iOS 12 App Development

Essentials

iOS 12 App Development Essentials

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Chapter 1

1. Start Here

The goal of this book is to teach the skills necessary to create iOS applications using the iOS 12 SDK, Xcode 10 and the Swift 4 programming language.

How you make use of this book will depend to a large extent on whether you are new to iOS development, or have worked with iOS 11 and need to get up to speed on the features of iOS 12 and the latest version of the Swift programming language. Rest assured, however, that the book is intended to address both category of reader.

1.1 For New iOS Developers

If you are entirely new to iOS development then the entire contents of the book will be relevant to you.

Beginning with the basics, this book provides an outline of the steps necessary to set up an iOS development environment. An introduction to the architecture of iOS 12 and programming in Swift 4 is provided, followed by an in-depth look at the design of iOS applications and user interfaces. More advanced topics such as file handling, database management, graphics drawing and animation are also covered, as are touch screen handling, gesture recognition, multitasking, location management, local notifications, camera access and video playback support. Other features are also covered including Auto Layout, local map search, user interface animation using UIKit dynamics, Siri integration, iMessage app development, CloudKit sharing and biometric authentication.

Additional features of iOS development using Xcode are also covered, including Swift playgrounds, universal user interface design using size classes, app extensions, Interface Builder Live Views, embedded frameworks, collection and stack layouts and CloudKit data storage in addition to drag and drop integration and the document browser.

The key new features of iOS 12 and Xcode 10 are also covered in detail, including Siri shortcuts and the new iOS machine learning features.

The aim of this book, therefore, is to teach you the skills necessary to build your own apps for iOS 12. Assuming you are ready to download the iOS 12 SDK and Xcode 10, have an Intel-based Mac and ideas for some apps to develop, you are ready to get started.

1.2 For iOS 11 Developers

If you have already read the iOS 11 edition of this book, or have experience with the iOS 11 SDK then you might prefer to go directly to the new chapters in this iOS 12 edition of the book.

All chapters have been updated to reflect the changes and features introduced as part of iOS 12, Swift 4.2 and Xcode 10. Chapters included in this edition that were not contained in the previous edition, or have been significantly rewritten for iOS 12 and Xcode 10 are as follows:

- *Using iCloud Drive Storage in an iOS 12 App*
- *An Overview of Siri Shortcut App Integration*
- *Building Siri Shortcut Support into an iOS App*
- *An Introduction to Machine Learning on iOS*
- *Using Create ML to Build an Image Classification Model*
- *An iOS Vision and CoreML Image Classification Tutorial*

1.3 **Source Code Download**

The source code and Xcode project files for the examples contained in this book are available for download at:

https://www.ebookfrenzy.com/retail/ios12/

1.4 **Feedback**

We want you to be satisfied with your purchase of this book. If you find any errors in the book, or have any comments, questions or concerns please contact us at *feedback@ebookfrenzy.com*.

1.5 **Errata**

While we make every effort to ensure the accuracy of the content of this book, it is inevitable that a book covering a subject area of this size and complexity may include some errors and oversights. Any known issues with the book will be outlined, together with solutions at the following URL:

https://www.ebookfrenzy.com/errata/ios12.html

In the event that you find an error not listed in the errata, please let us know by emailing our technical support team at *feedback@ebookfrenzy.com*.

Chapter 2

2. Joining the Apple Developer Program

The first step in the process of learning to develop iOS 12 based applications involves gaining an understanding of the advantages of enrolling in the Apple Developer Program and deciding the point at which it makes sense to pay to join. With these goals in mind, this chapter will outline the costs and benefits of joining the developer program and, finally, walk through the steps involved in enrolling.

2.1 **Downloading Xcode 10 and the iOS 12 SDK**

The latest versions of both the iOS SDK and Xcode can be downloaded free of charge from the Mac App Store. Since the tools are free, this raises the question of whether to enroll in the Apple Developer Program, or to wait until it becomes necessary later in your app development learning curve.

2.2 **Apple Developer Program**

Membership in the Apple Developer Program currently costs $99 per year to enroll as an individual developer. Organization level membership is also available.

Prior to the introduction of iOS 9 and Xcode 7, one of the key advantages of the developer program was that it permitted the creation of certificates and provisioning profiles to test your applications on physical iOS devices. Fortunately this is no longer the case and all that is now required to test apps on physical iOS devices is an Apple ID.

Clearly much can be achieved without the need to pay to join the Apple Developer program. There are, however, areas of app development which cannot be fully tested without program membership. Of particular significance is the fact that iCloud access, Apple Pay, Game Center and In-App Purchasing can only be enabled and tested with Apple Developer Program membership.

Of further significance is the fact that Apple Developer Program members have access to technical support from Apple's iOS support engineers (though the annual fee initially covers the submission of only two support incident reports more can be purchased) and membership of the Apple Developer forums which can be an invaluable resource for obtaining assistance and guidance from other iOS developers and for finding solutions to problems that others have encountered and subsequently resolved.

Program membership also provides early access to the pre-release Beta versions of both Xcode and iOS.

By far the most important aspect of the Apple Developer Program is that membership is a mandatory requirement in order to publish an application for sale or download in the App Store.

Clearly, program membership is going to be required at some point before your application reaches the App Store. The only question remaining is when exactly to sign up.

2.3 **When to Enroll in the Apple Developer Program?**

Clearly, there are many benefits to Apple Developer Program membership and, eventually, membership will be necessary to begin selling applications. As to whether or not to pay the enrollment fee now or later will depend on individual circumstances. If you are still in the early stages of learning to develop iOS applications or have yet to come up with a compelling idea for an application to develop then much of what you need is provided without program membership. As your skill level increases and your ideas for applications to develop take shape you can, after all, always enroll in the developer program at a later date.

If, on the other hand, you are confident that you will reach the stage of having an application ready to publish or know that you will need access to more advanced features such as iCloud, In-App Purchasing and Apple Pay then it is worth joining the developer program sooner rather than later.

2.4 Enrolling in the Apple Developer Program

If your goal is to develop iOS applications for your employer then it is first worth checking whether the company already has membership. That being the case, contact the program administrator in your company and ask them to send you an invitation from within the Apple Developer Program Member Center to join the team. Once they have done so, Apple will send you an email entitled *You Have Been Invited to Join an Apple Developer Program* containing a link to activate your membership. If you or your company is not already a program member, you can enroll online at:

https://developer.apple.com/programs/enroll/

Apple provides enrollment options for businesses and individuals. To enroll as an individual you will need to provide credit card information in order to verify your identity. To enroll as a company you must have legal signature authority (or access to someone who does) and be able to provide documentation such as a Dun & Bradstreet D-U-N-S number and documentation confirming legal entity status.

Acceptance into the developer program as an individual member typically takes less than 24 hours with notification arriving in the form of an activation email from Apple. Enrollment as a company can take considerably longer (sometimes weeks or even months) due to the burden of the additional verification requirements.

While awaiting activation you may log into the Member Center with restricted access using your Apple ID and password at the following URL:

https://developer.apple.com/membercenter

Once logged in, clicking on the *Your Account* tab at the top of the page will display the prevailing status of your application to join the developer program as *Enrollment Pending*. Once the activation email has arrived, log into the Member Center again and note that access is now available to a wide range of options and resources as illustrated in Figure 2-1:

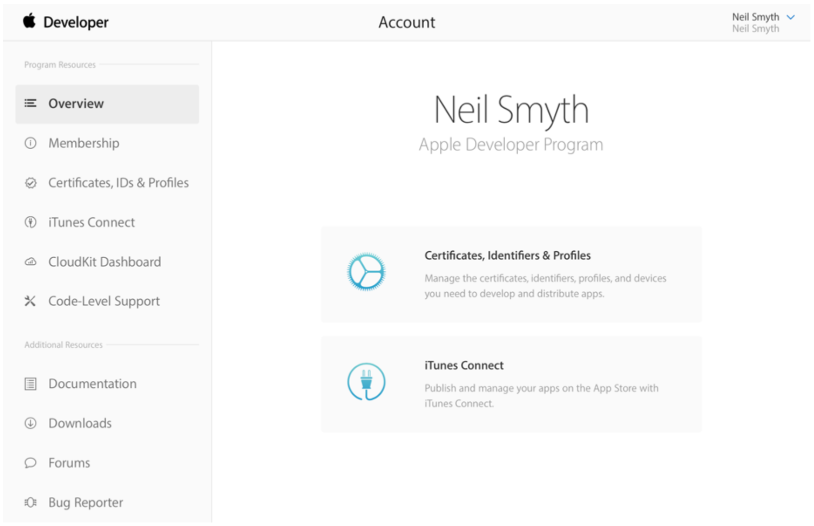

Developer
Account
Neil Smyth
Neil Smyth
Program Resources
Overview
Membership
Certificates, IDs & Profiles
iTunes Connect
CloudKit Dashboard
Code-Level Support
Additional Resources
Documentation
Downloads
Forums
Bug Reporter
Neil Smyth
Apple Developer Program
Certificates, Identifiers & Profiles
Manage the certificates, identifiers, profiles, and devices you need to develop and distribute apps.
iTunes Connect
Publish and manage your apps on the App Store with iTunes Connect.

Figure 2-1

2.5 Summary

An important early step in the iOS 12 application development process involves identifying the best time to enroll in the Apple Developer Program. This chapter has outlined the benefits of joining the program, provided some guidance to keep in mind when considering developer program membership and walked briefly through the enrollment process. The next step is to download and install the iOS 12 SDK and Xcode 10 development environment.

Chapter 3

3. Installing Xcode 10 and the iOS 12 SDK

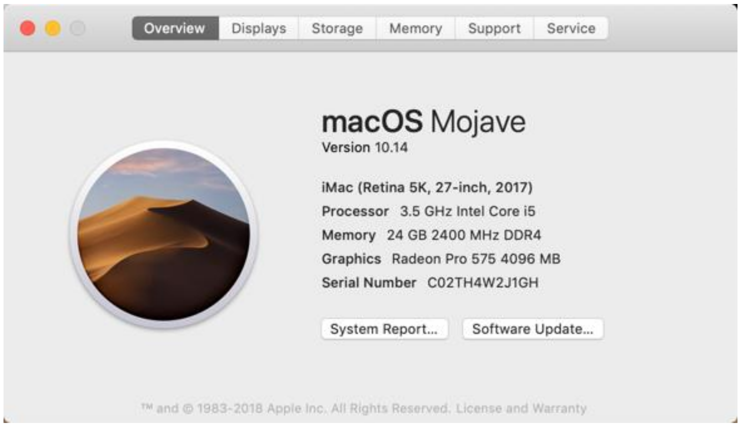
iOS apps are developed using the iOS SDK in conjunction with Apple's Xcode development environment. Xcode is an integrated development environment (IDE) within which you will code, compile, test and debug your iOS applications. The Xcode environment also includes a feature called Interface Builder which enables you to graphically design the user interface of your application using the components provided by the UIKit Framework.

In this chapter we will cover the steps involved in installing both Xcode and the iOS 12 SDK on macOS.

3.1 Identifying Your macOS Version

The Xcode 10 environment requires that the version of macOS running on the system be version 10.13.4 or later. If you are unsure of the version of macOS on your Mac, you can find this information by clicking on the Apple menu in the top left-hand corner of the screen and selecting the *About This Mac* option from the menu. In the resulting dialog check the *Version* line

If the "About This Mac" dialog does not indicate that macOS 10.13.4 or later is running, click on the *Software Update…* button to download and install the appropriate operating system upgrades.



macOS Mojave
Version 10.14

iMac (Retina 5K, 27-inch, 2017)
Processor 3.5 GHz Intel Core i5
Memory 24 GB 2400 MHz DDR4
Graphics Radeon Pro 575 4096 MB
Serial Number C02TH4W2J1GH

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Figure 3-1

3.2 Installing Xcode 10 and the iOS 12 SDK

The best way to obtain the latest versions of Xcode and the iOS SDK is to download them from the Apple Mac App Store. Launch the App Store on your macOS system, enter Xcode into the search box and click on the *Get* button to initiate the installation.

3.3 Starting Xcode

Having successfully installed the SDK and Xcode, the next step is to launch it so that we can create a sample iOS 12 application. To start up Xcode, open the Finder and search for *Xcode*. Since you will be making frequent use of this tool take this opportunity to drag and drop it into your dock for easier access in the future. Click on the Xcode icon in the dock to launch the tool. The first time Xcode runs you may be prompted to install additional components. Follow these steps, entering your username and password when prompted to do so.

Once Xcode has loaded, and assuming this is the first time you have used Xcode on this system, you will be presented with the *Welcome* screen from which you are ready to proceed:

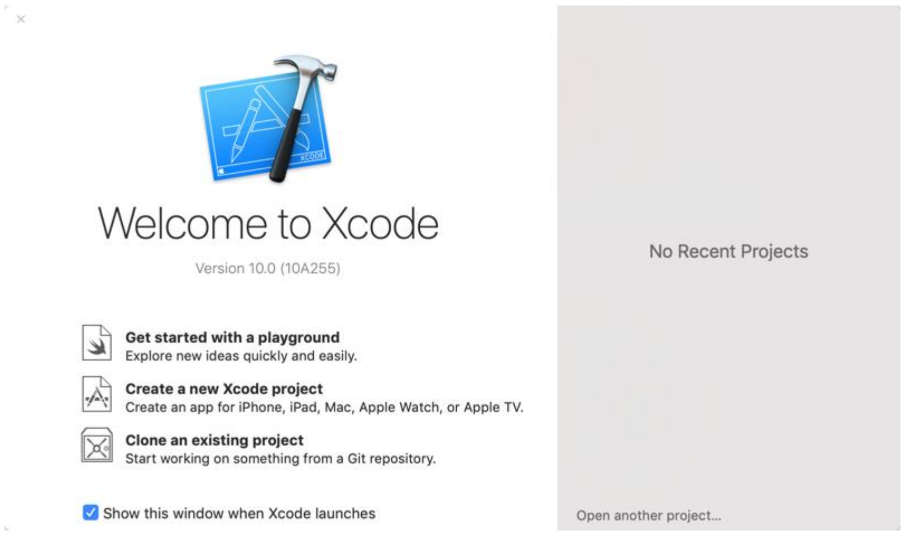

Welcome to Xcode
Version 10.0 (10A255)
Get started with a playground
Explore new ideas quickly and easily.
Create a new Xcode project
Create an app for iPhone, iPad, Mac, Apple Watch, or Apple TV.
Clone an existing project
Start working on something from a Git repository.
Show this window when Xcode launches
No Recent Projects
Open another project...

Figure 3-2

3.4 Adding Your Apple ID to the Xcode Preferences

Regardless of whether or not you choose to enroll in the Apple Developer Program it is worth adding your Apple ID to Xcode now that it is installed and running. Select the *Xcode -> Preferences…* menu option and select the *Accounts* tab. On the Accounts screen, click on the + button highlighted in Figure 3-3, select *Apple ID* from the resulting panel and click on the *Continue* button. When prompted, enter your Apple ID and associated password and click on the *Sign In* button to add the account to the preferences.

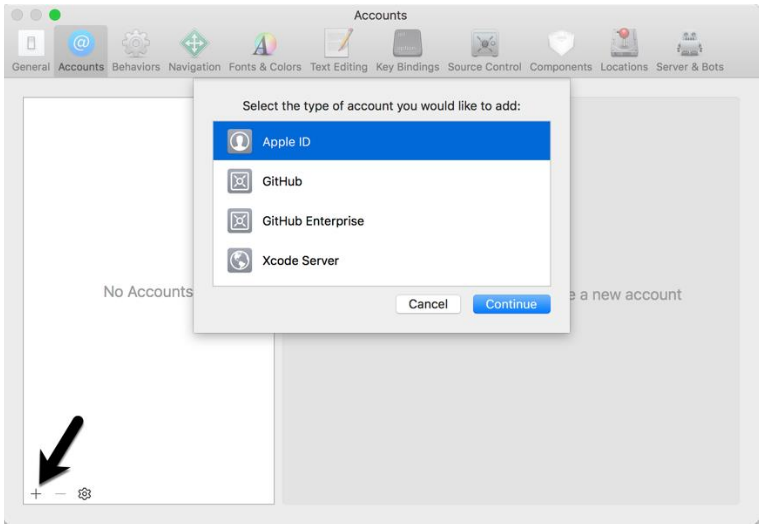


Figure 3-3

3.5 Developer and Distribution Signing Identities

Once the Apple ID has been entered the next step is to generate signing identities. To view the current signing identities, select the newly added Apple ID in the Accounts panel and click on the *Manage Certificates…* button at which point a list of available signing identities will be listed. If you have not yet enrolled in the Apple Developer Program it will only be possible to create iOS and Mac Development identities. To create the iOS Development signing identity, simply click on the + button highlighted in Figure 3-4 and make the appropriate selection from the menu:

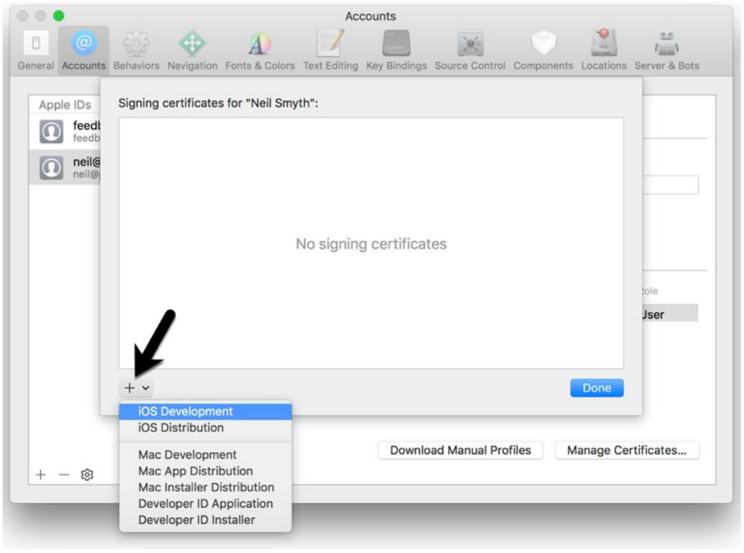


Figure 3-4

If the Apple ID has been used to enroll in the Apple Developer program, the option to create an *iOS Distribution* certificate will, when clicked, generate the signing identity required to submit the app to the Apple App Store.

Having installed the iOS SDK and successfully launched Xcode 10 we can now look at Xcode in more detail.

Chapter 4

4. A Guided Tour of Xcode 10

Just about every activity related to developing and testing iOS applications involves the use of the Xcode environment. This chapter is intended to serve two purposes. Primarily it is intended to provide an overview of many of the key areas that comprise the Xcode development environment. In the course of providing this overview, the chapter will also work through the creation of a very simple iOS application project designed to display a label which reads “Hello World” on a colored background.

By the end of this chapter you will have a basic familiarity with Xcode and your first running iOS application.

4.1 Starting Xcode 10

As with all iOS examples in this book, the development of our example will take place within the Xcode 10 development environment. If you have not already installed this tool together with the latest iOS SDK refer first to the *Installing Xcode 10 and the iOS 12 SDK* chapter of this book. Assuming that the installation is complete, launch Xcode either by clicking on the icon on the dock (assuming you created one) or use the macOS Finder to locate Xcode in the Applications folder of your system.

When launched for the first time, and until you turn off the *Show this window when Xcode launches* toggle, the screen illustrated in Figure 4-1 will appear by default:

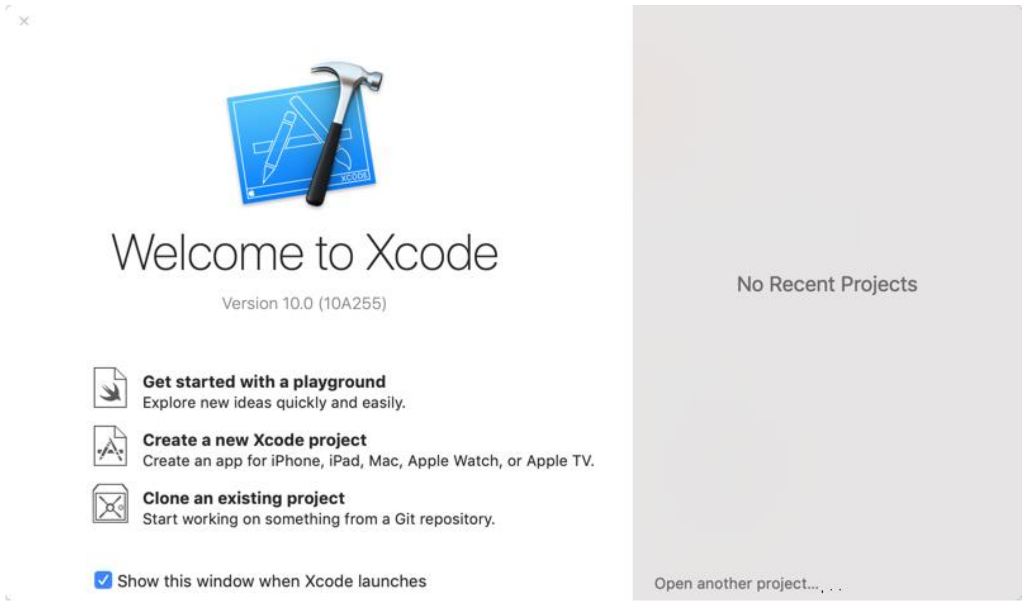

Welcome to Xcode
Version 10.0 (10A255)
Get started with a playground
Explore new ideas quickly and easily.
Create a new Xcode project
Create an app for iPhone, iPad, Mac, Apple Watch, or Apple TV.
Clone an existing project
Start working on something from a Git repository.
Show this window when Xcode launches
No Recent Projects
Open another project...

Figure 4-1

If you do not see this window, simply select the *Window -> Welcome to Xcode* menu option to display it. From within this window, click on the option to *Create a new Xcode project*. This will display the main Xcode project window together with the *project template* panel where we are able to select a template matching the type of project we want to develop:

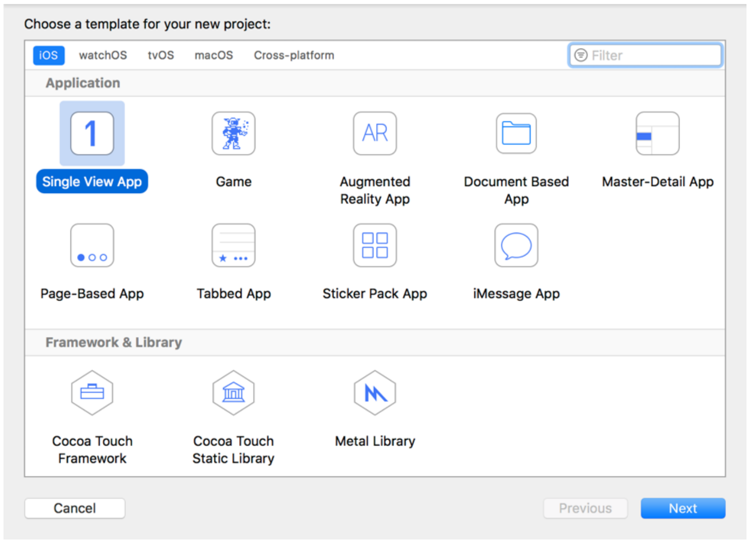


Figure 4-2

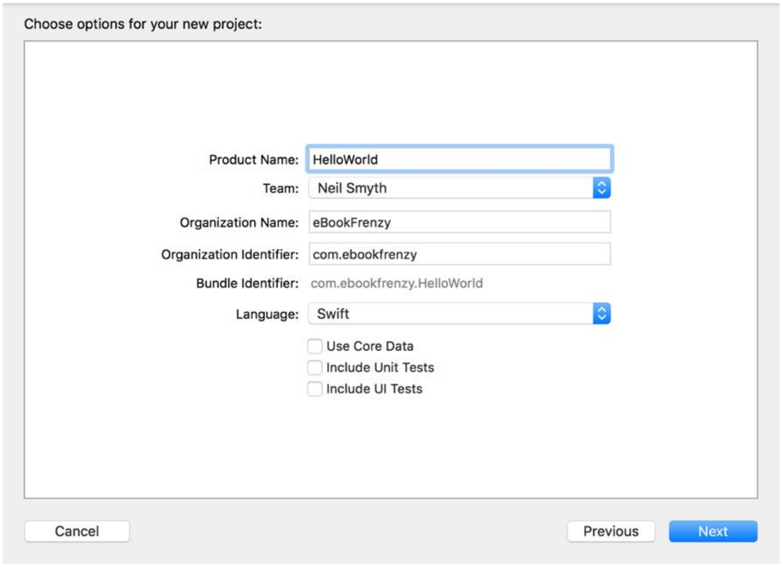
The toolbar located on the top edge of the window allows for the selection of the target platform, providing options to develop an application for iOS, watchOS, tvOS or macOS.

Begin by making sure that the *Application* option located beneath *iOS* is selected. The main panel contains a list of templates available to use as the basis for an application. The options available are as follows:

- **Master-Detail Application** – Used to create a list based application. Selecting an item from a master list displays a detail view corresponding to the selection. The template then provides a *Back* button to return to the list. You may have seen a similar technique used for news based applications, whereby selecting an item from a list of headlines displays the content of the corresponding news article. When used for an iPad based application this template implements a basic split-view configuration.
- **Page-based Application** – Creates a template project using the page view controller designed to allow views to be transitioned by turning pages on the screen.
- **Tabbed Application** – Creates a template application with a tab bar. The tab bar typically appears across the bottom of the device display and can be programmed to contain items that, when selected, change the main display to different views. The iPhone's built-in *Phone* user interface, for example, uses a tab bar to allow the user to move between favorites, contacts, keypad and voicemail.
- **Single View Application** – Creates a basic template for an application containing a single view and corresponding view controller.
- **Game** – Creates a project configured to take advantage of Sprite Kit, Scene Kit, OpenGL ES and Metal for the development of 2D and 3D games.
- **iMessage Application** – iMessage apps are extensions to the built-in iOS Messages app that allow users to send interactive messages such as games to other users. Once created, iMessage apps are made available for purchase through the Message App Store.
- **Sticker Pack Application** – Allows a sticker pack application to be created and sold within the Message App Store. Sticker pack apps allow additional images to be made available for inclusion in messages sent via the iOS Messages app.
- **Augmented Reality App** – Creates a template project pre-configured to make use of ARKit to integrate augmented reality support into an iOS app.

- **Document Based App** – Creates a project intended for making use of the iOS document browser. The document browser provides a visual environment in which the user can navigate and manage both local and cloud-based files from within an iOS app.

For the purposes of our simple example, we are going to use the *Single View Application* template so select this option from the new project window and click *Next* to configure some more project options:



Choose options for your new project:

Product Name:	HelloWorld
Team:	Neil Smyth
Organization Name:	eBookFrenzy
Organization Identifier:	com.ebookfrenzy
Bundle Identifier:	com.ebookfrenzy.HelloWorld
Language:	Swift

- [ ] Use Core Data
- [ ] Include Unit Tests
- [ ] Include UI Tests

Figure 4-3

On this screen, enter a Product name for the application that is going to be created, in this case "HelloWorld" and then select the development team to which this project is to be assigned. If you have already signed up to the Apple developer program, select your account from the menu, otherwise leave the option set to None.

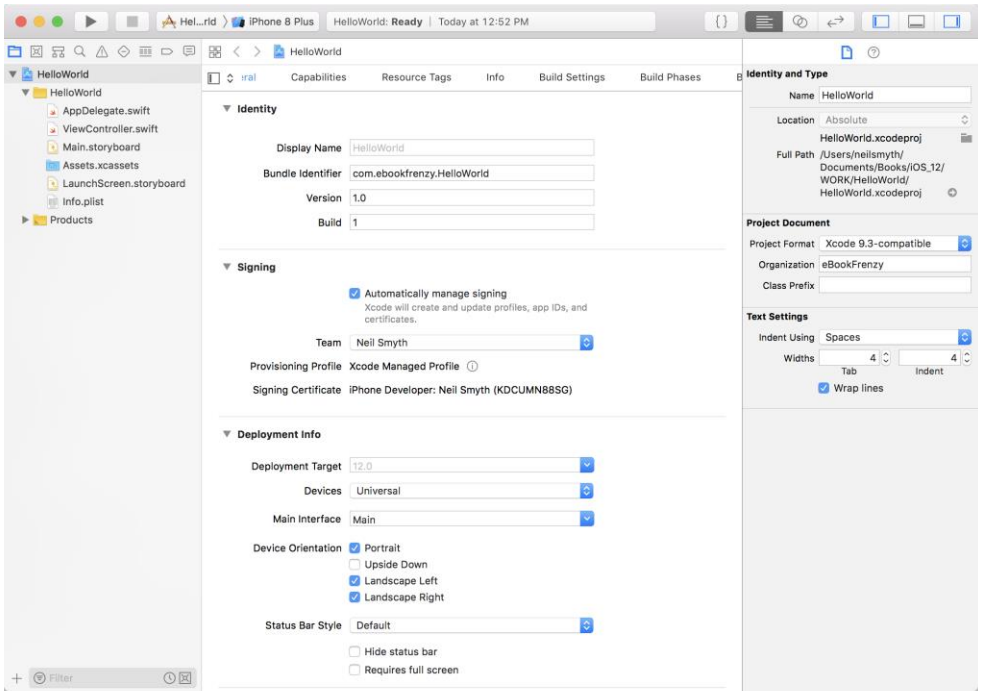
The text entered into the Organization Name field will be placed within the copyright comments of all of the source files that make up the project.

The company identifier is typically the reversed URL of your company's website, for example "com.mycompany". This will be used when creating provisioning profiles and certificates to enable testing of advanced features of iOS on physical devices. It also serves to uniquely identify the app within the Apple App Store when the app is published.

Apple supports two programming languages for the development of iOS apps in the form of *Objective-C* and *Swift.* While it is still possible to program using the older Objective-C language, Apple considers Swift to be the future of iOS development. All the code examples in this book are written in Swift, so make sure that the *Language* menu is set accordingly before clicking on the *Next* button.

On the final screen, choose a location on the file system for the new project to be created. This panel also provides the option to place the project under Git source code control. Source code control systems such as Git allow different revisions of the project to be managed and restored, and for changes made over the development lifecycle of the project to be tracked. Since this is typically used for larger projects, or those involving more than one developer, this option can be turned off for this and the other projects created in the book.

Once the new project has been created, the main Xcode window will appear as illustrated in Figure 4-4:



Identity

Display Name HelloWorld
Bundle Identifier com.ebookfrenzy.HelloWorld
Version 1.0
Build 1

Signing

Automatically manage signing
Xcode will create and update profiles, app IDs, and certificates.

Team Neil Smyth
Provisioning Profile Xcode Managed Profile
Signing Certificate iPhone Developer: Neil Smyth (KDCUMN88SG)

Deployment Info

Deployment Target 12.0
Devices Universal
Main Interface Main
Device Orientation ✓ Portrait, Upside Down, ✓ Landscape Left, ✓ Landscape Right
Status Bar Style Default
Hide status bar
Requires full screen

Identity and Type

Name HelloWorld
Location Absolute
HelloWorld.xcodeproj
Full Path /Users/neilsmyth/Documents/Books/iOS_12/WORK/HelloWorld/HelloWorld.xcodeproj

Project Document

Project Format Xcode 9.3-compatible
Organization eBookFrenzy
Class Prefix

Text Settings

Indent Using Spaces
Widths 4 (Tab) 4 (Indent)
✓ Wrap lines

Figure 4-4

Before proceeding we should take some time to look at what Xcode has done for us. First, it has created a group of files that we will need to create our application. Some of these are Swift source code files (with a .swift extension) where we will enter the code to make our application work.

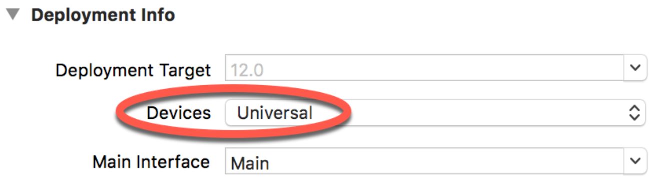
In addition, the *Main.storyboard* file is the save file used by the Interface Builder tool to hold the user interface design we will create. A second Interface Builder file named *LaunchScreen.storyboard* will also have been added to the project. This contains the user interface layout design for the screen which appears on the device while the application is loading.

Also present will be one or more files with a .plist file extension. These are *Property List* files which contain key/value pair information. For example, the *Info.plist* file contains resource settings relating to items such as the language, executable name and app identifier and, as will be shown in later chapters, is the location where a number of properties are stored to configure the capabilities of the project (for example to configure access to the user's current geographical location). The list of files is displayed in the *Project Navigator* located in the left-hand panel of the main Xcode project window. A toolbar at the top of this panel contains options to display other information such as build and run history, breakpoints and compilation errors.

By default, the center panel of the window shows a general summary of the settings for the application project. This includes the identifier specified during the project creation process and the target device. Options are also provided to configure the orientations of the device that are to be supported by the application together with options to upload icons (the small images the user selects on the device screen to launch the application) and launch screen images (displayed to the user while the application loads) for the application.

The Signing section provides the option to select an Apple identity to use when building the app. This ensures that the app is signed with a certificate when it is compiled. If you have registered your Apple ID with Xcode using the Preferences screen as outlined in the previous chapter, select that identity now using the Team menu. If no team is selected, it will not be possible to test apps on physical devices, though the simulator environment may still be used.

The Deployment Info section of the screen also includes a setting to specify the device types on which the completed app is intended to run as highlighted in Figure 4-5:



Deployment Target: 12.0
Devices: Universal
Main Interface: Main

Figure 4-5

The iOS ecosystem now includes a variety of devices and screen sizes. When developing a project it is possible to indicate that the project is intended to target either the iPhone or iPad family of devices. With the gap between iPad and iPhone screen sizes now reduced by the introduction of the iPad Mini and iPhone Plus/Max range of devices it no longer makes sense to create a project that targets just one device family. A much more sensible approach is to create a single project that addresses all device types and screen sizes. In fact, as will be shown in later chapters, Xcode 10 and iOS 12 include a number of features designed specifically to make the goal of *universal* application projects easy to achieve. With this in mind, make sure that the *Devices* menu is set to *Universal*.

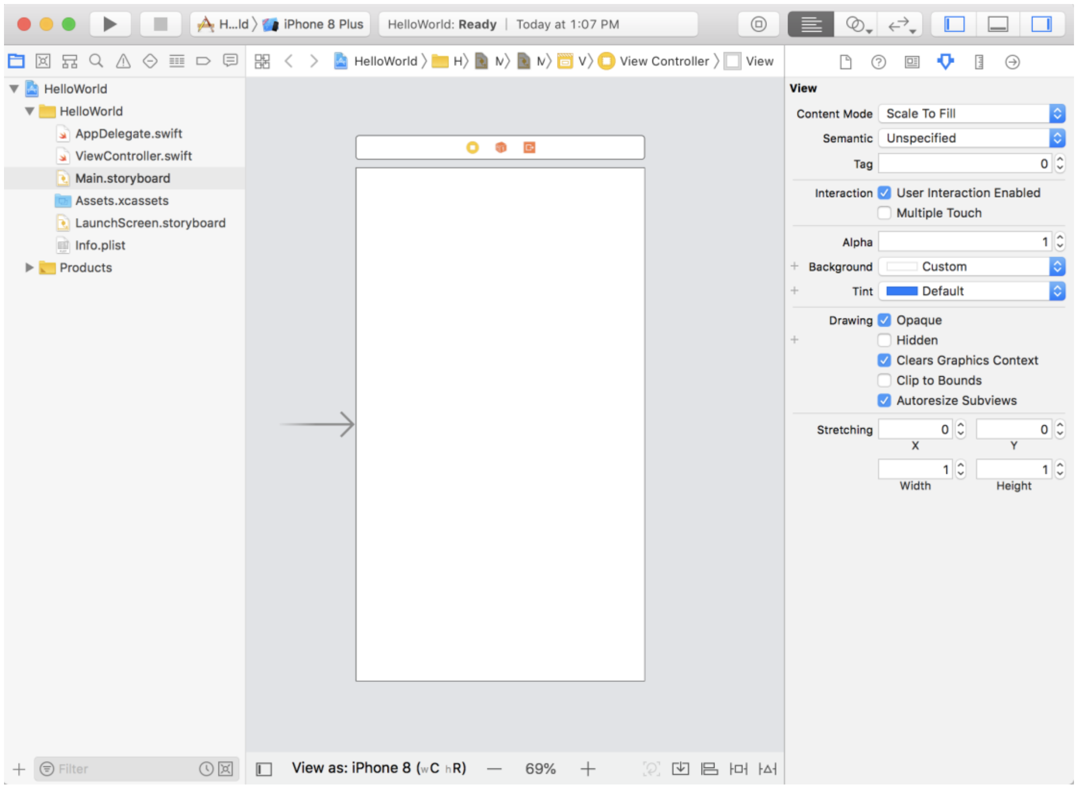
In addition to the General screen, tabs are provided to view and modify additional settings consisting of Capabilities, Info, Build Settings, Build Phases and Build Rules. As we progress through subsequent chapters of this book we will explore some of these other configuration options in greater detail. To return to the project settings panel at any future point in time, make sure the *Project Navigator* is selected in the left-hand panel and select the top item (the application name) in the navigator list.

When a source file is selected from the list in the navigator panel, the contents of that file will appear in the center panel where it may then be edited. To open the file in a separate editing window, simply double-click on the file in the list.

4.2 Creating the iOS App User Interface

Simply by the very nature of the environment in which they run, iOS apps are typically visually oriented. As such, a key component of just about any app involves a user interface through which the user will interact with the application and, in turn, receive feedback. While it is possible to develop user interfaces by writing code to create and position items on the screen, this is a complex and error prone process. In recognition of this, Apple provides a tool called Interface Builder which allows a user interface to be visually constructed by dragging and dropping components onto a canvas and setting properties to configure the appearance and behavior of those components.

As mentioned in the preceding section, Xcode pre-created a number of files for our project, one of which has a .storyboard filename extension. This is an Interface Builder storyboard save file and the file we are interested in for our HelloWorld project is named *Main.storyboard.* To load this file into Interface Builder simply select the file name in the list in the left-hand panel. Interface Builder will subsequently appear in the center panel as shown in Figure 4-6:



View

Content Mode	Scale To Fill
Semantic	Unspecified
Tag	0
Interaction	✓ User Interaction Enabled
	☐ Multiple Touch
Alpha	1
Background	Custom
Tint	Default
Drawing	✓ Opaque
	☐ Hidden
	✓ Clears Graphics Context
	☐ Clip to Bounds
	✓ Autoresize Subviews
Stretching	X 0, Y 0
	Width 1, Height 1

Figure 4-6

In the center panel a visual representation of the user interface of the application is displayed. Initially this consists solely of a *View Controller* (UIViewController) containing a single View (UIView) object. This layout was added to our design by Xcode when we selected the Single View Application option during the project creation phase. We will construct the user interface for our HelloWorld app by dragging and dropping user interface objects onto this UIView object. Designing a user interface consists primarily of dragging and dropping visual components onto the canvas and setting a range of properties. The user interface components are accessed from the Library panel which is displayed by clicking on the Show Library button in the Xcode toolbar as indicated in Figure 4-7:

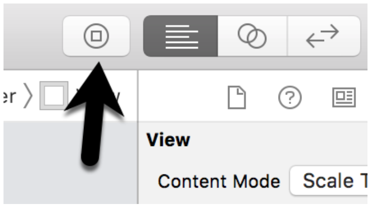
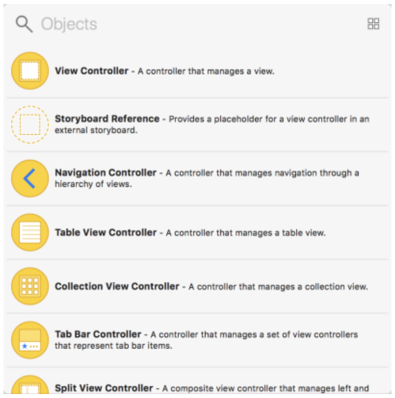


Figure 4-7

This button will display the UI components that can be used to construct our user interface. The layout of the items in the library may also be switched from a single column of objects with descriptions to multiple columns without descriptions by clicking on the button located in the top right-hand corner of the panel and to the right of the search box.


Objects

View Controller - A controller that manages a view.

Storyboard Reference - Provides a placeholder for a view controller in an external storyboard.

Navigation Controller - A controller that manages navigation through a hierarchy of views.

Table View Controller - A controller that manages a table view.

Collection View Controller - A controller that manages a collection view.

Tab Bar Controller - A controller that manages a set of view controllers that represent tab bar items.

Split View Controller - A composite view controller that manages left and

Figure 4-8

By default, the library panel will disappear either after an item has been dragged onto the layout or a click is performed outside of the panel. To keep the panel visible in this mode, hold down the Option key while clicking on the required Library item. Alternatively, displaying the Library panel by clicking on the toolbar button highlighted in Figure 4-7 while holding down the Option key will cause the panel to stay visible until it is manually closed.

In order to property settings it is necessary to display the Xcode right-hand panel (if it is not already displayed). This panel is referred to as the *Utilities panel* and can be displayed by selecting the right-hand button in the right-hand section of the Xcode toolbar:

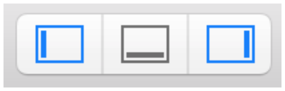
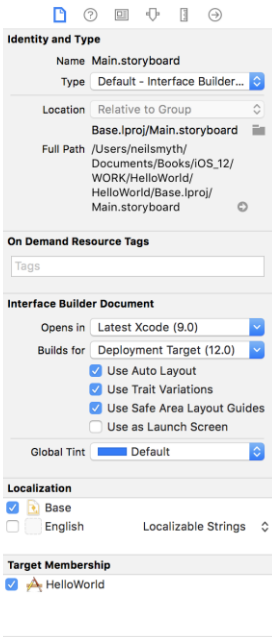


Figure 4-9

The Utilities panel, once displayed, will appear as illustrated in Figure 4-10:


Identity and Type

Name Main.storyboard

Type Default - Interface Builder...

Location Relative to Group

Base.lproj/Main.storyboard

Full Path /Users/neilsmyth/Documents/Books/iOS_12/WORK/HelloWorld/HelloWorld/Base.lproj/Main.storyboard

On Demand Resource Tags

Tags

Interface Builder Document

Opens in Latest Xcode (9.0)

Builds for Deployment Target (12.0)

☑ Use Auto Layout
☑ Use Trait Variations
☑ Use Safe Area Layout Guides
☐ Use as Launch Screen

Global Tint Default

Localization

☑ Base
☐ English Localizable Strings

Target Membership

☑ HelloWorld

Figure 4-10

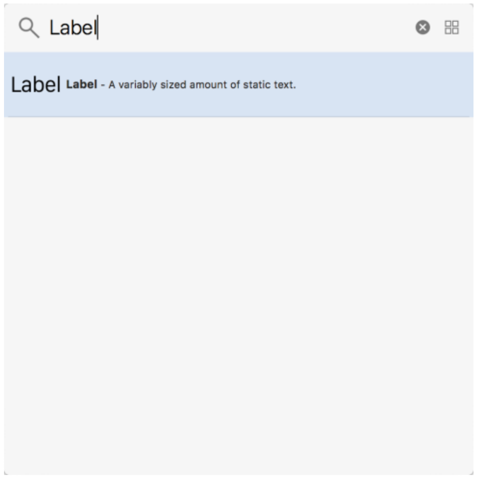
Along the top edge of the panel is a row of buttons which change the settings displayed in the upper half of the panel. By default the *File Inspector* is typically displayed. Options are also provided to display quick help, the *Identity Inspector*, *Attributes Inspector*, *Size Inspector* and *Connections Inspector*. Before proceeding, take some time to review each of these selections to gain some familiarity with the configuration options each provides. Throughout the remainder of this book extensive use of these inspectors will be made.

4.3 **Changing Component Properties**

With the property panel for the View selected in the main panel, we will begin our design work by changing the background color of this view. Start by making sure the View is selected and that the Attributes Inspector (*View -> Utilities -> Show Attributes Inspector*) is displayed in the Utilities panel. Click on the current property setting next to the *Background* setting and select the Custom option from the popup menu to display the *Colors* dialog. Using the color selection tool, choose a visually pleasing color and close the dialog. You will now notice that the view window has changed from white to the new color selection.

4.4 **Adding Objects to the User Interface**

The next step is to add a Label object to our view. To achieve this, display the Library panel as shown in Figure 4-7 above and either scroll down the list of objects in the Library panel to locate the Label object or, as illustrated in Figure 4-11, enter *Label* into the search box beneath the panel:



Label - A variably sized amount of static text.

Figure 4-11

Having located the Label object, click on it and drag it to the center of the view so that the vertical and horizontal center guidelines appear. Once it is in position release the mouse button to drop it at that location. We have now added an instance of the UILabel class to the scene. Cancel the Library search by clicking on the “x” button on the right-hand edge of the search field. Select the newly added label and stretch it horizontally so that it is approximately three times the current width. With the Label still selected, click on the centered alignment button in the Attributes Inspector (*View -> Utilities -> Show Attributes Inspector*) to center the text in the middle of the label view.

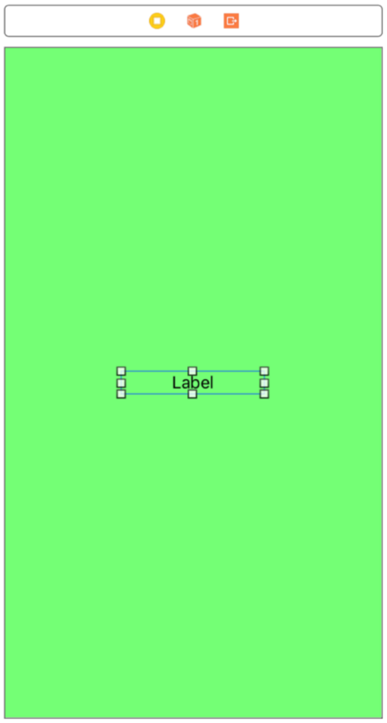
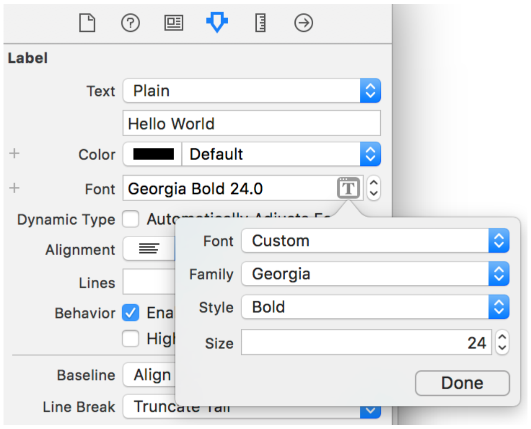


Figure 4-12

Double-click on the text in the label that currently reads "Label" and type in "Hello World". Locate the font setting property in the Attributes Inspector panel and click on the "T" button next to the font name to display the font selection menu. Change the Font setting from *System – System* to *Custom* and choose a larger font setting, for example a Georgia bold typeface with a size of 24 as shown in Figure 4-13:



Label

Text: Plain

Hello World

Color: Default

Font: Georgia Bold 24.0

Font: Custom

Family: Georgia

Style: Bold

Size: 24

Figure 4-13

The final step is to add some layout constraints to ensure that the label remains centered within the containing view regardless of the size of screen on which the application ultimately runs. This involves the use of the Auto Layout capabilities of iOS, a topic which will be covered extensively in later chapters. For this example, simply select the Label object, display the Align menu as shown in Figure 4-14 and enable both the

Horizontally in Container and *Vertically in Container* options with offsets of 0 before clicking on the *Add 2 Constraints* button.

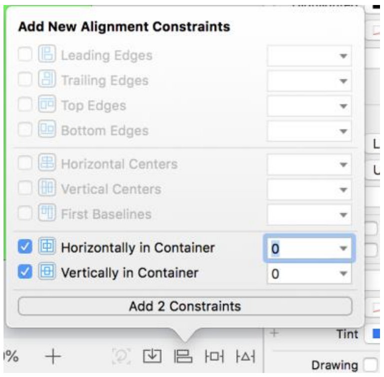


Figure 4-14

At this point, your View window will hopefully appear as outlined in Figure 4-15 (allowing, of course, for differences in your color and font choices).

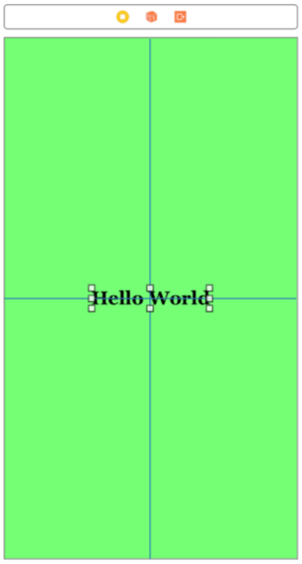


Figure 4-15

Before building and running the project it is worth taking a short detour to look at the Xcode *Document Outline* panel. This panel appears by default to the left of the Interface Builder panel and is controlled by the small button in the bottom left-hand corner (indicated by the arrow in Figure 4-16) of the Interface Builder panel.

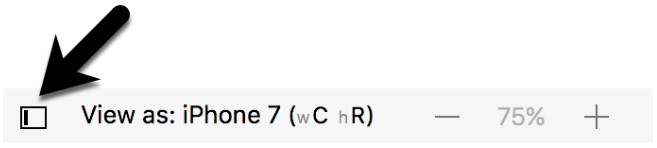


Figure 4-16

When displayed, the document outline shows a hierarchical overview of the elements that make up a user interface layout together with any constraints that have been applied to views in the layout.

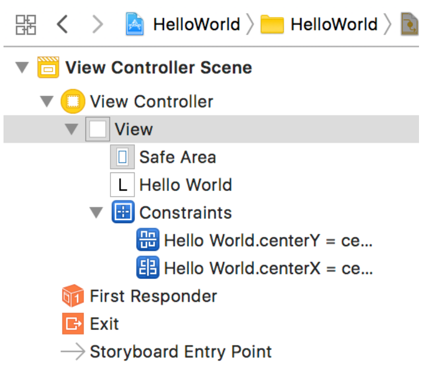


Figure 4-17

4.5 Building and Running an iOS 12 App in Xcode 10

Before an app can be run it must first be compiled. Once successfully compiled it may be run either within a simulator or on a physical iPhone, iPad or iPod Touch device. For the purposes of this chapter, however, it is sufficient to run the app in the simulator.

Within the main Xcode project window, make sure that the menu located in the top left-hand corner of the window (marked C in Figure 4-18) has the *iPhone 8 Plus* simulator option selected:

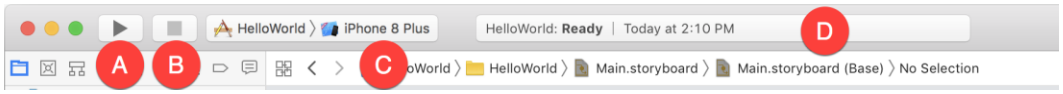


Figure 4-18

Click on the *Run* toolbar button (A) to compile the code and run the app in the simulator. The small panel in the center of the Xcode toolbar (D) will report the progress of the build process together with any problems or errors that cause the build process to fail. Once the app is built, the simulator will start and the HelloWorld app will run:

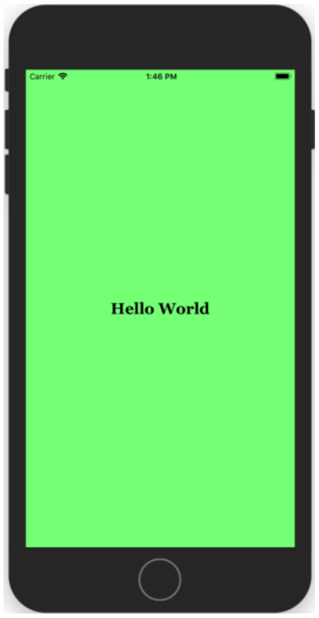


Figure 4-19

Note that the user interface appears as designed in the Interface Builder tool. Click on the stop button (B), change the target menu from iPhone 8 Plus to iPad Air 2 and run the application again. Once again, the label will appear centered in the screen even with the larger screen size. Finally, verify that the layout is correct in landscape orientation by using the *Hardware -> Rotate Left* menu option. This indicates that the Auto Layout constraints are working and that we have designed a *universal* user interface for the project.

4.6 Running the App on a Physical iOS Device

Although the Simulator environment provides a useful way to test an app on a variety of different iOS device models, it is important to also test on a physical iOS device.

If you have entered your Apple ID in the Xcode preferences screen as outlined in the previous chapter and selected a development team for the project, it is possible to run the app on a physical device simply by connecting it to the development Mac system with a USB cable and selecting it as the run target within Xcode.

With a device connected to the development system, and an application ready for testing, refer to the device menu located in the Xcode toolbar. There is a reasonable chance that this will have defaulted to one of the iOS Simulator configurations. Switch to the physical device by selecting this menu and changing it to the device name as shown in Figure 4-20:

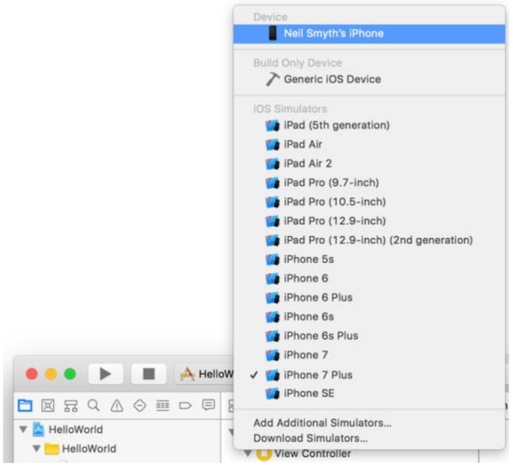
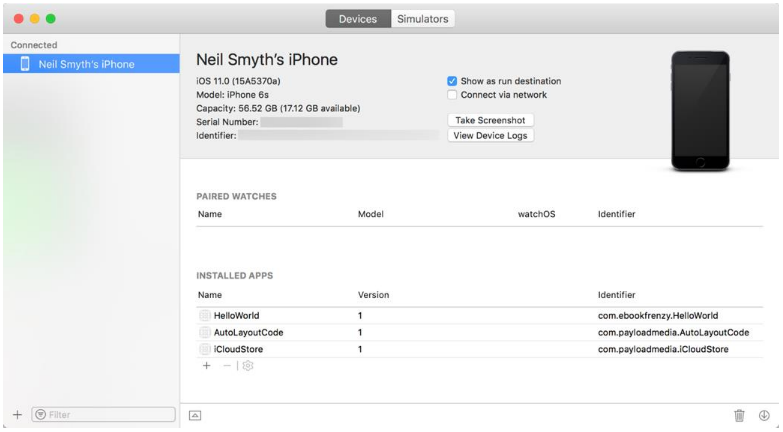


Figure 4-20

With the target device selected, make sure the device is unlocked and click on the run button at which point Xcode will install and launch the app on the device. As will be discussed later in this chapter, a physical device may also be configured for network testing, whereby apps are installed and tested on the device via a network connection without the need to have the device connected by a USB cable.

4.7 Managing Devices and Simulators

Currently connected iOS devices and the simulators configured for use with Xcode can be viewed and managed using the Xcode Devices window which is accessed via the *Window -> Devices and Simulators* menu option. Figure 4-21, for example, shows a typical Device screen on a system where an iPhone has been detected:



Neil Smyth's iPhone

iOS 11.0 (15A5370a)
Model: iPhone 6s
Capacity: 56.52 GB (17.12 GB available)
Serial Number: [redacted]
Identifier: [redacted]

☑ Show as run destination
☐ Connect via network

Take Screenshot
View Device Logs

PAIRED WATCHES

Name	Model	watchOS	Identifier

INSTALLED APPS

Name	Version	Identifier
HelloWorld	1	com.ebookfrenzy.HelloWorld
AutoLayoutCode	1	com.payloadmedia.AutoLayoutCode
iCloudStore	1	com.payloadmedia.iCloudStore

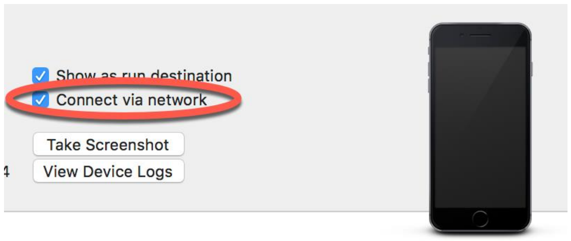
Figure 4-21

A wide range of simulator configurations are set up within Xcode by default and can be view by selecting the *Simulators* tab at the top of the dialog. Other simulator configurations can be added by clicking on the + button located in the bottom left-hand corner of the window. Once selected, a dialog will appear allowing the simulator to be configured in terms of device, iOS version and name.

The button displaying the gear icon in the bottom left corner allows simulators to be renamed or removed from the Xcode run target menu.

4.8 Enabling Network Testing

Earlier in this chapter, the example app was installed and run on a physical device connected to the development system via a USB cable. Xcode 10 also supports testing via a network connection. This option is enabled on a per device basis within the Devices and Simulators dialog introduced in the previous section. With the device connected via the USB cable, display this dialog, select the device from the list and enable the *Connect via network* option as highlighted in Figure 4-22:



☑ Show as run destination
☑ Connect via network

Figure 4-22

Once the setting has been enabled, the device may continue to be used as the run target for the app even when the USB cable is disconnected. The only requirement being that both the device and development computer be connected to the same Wi-Fi network. Assuming this requirement has been met, clicking on the run button with the device selected in the run menu will install and launch the app over the network connection.

4.9 Dealing with Build Errors

As we have not actually written or modified any code in this chapter it is unlikely that any errors will be detected during the build and run process. In the unlikely event that something did get inadvertently changed thereby causing the build to fail it is worth taking a few minutes to talk about build errors within the context of the Xcode environment.

If for any reason a build fails, the status window in the Xcode toolbar will report that an error has been detected by displaying "Build" together with the number of errors detected and any warnings. In addition, the left-hand panel of the Xcode window will update with a list of the errors. Selecting an error from this list will take you to the location in the code where corrective action needs to be taken.

4.10 Monitoring Application Performance

Another useful feature of Xcode is the ability to monitor the performance of an application while it is running. This information is accessed by displaying the *Debug Navigator*.

When Xcode is launched, the project navigator is displayed in the left-hand panel by default. Along the top of this panel is a bar with a range of other options. The sixth option from the left displays the debug navigator when selected as illustrated in Figure 4-23. When displayed, this panel shows a number of real-time statistics relating to the performance of the currently running application such as memory, CPU usage, disk access, energy efficiency, network activity and iCloud storage access.

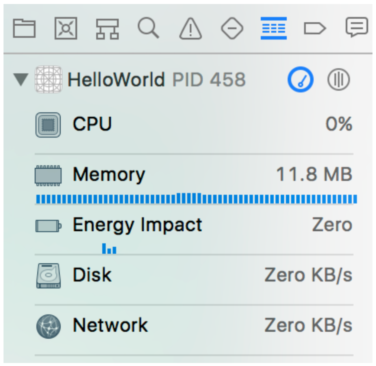


Figure 4-23

When one of these categories is selected, the main panel (Figure 4-24) updates to provide additional information about that particular aspect of the application's performance:

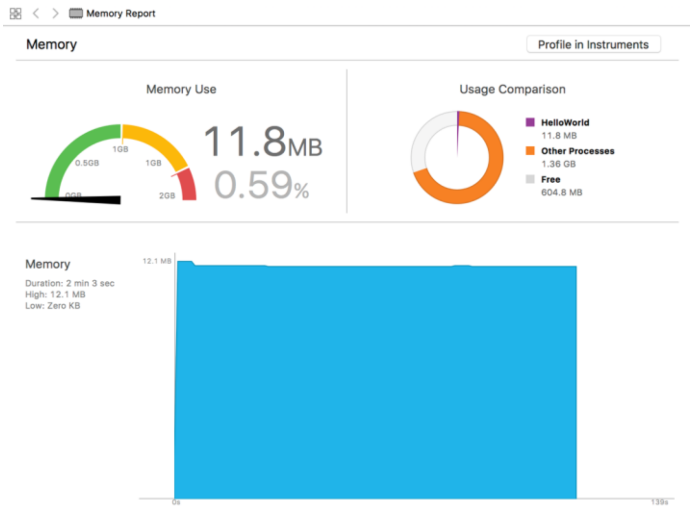


Figure 4-24

Yet more information can be obtained by clicking on the *Profile in Instruments* button in the top right-hand corner of the panel.

4.11 **An Exploded View of the User Interface Layout Hierarchy**

Xcode also provides an option to break the user interface layout out into a rotatable 3D view that shows how the view hierarchy for a user interface is constructed. This can be particularly useful for identifying situations where one view object is obscured by another appearing on top of it or a layout is not appearing as intended. To access the View Hierarchy in this mode, run the application and click on the *Debug View Hierarchy* button highlighted in Figure 4-25:

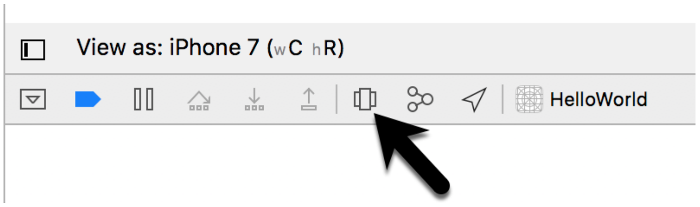


Figure 4-25

Once activated, a 3D "exploded" view of the layout will appear. Note that it may be necessary to click on the *Orient to 3D* button highlighted in Figure 4-26 to switch to 3D mode:

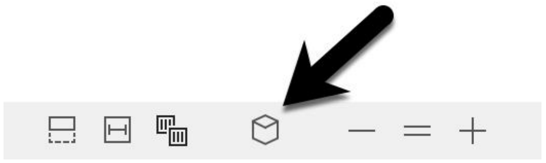


Figure 4-26

Figure 4-27 shows an example layout in this mode for a more complex user interface than that created in this chapter:

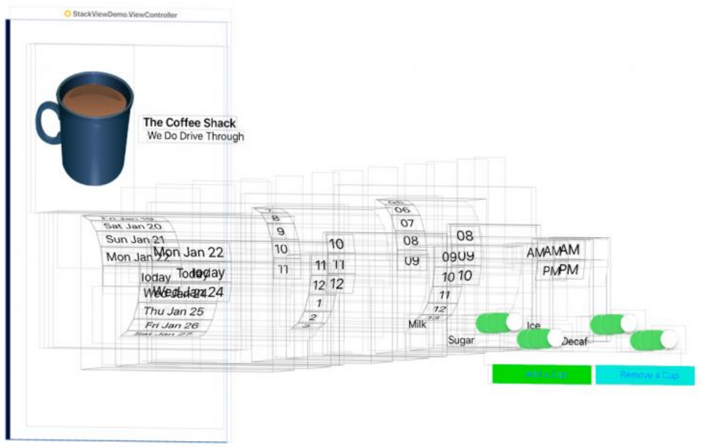


Figure 4-27

4.12 **Summary**

Applications are primarily created within the Xcode development environment. This chapter has served to provide a basic overview of the Xcode environment and to work through the creation of a very simple example application. Finally, a brief overview was provided of some of the performance monitoring features in Xcode 10. Many more features and capabilities of Xcode and Interface Builder will be covered in subsequent chapters of the book.

Chapter 5

5. An Introduction to Xcode 10 Playgrounds

Before introducing the Swift programming language in the chapters that follow, it is first worth learning about a feature of Xcode known as *Playgrounds*. Playgrounds are a feature of Xcode designed to make learning Swift and experimenting with the iOS SDK much easier. The concepts covered in this chapter can be put to use when experimenting with many of the introductory Swift code examples contained in the chapters that follow and will be of continued use in future when experimenting with many of the features of UIKit framework when designing dynamic user interfaces.

5.1 What is a Playground?

A playground is an interactive environment where Swift code can be entered and executed with the results appearing in real-time. This makes an ideal environment in which to learn the syntax of Swift and the visual aspects of iOS app development without the need to work continuously through the edit/compile/run/debug cycle that would ordinarily accompany a standard Xcode iOS project. With support for rich text comments, playgrounds are also a good way to document code as a teaching environment.

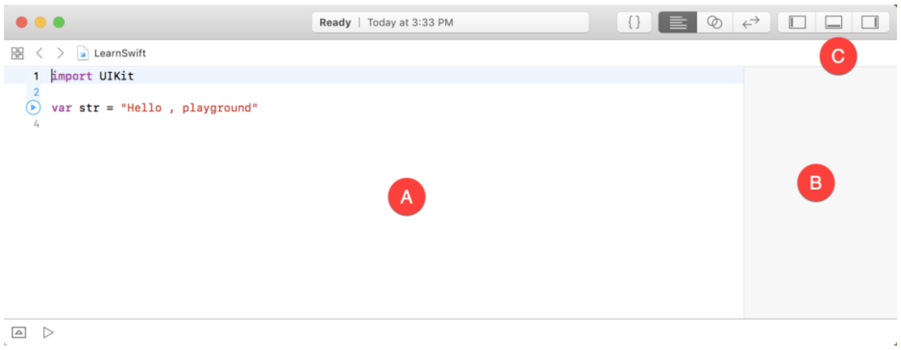
5.2 Creating a New Playground

To create a new Playground, start Xcode and select the *Get started with a playground* option from the welcome screen or select the *File -> New -> Playground…* menu option. Choose the iOS option on the resulting panel and select the Blank template.

The Blank template is useful for trying out Swift coding. The Single View template, on the other hand, provides a view controller environment for trying out code that requires a user interface layout. The game and map templates provide preconfigured playgrounds that allow you to experiment with the iOS MapKit and SpriteKit frameworks respectively.

On the next screen, name the playground *LearnSwift* and choose a suitable file system location into which the playground should be saved before clicking on the *Create* button.

Once the playground has been created, the following screen will appear ready for Swift code to be entered:

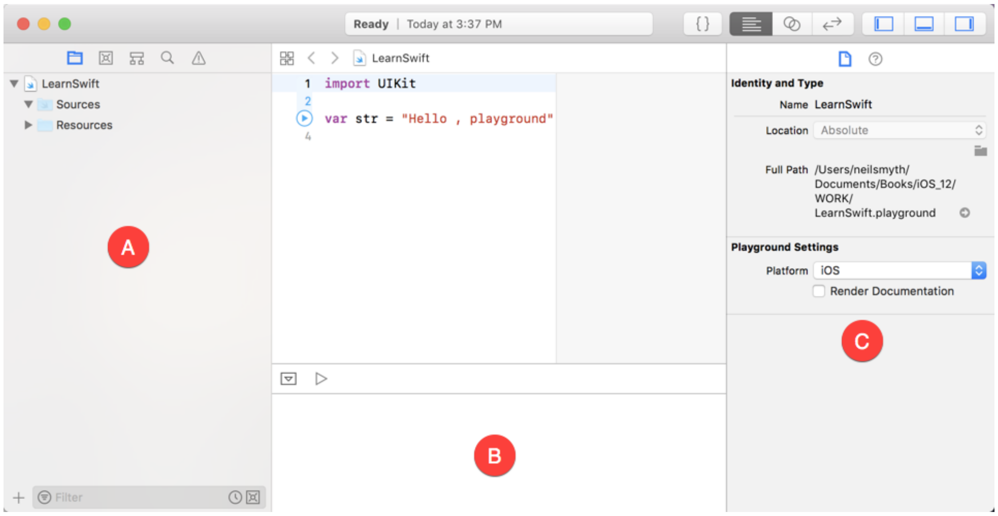


```
import UIKit

var str = "Hello , playground"
```

Figure 5-1

The panel on the left-hand side of the window (marked A in Figure 5-1) is the *playground editor* where the lines of Swift code are entered. The right-hand panel (marked B) is referred to as the *results panel* and is where the results of each Swift expression entered into the playground editor panel are displayed.

The cluster of three buttons at the right-hand side of the toolbar (marked C) are used to hide and display other panels within the playground window. The left most button displays the Navigator panel which provides access to the folders and files that make up the playground (marked A in Figure 5-2 below). The middle button, on the other hand, displays the Debug view (B) which displays code output and information about coding or runtime errors. The right most button displays the Utilities panel (C) where a variety of properties relating to the playground may be configured.



```
import UIKit

var str = "Hello , playground"
```

Figure 5-2

By far the quickest way to gain familiarity with the playground environment is to work through some simple examples.

5.3 A Basic Swift Playground Example

Perhaps the simplest of examples in any programming language (that at least does something tangible) is to write some code to output a single line of text. Swift is no exception to this rule so, within the playground window, begin adding another line of Swift code so that it reads as follows:

```
import UIKit

var str = "Hello , playground"

print("Welcome to Swift")
```

All that the additional line of code does is make a call to the built-in Swift *print* function which takes as a parameter a string of characters to be displayed on the console. Those familiar with other programming languages will note the absence of a semi-colon at the end of the line of code. In Swift, semi-colons are optional and generally only used as a separator when multiple statements occupy the same line of code.

Note that although some extra code has been entered, nothing yet appears in the results panel. This is because the code has yet to be executed. One option to run the code is to click on the Execute Playground button located in the bottom left-hand corner of the main panel as indicated by the arrow in Figure 5-3:

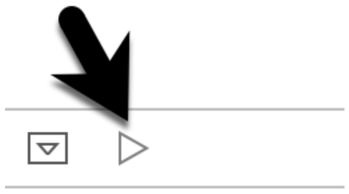
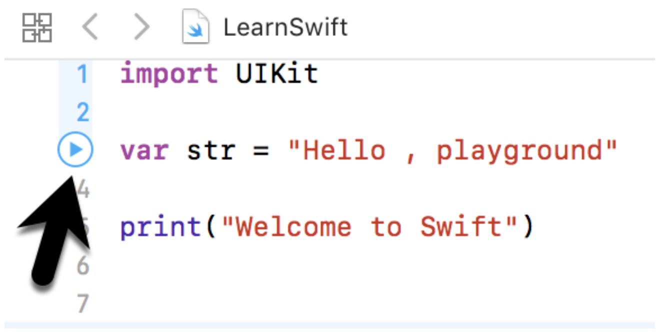


Figure 5-3

When clicked, this button will execute all of the code in the current playground page from the first line of code to the last. Another option is to execute the code in stages using the run button located in the margin of the code editor as shown in Figure 5-4:

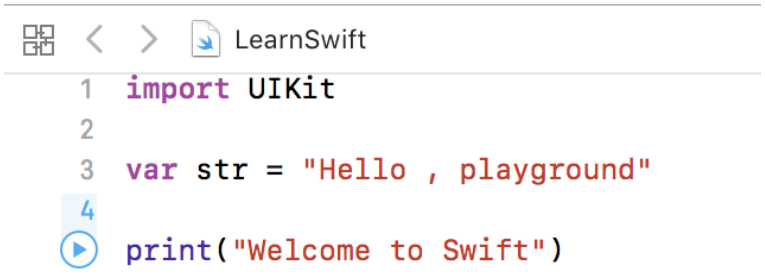


```
1  import UIKit
2
   var str = "Hello , playground"
4
5  print("Welcome to Swift")
6
7
```

Figure 5-4

This button executes the line numbers with the shaded blue background including the line on which the button is currently positioned. In the above figure, for example, the button will execute lines 1 through 3 and then stop.

The position of the run button can be moved by hovering the mouse pointer over the line numbers in the editor. In Figure 5-5, for example, the run button is now positioned on line 5 and will execute lines 4 and 5 when clicked. Note that lines 1 to 3 are no longer highlighted in blue indicating that these have already been executed and are not eligible to be run this time:



```
1  import UIKit
2
3  var str = "Hello , playground"
4
   print("Welcome to Swift")
```

Figure 5-5

This technique provides an easy way to execute the code in stages making it easier to understand how the code functions and to identify problems in code execution.

To reset the playground so that execution can be performed from the start of the code, simply click on the stop button as indicated in Figure 5-6.:

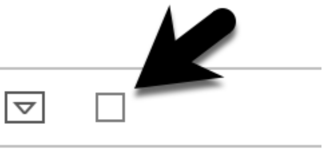
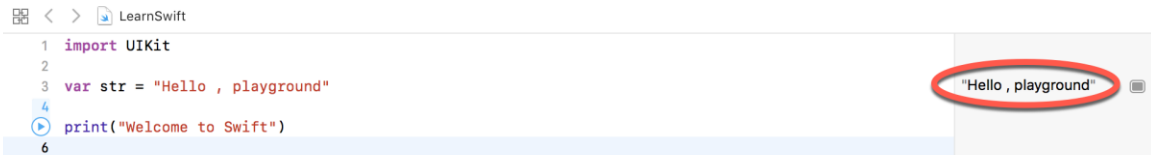


Figure 5-6

Using this incremental execution technique, execute lines 1 through 3 and note that output now appears in the results panel indicating that the variable has been initialized:

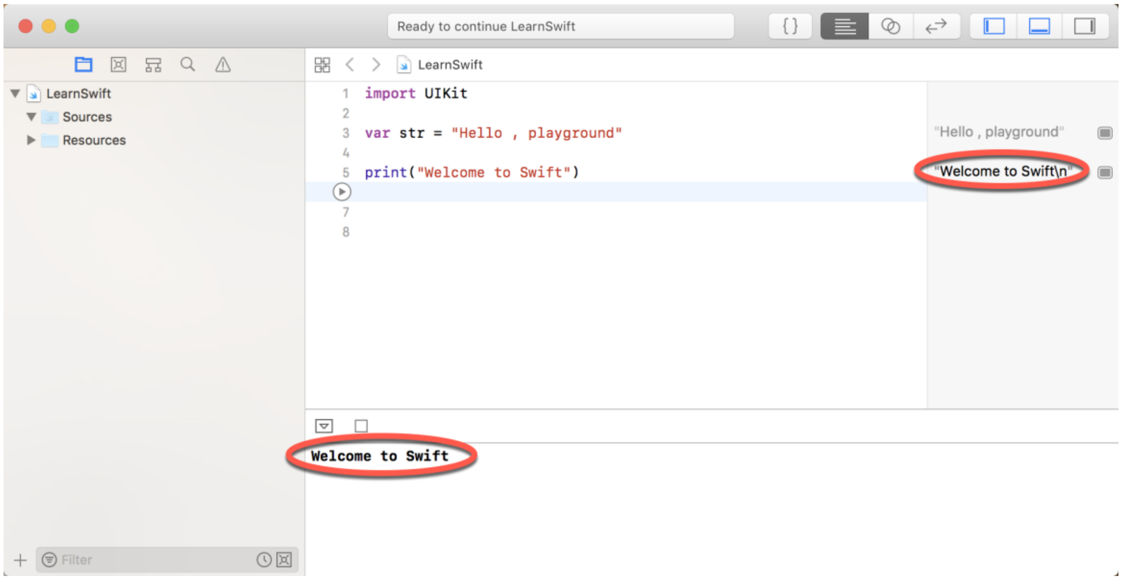


```
import UIKit

var str = "Hello , playground"

print("Welcome to Swift")
```

"Hello , playground"

Figure 5-7

Next, execute the remaining lines up to and including line 5 at which point the “Welcome to Swift” output should appear both in the results panel and Debug panel:



```
import UIKit

var str = "Hello , playground"

print("Welcome to Swift")
```

"Hello , playground"
"Welcome to Swift\n"

```
Welcome to Swift
```

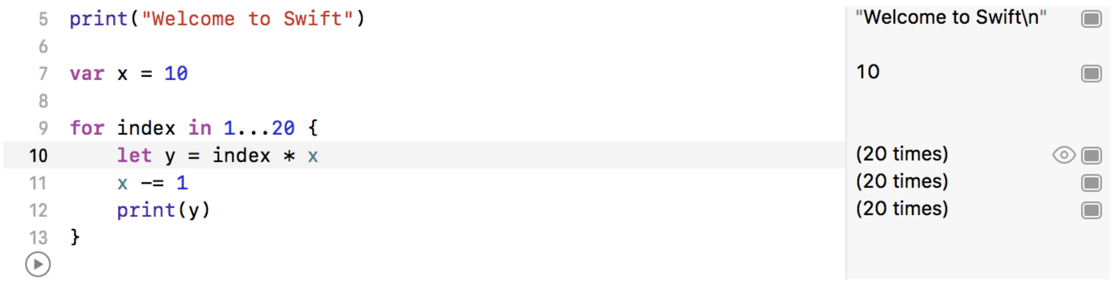
Figure 5-8

5.4 **Viewing Results**

Playgrounds are particularly useful when working and experimenting with Swift algorithms. This can be useful when combined with the Quick Look feature. Remaining within the playground editor, enter the following lines of code beneath the existing print statement:

```
var x = 10

for index in 1...20 {
    let y = index * x
    x -= 1
    print(y)
}
```

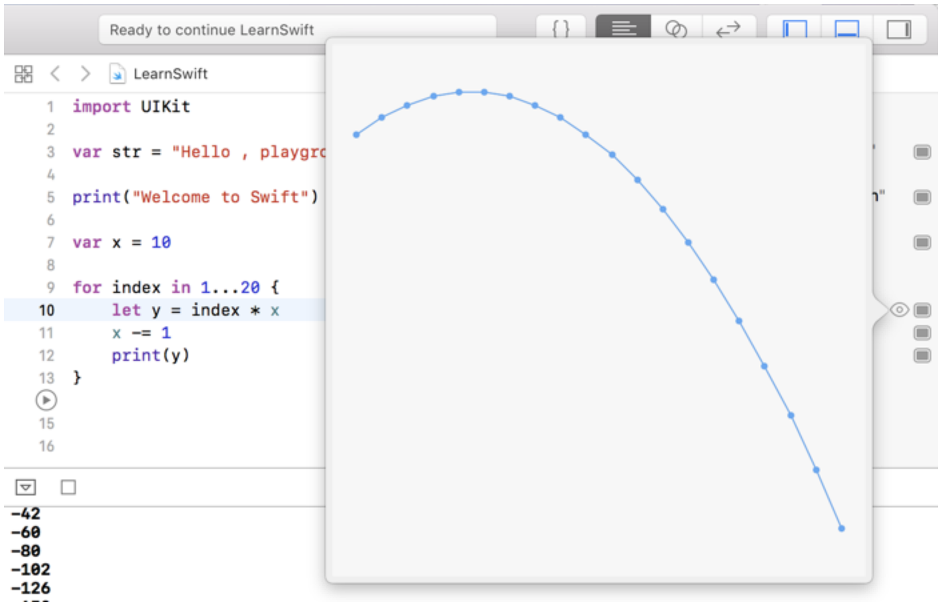
This expression repeats a loop 20 times, performing an arithmetic expression on each iteration of the loop. Once the code has been entered into the editor, click on the run button positioned at line 13 to execute these new lines of code. The playground will execute the loop and display in the results panel the number of times the loop was performed. More interesting information, however, may be obtained by hovering the mouse pointer over the results line so that two additional buttons appear as shown in Figure 5-9:



```
print("Welcome to Swift")                "Welcome to Swift\n"

var x = 10                               10

for index in 1...20 {
    let y = index * x                    (20 times)
    x -= 1                               (20 times)
    print(y)                             (20 times)
}
```

Figure 5-9

The left most of the two buttons is the *Quick Look* button which, when selected, will show a popup panel displaying the results as shown in Figure 5-10:

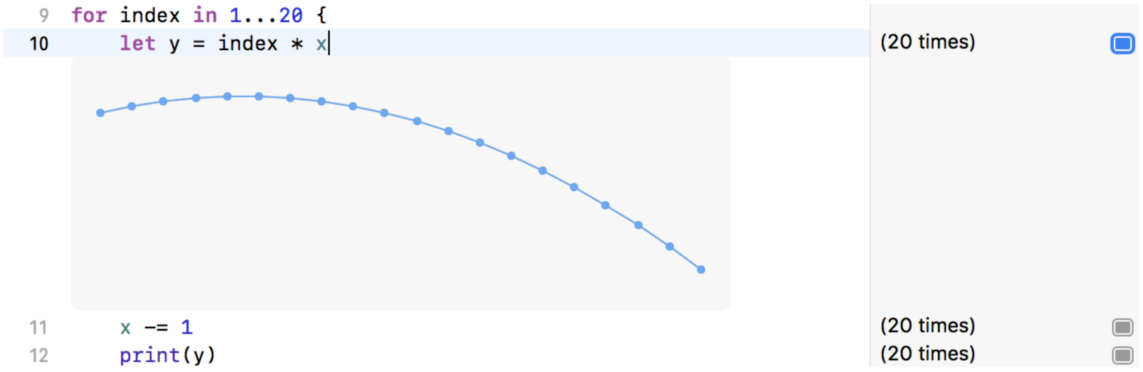


```
import UIKit

var str = "Hello , playgro

print("Welcome to Swift")

var x = 10

for index in 1...20 {
    let y = index * x
    x -= 1
    print(y)
}
```

```
-42
-60
-80
-102
-126
```

Figure 5-10

The right-most button is the *Show Result* button which, when selected, displays the results in-line with the code:



```
for index in 1...20 {
    let y = index * x
    x -= 1
    print(y)
```

(20 times)
(20 times)
(20 times)

Figure 5-11

5.5 Adding Rich Text Comments

Rich text comments allow the code within a playground to be documented in a way that is easy to format and read. A single line of text can be marked as being rich text by preceding it with a //: marker. For example:

```
//: This is a single line of documentation text
```

Blocks of text can be added by wrapping the text in /*: and */ comment markers:

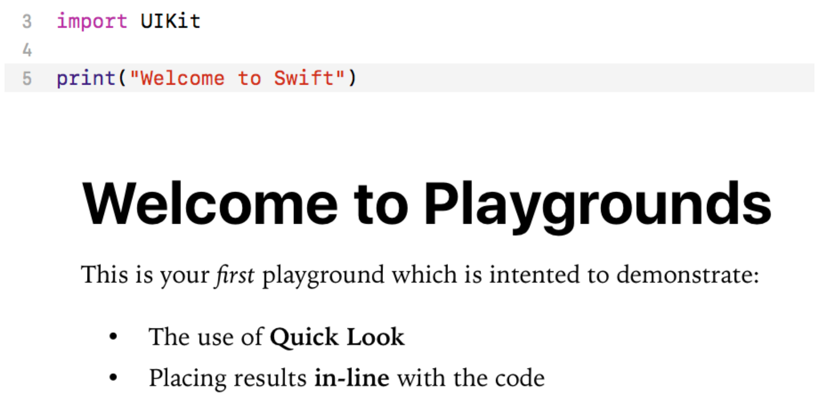
```
/*:
This is a block of documentation text that is intended
to span multiple lines
*/
```

The rich text uses the Markdown markup language and allows text to be formatted using a lightweight and easy to use syntax. A heading, for example, can be declared by prefixing the line with a '#' character while text is displayed in italics when wrapped in '*' characters. Bold text, on the other hand, involves wrapping the text in '**' character sequences. It is also possible to configure bullet points by prefixing each line with a single '*'. Among the many other features of Markdown are the ability to embed images and hyperlinks into the content of a rich text comment.

To see rich text comments in action, enter the following markdown content into the playground editor immediately after the *print("Welcome to Swift")* line of code:

```
/*:
# Welcome to Playgrounds
This is your *first* playground which is intended to demonstrate:
* The use of **Quick Look**
* Placing results **in-line** with the code
*/
```

As the comment content is added it is said to be displayed in *raw markup* format. To display in *rendered markup* format, either select the *Editor -> Show Rendered Markup* menu option, or enable the *Render Documentation* option located under *Playground Settings* in the Utilities panel (marked C in Figure 5-2). Once rendered, the above rich text should appear as illustrated in Figure 5-12:



```
import UIKit

print("Welcome to Swift")
```

Welcome to Playgrounds

This is your *first* playground which is intented to demonstrate:

- The use of **Quick Look**
- Placing results **in-line** with the code

Figure 5-12

Detailed information about the Markdown syntax can be found online at the following URL:

https://developer.apple.com/library/content/documentation/Xcode/Reference/xcode_markup_formatting_ref/index.html

5.6 Working with Playground Pages

A playground can consist of multiple pages, with each page containing its own code, resources and rich text comments. So far, the playground used in this chapter contains a single page. Add an additional page to the playground now by selecting the LearnSwift entry at the top of the Navigator panel, right-clicking and selecting the *New Playground Page* menu option. Once added, click on the left most of the three view buttons (marked C in Figure 5-1) to display the Navigator panel. Note that two pages are now listed in the Navigator named “Untitled Page” and “Untitled Page 2”. Select and then click a second time on the “Untitled Page 2” entry so that the name becomes editable and change the name to *UIKit Examples* as outlined in Figure 5-13:

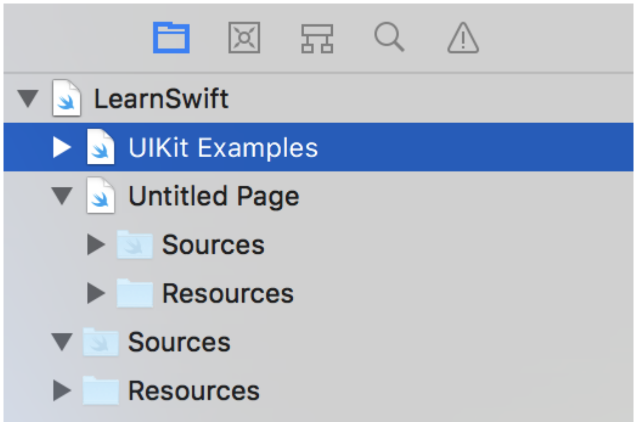


Figure 5-13

Note that the newly added page has Markdown links which, when clicked, navigate to the previous or next page in the playground.

5.7 Working with UIKit in Playgrounds

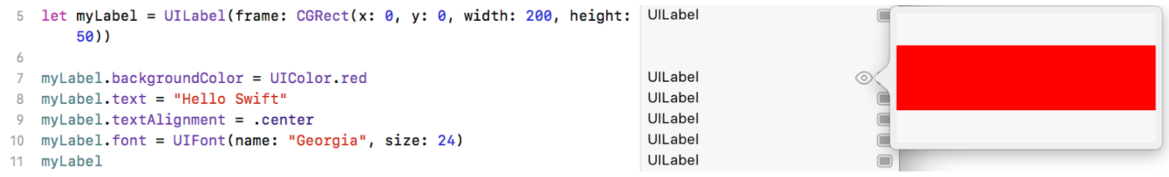
The playground environment is not restricted to simple Swift code statements. Much of the power of the iOS SDK is also available for experimentation within a playground.

When working with UIKit within a playground page it is necessary to import the iOS UIKit Framework. The UIKit Framework contains most of the classes necessary to implement user interfaces for iOS applications and is an area which will be covered in significant detail throughout the book. An extremely powerful feature of playgrounds is that it is also possible to work with UIKit along with many of the other frameworks that comprise the iOS SDK.

The following code, for example, imports the UIKit framework, creates a UILabel instance and sets color, text and font properties on it:

```
import UIKit

let myLabel = UILabel(frame: CGRect(x: 0, y: 0, width: 200, height: 50))

myLabel.backgroundColor = UIColor.red
myLabel.text = "Hello Swift"
myLabel.textAlignment = .center
myLabel.font = UIFont(name: "Georgia", size: 24)
myLabel
```

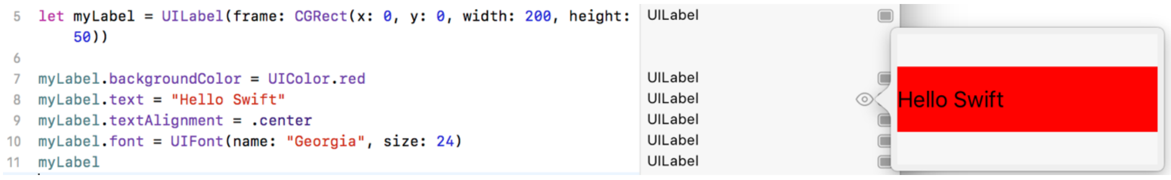
Enter this code into the playground editor on the UIKit Examples page (the existing code can be removed) and run the code. This code provides a good example of how the Quick Look feature can be useful. Each line of the example Swift code configures a different aspect of the appearance of the UILabel instance. Clicking on the Quick Look button for the first line of code will display an empty view (since the label exists but has yet to be given any visual attributes). Clicking on the Quick Look button in the line of code which sets the background color, on the other hand, will show the red label:



```
let myLabel = UILabel(frame: CGRect(x: 0, y: 0, width: 200, height:    UILabel
    50))

myLabel.backgroundColor = UIColor.red                                UILabel
myLabel.text = "Hello Swift"                                         UILabel
myLabel.textAlignment = .center                                      UILabel
myLabel.font = UIFont(name: "Georgia", size: 24)                     UILabel
myLabel                                                              UILabel
```

Figure 5-14

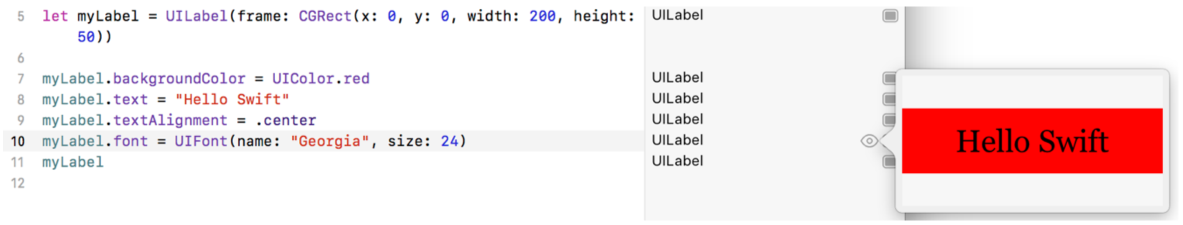
Similarly, the quick look view for the line where the text property is set will show the red label with the “Hello Swift” text left aligned:



```
let myLabel = UILabel(frame: CGRect(x: 0, y: 0, width: 200, height:    UILabel
    50))

myLabel.backgroundColor = UIColor.red                                UILabel
myLabel.text = "Hello Swift"                                         UILabel
myLabel.textAlignment = .center                                      UILabel
myLabel.font = UIFont(name: "Georgia", size: 24)                     UILabel
myLabel                                                              UILabel
```

Figure 5-15

The font setting quick look view on the other hand displays the UILabel with centered text and the larger Georgia font:



```
let myLabel = UILabel(frame: CGRect(x: 0, y: 0, width: 200, height:
    50))

myLabel.backgroundColor = UIColor.red
myLabel.text = "Hello Swift"
myLabel.textAlignment = .center
myLabel.font = UIFont(name: "Georgia", size: 24)
myLabel

```

Figure 5-16

5.8 Adding Resources to a Playground

Another useful feature of playgrounds is the ability to bundle and access resources such as image files in a playground. Within the Navigator panel, click on the right facing arrow (known as a *disclosure arrow*) to the left of the UIKit Examples page entry to unfold the page contents (Figure 5-17) and note the presence of a folder named *Resources*:

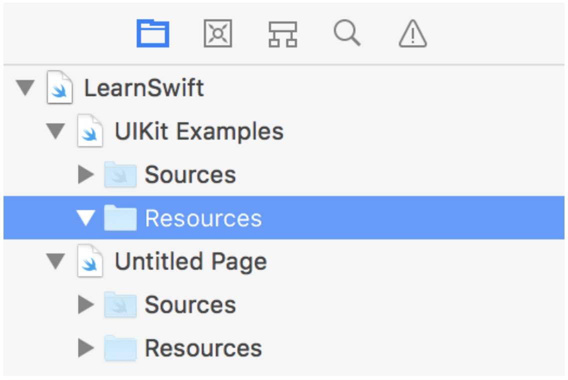


Figure 5-17

If you have not already done so, download and unpack the code samples archive from the following URL:

https://www.ebookfrenzy.com/retail/ios12/

Open a Finder window, navigate to the *playground_images* folder within the code samples folder and drag and drop the image file named *waterfall.png* onto the *Resources* folder beneath the UIKit Examples page in the Playground Navigator panel:

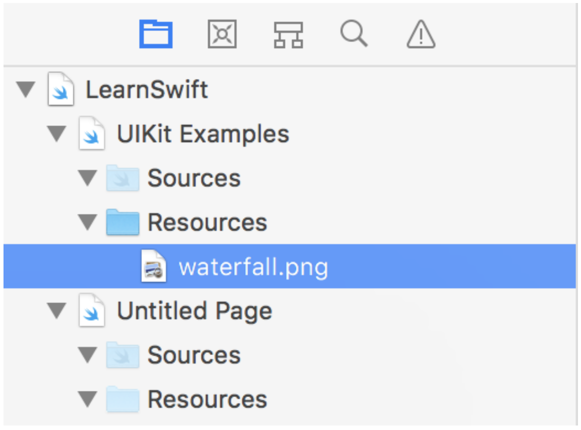
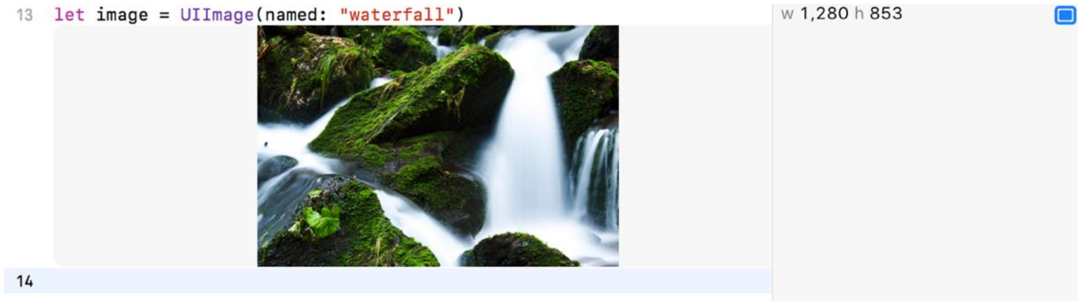


Figure 5-18

With the image added to the resources, add code to the page to create an image object and display the waterfall image on it:

```
let image = UIImage(named: "waterfall")
```

With the code added, run the new statement and use either the Quick Look or inline option to view the results of the code:



```
let image = UIImage(named: "waterfall")
```

Figure 5-19

5.9 Working with Enhanced Live Views

So far in this chapter, all of the UIKit examples have involved presenting static user interface elements using the Quick Look and in-line features. It is, however, also possible to test dynamic user interface behavior within a playground using the Xcode Enhanced Live Views feature. To demonstrate live views in action, create a new page within the playground named *Live View Example*. Within the newly added page, remove the existing lines of Swift code before adding import statements for the UIKit framework and an additional playground module named PlaygroundSupport:

```
import UIKit
import PlaygroundSupport
```

The PlaygroundSupport module provides a number of useful features for playgrounds including the ability to present a live view within the playground timeline.

Beneath the import statements, add the following code:

```
import UIKit
import PlaygroundSupport

let container = UIView(frame: CGRect(x: 0,y: 0,width: 200,height: 200))
container.backgroundColor = UIColor.white
let square = UIView(frame: CGRect(x: 50,y: 50,width: 100,height: 100))
square.backgroundColor = UIColor.red

container.addSubview(square)

UIView.animate(withDuration: 5.0, animations: {
    square.backgroundColor = UIColor.blue
    let rotation = CGAffineTransform(rotationAngle: 3.14)
    square.transform = rotation
})
```

The code creates a UIView object to act as a container view and assigns it a white background color. A smaller view is then drawn positioned in the center of the container view and colored red. The second view is then added as a child of the container view. An animation is then used to change the color of the smaller view to blue and to rotate it through 360 degrees. If you are new to iOS programming rest assured that these areas will be covered in detail in later chapters. At this point the code is simply provided to highlight the capabilities of live views.

Once the code has been executed, clicking on any of the Quick Look buttons will show a snapshot of the views at each stage in the code sequence. None of the quick look views, however, show the dynamic animation. To see how the animation code works it will be necessary to use the live view playground feature.

The PlaygroundSupport module includes a class named PlaygroundPage that allows playground code to interact with the pages that make up a playground. This is achieved through a range of methods and properties of the class, one of which is the *current* property. This property, in turn, provides access to the current playground page. In order to execute the live view within the playground timeline, the *liveView* property of the current page needs to be set to our new container. To display the timeline, click on the toolbar button containing the interlocking circles as highlighted in Figure 5-20:

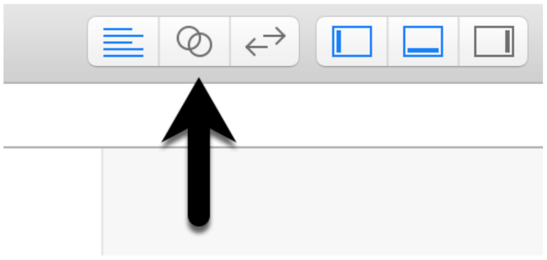


Figure 5-20

When clicked, this button displays the Assistant Editor panel containing the timeline. Once the timeline is visible, add the code to assign the container to the live view of the current page as follows:

```
import UIKit
import PlaygroundSupport

let container = UIView(frame: CGRect(x: 0,y: 0,width: 200,height: 200))

PlaygroundPage.current.liveView = container

container.backgroundColor = UIColor.white
let square = UIView(frame: CGRect(x: 50,y: 50,width: 100,height: 100))
square.backgroundColor = UIColor.red

container.addSubview(square)

UIView.animate(withDuration: 5.0, animations: {
    square.backgroundColor = UIColor.blue
    let rotation = CGAffineTransform(rotationAngle: 3.14)
    square.transform = rotation
})
```

Once the call has been added, re-execute the code at which point the views should appear in the timeline (Figure 5-21). During the 5 second animation duration, the red square should rotate through 360 degrees while gradually changing color to blue:

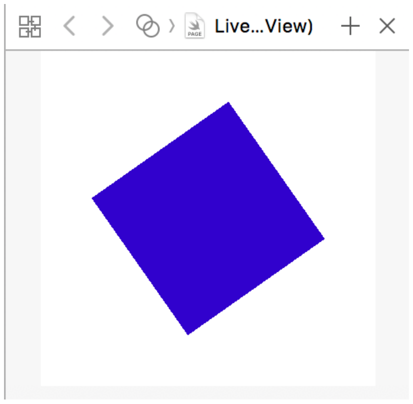


Figure 5-21

To repeat the execution of the code in the playground page, click on the stop button highlighted in Figure 5-6 to reset the playground and change the stop button into the run button (Figure 5-3). Click the run button to repeat the execution.

5.10 When to Use Playgrounds

Clearly Swift Playgrounds provide an ideal environment for learning to program using the Swift programming language and the use of playgrounds in the Swift introductory chapters that follow is recommended.

It is also important to keep in mind that playgrounds will remain useful long after the basics of Swift have been learned and will become increasingly useful when moving on to more advanced areas of iOS development.

The iOS SDK is a vast collection of frameworks and classes and it is not unusual for even experienced developers to need to experiment with unfamiliar aspects of iOS development before adding code to a project. Historically this has involved creating a temporary iOS Xcode project and then repeatedly looping through the somewhat cumbersome edit, compile, run cycle to arrive at a programming solution. Rather than fall into this habit, consider having a playground on standby to carry out experiments during your project development work.

5.11 Summary

This chapter has introduced the concept of playgrounds. Playgrounds provide an environment in which Swift code can be entered and the results of that code viewed dynamically. This provides an excellent environment both for learning the Swift programming language and for experimenting with many of the classes and APIs included in the iOS SDK without the need to create Xcode projects and repeatedly edit, compile and run code.

Chapter 6

6. Swift Data Types, Constants and Variables

Prior to the introduction of iOS 8, the stipulated programming language for the development of iOS applications was Objective-C. When Apple announced iOS 8, however, the company also introduced an alternative to Objective-C in the form of the Swift programming language.

Due entirely to the popularity of iOS, Objective-C had become one of the more widely used programming languages. With origins firmly rooted in the 40-year-old C Programming Language, however, and in spite of recent efforts to modernize some aspects of the language syntax, Objective-C was beginning to show its age.

Swift, on the other hand, is an entirely new programming language designed specifically to make programming easier, faster and less prone to programmer error. Starting with a clean slate and no burden of legacy, Swift is a new and innovative language with which to develop applications for iOS, macOS, watchOS and tvOS with the advantage that much of the syntax will be familiar to those with experience of other programming languages.

The introduction of Swift aside, it is still perfectly acceptable to continue to develop applications using Objective-C. Indeed, it is also possible to mix both Swift and Objective-C within the same application code base. That being said, Apple clearly sees the future of development in terms of Swift rather than Objective-C. In recognition of this fact, all of the examples in this book are implemented using Swift. Before moving on to those examples, however, the next several chapters will provide an overview and introduction to Swift programming. The intention of these chapters is to provide enough information so that you can begin to confidently program using Swift. For an exhaustive and in-depth guide to all the features, intricacies and capabilities of Swift, some time spent reading Apple's excellent book entitled "The Swift Programming Language" (available free of charge from within the Apple iBookStore) is strongly recommended.

6.1 Using a Swift Playground

Both this and the following few chapters are intended to introduce the basics of the Swift programming language. As outlined in the previous chapter, entitled *An Introduction to Swift Playgrounds* the best way to learn Swift is to experiment within a Swift playground environment. Before starting this chapter, therefore, create a new playground and use it to try out the code in both this and the other Swift introduction chapters that follow.

6.2 Swift Data Types

When we look at the different types of software that run on computer systems and mobile devices, from financial applications to graphics intensive games, it is easy to forget that computers are really just binary machines. Binary systems work in terms of 0 and 1, true or false, set and unset. All the data sitting in RAM, stored on disk drives and flowing through circuit boards and buses are nothing more than sequences of 1s and 0s. Each 1 or 0 is referred to as a *bit* and bits are grouped together in blocks of 8, each group being referred to as a *byte*. When people talk about 32-bit and 64-bit computer systems they are talking about the number of bits that can be handled simultaneously by the CPU bus. A 64-bit CPU, for example, is able to handle data in 64-bit blocks, resulting in faster performance than a 32-bit based system.

Humans, of course, don't think in binary. We work with decimal numbers, letters and words. In order for a human to easily (easily being a relative term in this context) program a computer, some middle ground between human and computer thinking is needed. This is where programming languages such as Swift come into play. Programming languages allow humans to express instructions to a computer in terms and structures we understand, and then compile that down to a format that can be executed by a CPU.

One of the fundamentals of any program involves data, and programming languages such as Swift define a set of *data types* that allow us to work with data in a format we understand when programming. For example, if we want to store a number in a Swift program we could do so with syntax similar to the following:

```
var mynumber = 10
```

In the above example, we have created a variable named *mynumber* and then assigned to it the value of 10. When we compile the source code down to the machine code used by the CPU, the number 10 is seen by the computer in binary as:

```
1010
```

Now that we have a basic understanding of the concept of data types and why they are necessary we can take a closer look at some of the more commonly used data types supported by Swift.

6.2.1 Integer Data Types

Swift integer data types are used to store whole numbers (in other words a number with no decimal places). Integers can be *signed* (capable of storing positive, negative and zero values) or *unsigned* (positive and zero values only).

Swift provides support for 8, 16, 32 and 64-bit integers (represented by the Int8, Int16, Int32 and Int64 types respectively). The same variants are also available for unsigned integers (UInt8, UInt16, UInt32 and UInt64).

In general, Apple recommends using the *Int* data type rather than one of the above specifically sized data types. The Int data type will use the appropriate integer size for the platform on which the code is running.

All integer data types contain bounds properties which can be accessed to identify the minimum and maximum supported values of that particular type. The following code, for example, outputs the minimum and maximum bounds for the 32-bit signed integer data type:

```
print("Int32 Min = \(Int32.min) Int32 Max = \(Int32.max)")
```

When executed, the above code will generate the following output:

```
Int32 Min = -2147483648 Int32 Max = 2147483647
```

6.2.2 Floating Point Data Types

The Swift floating point data types are able to store values containing decimal places. For example, 4353.1223 would be stored in a floating point data type. Swift provides two floating point data types in the form of *Float* and *Double*. Which type to use depends on the size of value to be stored and the level of precision required. The Double type can be used to store up to 64-bit floating point numbers with a level of precision of 15 decimal places or greater. The Float data type, on the other hand, is limited to 32-bit floating point numbers and offers a level of precision as low as 6 decimal places depending on the native platform on which the code is running.

6.2.3 Bool Data Type

Swift, like other languages, includes a data type for the purpose of handling true or false (1 or 0) conditions. Two Boolean constant values (*true* and *false*) are provided by Swift specifically for working with Boolean data types.

6.2.4 Character Data Type

The Swift Character data type is used to store a single character of rendered text such as a letter, numerical digit, punctuation mark or symbol. Internally characters in Swift are stored in the form of *grapheme clusters*. A grapheme cluster is made of two or more Unicode scalars that are combined to represent a single visible character.

The following lines assign a variety of different characters to Character type variables:

```
var myChar1 = "f"
var myChar2 = ":"
var myChar3 = "X"
```

Characters may also be referenced using Unicode code points. The following example assigns the ‘X’ character to a variable using Unicode:

```
var myChar4 = "\u{0058}"
```

6.2.5 String Data Type

The String data type is a sequence of characters that typically make up a word or sentence. In addition to providing a storage mechanism, the String data type also includes a range of string manipulation features allowing strings to be searched, matched, concatenated and modified. Strings in Swift are represented internally as collections of characters (where a character is, as previously discussed, comprised of one or more Unicode scalar values).

Strings can also be constructed using combinations of strings, variables, constants, expressions, and function calls using a concept referred to as *string interpolation*. For example, the following code creates a new string from a variety of different sources using string interpolation before outputting it to the console:

```
var userName = "John"
var inboxCount = 25
let maxCount = 100

var message = "\(userName) has \(inboxCount) messages. Message capacity
remaining is \(maxCount - inboxCount)"

print(message)
```

When executed, the code will output the following message:

```
John has 25 messages. Message capacity remaining is 75 messages.
```

A multiline string literal may be declared by encapsulating the string within triple quotes as follows:

```
var multiline = """

    The console glowed with flashing warnings.
    Clearly time was running out.

    "I thought you said you knew how to fly this!" yelled Mary.

    "It was much easier on the simulator" replied her brother,
     trying to keep the panic out of his voice.

"""

print(multiline)
```

The above code will generate the following output when run:

```
    The console glowed with flashing warnings.
    Clearly time was running out.

    "I thought you said you knew how to fly this!" yelled Mary.

    "It was much easier on the simulator" replied her brother,
    trying to keep the panic out of his voice.
```

The amount by which each line is indented within a multiline literal is calculated as the number of characters by which the line is indented minus the number of characters by which the closing triple quote line is indented. If, for example, the fourth line in the above example had a 10 character indentation and the closing triple quote was indented by 5 characters, the actual indentation of the fourth line within the string would be 5 characters. This allows multiline literals to be formatted tidily within Swift code while still allowing control over indentation of individual lines.

6.2.6 Special Characters/Escape Sequences

In addition to the standard set of characters outlined above, there is also a range of *special characters* (also referred to as *escape sequences*) available for specifying items such as a new line, tab or a specific Unicode value within a string. These special characters are identified by prefixing the character with a backslash (a concept referred to as *escaping*). For example, the following assigns a new line to the variable named newline:

```
var newline = "\n"
```

In essence, any character that is preceded by a backslash is considered to be a special character and is treated accordingly. This raises the question as to what to do if you actually want a backslash character. This is achieved by *escaping* the backslash itself:

```
var backslash = "\\"
```

Commonly used special characters supported by Swift are as follows:

- **\n** - New line
- **\r** - Carriage return
- **\t** - Horizontal tab
- \\ - Backslash
- **\"** - Double quote (used when placing a double quote into a string declaration)
- **\'** - Single quote (used when placing a single quote into a string declaration)

- **\u{*nn*}** – Single byte Unicode scalar where *nn* is replaced by two hexadecimal digits representing the Unicode character.
- **\u{*nnnn*}** – Double byte Unicode scalar where *nnnn* is replaced by four hexadecimal digits representing the Unicode character.
- **\U{*nnnnnnnn*}** – Four byte Unicode scalar where *nnnnnnnn* is replaced by eight hexadecimal digits representing the Unicode character.

6.3 Swift Variables

Variables are essentially locations in computer memory reserved for storing the data used by an application. Each variable is given a name by the programmer and assigned a value. The name assigned to the variable may then be used in the Swift code to access the value assigned to that variable. This access can involve either reading the value of the variable, or changing the value. It is, of course, the ability to change the value of variables which gives them the name *variable*.

6.4 Swift Constants

A constant is similar to a variable in that it provides a named location in memory to store a data value. Constants differ in one significant way in that once a value has been assigned to a constant it cannot subsequently be changed.

Constants are particularly useful if there is a value which is used repeatedly throughout the application code. Rather than use the value each time, it makes the code easier to read if the value is first assigned to a constant which is then referenced in the code. For example, it might not be clear to someone reading your Swift code why you used the value 5 in an expression. If, instead of the value 5, you use a constant named interestRate the purpose of the value becomes much clearer. Constants also have the advantage that if the programmer needs to change a widely used value, it only needs to be changed once in the constant declaration and not each time it is referenced.

As with variables, constants have a type, a name and a value. Unlike variables, however, once a value has been assigned to a constant, that value cannot subsequently be changed.

6.5 Declaring Constants and Variables

Variables are declared using the *var* keyword and may be initialized with a value at creation time. If the variable is declared without an initial value it must be declared as being *optional* (a topic which will be covered later in this chapter). The following, for example, is a typical variable declaration:

```
var userCount = 10
```

Constants are declared using the *let* keyword.

```
let maxUserCount = 20
```

For greater code efficiency and execution performance, Apple recommends the use of constants rather than variables whenever possible.

6.6 Type Annotations and Type Inference

Swift is categorized as a *type safe* programming language. This essentially means that once the data type of a variable has been identified, that variable cannot subsequently be used to store data of any other type without inducing a compilation error. This contrasts to *loosely typed* programming languages where a variable, once declared, can subsequently be used to store other data types.

There are two ways in which the type of a constant or variable will be identified. One approach is to use a *type annotation* at the point the variable or constant is declared in the code. This is achieved by placing a colon after the constant or variable name followed by the type declaration. The following line of code, for example, declares a variable named userCount as being of type Int:

```
var userCount: Int = 10
```

In the absence of a type annotation in a declaration, the Swift compiler uses a technique referred to as *type inference* to identify the type of the constant or variable. When relying on type inference, the compiler looks to see what type of value is being assigned to the constant or variable at the point that it is initialized and uses that as the type. Consider, for example, the following variable and constant declarations:

```
var signalStrength = 2.231
let companyName = "My Company"
```

During compilation of the above lines of code, Swift will infer that the signalStrength variable is of type Double (type inference in Swift defaults to Double for all floating point numbers) and that the companyName constant is of type String.

When a constant is declared without a type annotation it must be assigned a value at the point of declaration:

```
let bookTitle = "iOS 12 App Development Essentials"
```

If a type annotation is used when the constant is declared, however, the value can be assigned later in the code. For example:

```
let bookTitle: String
.
.
if iosBookType {
        bookTitle = "iOS 12 App Development Essentials"
} else {
        bookTitle = "Android Studio Development Essentials"
}
```

It is important to note that a value may only be assigned to a constant once. A second attempt to assign a value to a constant will result in a syntax error.

6.7 The Swift Tuple

Before proceeding, now is a good time to introduce the Swift tuple. The tuple is perhaps one of the simplest, yet most powerful features of the Swift programming language. A tuple is, quite simply, a way to temporarily group together multiple values into a single entity. The items stored in a tuple can be of any type and there are no restrictions requiring that those values all be of the same type. A tuple could, for example, be constructed to contain an Int value, a Float value and a String as follows:

```
let myTuple = (10, 432.433, "This is a String")
```

The elements of a tuple can be accessed using a number of different techniques. A specific tuple value can be accessed simply by referencing the index position (with the first value being at index position 0). The code below, for example, extracts the string resource (at index position 2 in the tuple) and assigns it to a new string variable:

```
let myTuple = (10, 432.433, "This is a String")
let myString = myTuple.2
print(myString)
```

Alternatively, all of the values in a tuple may be extracted and assigned to variables or constants in a single statement:

```
let (myInt, myFloat, myString) = myTuple
```

This same technique can be used to extract selected values from a tuple while ignoring others by replacing the values to be ignored with an underscore character. The following code fragment extracts the integer and string values from the tuple and assigns them to variables, but ignores the floating point value:

```
var (myInt, _, myString) = myTuple
```

When creating a tuple it is also possible to assign a name to each value:

```
let myTuple = (count: 10, length: 432.433, message: "This is a String")
```

The names assigned to the values stored in a tuple may then be used to reference those values in code. For example to output the *message* string value from the myTuple instance, the following line of code could be used:

```
print(myTuple.message)
```

Perhaps the most powerful use of tuples is, as will be seen in later chapters, the ability to return multiple values from a function.

6.8 The Swift Optional Type

The Swift optional data type is a new concept that does not exist in most other programming languages. The purpose of the optional type is to provide a safe and consistent approach to handling situations where a variable or constant may not have any value assigned to it.

Variables are declared as being optional by placing a ? character after the type declaration. The following code declares an optional Int variable named index:

```
var index: Int?
```

The variable *index* can now either have an integer value assigned to it, or have nothing assigned to it. Behind the scenes, and as far as the compiler and runtime are concerned, an optional with no value assigned to it actually has a value of nil.

An optional can easily be tested (typically using an if statement) to identify whether or not it has a value assigned to it as follows:

```
var index: Int?

if index != nil {
    // index variable has a value assigned to it
} else {
    // index variable has no value assigned to it
}
```

If an optional has a value assigned to it, that value is said to be “wrapped” within the optional. The value wrapped in an optional may be accessed using a concept referred to as *forced unwrapping*. This simply means that the underlying value is extracted from the optional data type, a procedure that is performed by placing an exclamation mark (!) after the optional name.

To explore this concept of unwrapping optional types in more detail, consider the following code:

```
var index: Int?

index = 3

var treeArray = ["Oak", "Pine", "Yew", "Birch"]

if index != nil {
    print(treeArray[index!])
} else {
    print("index does not contain a value")
}
```

The code simply uses an optional variable to hold the index into an array of strings representing the names of tree types (Swift arrays will be covered in more detail in the chapter entitled *Working with Array and Dictionary Collections in Swift*). If the index optional variable has a value assigned to it, the tree name at that location in the array is printed to the console. Since the index is an optional type, the value has been unwrapped by placing an exclamation mark after the variable name:

```
print(treeArray[index!])
```

Had the index not been unwrapped (in other words the exclamation mark omitted from the above line), the compiler would have issued an error similar to the following:

```
Value of optional type Int? not unwrapped
```

As an alternative to forced unwrapping, the value assigned to an optional may be allocated to a temporary variable or constant using *optional binding*, the syntax for which is as follows:

```
if let constantname = optionalName {

}

if var variablename = optionalName {

}
```

The above constructs perform two tasks. In the first instance, the statement ascertains whether or not the designated optional contains a value. Second, in the event that the optional has a value, that value is assigned to the declared constant or variable and the code within the body of the statement is executed. The previous forced unwrapping example could, therefore, be modified as follows to use optional binding instead:

```
var index: Int?

index = 3

var treeArray = ["Oak", "Pine", "Yew", "Birch"]

if let myvalue = index {
    print(treeArray[myvalue])
} else {
    print("index does not contain a value")
}
```

In this case the value assigned to the index variable is unwrapped and assigned to a temporary constant named *myvalue* which is then used as the index reference into the array. Note that the myvalue constant is described as temporary since it is only available within the scope of the if statement. Once the if statement completes execution, the constant will no longer exist. For this reason, there is no conflict in using the same temporary name as that assigned to the optional. The following is, for example, valid code:

```
.
.
if let index = index {
    print(treeArray[index])
} else {
.
.
```

Optional binding may also be used to unwrap multiple optionals and include a Boolean test condition, the syntax for which is as follows:

```
if let constname1 = optName1, let constname2 = optName2,
     let optName3 = …, <boolean statement> {

}
```

The following code, for example, uses optional binding to unwrap two optionals within a single statement:

```
var pet1: String?
var pet2: String?

pet1 = "cat"
pet2 = "dog"

if let firstPet = pet1, let secondPet = pet2 {
    print(firstPet)
    print(secondPet)
} else {
    print("insufficient pets")
}
```

The code fragment below, on the other hand, also makes use of the Boolean test clause condition:

```
if let firstPet = pet1, let secondPet = pet2, petCount > 1 {
    print(firstPet)
    print(secondPet)
} else {
    print("insufficient pets")
}
```

In the above example, the optional binding will not be attempted unless the value assigned to *petCount* is greater than 1.

It is also possible to declare an optional as being *implicitly unwrapped*. When an optional is declared in this way, the underlying value can be accessed without having to perform forced unwrapping or optional binding. An optional is declared as being implicitly unwrapped by replacing the question mark (?) with an exclamation mark (!) in the declaration. For example:

```
var index: Int! // Optional is now implicitly unwrapped

index = 3

var treeArray = ["Oak", "Pine", "Yew", "Birch"]

if index != nil {
    print(treeArray[index])

} else {
    print("index does not contain a value")
}
```

With the index optional variable now declared as being implicitly unwrapped, it is no longer necessary to unwrap the value when it is used as an index into the array in the above print call.

One final observation with regard to optionals in Swift is that only optional types are able to have no value or a value of nil assigned to them. In Swift it is not, therefore, possible to assign a nil value to a non-optional variable or constant. The following declarations, for instance, will all result in errors from the compiler since none of the variables are declared as optional:

```
var myInt = nil // Invalid code
var myString: String = nil // Invalid Code
let myConstant = nil // Invalid code
```

6.9 Type Casting and Type Checking

When writing Swift code, situations will occur where the compiler is unable to identify the specific type of a value. This is often the case when a value of ambiguous or unexpected type is returned from a method or function call. In this situation it may be necessary to let the compiler know the type of value that your code is expecting or requires using the *as* keyword (a concept referred to as *type casting*).

The following code, for example, lets the compiler know that the value returned from the *object(forKey:)* method needs to be treated as a String type:

```
let myValue = record.object(forKey: "comment") as! String
```

In fact, there are two types of casting which are referred to as *upcasting* and *downcasting*. Upcasting occurs when an object of a particular class is cast to one of its superclasses. Upcasting is performed using the *as* keyword and is also referred to as *guaranteed conversion* since the compiler can tell from the code that the cast will be successful. The UIButton class, for example, is a subclass of the UIControl class as shown in the fragment of the UIKit class hierarchy shown in Figure 6-1:

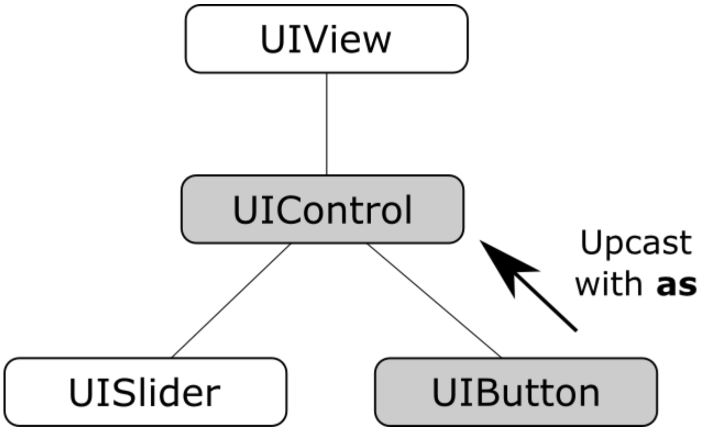


Figure 6-1

Since UIButton is a subclass of UIControl, the object can be safely upcast as follows:

```
let myButton: UIButton = UIButton()

let myControl = myButton as UIControl
```

Downcasting, on the other hand, occurs when a conversion is made from one class to another where there is no guarantee that the cast can be made safely or that an invalid casting attempt will be caught by the compiler. When an invalid cast is made in downcasting and not identified by the compiler it will most likely lead to an error at runtime.

Downcasting usually involves converting from a class to one of its subclasses. Downcasting is performed using the *as!* keyword syntax and is also referred to as *forced conversion*. Consider, for example, the UIKit UIScrollView class which has as subclasses both the UITableView and UITextView classes as shown in Figure 6-2:

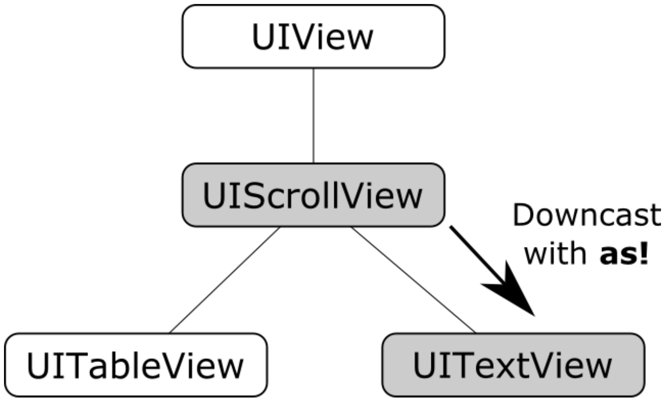


Figure 6-2

In order to convert a UIScrollView object to a UITextView class a downcast operation needs to be performed. The following code attempts to downcast a UIScrollView object to UITextView using the *guaranteed conversion* or *upcast* approach:

```
let myScrollView: UIScrollView = UIScrollView()
let myTextView = myScrollView as UITextView
```

The above code will result in the following error:

```
'UIScrollView' is not convertible to 'UITextView'
```

The compiler is indicating that a UIScrollView instance cannot be safely converted to a UITextView class instance. This does not necessarily mean that it is incorrect to do so, the compiler is simply stating that it cannot guarantee the safety of the conversion for you. The downcast conversion could instead be forced using the *as!* annotation:

```
let myTextView = myScrollView as! UITextView
```

Now the code will compile without an error. As an example of the dangers of downcasting, however, the above code will crash on execution stating that UIScrollView cannot be cast to UITextView. Forced downcasting should, therefore, be used with caution.

A safer approach to downcasting is to perform an optional binding using *as?*. If the conversion is performed successfully, an optional value of the specified type is returned, otherwise the optional value will be nil:

```
if let myTextView = myScrollView as? UITextView {
    print("Type cast to UITextView succeeded")
} else {
    print("Type cast to UITextView failed")
}
```

It is also possible to *type check* a value using the *is* keyword. The following code, for example, checks that a specific object is an instance of a class named MyClass:

```
if myobject is MyClass {
        // myobject is an instance of MyClass
}
```

6.10 **Summary**

This chapter has begun the introduction to Swift by exploring data types together with an overview of how to declare constants and variables. The chapter has also introduced concepts such as type safety, type inference and optionals, each of which is an integral part of Swift programming and designed specifically to make code writing less prone to error.