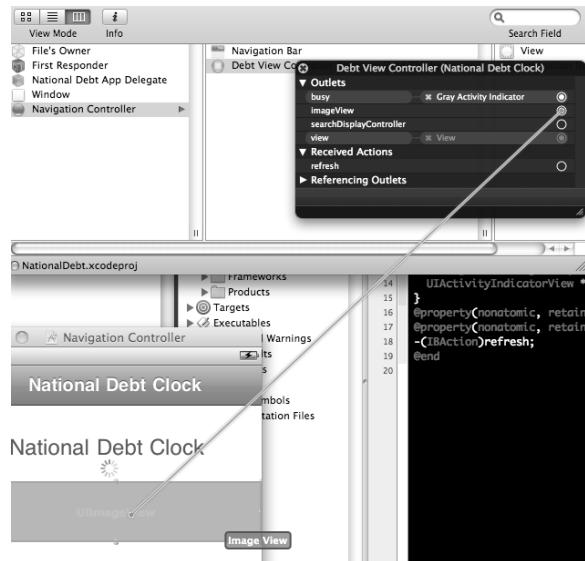


Figure F.28 Connecting the `imageView` property to the Image View.

Now, we would like to add a Refresh button on the navigation bar so that the user can refresh the National Debt Clock.

Under Windows, Views, & Bars window, select the Bar Button Item object and drop it on the navigation bar as shown in Figure F.29.



Figure F.29 Adding a Bar Button Item to the navigation bar.

Click on it and choose the Refresh for Identifier as shown in Figure F.30.

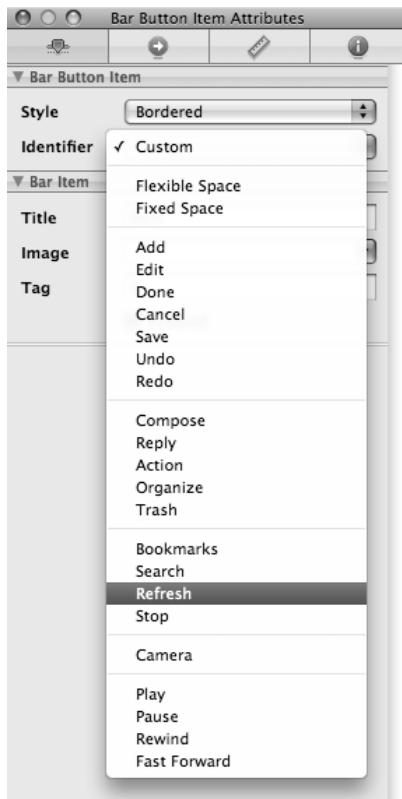


Figure F.30 Choosing a Refresh style for the bar button item.

Now, Control-click on the view controller and connect the `refresh` action to the button as shown in Figure F.31.

The connectivity of the outlets and actions of the view controller should look like the one in Figure F.32.

Finishing the view controller class

We would like to show the National Debt Clock on startup. Override the `viewDidLoad` of the view controller as shown below:

```
- (void)viewDidLoad {
    [super viewDidLoad];
    [self refresh];
}
```

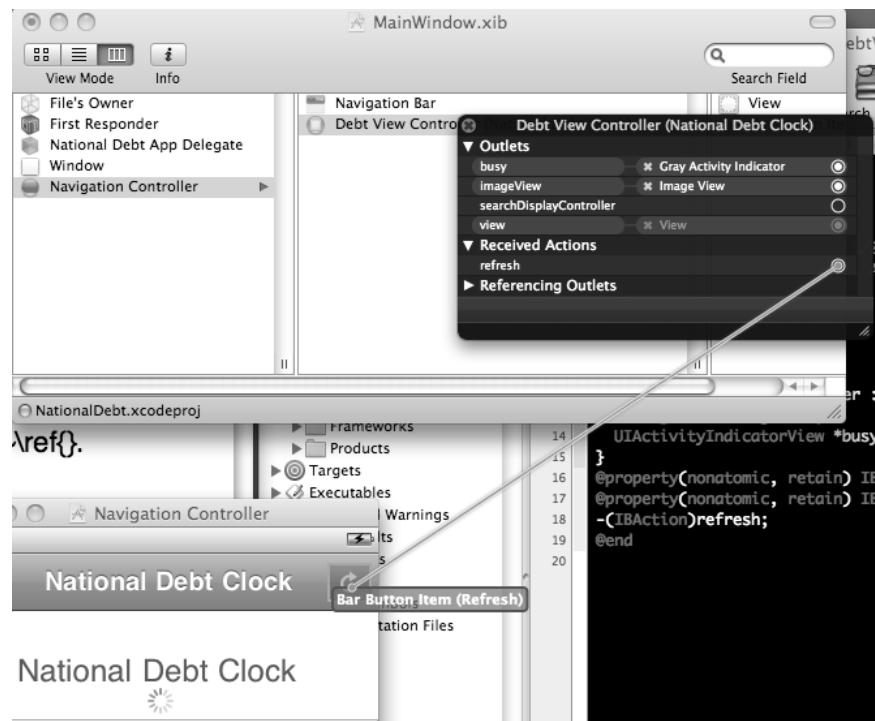


Figure F.31 Connecting the `refresh` action method to the button.

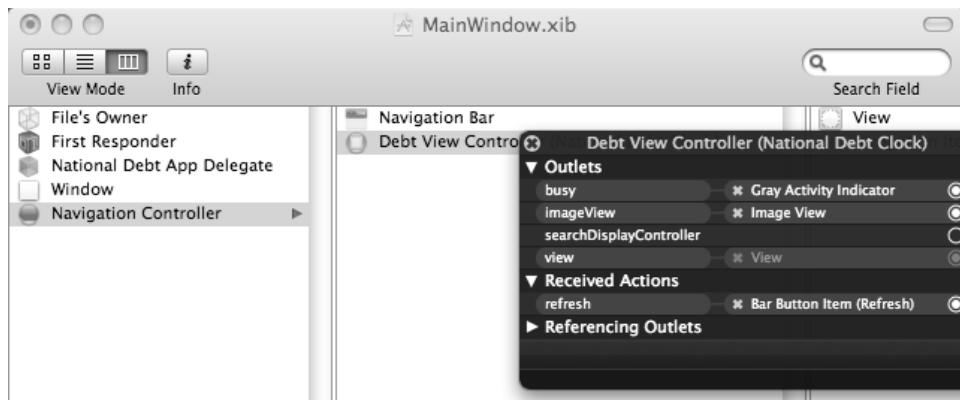


Figure F.32 The connectivity of the outlets and actions of the view controller.

The refresh action method shows the activity indicator view while fetching the image from the Internet and is shown below:

```
- (IBAction)refresh{
    [self performSelectorInBackground:@selector(showActivityIndicator:)
        withObject:[NSNumber numberWithBool:YES]];
    self.imageView.image = [UIImage imageNamed:
        [NSData dataWithContentsOfURL:[NSURL URLWithString:DEBT_IMAGE]]];
    [self performSelectorInBackground:@selector(showActivityIndicator:)
        withObject:[NSNumber numberWithBool:NO]];
}
```

The DEBT_IMAGE is defined as follows:

```
#define DEBT_IMAGE @"http://www.brillig.com/debt_clock/debtiv.gif"
```

The showActivityIndicator: method, which is shown below, shows/hides the activity view in its own thread.

```
- (void)showActivityIndicator:(NSNumber*)show{
    NSAutoreleasePool *pool = [[NSAutoreleasePool alloc] init];
    [show boolValue] ? [busy startAnimating] : [busy stopAnimating];
    [pool release];
}
```

The complete application can be found in the NationalDebtClock project available in the source downloads.

F.2 Toolbar Application

In this section, you learn how to create a view controller whose view is loaded from an XIB file. The view will consist of a toolbar with four buttons and a label. When the user taps on a button, the label's text changes to reflect the tapped button. Figure F.33 shows a screenshot of the application.

F.2.1 Writing code

Create a new project and call it ToolBarDemo. Create a new view controller subclass and call it ToolBarController.

The ToolBarController class has a reference to the label UI element and four action outlets. The following shows the declaration of this view controller:

```
@interface ToolBarController : UIViewController {
    UILabel *message;
}
@property(nonatomic, retain) IBOutlet UILabel *message;
```

```
- (IBAction)bart;
- (IBAction)lisa;
- (IBAction)homer;
- (IBAction)marge;
@end
```



Figure F.33 A screenshot of a toolbar-based application.

The view controller has a message `IBOutlet` referring to a `UILabel` instance which will be loaded from the `XIB` file. In addition, four actions are declared, each corresponding to a button on the toolbar.

The implementation of this view controller class is shown below:

```
#import "ToolBarController.h"
@implementation ToolBarController
@synthesize message;
-(IBAction)bart{
    [self.message setText:@"Bart Simpson"];
}
-(IBAction)lisa{
    [self.message setText:@"Lisa Simpson"];
}
```

```

- (IBAction)homer{
    [self.message setText:@"Homer Simpson"];
}
- (IBAction)marge{
    [self.message setText:@"Marge Simpson"];
}
- (void)dealloc{
    self.message = nil;
    [super dealloc];
}
@end

```

Each action method simply changes the label's text.

F.2.2 Building the UI

Now, let's go ahead and create the view of this controller using Interface Builder.

Right-click on the Resources group and select Add > New File as shown in Figure F.34.

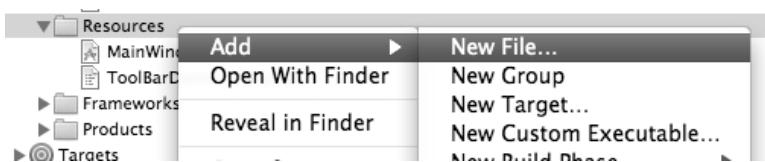


Figure F.34 Adding a new file to the Resources group.

Select the User Interface category and the Empty XIB template as shown in Figure F.35.

Click on Next and name the file `ToolBarView.xib` and hit Finish. Now, open the `ToolBarView.xib` file by double-clicking on it. Interface Builder will be launched and the file will be opened as shown in Figure F.36.

Select the File's Owner node and click on the Identity tab. Choose the class to be `ToolBarController` as shown in Figure F.37.

Select the View UI element under Windows, Views & Bars shown in Figure F.38.

Drag and drop a view on the `ToolBarView.xib` document. The document should look like the one shown in Figure F.39.

Change the height of the View to 480 as shown in Figure F.40.

Drag and drop a Label UI element on the view. Change the layout of the label to center and its font's size to 36 as shown in Figure F.41.

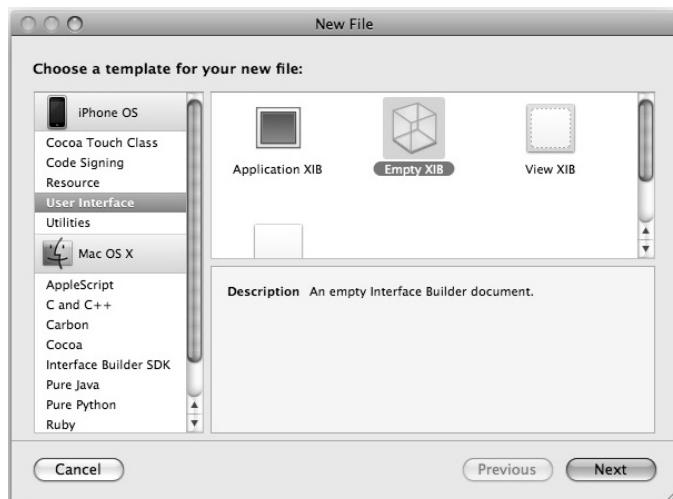


Figure F.35 Selecting an Empty XIB template.



Figure F.36 An empty XIB file.



Figure F.37 Changing the identity of the File's Owner to the ToolBarController class.

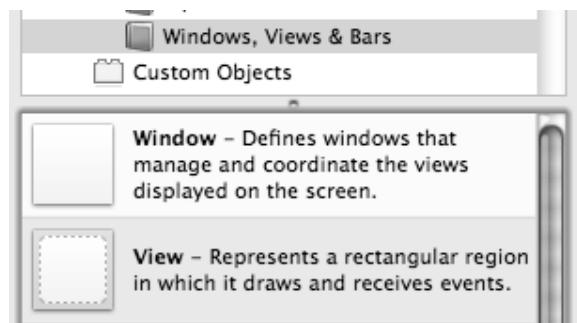


Figure F.38 The View UI element in the Library.

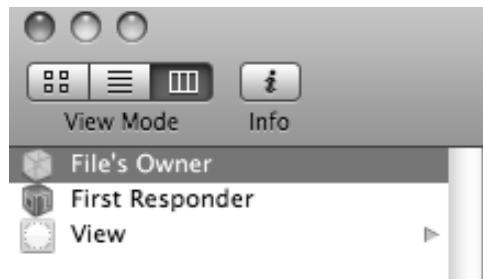


Figure F.39 The XIB document after adding a View to it.

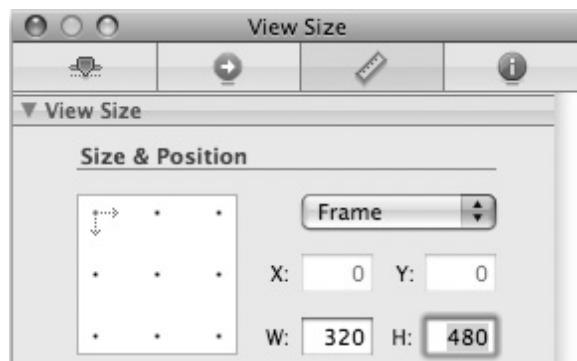


Figure F.40 Changing the height of the View.

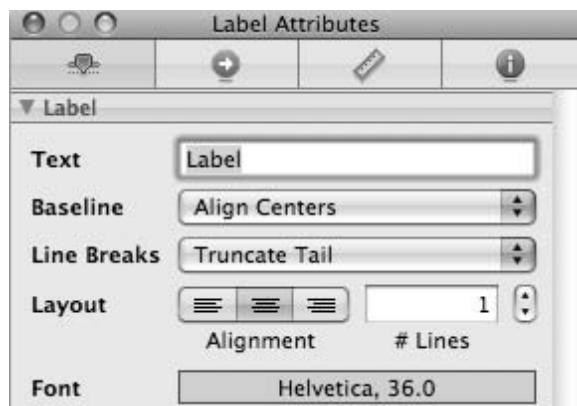


Figure F.41 Changing the label's layout and font size.

Drag and drop a Toolbar UI element on the view as shown in Figure F.42.



Figure F.42 The state of the view after adding a label and a toolbar.

Add an additional three Bar Button Items (Figure F.43) to the toolbar as shown in Figure F.44.

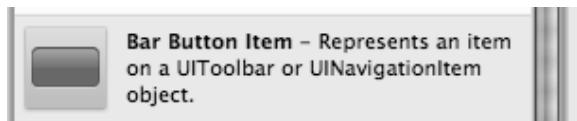


Figure F.43 A Bar Button Item UI element.



Figure F.44 Adding an addition three Bar Button Items to the toolbar.

Locate the Fixed Space Bar Button Item UI element shown in Figure F.45.

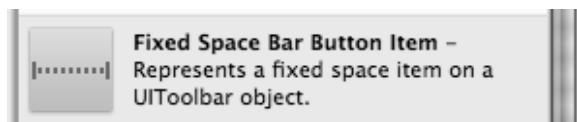


Figure F.45 Fixed Space Bar Button Item.

Drag and drop it on the left-hand side of the toolbar as shown in Figure F.46.



Figure F.46 A Fixed Space Bar Button Item added to the toolbar.

You can resize this element to make the right and left margins of the toolbar equal.

Control-click the File's Owner and link the message outlet to the label as shown in Figure F.47.

Connect the view property to the View UI element as shown in Figure F.48.

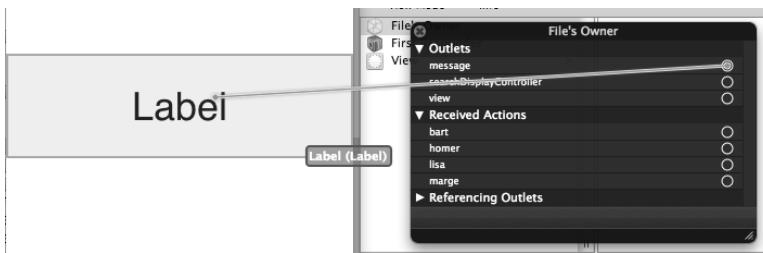


Figure F.47 Connecting the message outlet to the Label UI element.

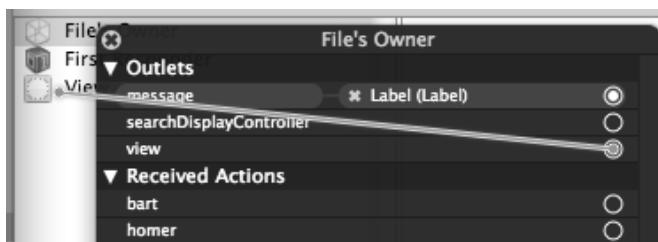


Figure F.48 Connecting the view property to the View UI element.

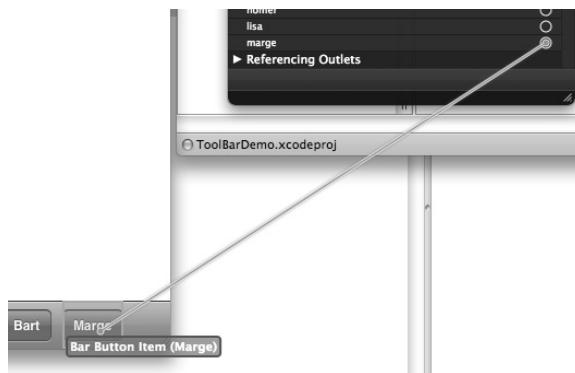


Figure F.49 Connecting the merge action method to the Merge bar button item.

Connect the `merge` action method to the Merge bar button item as shown in Figure F.49.

Repeat the process for the other three bar button items. The connectivity state of the `ToolBarController` is shown in Figure F.50.



Figure F.50 The state of connectivity of the ToolBarController.

F.2.3 Putting it together

Now that the view controller is complete, we can create a new instance of it and add its view as a subview of the main window as shown below.

```
- (void)applicationDidFinishLaunching:(UIApplication *)application {
    self.ctrl = [[[ToolBarController alloc]
        initWithNibName:@"ToolBarView" bundle:nil] autorelease];
    [window addSubview:ctrl.view];
    [window makeKeyAndVisible];
}
```

The complete application can be found in the `ToolBarDemo` project available from the source downloads.

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INDEX

ABAddressBookAddRecord, 500, 502
ABAddressBookCopyArrayOfAllGroups,
 502
ABAddressBookCopyArrayOfAllPeople,
 502
ABAddressBookCopyPeopleWithName,
 502, 505
ABAddressBookCreate, 501
ABAddressBookGetGroupCount, 502
ABAddressBookGetPersonCount, 501
ABAddressBookHasUnsavedChanges, 502
ABAddressBookRef, 501
ABAddressBookRemoveRecord, 502
ABAddressBookRevert, 503
ABGroupAddMember, 500
ABGroupCopyArrayOfAllMembers, 501
ABMultiValueAddValueAndLabel, 499
ABMultiValueCopyArrayOfAllValues,
 497
ABMultiValueCopyLabelAtIndex, 497
ABMultiValueCreateMutable, 499
ABMultiValueGetIdentifierAtIndex,
 503
ABMultiValueGetIndexForIdentifier,
 503
ABMultiValueRef, 496
ABNewPersonViewController, 510–512
ABPeoplePickerNavigation
 Controller, 507–509
ABPersonCopyImageData, 501, 505
ABPersonCreate, 500
ABPersonViewController, 509–510
 delegate, 510
ABRecordCopyValue, 495, 496
AbRecordCopyValue, 494
ABRecordGetRecordID, 503
ABRecordGetType, 494
ABRecordRef, 500
ABRecordRemoveValue, 494
ABRecordSetValue, 494, 500
absconders, 353
 fetchAbsconders, 358
absoluteString, 243
ABUnknownPersonViewController,
 505–506
accDistance, 133, 134
accelerationValues, 406
accelerometer, 403–408
achievements, 32
action, 151
 @selector(paste:), 551
action sheets, 224–226
actionsForTarget:forControlEvents:,
 153
actionSheet:clickedButtonAtIndex:,
 225
Activity Indicator View, 603–604
 busy, 605
Add ID, 474–475
addEntriesFromDictionary:, 103
addKey:, 381
addObject:, 99
addObserver:selector:name:object:,
 56
addOperation:, 54
addRecord:, 42–43
address, 230
Address Book, 494–513
 identifiers, 503
 multithreading, 503
 multi-value properties, 496–500
 person and group record, 500–501

pictures, 503–505
 properties, 494
 single-value properties, 494–496

Address Level Accuracy, 380

AddressBook, 493–513

addressBook, 23

addValue:, 545

addValue:@"Original", 540

Advanced Gesture Tracking, 132–137

alert view, 221–224

- delegate, 455
- UI, 455

alertView, 223

alertViewCancel, 223

alertView:clickedButtonAtIndex:, 223, 446, 451

allControlEvents, 153

allies, 48

allKeys, 102

alloc, 24

- NSArray, 85
- release, 25
- UIWindow, 107

allowsAddingToAddressBook, 506

allowsEditing, 509

allowsImageEditing, 421

allowsPickingMultipleItems, 413

allRecordsInHTML, 227

- records, 229

allTargets, 153

allTouches, 123

allValues, 103

alsoDelete, 557

alt, 233

altitude, 376

ALU.png, 34

aMethod:, 23

anAddress, 32

aName, 56

anchor, 242

animation, 137–170

- applicationDidFinishLaunching:, 137
- delegates, 140–141
- UIView, 137–141

animation, 263–264

animationDidStart:, 140

animationDidStop:finished:, 140, 141

 animationID, 139

 AnimView, 137, 138–139, 141, 144

anInstanceMethod, 65

annotation, 397

anObject, 23, 56

- nil, 40
- NSMutableString, 25

anotherMethod, 67

anyObject, 99

aObject, 22

- name, 29

[aObjectaMessage], 22

apns.cer, 480

aPoint, 22

aPoint.setLocation, 22

.app, 319

App ID, 474–477

- APS, 479

App Store, 569–570

Apple Push Service (APS), 477, 479

AppleLanguages, 430

application:didFailToRegisterForRemoteNotificationsWith Error:, 486

applicationDidFinishLaunching:, 5, 106, 128, 143, 177

- accelerometer, 408
- animation, 137
- applicationWillTerminate:, 564
- audio, 409–410
- dictionaries, 284
- GoogleMapsWrapper, 385
- IB, 594–595
- Location Awareness, 377
- LocationViewController, 387
- MyViewController, 238
- nil, 174
- NSUndoManager, 542
- push notification, 484
- table view controller, 368

 UITableView, 250, 265–266, 274

 UITableViewController, 277

 UITableViewGrouped, 286

 UIWebView, 228

 window, 368

application:didReceiveRemoteNotification:, 486

application:didRegisterForRemote
 NotificationsWithDevice
 Token:, 485–486
 application:handleOpenURL, 567
 applications, 105–113
 delegates, 174–175, 567, 594–595
 external, 567–568
 saving and restoring, 563–566
 windows, 6
 applicationWillTerminate:, 564
 AppName.app, 307
 \$AppServer, 574–575
 APS *see* Apple Push Service
 Arabic, 429
 Localizable.strings, 432
 arr1, 85–86
 copy, 87
 arrays, 83–96
 deep copy, 88–93
 immutable copy, 86–88
 mutable copy, 88–89
 sort, 93–96
 arrayWithObjects:, 85, 92
 ar_SA, 429
 artistsQuery, 416
 aSelector, 56
 Aspect Fit Mode, 603
 assign, 30
 anAddress, 32
 self, 46–47
 asynchronous networking, 469
 attachments
 compression, 489
 email, 489
 attributes
 Core Data, 515
 Inspector, 7
 Title, 10
 attributes, 315
 audio, 408–418
 playing, 412
 recording, 410–412
 AudioServicesCreateSystem
 SoundID(), 409
 AudioServicesPlaySystemSound(), 409
 <AudioToolbox/AudioToolbox.h>,
 include, 409
 AudioToolbox.framework, 409
 aUserInfo, 55
 autocapitalizationType, 157
 autocorrectionType, 157
 autorelease, 26
 copy, 92
 fetchURL, 469
 NSError, 44
 NSMutableArray, 33
 XOAbsconder, 358
 autoreleased, NSManagedObject, 518
 autoresizingMask, 173
 AVAudioPlayer, 412
 AVAudioRecorder, 411, 412
 AVFoundation, 410
 background, 154
 badgeValue, 183–184
 batteryLevel, 424
 BatteryMonitor, 425–426
 batteryState, 424
 battery, 424–426
 Bcc, 489
 beginAnimations:context:, 137
 Belongs-To, 530
 binding functions, 340
 BLOB, 326
 BLOBs, 323
 binding, 340
 main(), 338–339, 341–342
 retrieving, 341–343
 storing, 337–341
 Bluetooth, 373
 bookmarks, 4
 BOOL, 43, 62, 70
 borderStyle, 154
 bounds, 115, 119–120
 Build and Go, 6, 8, 112
 debugger, 14
 Text, 10
 XCode, 13
 build dependency, 589
 Build Project, 571
 build-based configurations, 574–576
 Bundle Identifier, 474–475
 XCode, 483
 bundle seed ID, 474
 busy, 605
 buttonIndex, 223

buttons, 163–164
buttonTapped
 labels, 12
 My_ProjectAppDelegate, 12
XCode, 14

CAAnimation, 144
CAAnimationDelegate, 140
CAAnimation.h, 140
cache, 376
CALayer, 142
calendar, 168–169
callbacks, 327–328
 SAX, 359
 XOAbsconder, 365
_caller, 444
callout view, 398
canBecomeFirstResponder, 542, 552
cancelAction:, 269
cancelButtonTitle, 221, 224–225
cancellation, 23
canFilterByProperty:MPMediaItem,
 418
canPerformAction:, 551, 555
canPerformAction:withSender:,
 UIResponderStandardEdit
 Actions, 552
canShowCallout, 398
Cascade, 524
caseInsensitiveCompare:, 96
catch(), 39
@catch(), 39
categories
 Cocoa, 37
 Objective-C, 36–37
CATransition, 144
Cc, 489
CC_MD5, 465–466
[cd], 529
CDAAppDelegate, 174
CDAAppDelegate.m, 174
CDAUIView, 173–174
CDAViewController, 172
CDAViewController.h, 172
CDAViewController.m, 172
CDBUIView
 drawRect:, 180
 myController, 179

CDBViewController, 177
CDCUIView, 189
CDCViewController, 188
cellForRowAtIndexPath:, 296–297
Cell-Identification, 373
cellularConnected, 459
 EDGE, 460–461
 GPRS, 460–461
center, 115, 118–119
 animation, 140
.cer, 480
certificate signing request (CSR), 477
CFAllocatorGetDefault(), 461
CFDateRef, 494
CFDictionaryRef, 494
CFNumberRef, 494
CFRelease(), 366
CFRelease, 495
CFStringCreateWithBytes(), 366
CFStringRef, 494
CFTypeRef, 495
 ABMultiValueRef, 496
CFURL, 410
CFURLRef, 409, 410
CGAffineTransform, 140
CGAffineTransformMakeScale(), 141
CGContextAddEllipseInRect(), 145
CGContextAddLineToPoint(), 145
CGContextFillPath(), 145–146
CGContextMoveToPoint(), 145
CGContextSetRGBFillColor(), 146
CGContextSetRGBStrokeColor(), 146
CGContextStrokePath(), 145–146
CGFloat, 115
CGPoint, 115–116
CGPointMake(), 116
CGRect, 16
CGRectMake(), 16
CGRectZero, 211
CGSize, 116
CGSizeMake(), 16
channel, 349
char, 62
characterNameForShowIndex:
 atIndex:, 282
charactersFoundSAX(), 363, 365–366, 371
charactersSaxFunc(), 365
charactersSaxFunc, 371

CharacterViewController, 282–283
 tableView:didSelectRowAtIndexPath:, 281
child
 RSS, 349
 views, 6
children, 355
childView, 139
circular references, 34–36
city, 393
Class, 58
@class, 21
class methods, 20–21
 @interface, 22
class variables, 21
 (**Class**) 0, 23
class_addIvar, 73
class_addMethod(), 69–70
class_copyMethodList(), 67
classes, 56–57
 Cocoa, 24
 creating, 72–74
 declaration, 20–21
 @implementation, 57
 @interface, 57
 Object-C, 20
Classes, 5
class_getInstanceMethod(), 62
class.h, 572
class.m, 572
clearButtonMode, 154
clearQuery(), 241, 242
CLLocationManager, 373–377
CLLocationManagerDelegate, 387
closeFile, 320
cls, 69–70
 _cmd, 60
Cocoa
 categories, 37
 classes, 24
 collections, 83–104
 C-string, 370
 errors, 43–45
 exceptions, 39
 Foundation Framework, 495
 multithreading, 51–55
 NSIndexPath, 253
 Objective-C code, 19–82
code, UI, 604–607
code, 43
collections, Cocoa, 83–104
collections, 416
colors, pasteboards, 550
columns, databases, 323
Command-shift-E, 5
Comment
 Belongs-To, 530
 modeling tool, 521–526
 To-Many, 526
 User, 530
Community, 48
comparator, 95
compiler directive, 20
COMPLETE, 468
components, 208–209
compression
 attachments, 489
 pictures, 464
computationFinished, 54
computationResult, 54
compute
 ProgressAlertView, 455–456
 task, 455
compute:
 data, 52
 ds, 54
 myComputationallyIntensiveTaskObject, 52
 release, 52
computeInBackground:, 52, 54
conditional fetch requests, 528–529
conformsToProtocol, 28
connection:didFailWithError:, 470
connectionDidFinishLoading:, 471
connection:didReceiveResponse:, 470–471
containers, 4
contents, 383
contentsAtPath:, 312
contentSize, 217
contentView, 296, 297
continuous, 161
controlEvents, 151
controls, 149–170
 buttons, 163–164
 date pickers, 168–169

delegates, 158–159
page, 167–168
segmented, 164–167
sliders, 160–161
switches, 161–162
text field, 153–160
coordinate, 375–376
copy, 25
 arr1, 87
 autorelease, 92
 copyWithZone:, 90
 mutableCopy, 33, 87
 NSArray, 85
copy:, 556–557
copy and paste, 547–559
 Editing Menu, 551–552
 loadView, 554–555
 view controllers, 554–558
copyright, 349
copyWithZone:, 90
 NSCopying, 89
Core Animation, 142
Core Data, 515–538
 CRUD, 527–530
 key players, 516–521
 modeling tool, 521–526
 relationships, 530
 search application, 531–538
Core Foundation, 461
Core Location, 373–377
CoreDataWrapper, 533
CoreGraphics, 577
CoreLocation.framework, 578
count, 98
CounterpartTemplateFile, 572
countries, sort, 441
countrySort, 441
county, 393
CREATE, 330
Create, Read, Update and Delete (CRUD),
 527–530
createAFileInTMP
 NSURL, 312
 viewDidLoad, 311
createDirectoryAtPath:attributes:,
 308
createFileAtPath:contents:
 attributes:, 312, 314
CRUD *see* Create, Read, Update and Delete
CSR *see* certificate signing request
C-string
 Cocoa, 370
 Distance(), 393–394
 SAX, 359
 XML, 354
cStringUsingEncoding:, 353, 370
currAbsconder, 366
currentElementContent, 363
custom components, 443–457
 progress alert views, 452–456
 table alert view, 447–452
 text field alert view, 443–447
customizableViewController, 185–186
Customize Toolbar, 3
cut:, 556–557

data, compute:, 52
data modeling
 managed objects, 516–517
 modeling tool, 521–526
Data Source, 257–258
databases, 323–343
 Address Book, 494–513
 BLOB, 337–343
 columns, 323
 creating, opening, and closing, 325
 prepared statements, 330–333
 records, 323
 row result processing, 327–330
 rows, 323
 tables, 323
 user-defined functions, 333–337
dataForPasteboardType:, 550
dataFromPropertyList:format:error:
 Description:, 564
dataUsingEncoding:, 314
dataWithBytes:length:, 342
dataWithContentsOfFile:, 319, 341
date, 494
date, 168
 date formatting, 435–438
 custom formats, 437–438
date pickers, 168–169
datePickerChanged, 169
datePickerMode, 169
DAUImageView.m, 174

day, 437
 db, 330
 dealloc, 6
 circular references, 34
 IB, 594–595
 navCtrl, 594–595
 notifications, 56
 release name, 31
 super, 35, 107
 table view controller, 473
 Debug, 575–576
 debugger, 14–15
 Build and Go, 14
 My_ProjectAppDelegate.m, 14
 deep copy, 88–93
 defaultManager, 306
 defaultCenter, 55
 delegate, 154
 accelerometer, 406
 CLLocationManager, 374–375
 Location Awareness, 378
 MKMapView, 397
 MPMediaPickerController, 413–414
 MyView, 555
 ProgressAlertView, 455
 UIAlertView, 221
 UIImagePickerController, 420
 delegate(s)
 ABPersonViewController, 510
 alert view, 455
 animation, 140–141
 applications, 174–175, 567, 594–595
 connection:didFailWithError:, 470
 controls, 158–159
 email, 490
 Property Lists, 564
 search application, 532–533
 TableAlertView, 451
 tableView:cellForRowAtIndexPath:, 451–452
 UI, 455
 UIPickerView, 206–207
 UIWebView, 242–247
 delete:, 545
 deleteObject:, 527
 deleteRowAtIndexPath:, 544–545
 setActionName:, 545
 deleteRowsAtIndexPaths:withRowAnimation:, 263
 dequeueReusableCellWithIdentifierWithIdentifier:, 398
 dequeueReusableCellWithIdentifierWithIdentifier:, 254
 Description, 572
 description
 charactersSaxFunc(), 365
 didSelectRowAtIndexPath:withContext:, 449
 DynamicTableViewController, 294
 NSNumber, 464
 NSString, 295, 464
 RSS, 349
 TableAlertViewDelegate, 449
 tableView:cellForRowAtIndexPath:, 451
 XML, 358
 description:, 99
 desiredAccuracy, 374
 destructiveButtonTitle, 224–225
 detachNewThreadSelector:toTarget:withObject:, 469
 Details, 5
 Developer Documentation, 15
 XCode, 15–16
developer.apple.com/iphone/, 1, 15
 Development Provisioning Profiles, 481–482
devforums.apple.com, 15
 devices, 403–428
 accelerometer, 403–408
 audio, 408–418
 battery, 424–426
 pictures, 420–423
 provisioning profile, 482–483
 proximity sensor, 426–428
 tokens, 485–486
 video, 418–419
 dictionaries, 101–103, 494
 applicationDidFinishLaunching:, 284
 dictionaryWithObjectsAndKeys:, 102
 didSelectRowAtIndexPath:withContext:, 449
 difficultyForRecipe:resources:patience:, 76–77

directories, 308–309
directoryAttributes, 307
disability, 33–34
disabledBackground, 154
dismiss button, 197–199
dismissModalControllerAnimated:, 197–198
dispatch table, 59
displayedPerson, 509
displayedProperties, 507
displayNameForKey:value:, 439
dissent, 242
Distance()
 C-string, 393–394
 SQL, 393
distance(), 134
distanceFilter, 374
Document, 12
Document Object Model (DOM)
 parsing, 352–353, 370–371
 XML, 351–358
Documentation, 571
Documents, 307
 NSData, 563
Documents/fileNew.txt, 319
doesNotRecognizeSelector:, 60, 77
DOM *see* Document Object Model
domain, 43
drawing, 145–146
drawRect:, 107, 136, 145–146, 190
 CDBUIView, 180
 image view, 554
 setNeedsDisplay, 135
 swipes, 131
DROP, 330
ds, 54
DWebview, 230
dynaGuide, 102
@dynamic, 30, 521
DynamicTableView, 294
DynamicTableViewController, 294–297
 description, 294

EDGE, 460–461
 pictures, 464
Edit, 544
editable, 218
editAction:, 262
editButton, 259
editing, 155, 262
 UIViewControllerAnimated, 196
Editing Menu
 canPerformAction, 555
 copy and paste, 551–552
 view controllers, 552
editingStyle, 263
email
 attachments, 489
 delegate, 490
 networking, 487–490
Enable Push Notification Services, 476
enabled, 149
enablesReturnKeyAutomatically, 157
encoding, 349
@end, 20
endElementNsSax2Func(), 364
endElementNsSax2Func, 371
endElementSAX()
 charactersFoundSAX(), 363

state.plist, 565
 XCode, 350–351
 external applications, 567–568

F
 FAILED, 468
 fatalErrorEncounteredSAX(), 367
 feedURL, 353
 fetch requests, 527–530

- conditional, 528–529
- sort, 528, 529–530
- UIActivityIndicatorView, 592
- unconditional, 528

 fetchAbsconders, 353

- absconders, 358
- SAX, 358–359

 FETCHING

- InternetResource, 468
- status, 469

 fetchURL

- autorelease, 469
- nil, 469
- self, 469

 file management, 305–321

- attribute retrieval and change, 312–317
- directory creation and deletion, 308–309
- directory enumeration, 306–307
- file creation, 309–312
- Home, 305–306
- resources, 317–320

 fileAttributes, 307
 fileAttributesAtPath:

- traverseLink:, 314

 «FILEBASENAMEASIDENTIFIER», 573
 fileHandleForReadingAtPath:, 320
 fileHandleForUpdatingAtPath:, 320
 fileHandleForWritingAtPath:, 320
 filename, 325
 File->New, 107
 File->New Project, 2
 filePath, 319
 file.txt, 314
 fileURLWithPath:isDirectory:, 410
 filteredListContent, 534, 535–538
 filters, 418
 finally, 39, 41
 @finally, 39
 financial.db, 328

findGeoInfoForAddress:andReturnLatitude:andLongitude:, 380, 383
 findNextItem(), 355
 FinishLoading, 472
 first responder, 122

- undo management, 543–544

 firstTouchLocInView, 133
 firstTouchTimeStamp, 133
 flags, 461
 Flickr, 459
 flip animation, 142
 float, 438
 font, 155, 218
 footers, UITableView, 257–258
 forwardInvocation:

- invokeWithTarget:, 78
- NSUndoManager, 541

 Foundation, 577
 Foundation Framework, 26

- Cocoa, 495

 frame, 115, 118–119
 frameworks, 577–579
 free, 67
 fromIndexPath, 274
 «FULLUSERNAME», 573

garbage collection, 24
 GCC_PREFIX_HEADER, 584
 generalPasteBoard, 548
 genresQuery, 416
 geocoding, 380–386
 Get, 462
 getDistanceFrom:, 377
 getEntryAtIndex:0, 23
 getItem(), 356
 getKey, 381
 getQuery(), 241, 242
 getReturnValue:, 76
 getter=getterName,

- setter=setterName, 30

 GGeoAddressAccuracy, 380
 giveMeAString, 26
 Global Positioning System (GPS), 373
 Global Search, 571

Google Maps, 380–386
GoogleMapsWrapper, 380–386
 applicationDidFinishLaunching:, 385
 UITextView, 384
GPRS, 460–461
GPS *see* Global Positioning System
groupingType, 415
Groups & Files, 110
 UIWebFile, 234
 XCode, 4

handleCancellation, 443, 446
handleEnteredValue:, 443
handleFinishedLoading:
 reloadTheData:, 473
 waitForDone, 473
hash, 299
hasSuffix:, 244
headers, 4
 multimedia uploads, 462
 runtime, 57
 UITableView, 257–258
HEADER_SEARCH_PATHS =
 /usr/include/libxml2, 352
Hello iPhone, 8, 10
Hello World, 105–112
 main(), 105
 XCode, 107
Help->Documentation, 15
hidden, 451
hidesWhenStopped, 212
highlighted, 149–150
hit-testing, 122
Home, 230, 305–306, 307
 main(), 306–307, 308
 rec.aif, 411
horizontalAccuracy, 376
hour, 437
HTML
 tracking application, 390–391
 UTI, 549
 web view, 226–229
html, 230
 loadWebViewWithFileInTMP, 312
 tmp, 309
htmlContents, 233
HTTP, Google Maps, 380
 HTTP, 462
 http, 309
 hugs, 405
i18n *see* internationalization
IB *see* Interface Builder
IBAction, 594, 595
IBOutlets, 595
 (id) 0, 23
IDE, 3–5
identifier
 person, 508
 property, 509
identifiers, 503
image
 RSS, 349
 UIImageView, 593
 UITabBarItem, 179
imageNamed:, 257
 UIImage, 182
imagePickerControllerDidCancel:, 421
imagePickerController:didFinishPickingMediaWithInfo:, 421, 422
images
 MyImageView, 553–554
 pasteboards, 550
 UITableView, 255–256
imageView, 256
imageWithData:, 501
IMG, 231, 233
immutable copy, 86–88
immutable sets, 97–99
@implementation, 20
 classes, 57
implementations, 4
 Object-C, 20
 runtime, 65–67
#import, 21
include, 409
#include, 21
index.html, 312
indexPath, 280
 NSArray, 263
 NSIndexPath, 263
InfoPlist.strings, 434

```

init, 24
    managedObjectContext, 519
    methodSignatureForSelector:, 78
    MPMediaPickerController, 413
    super, 25
initialized, XML_SAX2_MAGIC, 361, 371
initiateCompute:, 52
initWithNibName:bundle:, 173
initWithCaller:data:title:
    andContext:, 449–450
initWithContentsOfURL:, 383
initWithContentsOfURL:error:, 412
initWithContentURL:, 418–419
initWithCoordinate:altitude:
    horizontalAccuracy:, 376–377
initWithData:
    DynamicTableView, 294
    initWithStyle:, 295
initWithFrame:, 136
    UIView, 251
initWithFrame:style:, 250
initWithKey:ascending:, 529
initWithLatitude:longitude:, 376
initWithMediaTypes:, 413
initWithMessage:andImage:, 178
initWithNibName:bundle:, 179
    JavaScript, 240
    nil, 174
    tracking application, 387–388
initWithObjects:, 97
initWithRootViewController:, 191
initWithStyle:, 279
    initWithData:, 295
    subclasses, 277
    UITableViewController, 276
initWithStyle:reuseIdentifier:, 253
initWithTarget:selector:object:, 54
initWithURL:settings:error:, 411
inputACharacterView, 269
InputAlertView, 443–444
    OK/Cancel buttons, 445–446
    prepare, 445
    self, 444–445
InputAlertViewDelegate, 443
    _caller, 444
inputAlertViewWithTitle:intial
    FieldText:caller:, 444–445
Inputs & Values, 8
INSERT, 330
    insertCompany(), 339
    sqlite3_step(), 34
insertCharacter, 268–269
insertCompany(), 339
    PNG, 34
insertNewObjectforEntityForName:
    in, NSEntityDescription,
    527
insertRecord:, 42–43
insertSegmentWithImage:, 167
insertSegmentWithTitle:, 167
insertStockPurchase(), 326–327
Inspector
    attributes, 7
    labels, 8, 9
instance method
    NSObject, 36–37
    NSUndoManager, 542
instance variables, 20, 71
instancesRespondToSelector:, 64
int, 62
    NSNumber, 438
INTEGER, 326
integers, 494
    binding, 340
interface, Object-C, 20
@interface, 20
    class methods, 22
    classes, 57
    properties, 29
Interface Builder (IB), 6, 7–13, 591–617
    labels, 9
    National Debt Clock application, 591–609
    toolbar application, 609–617
    UI, 595–609
    XCode, 8, 14, 594
interfaceOrienation, 173
interfaces, 6–14
internationalization (i18n), 429–441
    countries sorted, 441
    date formatting, 435–438
    number formatting, 438–440
    string localization, 430–434

```

InternetResource, 467–471
table view controller, 472
tableView:cellForRowAtIndex
Path:, 472–473
intersectsSet:, 98
intSort(), 95
intSortedArray, 96
intWithName:, 46
invocationWithMethodSignature:, 76
invokeWithTarget:, 76
 forwardInvocation:, 78
iPhone Dev Center, 15
iPod library, 415–418
isa, 58
isCancelled, 453, 455
isEqualToString:, 103
isEqualToString:, 99
isKindOfClass:, 556
isMarried, 33
ISOCountryCodes, 441
 NSLocale, 440
isPalindrome(), 337
isSourceTypeAvailable:, 420
isSubsetOfSet:, 98
item
 RSS, 355–356
 XOAbsconder, 363
items
 NSArray, 414
 pasteboards, 548–550, 557
Items & Values, 10
Ivar, 71

Java, 22
JavaScript, 235–242
 Objective-C, 235–236
 tracking application, 391
 UIWebView, 239–240, 241
JPEG
 pasteboards, 555
 UTI, 549
JSON, 487

kABDateTimePropertyType, 494
kABDictionaryPropertyType, 494
kABGroupNameProperty, 495
kABHomeLabel, 497
kABIIntegerPropertyType, 494
kABMultiDateTimePropertyType, 494
kABMultiDictionaryPropertyType,
 494, 499
kABMultiIntegerPropertyType, 494
kABMultiRealPropertyType, 494
kABOtherLabel, 497
kABPersonAddressProperty, 497
kABPersonBirthdayProperty, 496
kABPersonDateProperty, 497
kABPersonFirstNameProperty, 495
kABPersonLastNameProperty, 495
kABPersonMiddleNameProperty, 495
kABPersonNicknameProperty, 496
kABPersonNoteProperty, 496
kABPersonPhoneProperty, 497
kABPersonURLProperty, 497
kABRealPropertyType, 494
kABStringPropertyType, 494
kABWorkLabel, 497
kCFAllocatorDefault, 366
kCFStringEncodingUTF8, 366
kCLLocationAccuracyKilometer, 374
kCLLocationAccuracyBest, 374
kCLLocationAccuracyHundredMeter,
 374
kCLLocationAccuracyNearestTen
 Meters, 374
kCLLocationAccuracyThree
 Kilometers, 374
key, 45
key path, 45
key players, 516–521
keyboard, UITextField, 155–158
keyboardAppearance, 156–157
keyboardType, 155
Keychain Access, 477
keyEnumerator, 102
keysSortedByValueUsingSelector:,
 103
key-value coding (KVC), 19, 45–51
kSystemSoundID_Vibrate, 409
KVC *see* key-value coding

l10n *see* localization
labels
 buttonTapped, 12
 IB, 9

Inspector, 8, 9
 UI, 8
 latitude, 380
 zipcode, 393
 latitudeDelta, 395
 layer, 142
 showOtherView:, 144
 leftBarButtonItem, 194
 levelIndexPath, 278
 Library, 8, 307
 Items & Values, 10
 libsqlite3.0.dylib, 323
 libxml2, 346–347, 351
 SAX, 359
 xmlFree(), 370
 libxml2xml
 ParseMemory(), 370
 xmlSAXUserParseMemory(), 371
 link, 349
 charactersSaxFunc(), 365
 XML, 358
 listAllMethods(), 68
 Litigating, 27
 loadHTMLString, 241
 loadView, 159, 173
 BatteryMonitor, 425–426
 copy and paste, 554–555
 JavaScript, 241
 LocalizedString, 430–431
 MainView, 199
 MainViewController, 311
 tracking application, 390
 UILabel, 282
 UIPickerView, 211
 UIScrollView, 216
 UITextView, 219
 UIWebView, 233, 241, 244
 view, 174
 loadWebViewWithFileInTMP, 311
 html, 312
 Localizable.strings, 431–433
 Arabic, 432
 English, 431–432
 XCode-, 432–433
 localization (l10n), 429
 LocalizedString, 430–433
 loadView, 430–431
 MainViewController, 430
 LocalizedString-Info.plist, 434
 localtime, 361
 Location Awareness, 373–402
 Core Location, 373–377
 Google Maps, 380–386
 Map Kits, 394–402
 tracking application, 386–392
 ZIP codes, 392–394
 locationInView, 122
 locationManager:didFailWithError:, 375
 locationManager:didUpdateTo Location:fromLocation:, 374, 378
 LocationViewController
 applicationDidFinish Launching:, 387
 tracking application, 387–390
 longitude, 380
 zipcode, 393
 longitudeDelta, 395
 loseFocusOfField(), 241
 lost, 49
 lover, 48
.m, 20
Mail.app, 488
main(), 5, 317
 BLOB, 338–339, 341–342
 callbacks, 328
 Hello World, 105
 Home, 306–307, 308
 main.m, 105
 prepared statements, 331–332
 SQLite, 324
 sqlite3_exec(), 328–329
 user-defined database functions, 334–335
main.m, 5
 main(), 105
 UIApplicationMain(), 110
 MainTemplateFile, 572
 MainView, 199
 MainViewController
 loadView, 311
 LocalizedString, 430
 modal view controllers, 198
 UIWebView, 310

MainWindow.xib, 7, 10
IB, 595
(void)makeObjectsPerformSelector:
 (SEL)aSelector, 101
managed memory, 24
managed object context, 515, 517
managed objects, 516–518
 Core Data, 515
 User, 520–521
managedObjectContext, init, 519
manager, 32
Map Kit, 394–402
<MapKit/MapKit.h>, 395
MapView, 401
mapView:viewForAnnotation, 399–400
marge, 616
market, 59
married, 33
maximumValue, 160
maximumZoomScale, 217
maxRows, 372
MD5, 465–466
 NSString, 459, 465–466
media picker controller, 412–415
mediaPickerController:, 414
MediaPlayer, 412
memory management, 24–27
mergedModelFromBundles:, 516–517
message, 57
 expression, 23
message
 UIAlertView, 221
 UIViewController, 172
Message Bubbles, 571
message IBOOutlet, 610
metaclass, 57
Method
 free, 67
 method_getName(), 63
 runtime, 61
method invocation, 22–23
method_copyReturnType(), 69
method_exchangeImplementations(),
 66
method_getImplementation(), 63
method_getName(), 63
methodReturnLength, 76
methodSignatureForSelector:, 77
init, 78
MFMailComposeResultCancelled, 490
MFMailComposeResultFailed, 490
MFMailComposeResultSaved, 490
MFMailComposeResultSent, 490
MFMailComposeViewController, 488
MIME, 489
MIN_DISTANCE, 390
minHeightForText:, 295, 296
minimumValue, 160
minimumZoomScale, UIScrollView, 216
minute, 437
MKAnnotation, 396–397
MKAnnotationView, 397–399
 callout view, 398
 UIView, 397
MKCoordinateRegion, 395–396
MKCoordinateSpan, 395
MKMapView
 delegate, 397
 dequeueReusableAnnotation
 ViewWithIdentifier:, 398
 UIView, 395
MKPinAnnotationView, 401
MKUserLocation, 399–400
modal view controllers, 197–202
 dismiss button, 197–199
modalTransitionStyle, 197
modalViewControllerAnimated:, 421
model, 419
model view controller (MVC), 171
modeling tool, 521–526
month, 437
More, 182–183
moreNavigationController, 183
movedSeparate, 132, 134
movedTogether, 132, 134
MPEG, 549
MPMediaGrouping, 415–416
MPMediaGroupingAlbum, 415
MPMediaGroupingAlbumArtist, 416
MPMediaGroupingArtist, 416
MPMediaGroupingComposer, 416
MPMediaGroupingGenre, 416
MPMediaGroupingPlaylist, 416
MPMediaGroupingPodcastTitle, 416

MPMediaGroupingTitle, 415
 MPMediaItem, 414
 MPMediaItemCollection, 414, 417
 MPMediaItemPropertyArtist, 414
 MPMediaItemPropertyPersistentID,
 414
 mpMediaItemPropertyPlayback
 Duration, 414
 MPMediaItemPropertyTitle, 414
 MPMediaPickerController, 412–413
 MPMediaPickerControllerDelegate,
 413–414
 MPMediaPredicateComparisonEqualTo,
 417
 MPMediaPropertyPredicate, 417–418
 MPMediaQuery, 415–416
 MPMediaTypeAny, 413
 MPMediaTypeAnyAudio, 413
 MPMediaTypeAudioBook, 413
 MPMediaTypeMusic, 413
 MPMediaTypePodcast, 413
 MPMovieControlModeDefault, 418
 MPMovieControlModeHidden, 418
 MPMovieControlModeVolumeOnly, 418
 MPMoviePlayerController, 418–419
 MThreadedDownloads, 467
 multimedia uploads, 462–465
 multipleTouchEnabled, 128
 Multithreaded Downloads, 467–473
 multithreading
 Address Book, 503
 Cocoa, 51–55
 multitouch interface, 121–137
 multi-value property, 494, 496–500
 mutabilityOption, 565
 mutable copy, 88–89
 mutable sets, 99–100
 mutableCopy
 copy, 33, 87
 dictionaries, 102
 MVC *see* model view controller
 MyClassName, 20
 myComputationallyIntensive
 TaskObject, 52
 myController, 173
 CDBUIView, 179
 CDCUIview, 189
 MYDBException, 43
 MyImageView
 images, 553–554
 isKindOfClass, 556
 MyParentName, 20
 My_ProjectAppDelegate
 buttonTapped, 12
 Touch Down, 12
 My_ProjectAppDelegate.h, 5
 My_ProjectAppDelegate.m, 14
 mySelector, 23
 MyView, 107
 delegate, 555
 touchesEnded:withEvent:, 107
 MyViewController, 238
 MyView.h, 110
 MyView.m, 110
 MyWebViewcontroler, 230

 name, 230
 aObject, 29
 NSError, 41
 NSNotification, 55
 NSString, 49
 pasteboards, 548
 National Debt Clock application, 591–609
 navCtrl, 597–598
 dealloc, 594–595
 Navigation Controller, 596–598
 navigation controllers, 186–196
 networkConnected, 459, 461
 networking, 459–491
 asynchronous, 469
 connectivity, 459–462
 email, 487–490
 MD5, 465–466
 multimedia uploads, 462–465
 Multithreaded Downloads, 467–473
 push notification, 474–487
 table view controller, 471–473
 NEW, 468
 new, 85
 newPersonViewController:did
 CompleteWithNewPerson:, 511
 newSetHighlighted:animated:, 298
 nextObect, 307
 .nib, 7

nil, 23
anObject, 40
applicationDidFinish
 Launching:, 174
CAAnimation, 144
copyWithZone:, 90
fetchURL, 469
getitem(), 356
initWithNibName:bundle:, 174
mapView:viewForAnnotation,
 399–400
NSArray, 85
NSDictionary, 315
NSLocaleCurrencySymbol, 439
NSNull, 51
NSObject, 59
NSString, 44
object, 56
Objective-C code, 14
otherButtonTitles, 222, 225
ptr, 24
STAssertNil, 588
UIApplication, 106
UIImage, 505
 view, 174
Nil, 23
nonatomic, 30
NO_OF_LOCATIONS, 391
notification center, 55
notifications, 55–56
 dealloc, 56
noUpdates, 377
NSArray, 24, 83–96, 286
 alloc, 85
 arrayWithObjects:, 92
 copy, 85
 indexPath, 263
 items, 414
 new, 85
 nil, 85
 objectAtIndex, 87
 pasteboardType, 550
 Property Lists, 563
 release, 74, 85
 setValue:forPasteboardType:,
 550
 viewControllers, 182
NSAutoreleasePool, 26
NSBundle, 318
NSCocoaErrorDomain, 43
NSCopying
 copyWithZone:, 89
 dictionaries, 101
 NSObject, 89
NSData, 462
 contentsAtPath:, 312
 dataWithContentsOfFile, 34
 Documents, 563
 filePath, 319
 initWithContentsOfURL:, 383
 NSPropertyListSerialization,
 563
 Property Lists, 563
 XML, 563
NSData*, 70
NSDate
 Formatter setDateFromFormat, 437
 pasteboardType, 550
 Property Lists, 563
 setValue:forPasteboardType:,
 550
 stringFromDate:, 436, 438
NSDate*, 494
NSDateFormatter, 435–438
NSDateFormatterFullStyle, 436, 437
NSDateFormatterLongStyle, 436
NSDateFormatterMediumStyle, 436
NSDateFormatterNoStyle, 436
NSDateFormatterShortStyle, 436
NSDictionary, 101–103
 nil, 315
 pasteboardType, 550
 Property Lists, 563
 setValue:forPasteboardType:,
 550
NSDictionary*, 494
NSDirectoryEnumerator, 307
NSEntityDescription, 516
 insertNewObjectforEntity
 ForName:inManagedObject
 Context:, 527
NSEnumerator, 307
NSError, 43–45, 315
 ABMultiValueAddValueAndLabel,
 499
 audio, 411, 412

autorelease, 44
 code, 43
 domain, 43
 NULL, 309, 496
 single-value properties, 496
 userInfo, 43
 NSet, 24
 NSException, 39
 name, 41
 reason, 41
 userInfo, 41
 NSFetchedRequest, 527
 NSFileBusy, 315
 NSFileCreationDate, 316
 NSFileExtensionHidden, 316, 317
 NSFileGroupOwnerAccountID, 316
 NSFileGroupOwnerAccountName, 316
 NSFileHandle, 320
 NSFileHFSCreatorCode, 316
 NSFileHFSTypeCode, 316
 NSFileImmutable, 316
 NSFileManager
 createDirectoryAt
 Path:attributes:, 308
 defaultManager, 306
 NSFileModificationDate, 316
 NSFileOwnerAccountID, 316
 NSFileOwnerAccountName, 316
 NSFilePosixPermissions, 316
 NSFileSize, 315
 NSFormatter, 435–438
 NSIndexPath
 Cocoa, 253
 indexPaths, 263
 NSInteger, 95
 NSInvalidArgumentException, 40, 77
 super, 60
 NSInvocation, 76, 77
 NSInvocationOperation, 51, 52
 addOperation:, 54
 NSKeyValueCoding, 45
 NSLocale, 429
 ISOCountryCodes, 441
 NSLocaleCurrencySymbol, 439
 NSLocaleCurrencySymbol
 nil, 439
 NSLocale, 439
 NSLocalizedString, 431
 NSManagedObject, 517–518
 autoreleased, 518
 User, 521
 NSManagedObjectContext, 517
 NSManagedObjectModel, 516–517
 NSMutableArray, 83–96
 achievements, 32
 autorelease, 33
 objectAtIndex, 87
 NSMutableDictionary, 101–103
 NSMutableSet, 24, 99–100
 NSMutableString
 anObject, 25
 currentElementContent, 363
 rankSelf, 37
 NSNotification, 55–56
 name, 55
 object, 55
 userInfo, 55
 NSNotificationCenter, 55
 NSNull
 dictionaries, 101
 nil, 51
 NSNumber, 315, 438–440
 description, 464
 float, 438
 int, 438
 NSString, 439
 pasteboardType, 550
 Property Lists, 563
 setValue:forPasteboardType:, 550
 updateProgress:, 453
 NSNumber*, 494
 NSNumberFormatter, 435, 438–440
 NSNumberFormatterDecimalStyle, 439
 NSNumberFormatterSpellOutStyle,
 stringFromNumber:, 439–440
 NSObject, 24, 57, 58–59
 CAAnimationDelegate, 140
 conformsToProtocol, 28
 instance method, 36–37
 nil, 59
 NSCopying, 89
 performSelector, 74
 UIResponder.h, 551
 value, 45

NSObject.h, 58
NSOperation, 51
NSPersistentStoreCoordinator, 517
NSPOSIXErrorDomain, 43
NSPredicate, 528
 predicateWithFormat:, 529
NSPropertyListBinaryFormat_v1_0,
 564
NSPropertyListImmutable, 565
NSPropertyListMutableContainers,
 565
NSPropertyListMutableContainers
 AndLeaves, 565
NSPropertyListSerialization
 dataFromPropertyList:format:
 errorDescription:, 564
 NSData, 563
NSRangeException, 184
NSRunLoop, 469
NSScanner
 NSString, 383
 zipcode, 393
NSSelectorFromString(), 23
NSSet, 98, 530
NSSortDescriptor, 529–530
 initWithKey:ascending:, 529
 setSortDescriptors:, 528
NSString, 24, 37, 494
 ABMultiValueCopyLabelAtIndex,
 497
 absoluteString, 243
 audio, 413
 @catch, 39
 cStringUsingEncoding, 370
 description, 295, 464
 dictionaries, 101
 hasSuffix:, 244
 key, 45
 MD5, 459, 465–466
 name, 49
 nil, 44
 NSNumber, 439
 NSScanner, 383
 pasteboardType, 550
 Property Lists, 563
 RSS, 353
 script, 241
 sectionIndexTitlesFor
 TableView:, 292
 SEL, 63
 setValue:forPasteboardType:,
 550
 stringWithContents
 OfURL:encoding:error:, 370
 stringWithFormat:, 257
 UIPickerView, 206
 UISegmentedControl, 164
 UIStringDrawing, 295
 updateProgress:, 453
 urlEncodedVersion, 464–465
 NSString*, 29, 70
NSThread
 receivedData, 469
 sleepForTimeInterval:, 455
NSTimeInterval, 129
NSTimer, 214
NSUndoManager, 539–546
 applicationDidFinish
 Launching:, 542
 forwardInvocation:, 541
 instance method, 542
 properties, 542
 UIApplication, 542
 UIResponder, 540
 view controllers, 543
 NSUndoManagerDidRedoChange
 Notification, 542
 NSUndoManagerDidUndoChange
 Notification, 542
 NSUndoManagerWillRedoChange
 Notification, 542
 NSUndoManagerWillUndoChange
 Notification, 542
NSURL, 353, 370, 462
 audio, 409, 411
 createAFileInTMP, 312
 MPMoviePlayerController, 418
 pasteboards, 550
 pasteboardType, 550
 setValue:forPasteboardType:,
 550
 URL, 568
NSURLConnection, 462–465, 469–470
NSURLRequest, 242–243, 462
 url, 469

NULL, 326
 binding, 340
 mySelector, 23
 NSError, 309, 496
 outCount, 67
 person, 506
 SAX, 359
 sqlite3_exec(), 326
 *zSql, 331
 number formatting, 438–440
 numberOfRows, 296
 numberOfSectionsInTableView, 257

 OBJC2_UNAVAILABLE, 58
 objc_allocateClassPair(), 72
 objc_msgSend(), 59, 70–71
 objc_registerClassPair(), 72
 objc_super, 74
 object
 nil, 56
 NSNotification, 55
 objectAtIndex
 NSArray, 87
 NSMutableArray, 87
 objectForKeyForInfoDictionaryKey:, 574
 objectForKey:, 102, 439
 object_getClass(), 68
 object_getInstanceVariable(), 71
 Objective-C, 6
 categories, 36–37
 Cocoa, 19–82
 endElementSAX(), 366
 exceptions, 38–43
 JavaScript, 235–236
 managed objects, 516
 nil, 14
 posing, 38
 properties, 29–36
 protocols, 27–29
 runtime, 56–78
 ZIP codes, 393–394
 observers, 56
 OK/Cancel buttons, 445–446
 openURL:, 488
 operation objects, 51
 @optional, 27
 orientation, 420
 originalMethod, 67

 Other Linker Flags, 350, 583
 Other Sources, 5
 otherButtonTitles, nil, 222, 225
 OTHER_LDFLAGS, 350–351
 outCount, 67

 page controls, 167–168
 Palindrome(), 334
 palindrome(), 337
 parent, 355
 parentViewController, 197
 ParseMemory(), 370
 parser.h, 354
 parsing
 DOM, 352–353, 370–371
 SAX, 370–371
 XML, 346
 password, 1
 paste:, 557–558
 pasteboards, 547–550
 items, 548–550, 557
 JPEG, 555
 name, 548
 UTI, 549
 pasteboardType, 550
 pasteboardWithUniqueName, 548
 .pbfiletemplate, 572
 PBXCustomTemplateMacroDefinitions,
 573
 performSelector, 74
 performSelectorOnMainThread:with
 Object:waitForCompletion:, 454
 performTask, 454
 period, 437
 persistence store coordinator, 517
 Core Data, 515
 Person, 48, 230
 MKAnnotation, 396–397
 person
 identifier, 508
 NULL, 506
 <person>, 346
 PersonPhotoRetriever, 503–505
 PersonPicker, 509
 phase, 122
 phone, 230
 photoForAPerson, 505
 photos *see* pictures

picker view, 208–211
pickerView:didSelectRow:
 inComponent, 207, 211
pickerView:rowHeightForComponent,
 206
pickerView:widthForComponent, 207
pictures, 420–423
 Address Book, 503–505
 compression, 464
 EDGE, 464
 UIImage, 504
 uploads, 462–463
play:, 410
playlistQuery, 416
.plist, 483
 Server, 574
PNG
 insertCompany(), 34
 pasteboards, 556
population, 48–49
 lost, 49
population.allies, 49–51
popViewControllerAnimated:, 191
posing, 38
POSIX permissions, 316
Post, 462
postNotificationName:object:
 userInfo:, 55–56
postPhoto:withLat:withLng:
 andCaption:, 463–464
predicates, 528
predicateWithFormat:, 529
predicateWithValue:forProperty:,
 417
predicateWithValue:forProperty:
 comparisonType:, 417
prefix, 361
prepare
 InputAlertView, 445
 table alert view, 449–450
prepared statements, 330–333
 main(), 331–332
prepareWithInvocationTarget:, 541
presentModalViewController:
 animated:, 197, 199
previousLocationInView, 123
printf(), sqlite3malloc(), 327
printYourself, 23
Prob, 30
processJavaScript, 240, 242
processRow(), 329–330
produceImageReference:withType:,
 231
progress, 211
progress alert views, 452–456
progress views, 211–215
ProgressAlertView, 452–456
 compute, 455–456
 delegate, 455
 start, 453, 455
 task, 453, 455
«PROJECTNAME», 573
properties
 Address Book, 494
 Core Data, 515
 multi-value, 494, 496–500
 NSUndoManager, 542
 Objective-C, 29–36
 single-value, 494–496
 types, 494
property, 509
@property, 29
Property Lists, 563–566
 delegate, 564
propertyListFromData:mutable
 Option=format:error
 Description:, 565
protected methods, 23
@protocol (protocol-name), 28
protocols
 conformance, 28–29
 Objective-C, 27–29
provisioning profile, 481–484
 devices, 482–483
proximity sensor, 426–428
proximityState, 427
ptr, 24
public methods, 23
public.html(kUTTypeHTML), 549
public.jpeg(kUTTypeJPEG), 549
public.mpeg(kUTTypeMPEG), 549
public.rtf(kUTTypeRTF), 549
push notification, 474–487
 client, 481–487
 coding, 484–486, 487
 server, 474–480, 487

pushes, 405
 pushViewController:animated:, 191
 PVAppDelegate, 207–211, 213–215
 PVViewController, 207–211, 213–215
 *pzTail, 331

 Quick Open, 571

 radio interfaces, 177–186
 raise, 39
 rankSelf, 37
 reader application, RSS, 367–369
 readonly, 30
 readwrite, 30
 REAL, 326
 Really Simple Syndication (RSS), 349

- item, 355–356
- NSString, 353
- reader application, 367–369
- table view controller, 368–369
- XML, 347–349

 reals, 494

- binding, 340

 reason, 41
 rec.aif, 411
 receivedData

- NSThread, 469
- status, 469

 records, databases, 323
 records, 227

- allRecordsInHTML, 229

 redo, 541
 Refresh, 593, 606–607
 refresh, 608–609
 registerForRemoteNotification

- Types:, 485

 registerUndoWithTarget:selector:

- object:, 540

 relationships, Core Data, 515, 530
 release, 30

- alloc, 25
- compute:, 52
- NSArray, 74, 85
- removeFromSuperview, 269
- startElementsSAX(), 363

 release name, dealloc, 31
 reloadData, 269
 reloadTheData:, 473

 (void)removeAllObjects, 100
 removeFromSuperview, 269
 removeItemAtPath:error:, 309
 removeObject:, 89, 99
 removeObjectForKey:, 102
 removeObserver:name:object:, 56
 removeObserver:, 56
 removePasteboardWithName:, 548
 removeTarget:action:forControlEvents:, 152
 replaceObjectAtIndex:withObject, 40
 @required, 27
 resignFirstResponder, 542
 resources, 4

- file management, 317–320

 Resources, 7

- UIWebFile, 234

 responder chain, 122
 ResponderDemoView, 132
 respondsToSelector, 63
 retain, 25, 30

- self, 35
- view, 121

 retain count, 25
 retrieveCompany(), 341–343
 returnKeyType, 156
 reuseIdentifier, 253
 rich text document, 549
 rightBarButtonItem, 194
 root view controller, 598–604
 Round Rect Button, 10
 rows, 208

- databases, 323
- tables, 534–535
- view controllers, 544

 RSS *see* Really Simple Syndication
 RSS Reader, 367–369
 runtime

- headers, 57
- implementations, 65–67
- Method, 61
- Objective-C, 56–78
- patching methods, 65–67

 runUntilDate:, 469

 saveAppState, 564
 saveImagesInPasteboardAndDelete:, 557

SAX *see* Simple API for XML
scalesPageToFit, 228
scanFloat:, 384
scannerWithString, 383
scanUpToCharactersFromSet:into
 String:, 384
schemas, Core Data, 515
SCNetworkReachabilityCreate
 WithName(), 460
SCNetworkReachabilityGetFlags(),
 461
script, 241
scroll view, 215–217
search application, 531–538
 delegate, 532–533
searchDisplayController:should
 ReloadTableForSearch
 Scope:, 533
searchDisplayController:should
 ReloadTableForSearch
 String:, 532–533
searchResultsDataSource, 531–532
searchResultsDelegate, 532
searchResultsTableView, 533
second, 437
SecondaryView, 201
SecondaryViewController, 199, 200
 SecondaryView, 201
sectionIndexTitlesForTableView:,
 292
secureTextEntry, 156
seekToFileOffset, 320
segmentChanged:, 164–165
segmented controls, 164–167
segmentedControlStyle, 165
SEL, 23, 61
 NSString, 63
sel, target, 54
SELECT, 328, 336–337
selectAll:, selected, 558
selected
 image view, 553
 selectAll:, 558
 UIControl, 150
selectedCharacter, 281, 283
selectedSegmentIndex, 164
selectedShow, 280, 283
selectedViewController, 184–185
 @selector, 23
 @selector(paste:), 551
selectors, 22
self, 25
 assign, 46–47
 fetchURL, 469
 InputAlertView, 444–445
 method_exchange
 Implementations(), 66
 performSelectorOnMainThread:
 withObject:waitUntilDone:,
 454
 retain, 35
sendActionsForControlEvents:, 151
sendAction:to:from:forEvent:, 151
server, push notification, 474–480
Server, .plist, 574
Server/\$AppServer, 574–575
setActionName:, 545
setAMSymbol:, 438
setArgumentAtIndex:, 76
setAttributes:ofItemAtPath:error:
 NSFileManager, 315
setBccRecipients:, 489
 setDate:animated:, 169
setDateFormat:, 437
setEditing:animated:, 262
 UIViewController, 195
 undo management, 544
setEntities:, 516–517
setEntity:, 528
setHighlighted:animated:, 298–299
setImage:forSegmentAtIndex:, 166
setLocation (float x, flat y,
 float z), 22
setlocationX:, andY:, andZ, 22
setmenuVisible:YES animated:YES,
 552
setNeedsDisplay, 136
 drawRect:, 135
setOn:animated:, 162
setPMSymbol:, 438
setProb, 30
sets, 96–101
setSelected:animated:, 297, 300
setSelector:, 76
(void) setSet:(NSSet *)otherSet, 100
setSortDescriptors:, 528

```

setSubject:, 488
Settings App, 430
setTitle:forSegmentAtIndex:, 166
setToRecipients:, 489
setUp, 587
setValue:forKey:, 45
setValue:forPasteboardType:, 549, 550
shakes, 405
    undo, 541
sharedAccelerometer, 406
sharedApplication, 189
Shift Text, 571
shouldAutorotateToInterfaceOrientation
    Orientation:, 173
show, 450
showActivityIndicator:, 608–609
ShowCharactersTableViewController,
    280–281
showInView:, 225
showModalController, 198
showNameAtIndex:, 280
showNextLevel
    CDCViewController, 188
    touchesBegan:withEvent:, 190
showOtherView:, 142
    layer, 144
showsSelectionIndicator, 211
showsUserLocation, 400
ShowTableViewController, 278–279
Simple API for XML (SAX)
    callbacks, 359
    C-string, 359
    fetchAbsconders, 358–359
    handler, 360–361
    libxml2, 359
    NULL, 359
    parsing, 370–371
    XML, 358–367
Simple Mail Transfer Protocol (SMTP), 488
single-value property, 494–496
size, 295
sizeThatFits, 211
skipDescendents, 307
sleepForTimeInterval:, 455
sliders, 160–161
sliderValueChanged, 161
sliding view, 141
SlidingUpDownView, 141
smart groups, 4
SMTP see Simple Mail Transfer Protocol
sort
    arrays, 93–96
    countries, 441
    fetch requests, 528, 529–530
sortedArrayUsingFunction:context:, 95
sortedArrayUsingSelector:, 96
sound.caf, 410
Spelling and Grammar, 571
SQL see Structured Query Language
SQLite, 323–343
    main(), 324
    table operations, 325–327
sqlite3, 325
sqlite3*, 325
sqlite3_bind_int(), 340
sqlite3_bind_xxxx(), 340
sqlite3_closed(), 325
sqlite3_column_blob(), 342
sqlite3_column_bytes(), 342
sqlite3_column_double(), 333
sqlite3_column_int(), 333
sqlite3_column_XXX(), 333
sqlite3_create_function(), 335
sqlite3_exec(), 325
    main(), 328–329
    NULL, 326
    SQL, 327
    SQLITE_ABORT, 328
sqlite3_finalized(), 331, 333
sqlite3_free(), 326, 327
sqlite3_malloc(), 326
    printf(), 327
sqlite3_mprintf(), 327, 342
sqlite3_open(), 325
    db, 330
sqlite3_prepare_v2(), 330–331, 332
sqlite3_prepare_v2, 342
sqlite3_result_error(), 336
sqlite3_result_XXX(), 337
sqlite3_step(), 331
    INSERT, 34
    SQLITE_ROW, 333
sqlite3_stmt, 333
sqlite3_stmt*, 330
SQLITE3_TEXT, 337

```

sqlite3_user_data(), 335
sqlite3_value_text(), 337
SQLITE_ABORT, 328
SQLITE_BLOB, 337
SQLITE_DONE, 331
SQLITE_FLOAT, 337
SQLITE_INTEGER, 337
SQLITE_NULL, 337
SQLITE_OK, 326, 333
SQLITE_ROW, 331
 sqlite3_step(), 333
SQLITE_STATIC, 34
SQLITE_STATIC(), 340
SQLITE_TRANSIENT, 340
sqlite_value, 337
sqlite3_column_text(), 333
sqlite3_errmsg(), 325
src, 233
SSL certificate, 476–480
start
 ProgressAlertView, 453, 455
 UIAlertView, 453
 UILabel, 453
 UIProgressView, 453–454
startAnimating, 212
startElementNsSAX2Func(), 361–362
startElementNsSAX2Func, 371
startElementSAX(), 363
STAssertEquals, 588
STAssertNil, 588
state, 129
 UIControl, 150
 zipcode, 393
state.plist, 565
static, 21, 57
static groups, 4
status
 connection:didFailWithError:, 470
 FETCHING, 469
 receivedData, 469
stocks, 326
stop, 454
stopUpdatingLocation, 378
str, 274
 CFRelease(), 366
string localization, 430–433
stringByEvaluatingJavaScript
 FromString:, 241, 391
stringFromDate:, 436, 438
stringFromNumber:, 439–440
strings, 494
 pasteboards, 550
.strings, 434
stringWithContentsOfURL:encoding:
 error:, 353
 NSString, 370
stringWithFormat:, 257
Structured Query Language (SQL), 323
 Distance(), 393
 sqlite3_exec(), 327
Subject, 488
super
 dealloc, 35, 107
 init, 25
 NSInvalidArgumentException, 60
 posing, 38
[super dealloc], 27
super_class, 59
superclasses, 57
 class_copyMethodList(), 67
swapMethod:withMethod:, 298
SwipeDemoView, 128
swipes, 128–132
switches, 161–162
@synchronized(), 54
@synthesize, 29, 30
 disability, 33–34
SystemConfiguration, network
 connectivity, 460
systemName, 419
SystemSoundID, 409
systemVersion, 419
tabBarController, 180
tabBarItem, 179
table(s)
 databases, 323
 rows, 534–535
table alert view, 447–452
table operations, SQLite, 325–327
table view controller
 applicationDidFinish
 Launching:, 368
 dealloc, 473

networking, 471–473
 RSS, 368–369
 table views, 249–303
 dynamic, 294–297
 grouped, 285–288
 headers and footers, 257–258
 hierarchy, 275–285
 images and text, 255–256
 indexed, 288–294
 row deletion, 258–265
 row insertion, 265–270
 row reordering, 270–275
 whitening text, 297–302
 TableAlertView, 447–452
 delegate, 451
 tableView:cellForRowAtIndexPath:, 451
 UIAlertView, 451
 TableAlertViewDelegate, 449
 tableView, 263, 534
 UITableViewController, 276
 tableView:canMoveRowAtIndexPath:, 271, 274, 275
 tableView:cellForRowAtIndexPath:, 252, 255, 268, 296
 delegate, 451–452
 description, 451
 InternetResource, 472–473
 reloadTheData:, 473
 showNameAtIndex:, 280
 TableAlertView, 451
 tableView:commitEditingStyle:forRowAtIndexPath:, 262, 268
 tableView:didSelectRowAtIndexPath:, 280
 CharacterViewController, 281
 UITableViewController, 278
 tableView:editingStyleForRowAtIndexPath:, 262
 tableView:heightForRowAtIndexPath:, 295–296
 tableView:moveRowAtIndexPath:toIndexPath:, 270–275
 tableView:numberOfRowsInSection:, 252, 257, 279
 tableView:sectionForSectionIndexTitleAtIndex:, 293
 tableView:titleForHeaderInSection:, 292
 Tag, 12
 takePic, 421–422
 tapCount, 122
 Target, 540
 target, 151
 NSUndoManager, 540
 sel, 54
 Target Info, 578–579
 target rectangle, 552
 target-action mechanism, 149, 150–153
 targets, 4
 task
 compute, 455
 ProgressAlertView, 453, 455
 tearDown, 587
 Terminal, 431
 text
 binding, 340
 UITableView, 255–256
 TEXT, 326
 Text, 10
 text, 153, 217
 text editor view, 5
 text field, 153–160
 text field alert view, 443–447
 text view, 217–221
 textAlignment, 154
 textColor, 154, 218
 textFieldDidBegingEditing:, 158, 159
 textFieldDidEndEditing:, 159
 textFieldShouldBeginEditing:, 159
 textField:shouldChangeCharactersInRange:replacementString:, 158
 textFieldShouldClear:, 158
 textFieldShouldReturn:, 158, 159–160, 269
 textFont, 295
 textViewDidBeginEditing:, 218, 221
 textViewDidEndEditing:, 218
 textViewShouldBeginEditing:, 218
 textViewShouldEndEditing:, 218
 theManager, 32
 theView, 219
 This is the contents of a file, 319
 @throw, 39

«TIME», 573
Time-of-Arrival (TOA), 373
timestamp, 122
 CLLocationManager, 376
 UIEvent, 123
Title, 10
title, 349
 charactersSaxFunc(), 365
 UIActionSheet, 224–225
 UITabBarItem, 179
 XML, 358
tmp, 307
 file.txt, 314
 html, 309
 UIWebView, 310
tmp/file.html, 312
To, 489
TOA *see* Time-of-Arrival
toIndexPath, 274
To-Many
 Comment, 524, 526
 User, 526
Toolbar, 3
toolbar application, 609–617
ToolBarController, 609–617
Touch Down, 12
touchesBegan:withEvent:, 123, 129,
 133–134, 200
 showNextLevel, 190
touchesCancelled:withEvent:, 124, 135
touchesEnded:withEvent:, 123, 130, 135
 childView, 139
 MyView, 107
touchesMoved:withEvent:, 123, 132, 134,
 135
tracking application, Location Awareness,
 386–392
transform, 140
transition animation, 142–145
tree.h, 359–360
 startElementNsSAX2Func(), 361
 xmlNode, 354
try, 38
@try, 39
turnAllToOriginal:, 298–299
turnAllToWhite:, 298–299
TVAppDelegate, 250, 259, 265, 271–272
TVAppDelegate.h, 219
TVAppDelegate.m, 219
TVViewController.h, 220
TVViewController.m, 220
UI
 alert view, 455
 code, 604–607
 custom components, 443–457
 delegate, 455
 IB, 595–609
 labels, 8
 progress alert views, 452–456
 table alert view, 447–452
 text field alert view, 443–447
UI, 454
UIAcceleration, 406
UIActionSheet, 224–225
UIActionSheetDelegate, 225
UIActivityIndicatorView, 211
 fetch requests, 592
 startAnimating, 212
UIalertView, 221–224
 hidden, 451
 show, 450
 start, 453
 TableAlertView, 451
 UITextField, 443–447
UIalertViewDelegate, 221, 223
UIApplication
 nil, 106
 NSUndoManager, 542
 openURL:, 488
 sendAction:to:from:forEvent:,
 151
 sharedApplication, 189
 UIWindow, 121–122
UIApplicationDelegate, 106
 accelerometer, 406
UIApplicationMain(), 105
 main.m, 110
UIApplicationOpenURL:, 488
UIBarButtonItem, 194
UIBarButtonItemStyleBordered, 194
UIBarButtonItemStyleDone, 194
UIBarButtonItemStylePlain, 194
UIButton, 163–164
 audio, 411
UIButtonTypeContactAdd, 163

UIButtonStyleDetailDisclosure, 163, 398
UIButtonTypeInfoDark, 163
UIButtonTypeInfoLight, 163
UIButtonTypeRoundedRect, 163
UIColor, 550
UIControl, 149–170
 callout view, 398
 enabled, 149
 highlighted, 149–150
 selected, 150
 state, 150
UIControlEventEditingDidBegin, 151
UIControlEventEditingDidEnd, 151
UIControlEventTouchDown, 151
UIControlEventValueChanged, 151, 161
 UISwitch, 162
UIControl.h, 151
UIDatePicker, 168–169
UIDevice, 403–428
 network connectivity, 459–460
UIDeviceBatteryLevelDidChange
 Notification, 424
UIDeviceBatteryStateCharging, 424
UIDeviceBatteryStateDidChange
 Notification, 425
UIDeviceBatteryStateFull, 424
UIDeviceBatteryStateUnknown, 424
UIDeviceBatteryStateUnplugged, 424
UIDeviceProximityStateDidChange
 Notification, 427
UIEvent, 121, 123
 timestamp, 123
UIGraphicsGetCurrentContext(), 145
UIImage, 463
 imageNamed:, 182
 imageView, 256
 imageWithData:, 501
 isKindOfClass, 555
 nil, 505
 pictures, 504
 UISegmentedControl, 164
UIImagePickerController, 420–423
UIImagePickerControllerCropRect,
 422
UIImagePickerControllerDelegate,
 420
UIImagePickerControllerEdited
 Image, 422
UIImagePickerControllerOriginal
 Image, 422
UIImagePNGRepresentation(), 423
UIImageView, 208, 282
 image, 593
UIInterfaceOrientation, 173
UIInterfaceOrientationLandscape
 Left, 173
UIInterfaceOrientationLandscape
 Right, 173
UIInterfaceOrientationPortrait
 UpsideDown, 173
UIInterfaceOrientationPortrait, 173
UIKeyboardTypeDefault, 219
UIKit, 577
UILabel, 208, 296, 300–301, 591
 loadView, 282
 message IBOutlet, 610
 start, 453
UIMenuController, 551–552
UIModalTransitionStyleCross
 Dissolve, 197
UINavigationController, 186–196
 IB, 594–595
UINavigationItem, 193
UIPageControl, 167–168
UIPasteboard, 547–550
UIPasteboardNameFind, 548
UIPickerView, 208–211
 delegates, 206–207
UIProgressView, 211–215
 start, 453–454
UIRemoteNotificationType, 485
UIResponder, 123–127
 image view, 553
 NSUndoManager, 540
 UIView, 142
 view controllers, 542, 555
UIResponder.h, 551
UIResponderStandardEditActions, 551
 canPerformAction:withSender:,
 552
UIReturnKeyDefault, 219
UIScreen, 117–118

UIScrollView, 215–217
 UITableView, 249–250
 UITextView, 217
 UIView, 250
UISearchDisplayController, 531–538
UISegmentControl, 164–167
UISegmentedControl
 NSString, 164
 UIImage, 164
UISegmentedControlStyleBar, 166
UISegmentedControlStyleBordered,
 166
UISegmentedControlStylePlain, 166
UISlider, 160–161
 value, 160
UIStringDrawing, 295
UIStringDrawing.h, 37
UISwitch, 161–162
 UIControlEventValueChanged, 162
UITabBarController, 180
UITabBarItem, 179
UITableView, 249–303
 UIScrollView, 249–250
 UITableViewCell, 254, 298
 UITableViewCellAccessoryDisclosure
 Indicator, 280
 UITableViewCellEditingStyleDelete,
 262
 UITableViewCellEditingStyleInsert,
 262, 267
 UITableViewCellSelectionStyleNone,
 298
 UITableViewCellStyleDefault, 253
 UITableViewCellStyleSubtitle, 253
 UITableViewCellStyleValue1, 253
 UITableViewCellStyleValue2, 253
UITableViewController
 applicationDidFinish
 Launching:, 277
 initWithStyle:, 276
 subclasses, 277
 tableView, 276
 tableView:didSelectRowAtIndexPath:
 IndexPath:, 278
 UIViewController, 195, 276
UITableViewDataSource, 250, 252, 532
UITableViewController, 250
 searchResultsDelegate, 532
UITableViewGrouped, 286
UITableViewControllerBottom, 264
UITableViewControllerFade, 264
UITableViewControllerLeft, 264
UITableViewControllerRight, 264
UITableViewControllerTop, 264
UITableViewStyleGrouped, 251
UITableViewStylePlain, 251
UITextField, 153–160
 keyboard, 155–158
 UIAlertView, 443–447
UITextFieldDelegate, 153, 158–159
UITextInputTraits, 153
UITextView, 217–221
 delegates, 218
 GoogleMapsWrapper, 384
UITouch, 121, 122–123
UITouchPhaseCancel, 124
UIView, 107, 115–147
 animation, 137–141
 initWithFrame:, 251
 MKAnnotationView, 397
 MKMapView, 395
 subclass, 177
 subclasses, 205–247
 UIAlertView, 221
 UIPickerView, 206
 UIResponder, 142
 UIScrollView, 250
 UIWebView, 225
UIViewControllerAnimatedTransitioning, 139
UIViewControllerAnimatedTransitioningEaseIn, 139
UIViewControllerAnimatedTransitioningEaseInOut, 139
UIViewControllerAnimatedTransitioningLinear, 139
UIViewControllerAnimatedTransitioningFlipFromLeft, 142
UIViewController, 171–203
 editing, 196
 message, 172
 setEditing:animated:, 195
 UIScrollView, 195, 276
UIViewController.m, 591
UIViewControllerAnimatedTransitioningEaseOut, 139
UIWebView, 225–247
 delegates, 242–247
 JavaScript, 239–240, 241
 loadView, 241

MainViewController, 310
tmp, 310
UIWebViewDelegate, 242
 webView:shouldStartLoadWithRequest:navigationType:, 244
UIWebViewNavigationTypeBack
 Forward, 243
UIWebViewNavigationTypeForm
 Submitted, 243
UIWebViewNavigationTypeLink
 Clicked, 243
UIWebViewNavigationTypeOther, 243
UIWebViewNavigationTypeReload, 243
UIWindow
 alloc, 107
 UIApplication, 121–122
unconditional fetch requests, 528
undo, 541
undo management, 539–546
 first responder, 543–544
 setEditing:animated:, 544
 view controllers, 543
uniform type identifier (UTI), 549
uniqueIdentifier, 419
Unit Test Bundle, 581–582
unit testing, 581–590
 build dependency, 589
 equality, 588
 nullity, 588
universal feed icon, 348
unknownPersonViewController:didResolveToPerson:, 506
unknownPersonViewDelegate, 506
updateInterval, 406
updateProgress, 214
updateProgress:
 NSNumber, 453
 NSString, 453
 UI, 454
upload_image, 465
URI, 361
url, **NSURLRequest**, 469
urlEncodedVersion, 464–465
URLs
 NSURL, 568
 pasteboards, 550
useAuxiliaryFile, 342

User
 Comment, 530
 managed objects, 520–521
 modeling tool, 521–526
 NSManagedObject, 521
 To-Many, 526
userInfo
 NSError, 43
 NSException, 41
 NSNotification, 55
userLocation, 399
UTF-8, 326, 366
utf-8, 314
UTF-16BE, 326
UTF-16-LE, 326
UTI *see* uniform type identifier

value
 NSObject, 45
 UISlider, 160
valueForKey:, 45
valueForPasteboardType:, 549–550
verticalAccuracy, 376
video, 418–419
view
 loadView, 174
 nil, 174
 retain, 121
 stop, 454
 UIScrollView, 215
view(s), 115–147
 alert, 221–224
 callout, 398
 CDAUIView, 173–174
 child, 6
 geometry, 115–120
 hierarchy, 6, 121
 picker, 208–211
 progress, 211–215
 scroll, 215–217
 special-purpose, 205–247
 table, 249–303
 text, 217–221
 web, 225–247
 .xib, 8
view controllers, 171–203
 copy and paste, 554–558
 Editing Menu, 552

navigation controllers, 186–196
NSUndoManager, 543
root view controller, 598–604
rows, 544
UIResponder, 542, 555
undo management, 543
viewDidLoad, 607
XIB, 609
viewControllers, 182
viewController.view, 174
viewDidDisappear, 542
viewDidLoad
 Core Data, 534
 createAFileInTMP, 311
 Edit, 544
 view controllers, 607
viewForZoomingInScrollView, 217
viewport, 229
VisuallyAddingContact, 506
void, 61, 335
void*, 71, 95
(void)addObjectsFromArray:
 (NSArray *)anArray, 100

waitForDone:, 473
web view, 225–247
webMaster, 349
webView:didFailLoadWithError:, 243
webViewDidFinishLoad:, 243
webViewDidStartLoad:, 243
webView:shouldStartLoadWith
 Request:navigationType:,
 244
width, 295
WiFi, 373, 459, 461–462
wiFiConnected, 459
Wikipedia Full-text Search, 371–372
window, 269
Window-Based Application, 107
windows, 6
writeToFile:atomically:, 342

XCode, 571–579
 Build and Go, 13
 build-based configurations, 574–576
 Bundle Identifier, 483
 buttonTapped, 14
 Developer Documentation, 15–16
 File->New Project, 2
 frameworks, 577–579
 Groups & Files, 4
 Hello World, 107
 Help->Documentation, 15
 IB, 8, 14, 594
 Localizable.strings, 432–433
 provisioning profile, 482–484
 shortcuts, 571
 templates, 571–573
 Toolbar, 3
 XML, 350–351
XIB, 596
 view controllers, 609
.xib, 7
 views, 8
XML *see* Extensible Markup Language
XML Path Language (XPath), 372
xmlChildrenNode, 356
xmlCleanupParser(), 371
xmlCreateDocParserCtxt(), 359, 371
xmlDoc, 354
xmlDocGetRootElement(), 354
XML_ELEMENT_NODE, 347
xmlFree(), 358
 libxml2, 370
xmlFreeDoc(), 370
xmlFreeParserCtxt(), 371
xmlNode, 354
xmlNodeListGetString, 358
xmlNodeListGetString(), 370
xmlNodePtr, 354
xmlParseMemory(), 354
XML_SAX2_MAGIC, initialized, 361, 371
xmlSAXHandler, 371
xmlSAXUserParseMemory(), 361
 libxml2xml, 371
 xmlFreeParserCtxt(), 371
xmlStrcmp(), 356
XML_TEXT_NODE, 347
XOAbsconder, 356–357, 363–364
 autorelease, 358
 callbacks, 365
 item, 363
XPath *see* XML Path Language
X_TOLERANCE, 131
XXX.app, 318
xxx_prefix.pch, 577

year, 437
Y_TOLERANCE, 131
 touchesMoved:withEvent, 132

zFunctionName, 335
ZIP *see* Zone Improvement Plan
zipcode, 393

zone, 437
Zone Improvement Plan (ZIP), 392–394, 568
 Objective-C, 393–394
zSql, 330
*zSql, 330–331
 NULL, 331