Start Developing iOS Apps Today

Developer

Contents

Introduction

Setup

Start Developing iOS Apps Today provides the perfect starting point for iOS development. On your Mac, you can create iOS apps that run on iPad, iPhone, and iPod touch. View this guide's four short modules as a gentle introduction to building your first app—including the tools you need and the major concepts and best practices that will ease your path.

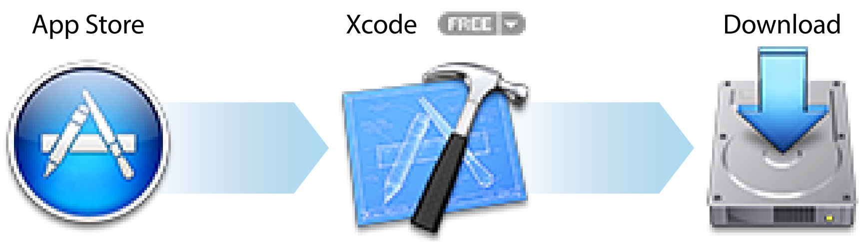
The first three modules each end with a tutorial, where you'll implement what you've learned. At the end of the last tutorial, you'll have created a simple to-do list app.

After you've built your first app in this guide and are considering your next endeavor, read the fourth module. It explores the technologies and frameworks you might consider adopting in your next app. You'll be on your way to keeping your customers engaged and looking forward to the next great thing.

Even though this guide takes you through every step of building a simple app, to benefit most it helps to be acquainted with computer programming in general and with object-oriented programming in particular.

Get the Tools

Before you can start developing great apps, set up a development environment to work in and make sure you have the right tools.



To develop iOS apps, you need:

- A Mac computer running OS X 10.7 (Lion) or later
- Xcode
- iOS SDK

Xcode is Apple's integrated development environment (IDE). Xcode includes a source editor, a graphical user interface editor, and many other features. The iOS SDK extends the Xcode toolset to include the tools, compilers, and frameworks you need specifically for iOS development.

You can download the latest version of Xcode for free from the App Store on your Mac. (The App Store app is installed with OS X version 10.7 and later. If you have an earlier version of OS X, you need to upgrade.) The iOS SDK is included with Xcode.

To download the latest version of Xcode

1. Open the App Store app on your Mac (by default it's in the Dock).
2. In the search field in the top-right corner, type `Xcode` and press the Return key.
3. Click Free FREE.

   Xcode is downloaded into your `/Applications` directory.

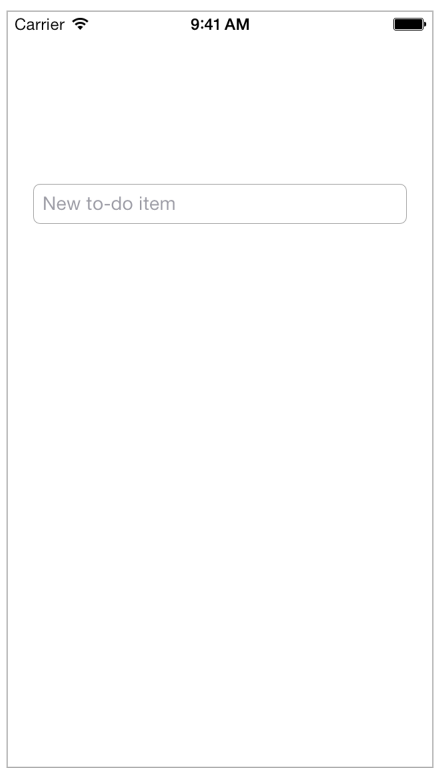
Tutorial: Basics

This tutorial takes you through the basics of what an app is, to the process of creating a simple **user interface**, and on to adding the custom behavior that transforms the interface into a working app.

Follow this tutorial to learn the basics of iOS app development, including:

- How to use Xcode to create and manage a project
- How to identify the key pieces of an Xcode project
- How to add standard user interface elements to your app
- How to build and run your app

After you finish the tutorial, you'll have an app that looks something like this:



To keep things simple, the tutorial project has only an iPhone interface, but you use the exact same tools and techniques to develop an iPad app. This tutorial uses Xcode 5.0 and iOS SDK 7.0.

Create a New Project

To get started developing your app, create a new Xcode project.

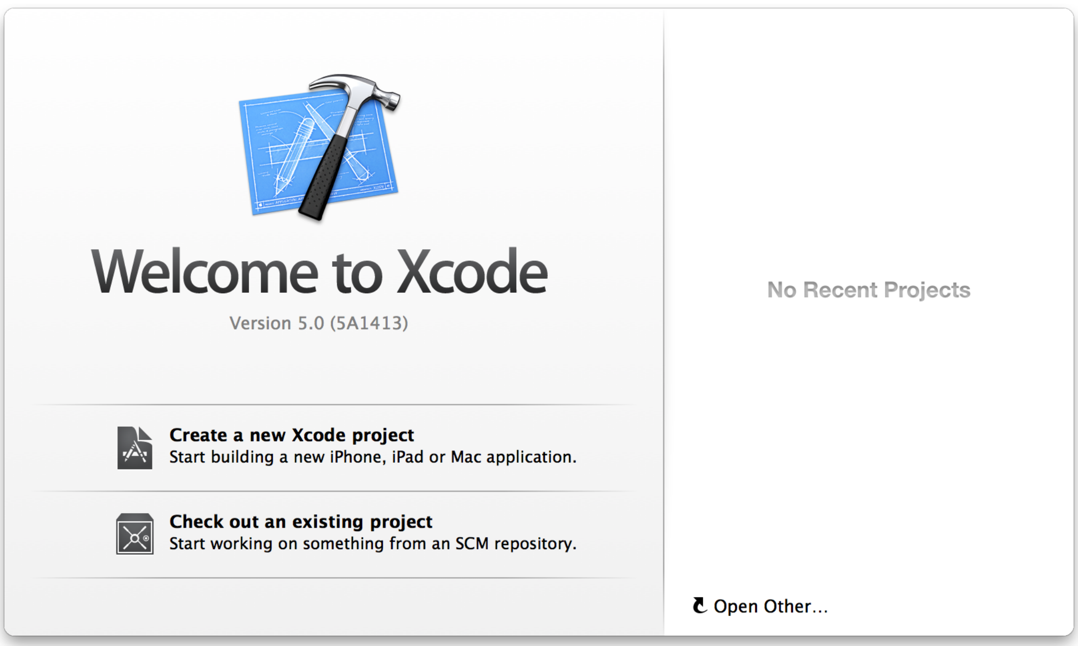
Xcode includes several built-in app **templates** that you can use to develop common styles of iOS apps, such as games, apps with tab-based navigation, and table-view-based apps. Most of these templates have preconfigured interface and source code files for you to start working with. For this tutorial, you'll start with the most basic template: Empty Application.

Working with the Empty Application template will help you understand the basic structure of an iOS app and how content gets onscreen. After you've learned how everything works, you can use one of the other templates for your own app to save yourself some configuration time.

To create a new empty project

1. Open Xcode from the `/Applications` directory.

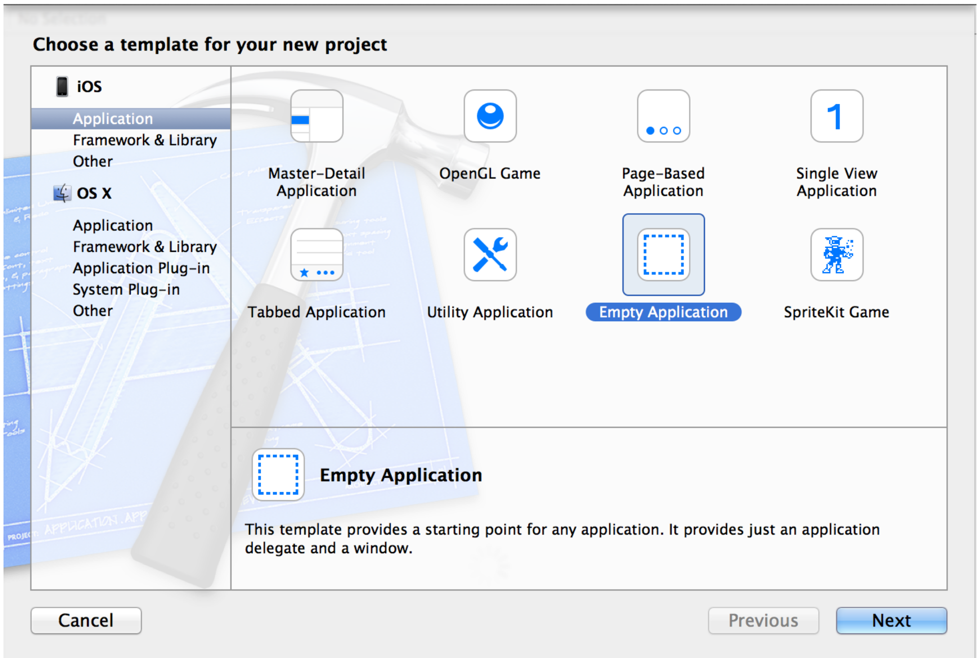
   The Xcode welcome window appears.

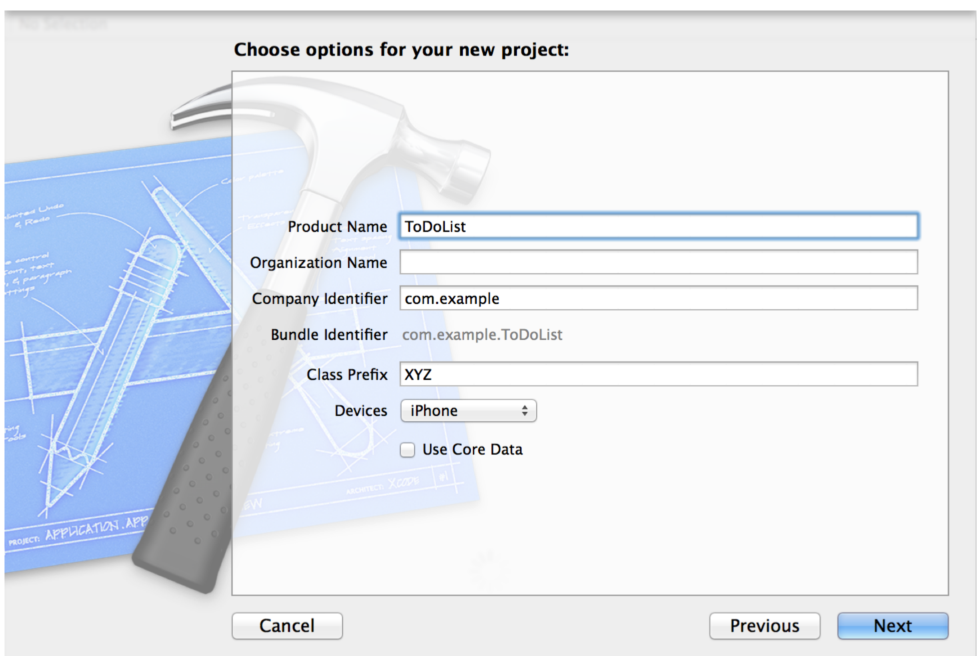
   If a project window appears instead of the welcome window, don't worry—you probably created or opened a project in Xcode previously. Just use the menu item in the next step to create the project.

2. In the welcome window, click "Create a new Xcode project" (or choose File > New > Project).

Xcode opens a new window and displays a dialog in which you can choose a template.



3. In the iOS section at the left of the dialog, select Application.
4. In the main area of the dialog, click Empty Application and then click Next.
5. In the dialog that appears, name your app and choose additional options for your project.



Use the following values:

- Product Name: `ToDoList`

Xcode uses the product name you entered to name your project and the app.

- Company Identifier: Your company identifier, if you have one. If you don't, use `com.example`.
- Class Prefix: `XYZ`

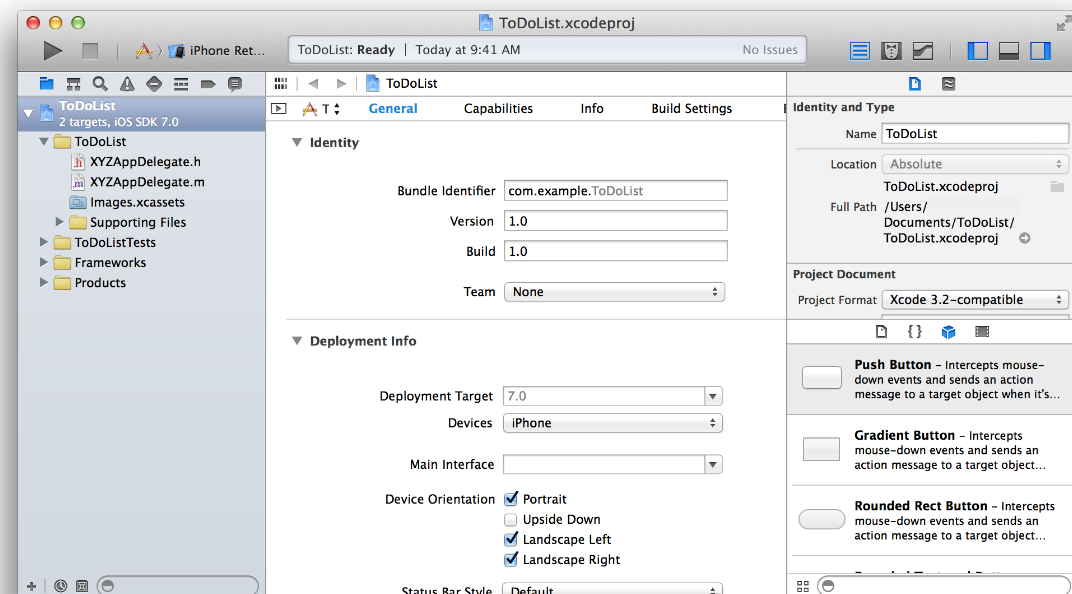
  Xcode uses the class prefix name to name the classes it creates for you. Objective-C classes must be named uniquely within your code and across any frameworks or bundles you might be using. To keep class names unique, the convention is to use prefixes for all classes. Two-letter prefixes are reserved by Apple for use in framework classes, so use something that's three letters or longer.

6. Choose iPhone from the Devices pop-up menu.

   As already mentioned, creating an app with an iPhone interface is the simplest way to start. The techniques used are the same for an iPad or universal app.

7. Click Next.
8. In the dialog that appears, choose a location for your project and click Create.

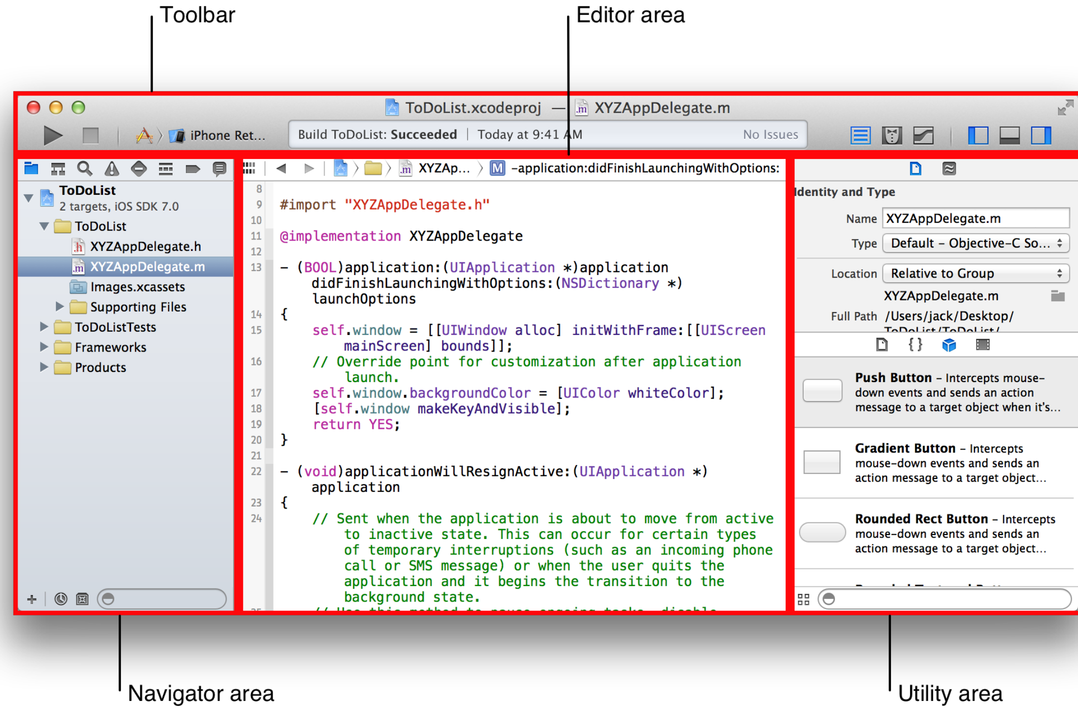
   Xcode opens your new project in a window (called the **workspace window**), which should look similar to this:



Get Familiar with Xcode

Xcode includes everything you need to create an app. It not only organizes the files that go into creating an app, it provides editors for code and interface elements, allows you to build and run your app, and includes a powerful integrated debugger.

Take a few moments to familiarize yourself with the Xcode workspace. You'll use the controls identified in the window below throughout the rest of this tutorial. Click different buttons to get a feel for how they work. If you want more information on part of the interface, read the help articles for it—you find them by Control-clicking an area of Xcode and choosing the article from the shortcut menu that appears.



Run iOS Simulator

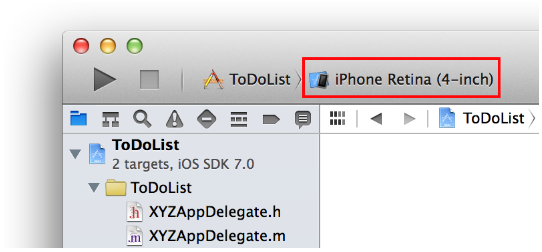
Because you based your project on an Xcode template, the basic app environment is automatically set up for you. Even though you haven't written any code, you can build and run the Empty Application template without any additional configuration.

To build and run your app, you can use the **iOS Simulator** app that's included in Xcode. As its name implies, iOS Simulator gives you an idea of how your app would look and behave if it were running on an iOS device.

iOS Simulator can model a number of different types of hardware—iPad, iPhone with different screen sizes, and so on. As a result, you can simulate your app on every device you're developing for. In this tutorial, use the iPhone Retina (4-inch) option.

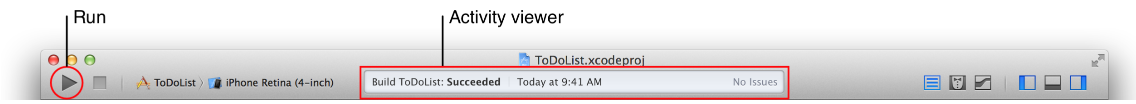
To run your app in iOS Simulator

1. Choose iPhone Retina (4-inch) from the Scheme pop-up menu in the Xcode toolbar.



   Go ahead and look through the menu to see what other hardware options are available in iOS Simulator.

2. Click the Run button, located in the top-left corner of the Xcode toolbar.



   Alternatively, you can choose Product > Run (or press Command-R).

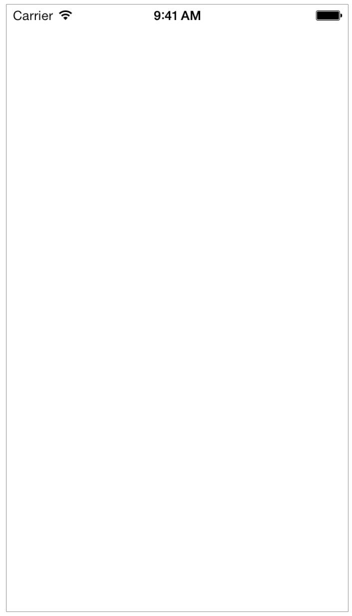
   If this is the first time you're running an app, Xcode asks whether you'd like to enable developer mode on your Mac. Developer mode allows Xcode access to certain debugging features without requiring you to enter your password each time. Decide whether you'd like to enable developer mode and follow the prompts. If you choose not to enable it, you may be asked for your password later on. The tutorials assume developer mode is enabled.

3. Watch the Xcode toolbar as the build process completes.

   Xcode displays messages about the build process in the **activity viewer**, which is in the middle of the toolbar.

After Xcode finishes building your project, iOS Simulator starts automatically. It may take a few moments to start up the first time.

iOS Simulator opens in iPhone mode, just as you specified. On the simulated iPhone screen, iOS Simulator opens your app.



As the name Empty Application implies, the template doesn't do much—it just displays a white screen. Other templates have more complex behavior. It's important to understand a template's uses before you extend it to make your own app. Running the template with no modifications is a good way to start developing that understanding.

After you've explored the app, quit iOS Simulator by choosing iOS Simulator > Quit iOS Simulator (or pressing Command-Q).

Review the Source Code

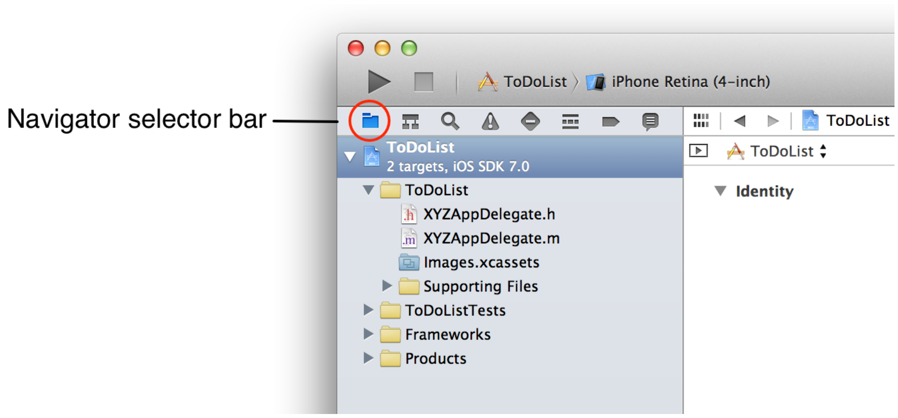
The Empty Application template comes with a few existing source code files that set up the app environment. Most of the work is done by the `UIApplicationMain` function, which is automatically called in your project's `main.m` source file. The `UIApplicationMain` function creates an application object that sets up the infrastructure for your app to work with the iOS system. This includes creating a **run loop** that delivers input events to your app.

You won't be dealing with the `main.m` source file directly, but it's interesting to understand how it works.

To look at the main.m source file

1. Make sure the project navigator is open in the navigator area.

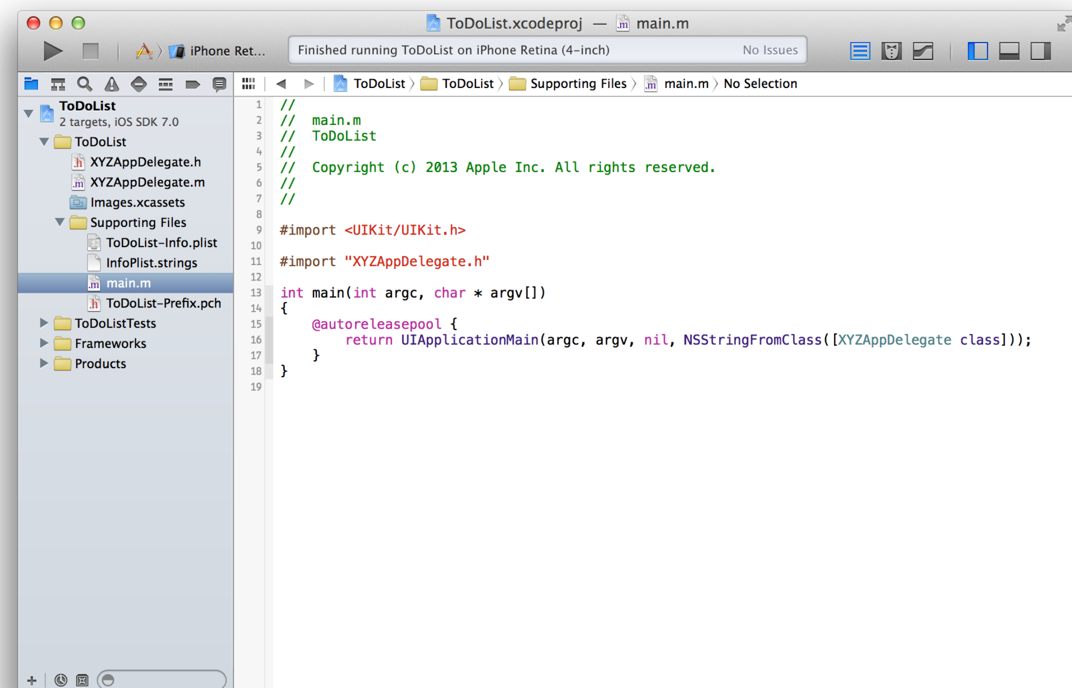
The **project navigator** displays all the files in your project. If the project navigator isn't open, click the leftmost button in the navigator selector bar.



2. Open the Supporting Files folder in the project navigator by clicking the disclosure triangle next to it.

3. Select `main.m`.

   Xcode opens the source file in the main editor area of the window, which looks similar to this:



   If you double-clicked the file, you'll notice that it opened in a separate window. You can choose to have a file open in the main project window by clicking it once, or you can open it in a separate window by double-clicking it.

The `main` function in `main.m` calls the `UIApplicationMain` function within an autorelease pool.

```
@autoreleasepool {
    return UIApplicationMain(argc, argv, nil, NSStringFromClass([HelloWorldAppDelegate
  class]));
}
```

The `@autoreleasepool` statement is there to support memory management for your app. Automatic Reference Counting (ARC) makes memory management straightforward by getting the compiler to do the work of keeping track of who owns an object; `@autoreleasepool` is part of the memory management infrastructure.

The call to `UIApplicationMain` creates two important initial components of your app:

- An instance of the `UIApplication` class, called the **application object**.

  The application object manages the app event loop and coordinates other high-level app behaviors. This class, defined in the UIKit framework, doesn't require you to write any additional code to get it to do its job.

- An instance of the `XYZAppDelegate` class, called the **app delegate**.

  Xcode created this class for you as part of setting up the Empty Application template. The app delegate creates the window where your app's content is drawn and provides a place to respond to state transitions within the app. This window is where you write your custom app-level code. Like all classes, the `XYZAppDelegate` class is defined in two source code files in your app: in the interface file, `XYZAppDelegate.h`, and in the implementation file, `XYZAppDelegate.m`.

Here's how the application object and app delegate interact. As your app starts up, the application object calls defined methods on the app delegate to give your custom code a chance to do its job—that's where the interesting behavior for an app is executed. To understand the role of the app delegate in more depth, view your app delegate source files, starting with the interface file. To view the app delegate interface file, select `XYZAppDelegate.h` in the project navigator. The app delegate interface contains a single property: `window`. With this property the app delegate keeps track of the window in which all of your app content is drawn.

Next, view the app delegate implementation file. To do this, select `XYZAppDelegate.m` in the project navigator. The app delegate implementation contains "skeletons" of important methods. These predefined methods allow the application object to talk to the app delegate. During a significant runtime event—for example, app launch, low-memory warnings, and app termination—the application object calls the corresponding method in the app delegate, giving it an opportunity to respond appropriately. You don't need to do anything special to make sure these methods get called at the correct time—the application object handles that part of the job for you.

Each of these automatically implemented methods has a default behavior. If you leave the skeleton implementation empty or delete it from your `XYZAppDelegate.m` file, you get the default behavior whenever that method is called. Use these skeletons to put additional custom code that you want to be executed when the methods are called. For example, the first method in the `XYZAppDelegate.m` file contains some lines of code that set up the app window and give it the white background color you saw when you ran your app for the first time. In this tutorial, you won't be using any custom app delegate code, so go ahead and remove the code that sets the window to have a plain white background.

To configure the app delegate implementation file

1. Find the `application:didFinishLaunchingWithOptions:` method in `XYZAppDelegate.m`.

   It is the first method in the file.

2. Delete the first three lines of code from that method so it looks just like this:

```
- (BOOL)application:(UIApplication *)application
didFinishLaunchingWithOptions:(NSDictionary *)launchOptions
{
    return YES;
}
```

Xcode automatically saves the changes. Xcode continuously tracks and saves all of your work. (You can undo your changes by choosing Edit > Undo Typing.)

Create a Storyboard

At this point, you're ready to create a storyboard for your app. A **storyboard** is a visual representation of the app's user interface, showing screens of content and the transitions between them. You use storyboards to lay out the flow—or story—that drives your app.

To see how a storyboard fits into an app, in this tutorial you create one manually and add it to your app. Unlike the Empty Application template you started with, other Xcode templates include preconfigured storyboards providing views, view controllers, and associated source code files that set up the basic architecture for an app of that type. After you've configured a storyboard manually, you'll see how the pieces fit together. Then you'll be able to start with a project template that comes with a preconfigured storyboard, which will save you some overhead.

To create a new storyboard

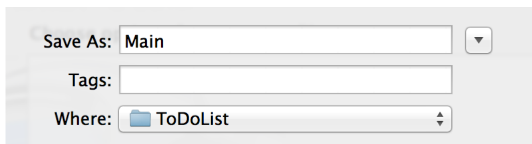
1. Choose File > New > File (or press Command-N).

A dialog appears that prompts you to choose a template for your new file.

2. On the left, select User Interface under iOS.
3. Click Storyboard, and click Next.
4. For the Devices option, select iPhone.
5. Click Next.

   A dialog appears that prompts you to choose a location and name for your new storyboard.

6. In the Save As field, name the file `Main`.
7. Make sure the file is saved in the same directory as your project.



8. For the Group option, select ToDoList.
9. For Targets, select the checkbox next to ToDoList.

   This option tells Xcode to include the new storyboard when it builds your app.

10. Click Create.

A new storyboard file is created and added to your project. You'll work in this file to lay out the content of your app.

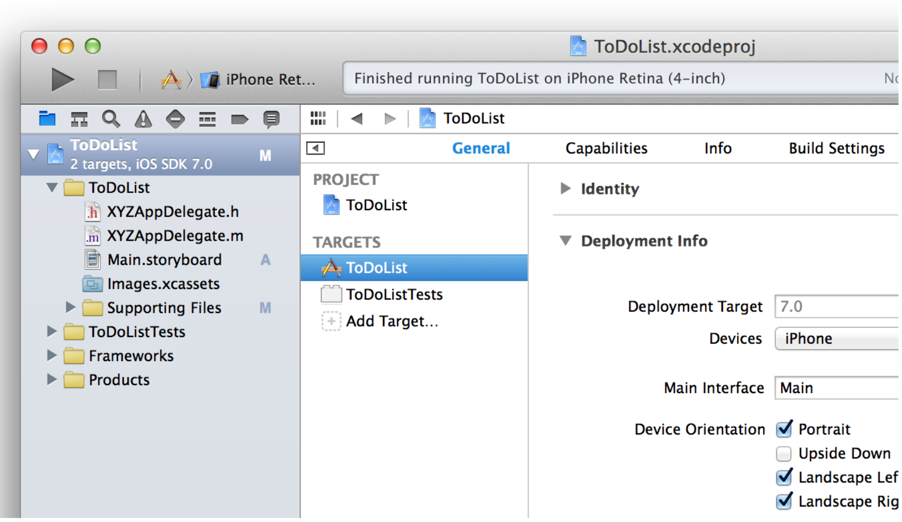
Now you need to tell Xcode that you want to use this storyboard as the interface to your app. When it starts up, the application object checks whether the app has a main interface configured. If it does, the application object loads the defined storyboard when the app launches.

To set the storyboard as the app's main interface

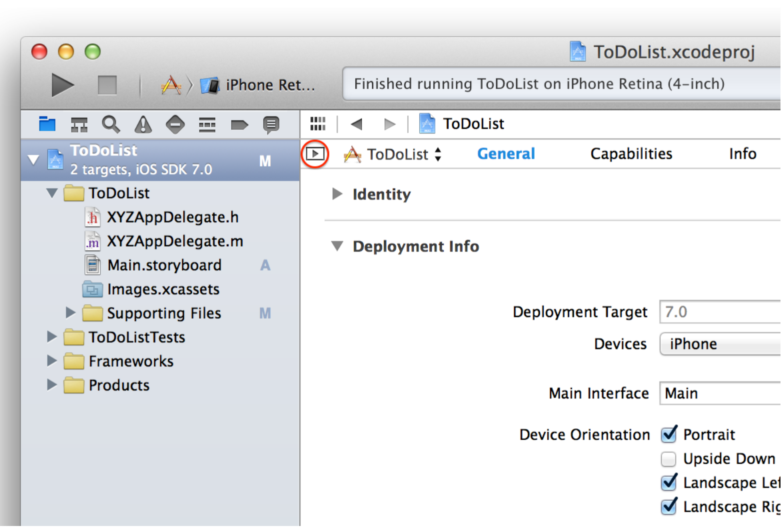
1. In the project navigator, select your project.

   In the editor area of the workspace window, Xcode displays the project editor, which allows you to view and edit details about how your app is built.

2. Under Targets, select ToDoList.



If the Project and Targets lists don't appear in the project editor, click the disclosure triangle in the top-left corner of the editor pane to reveal the lists.



3. Select the General tab.

4. Under Deployment Info, find the Main Interface option.

5. Select your storyboard, `Main.storyboard`.

Add a Scene to Your Storyboard

Now that you have a storyboard, it's time to start adding app content. Xcode provides a library of objects that you can add to a storyboard file. Some of these are user interface elements that belong in a view, such as buttons and text fields. Others define the behavior of your app but don't themselves appear onscreen, such as view controllers and gesture recognizers.

To start, you'll add a view controller to your storyboard. A view controller manages a corresponding view and its subviews. You'll learn more about the roles of views and view controllers in the next chapter, "App Development Process" (page 30).

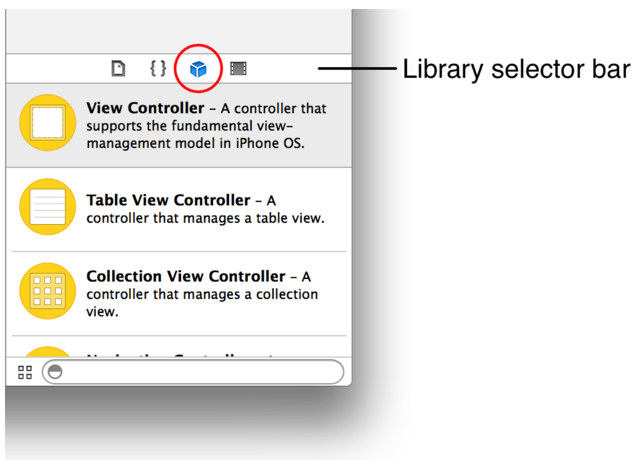
To add a view controller to your storyboard

1. In the project navigator, select `Main.storyboard`.

   Xcode opens the storyboard in **Interface Builder**—its visual interface editor—in the editor area. Because the storyboard is empty, what you see is a blank **canvas**. You use the canvas to add and arrange user interface elements.

2. Open the Object library.

   The **Object library** appears at the bottom of the utility area. If you don't see the Object library, you can click its button, which is the third button from the left in the library selector bar. (If you don't see the utility area, you can display it by choosing View > Utilities > Show Utilities.)



   A list appears showing each object's name, description, and visual representation.

3. Drag a View Controller object from the list to the canvas.

   If you can't find the object titled View Controller in the Object library, filter the list of objects by typing in the text field below the list. Type `View Controller`, and you see only view controller objects in the filtered list.

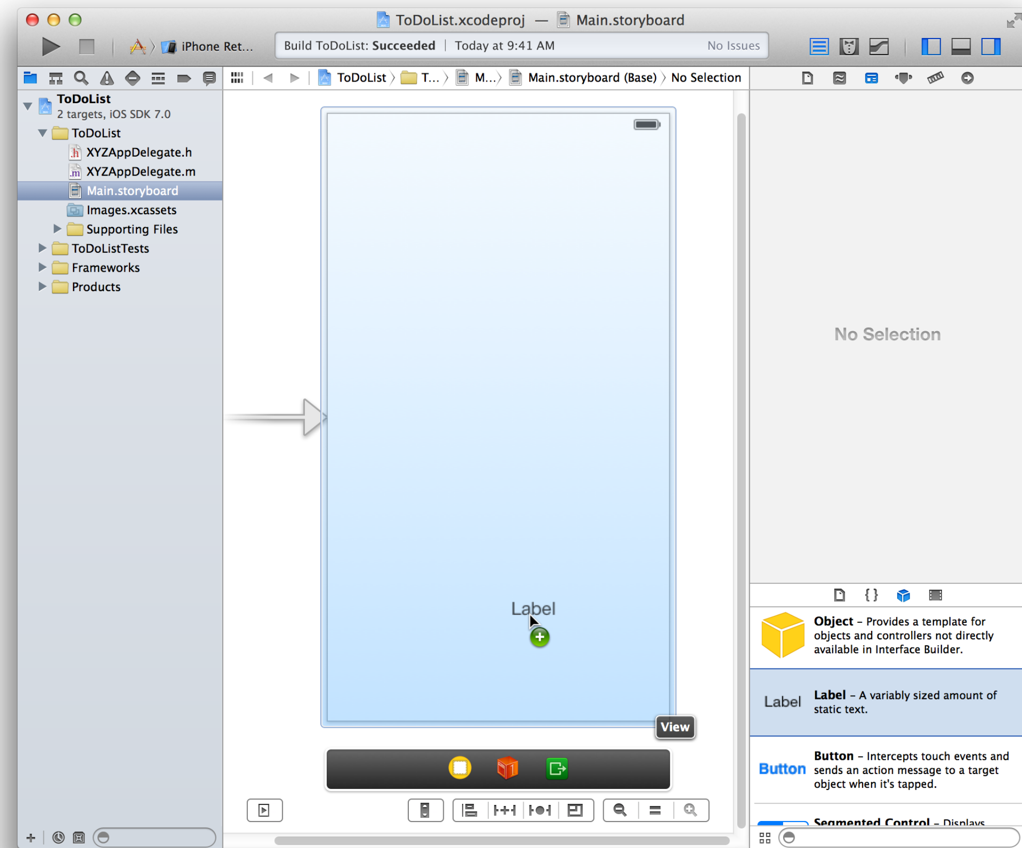
At this point, the storyboard in your app contains one **scene**. The arrow that points to the left side of the scene on the canvas is the **initial scene indicator**, which means that this scene is loaded first when the app starts. Right now, the scene that you see on the canvas contains a single view that's managed by a view controller. If you run your app in iOS Simulator, this view is what you see on the device screen. It's useful to run your app in iOS Simulator to verify that everything is configured correctly. Before doing that, add something to the scene that you'll be able to see when you run the app.

To add a label to your scene

1. In the Object library, find the Label object.

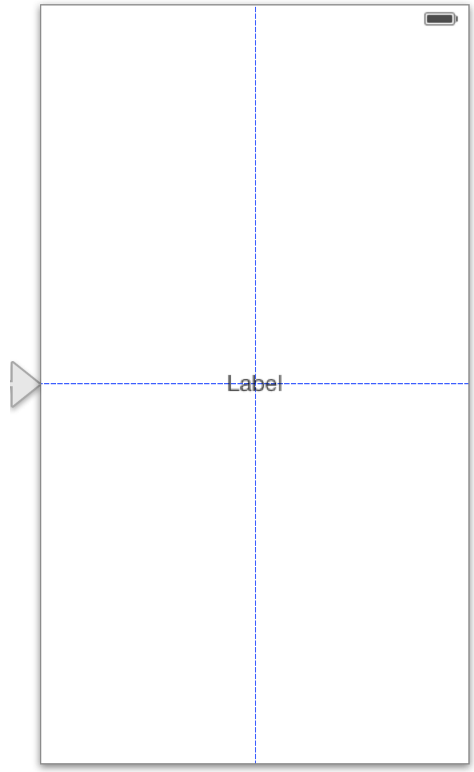
   If you entered text in the filter text field, you may need to clear its contents before you can see the Label object. You can also type `Label` in the filter field to find the Label object quickly.

2. Drag a Label object from the list to your scene.



3. Drag the label to the center of the scene until horizontal and vertical guides appear.

Stop dragging the label when you see something like this:



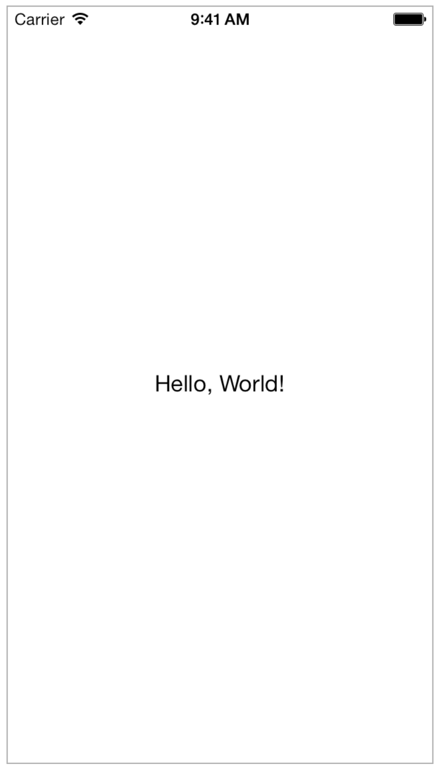
The guides mean that the label is now centered horizontally and vertically. (The guides are visible only when you're dragging or resizing objects next to them, so they will disappear when you let go of the label.)

4. Double-click the text of the label to select it for editing.
5. Type `Hello, World!` and press Return.

   If necessary, recenter the label.

Test Your Changes

Running your app in iOS Simulator is a great way to periodically check that everything is working the way you expect. At this point your app should launch and load the scene you created in your main storyboard. Click the Run button in Xcode. You should see something like this:



If you don't see the label you added, make sure the storyboard you created is configured as the main interface for your app and make sure you've removed the code that creates the empty white window in the app delegate. If necessary, go back and repeat the steps for those sections.

This is also a good time to experiment with what you can add to an interface. Explore Interface Builder by changing:

- The text of the label
- The font size of the label
- The color of the text

Build the Basic Interface

Now that you can put content in a scene, it's time to build the basic interface for the scene that lets you add a new item to the to-do list.

To add an item to the to-do list, you need a single piece of information: the item name. You get this information from a text field. A text field is the interface element that lets a user input a single line of text using a keyboard. But first, you need to remove the label you added earlier.

To remove the label from your scene

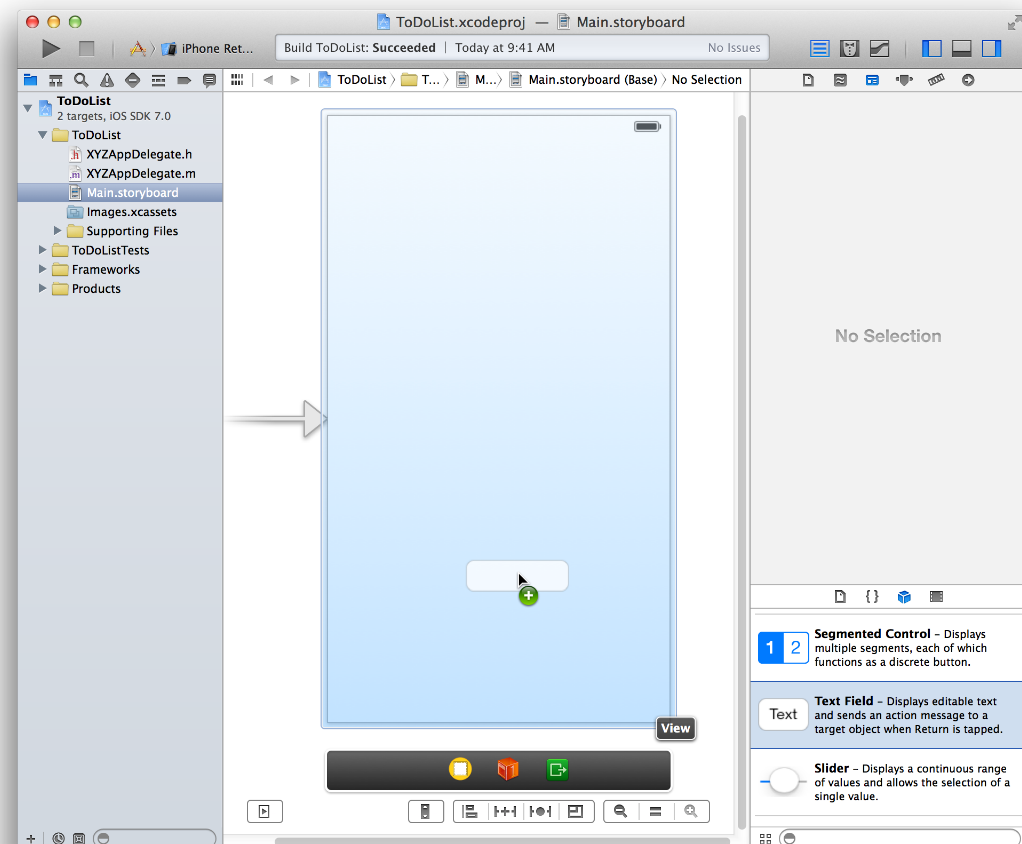
1. Click the label to select it.
2. Press the Delete key.

   The label is removed from the scene. If this wasn't what you wanted, you can choose Edit > Undo Delete Label. (Every editor has an Edit > Undo command to undo the last action.)

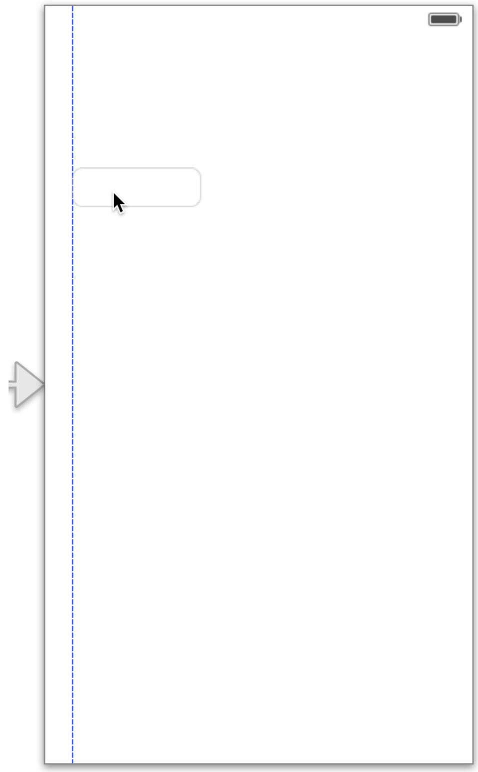
Now that you again have a blank canvas, create the scene for adding a to-do item.

To add a text field to your scene

1. If necessary, open the Object library.
2. Drag a Text Field object from the list to your scene.

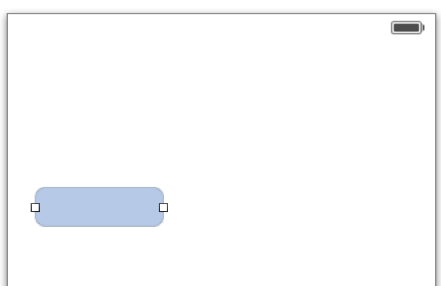


3. Drag the text field so that it's positioned about two-thirds from the bottom of the screen.



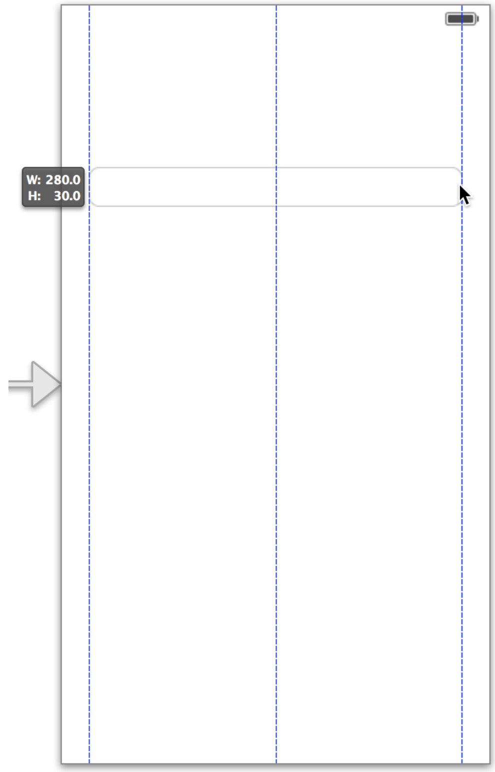
4. If necessary, click the text field to reveal the resize handles.

   You resize a UI element by dragging its **resize handles**, which are small white squares that appear on the element's borders. You reveal an element's resize handles by selecting it. In this case, the text field should already be selected because you just stopped dragging it. If your text field looks like the one below, you're ready to resize it; if it doesn't, select it on the canvas.



5. Resize the left and right edges of the text field until you see vertical guides appear.

Stop resizing the text field when you see something like this:

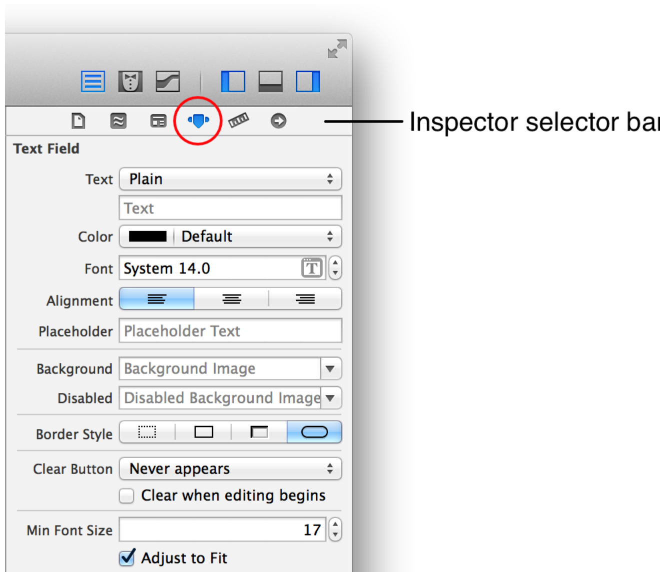


Although you have the text field in your scene, there's no instruction to the user about what to enter in the field. Use the text field's placeholder text to prompt the user to enter the name of a new to-do item.

To configure the text field's placeholder text

1. With the text field selected, open the Attributes inspector in the utility area.

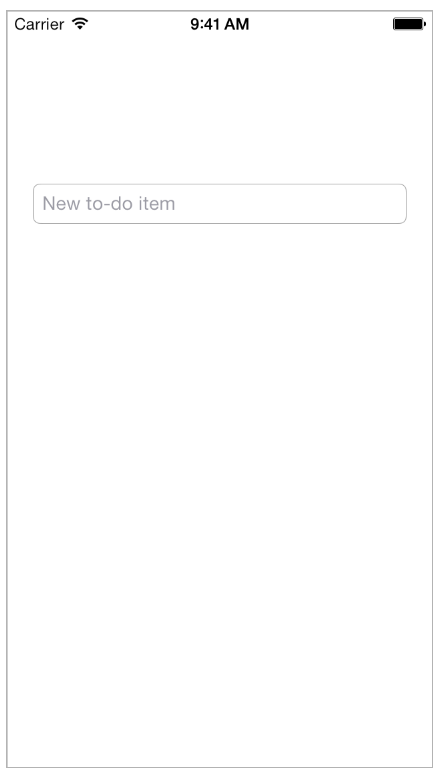
The **Attributes inspector** appears when you select the fourth button from the left in the inspector selector bar. It lets you edit the properties of an object in your storyboard.



2. In the Attributes inspector, find the field labeled Placeholder and type `New to-do item`.

   To display the new placeholder text in the text field, press Return.

Checkpoint: Run your app in iOS Simulator to make sure that the scene you created looks the way you expect it to. You should be able to click inside the text field and enter a string using the keyboard.



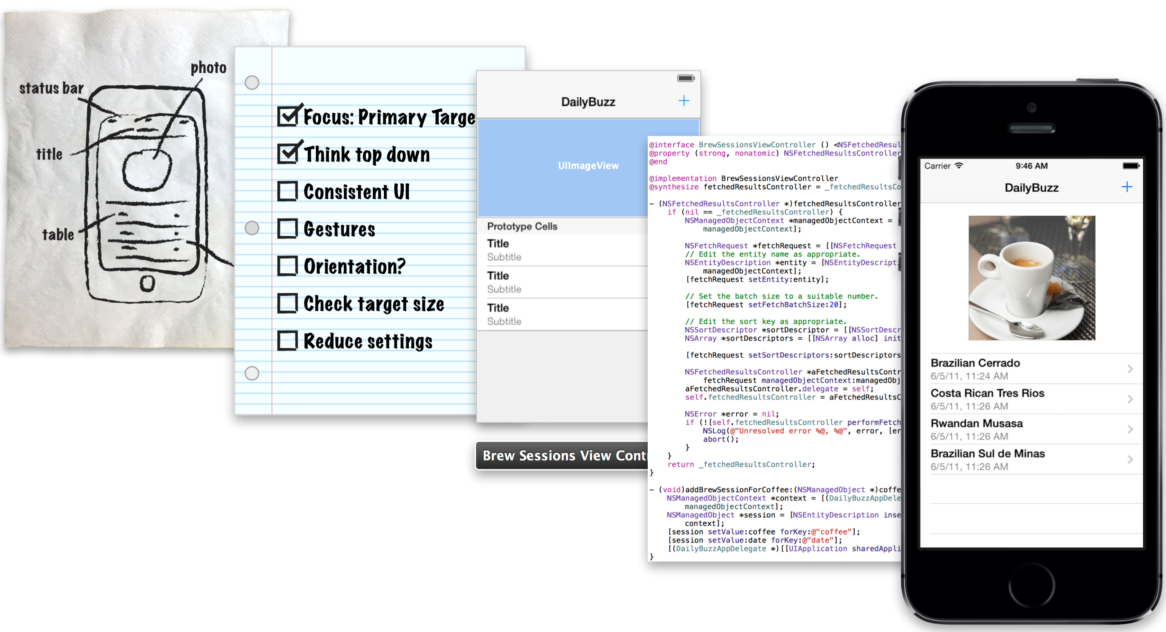
Recap

You're now well on your way to being able to create a basic interface using storyboards. In the remaining tutorials, you'll learn more about adding interaction to your interface and writing code to create custom behavior. The chapters between the tutorials guide you through the concepts that you'll put into practice while working on your app.

Structuring an App

App Development Process

Although the task of developing an app may seem daunting, the process can be distilled into several digestible steps. The steps that follow will help you get started and guide you in the right direction as you develop your first app.



Defining the Concept

Every great app starts with a concept.

The best way to arrive at that concept is to consider the problem you want your app to solve. Great apps solve a single, well-defined problem. For example, the Settings app allows users to adjust all of the settings on their device. It provides a single interface for users to accomplish a related set of tasks.

Here are some key questions to consider when arriving at a concept:

Who is your audience? Your app content and experience will differ depending on whether you're writing a children's game, a to-do list app, or even a test app for your own learning.

What is the purpose of your app? It's important for an app to have a clearly defined purpose. Part of defining the purpose is understanding what one thing will motivate users to use your app.

What problem is your app trying to solve? An app should solve a single problem well instead of trying to offer solutions to multiple distinct problems. If you find that your app is trying to solve unrelated problems, you might consider writing multiple apps.

What content will your app incorporate? Consider what type of content your app will present to users and how they'll interact with it. Design the user interface to complement the type of content that's presented in the app.

An app concept doesn't have to be completely polished or finished when you start developing your app. Still, it helps to have an idea of where you're going and what you need to do to get there.

Designing a User Interface

After you have a concept for your app, designing a good user interface is the next step to creating a successful app. A user needs to be able to interact with the app interface in the simplest way possible. Design the interface with the user in mind, and make it efficient, clear, and straightforward.

Perhaps the most challenging thing about building a user interface is translating your concept into a design and then implementing that design. To help simplify this process, use storyboards. **Storyboards** let you design and implement your interface in a single step using a graphical environment. You can see exactly what you're building while you're building it, get immediate feedback about what's working and what's not, and make instantly visible changes to your interface.

When you build an interface in a storyboard, you're working with views. **Views** display content to the user. In "Tutorial: Basics" (page 8), you began to define a user interface for the ToDoList app using a single view in a storyboard scene. As you develop more complex apps, you'll create interfaces with more scenes and more views.

In "Tutorial: Storyboards" (page 47), you'll finish building the user interface for your ToDoList app using several different views to display different types of content. You'll learn more about working with views and storyboards to design and create a user interface in "Designing a User Interface" (page 36).

Defining the Interaction

A user interface doesn't do much without any logic backing it. After you've created an interface, you define how users can interact with what they see by writing code to respond to user actions in your interface.

Before you start thinking about adding the behaviors for your interface, it's important to understand that iOS apps are based on event-driven programming. In **event-driven programming**, the flow of the app is determined by events: system events or user actions. The user performs actions on the interface, which trigger events in the app. These events result in the execution of the app's logic and manipulation of its data. The app's response to user action is then reflected back in the interface.

As you define how a user can interact with your interface, keep event-driven programming in mind. Because the user, rather than the developer, is in control of when certain pieces of the app code get executed, you want to identify exactly which actions a user can perform and what happens in response to those actions.

You define much of your event-handling logic in **view controllers**. You'll learn more about working with view controllers in "Defining the Interaction" (page 42). Afterward, you'll apply these concepts to add functionality and interactivity to your ToDoList app in "Tutorial: Storyboards" (page 47).

Implementing the Behavior

After you've defined the actions a user can perform in your app, you implement the behavior by writing code.

When you write code for iOS apps, most of your time is spent working with the **Objective-C programming language**. You'll learn more about Objective-C in the third module, but for now, it helps to have some basic familiarity with the vocabulary of the language.

Objective-C is built on top of the C programming language and provides object-oriented capabilities and a dynamic runtime. You get all of the familiar elements, such as primitive types (`int`, `float`, and so on), structures, functions, pointers, and control flow constructs (`while`, `if...else`, and `for` statements). You also have access to the standard C library routines, such as those declared in `stdlib.h` and `stdio.h`.

Objects Are Building Blocks for Apps

When you build an iOS app, most of your time is spent working with objects.

Objects package data with related behavior. You can think of an app as a large ecosystem of interconnected objects that communicate with each other to solve specific problems, such as displaying a visual interface, responding to user input, or storing information. You use many different types of objects to build your app, ranging from interface elements, such as buttons and labels, to data objects, such as strings and arrays.

Classes Are Blueprints for Objects

A **class** describes the behavior and properties common to any particular type of object.

In the same way that multiple buildings constructed from the same blueprint are identical in structure, every instance of a class shares the same properties and behavior as all other instances of that class. You can write your own classes or use framework classes that have been defined for you.

You make an object by creating an **instance** of a particular class. You do this by allocating it and initializing it with acceptable default values. When you **allocate** an object, you set aside enough memory for the object and set all instance variables to zero. **Initialization** sets an object's initial state—that is, its instance variables and properties—to reasonable values and then returns the object. The purpose of initialization is to return a usable object. You need to both allocate and initialize an object to be able to use it.

One of the fundamental concepts in Objective-C programming is **class inheritance**, the idea that a class inherits behaviors from a parent class. When one class inherits from another, the child—or **subclass**—inherits all the behavior and properties defined by the parent. The subclass can define its own additional behavior and properties or override the behavior of the parent. This gives you the ability to extend the behaviors of a class without duplicating its existing behavior.

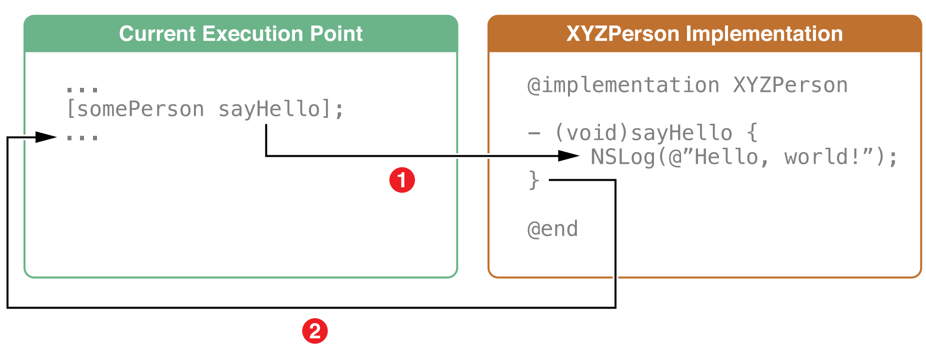
Objects Communicate Through Messages

Objects interact by sending each other messages at runtime. In Objective-C terms, one object **sends a message** to another object by **calling a method** on that object.

Although there are several ways to send messages between objects in Objective-C, by far the most common is the basic syntax that uses square brackets. If you have an object `somePerson` of class `Person`, you can send it the `sayHello` message like this:

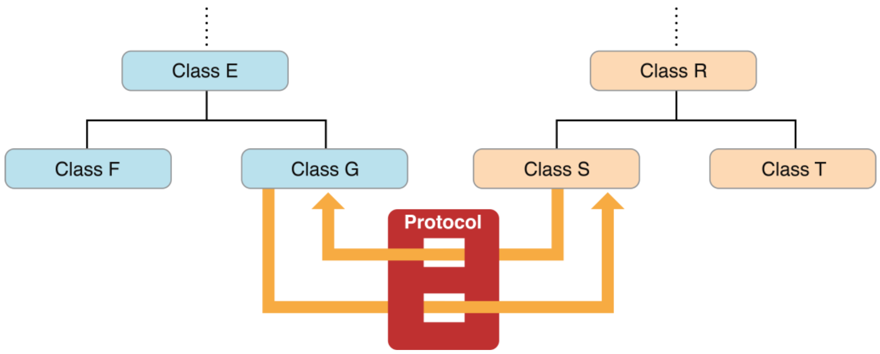
```
[somePerson sayHello];
```

The reference on the left, `somePerson`, is the receiver of the message. The message on the right, `sayHello`, is the name of the method to call on that receiver. In other words, when the above line of code is executed, `somePerson` will be sent the `sayHello` message.



Protocols Define Messaging Contracts

A **protocol** defines a set of behavior that's expected of an object in a given situation. A protocol comes in the form of a programmatic interface, one that any class may choose to implement. Using protocols, two classes distantly related by inheritance can communicate with each other to accomplish a certain goal, such as parsing XML code or copying an object.



Any class that can provide behavior that's useful to other classes can declare a programmatic interface for vending that behavior anonymously. Any other class can choose to adopt the protocol and implement one or more of its methods, making use of the behavior.

Incorporating the Data

After you implement your app's behavior, you create a **data model** to support your app's interface. An app's data model defines the way you maintain data in your app. Data models can range from a basic dictionary of objects to complex databases.

Your app's data model should reflect the app's content and purpose. There should be a clear correlation between the interface and the data, even though the user doesn't interact with the data directly.

A good data model is essential to creating a solid foundation for your app. It makes it easier to build a scalable app, improve functionality, and make changes to your features. You'll learn more about defining your own data model in "Incorporating the Data" (page 70).

Use the Right Resources

Design patterns are best practices for solving common problems in apps. Use design patterns to help you define the structure of your data model and its interaction with the rest of your app. When you understand and use the right design patterns, you can more easily create an app that's simple and efficient. You'll learn more about design patterns in "Using Design Patterns" (page 72).

As you start implementing your model, remember that you don’t have to implement everything from scratch. There are a number of **frameworks** that provide existing functionality for you to build upon. For instance, the **Foundation framework** includes classes representing basic data types—such as strings and numbers—as well as collection classes for storing other objects. It’s recommended that, where possible, you use existing framework classes—or subclass them to add your own app’s features—instead of trying to reimplement their functionality. In this way, you can create an efficient, functional, sophisticated app. You’ll learn more about the capabilities of the Foundation framework in “Working with Foundation” (page 75).

Often, you’ll write your own **custom classes** as part of your data model. Writing a custom class gives you control over how you organize the internal structure of your app. You’ll learn about creating custom classes in “Writing a Custom Class” (page 86).

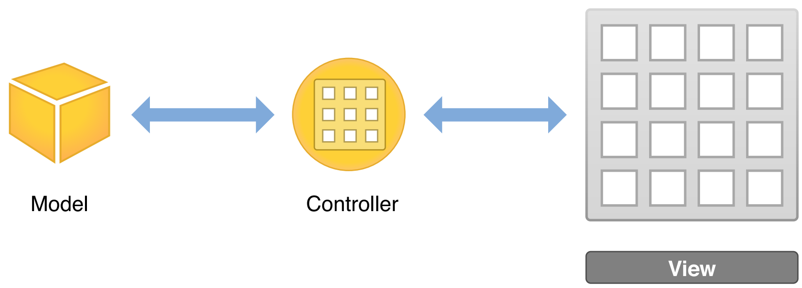
Incorporate Real Data

When you first test your data model, you may want to use static or fake data. This way, you don’t have to worry about supplying real data until you know the model is assembled and connected properly. After you’ve defined a data model that’s working properly, you can pull real data into your app.

The remainder of this guide takes you through these steps in more detail. As you make your way through the app development process, you’ll learn the necessary conceptual material and then put it to use in the tutorials.

Designing a User Interface

Views are the building blocks for constructing your user interface. It's important to understand how to use views to present your content in a clear, elegant, and useful way. Creating a great user interface that effectively showcases your app's content is essential to building a successful app. In this chapter, you'll learn about creating and managing views in a storyboard to define your interface.



The View Hierarchy

Views not only display themselves onscreen and react to user input, they also serve as containers for other views. As a result, views in an app are arranged in a hierarchical structure called the view hierarchy. The **view hierarchy** defines the layout of views relative to other views. Within that hierarchy, view instances enclosed within a view are called **subviews**, and the parent view that encloses a view is referred to as its **superview**. Even though a view instance can have multiple subviews, it can have only one superview.

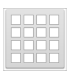
At the top of the view hierarchy is the **window** object. Represented by an instance of the `UIWindow` class, a window serves as the basic container into which you can add your view objects for display onscreen. By itself, a window doesn't display any content. To display content, you add a **content view** (with its hierarchy of subviews) to the window.

For a content view and its subviews to be visible to the user, the content view must be inserted into a window's view hierarchy. When you use a storyboard, this placement is configured automatically for you. The application object loads the storyboard, creates instances of the relevant view controller classes, unarchives the content view hierarchies for each view controller, and then adds the content view of the initial view controller into the window. You'll learn more about managing view controllers in the next chapter; for now, you'll focus on creating a hierarchy within a single view controller in your storyboard.

Building an Interface Using Views

When you design your app, it's important to know what kind of view to use for what purpose. For example, the kind of view you use to gather input text from a user, such as a text field, is different from what you might use to display static text, such as a label. Apps that use UIKit views for drawing are easy to create because you can assemble a basic interface quickly. A UIKit view object is an instance of the `UIView` class or one of its subclasses. The UIKit framework provides many types of views to help present and organize data.

Although each view has its own specific function, UIKit views can be grouped into seven general categories:

Category	Purpose	Examples
 Content	Display a particular type of content, such as an image or text.	Image view, label
 Collections	Display collections or groups of views.	Collection view, table view
 Controls	Perform actions or display information.	Button, slider, switch
 Bars	Navigate, or perform actions.	Toolbar, navigation bar, tab bar
 Input	Receive user input text.	Search bar, text view
 Containers	Serve as containers for other views.	View, scroll view
Modal	Interrupt the regular flow of the app to allow a user perform some kind of action.	Action sheet, alert view

You can assemble views graphically using Interface Builder. **Interface Builder** provides a library of the standard views, controls, and other objects that you need to build your interface. After dragging these objects from the library, you drop them onto the canvas and arrange them in any way you want. Next, use inspectors to configure those objects before saving them in a storyboard. You see the results immediately, without the need to write code, build, and run your app.

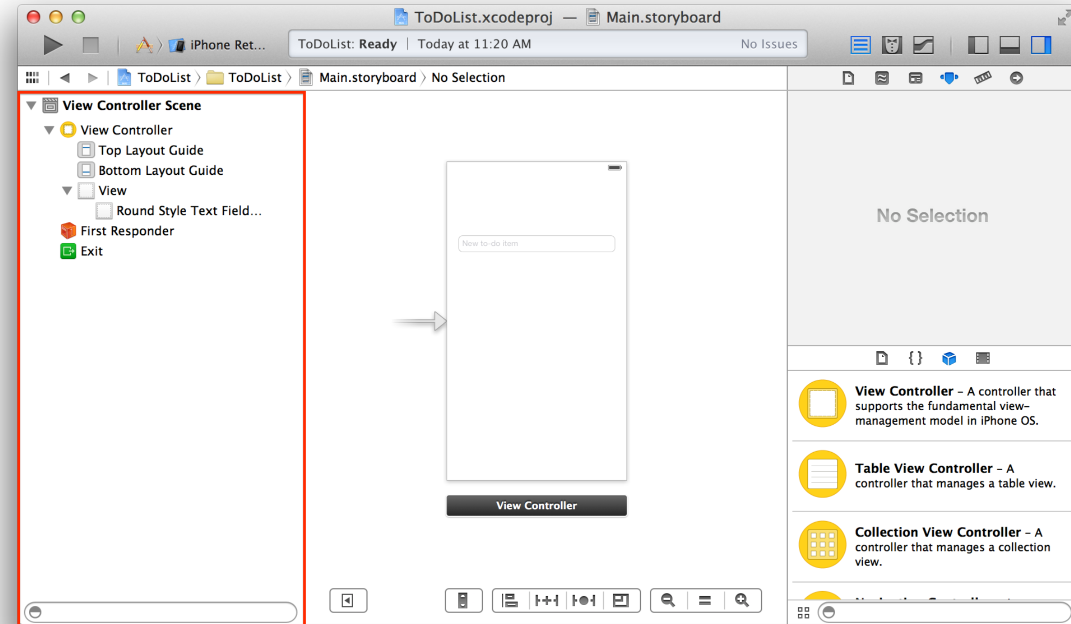
The UIKit framework provides standard views for presenting many types of content, but you can also define your own custom views by subclassing `UIView` (or its descendants). A custom view is a subclass of `UIView` in which you handle all of the drawing and event-handling tasks yourself. You won't be using custom views in these tutorials, but you can learn more about implementing a custom view in "Defining a Custom View" in *View Programming Guide for iOS* .

Use Storyboards to Lay Out Views

You use a storyboard to lay out your hierarchy of views in a graphical environment. Storyboards provide a direct, visual way to work with views and build your interface.

As you saw in the first tutorial, storyboards are composed of scenes, and each scene has an associated view hierarchy. You drag a view out of the object library and place it in a storyboard scene to add it automatically to that scene's view hierarchy. The view's location within that hierarchy is determined by where you place it. After you add a view to your scene, you can resize, manipulate, configure, and move it on the canvas.

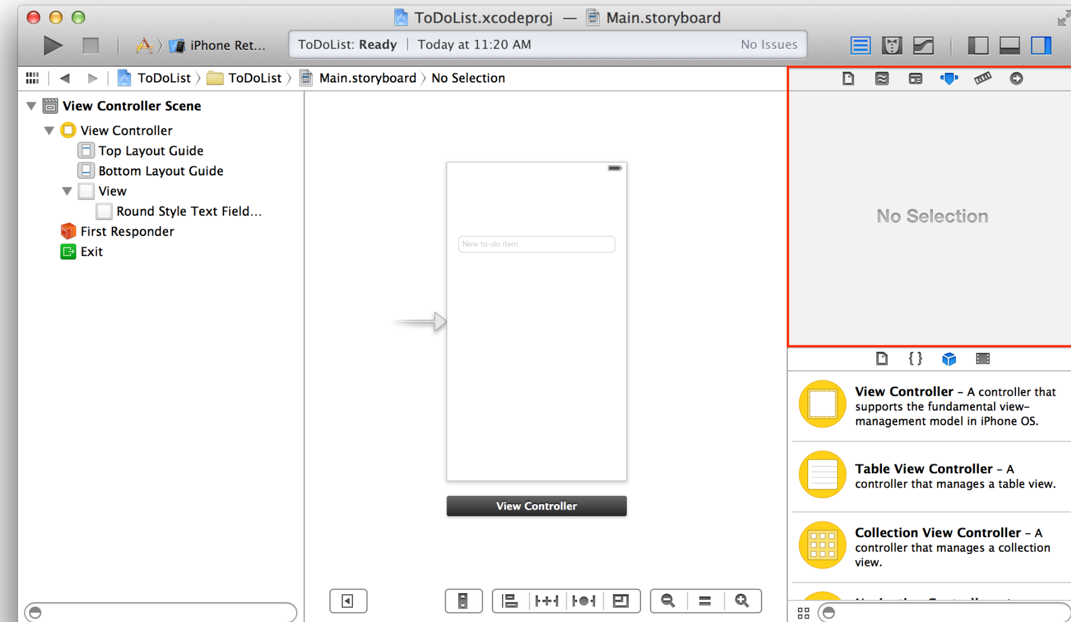
The canvas also shows an outline view of the objects in your interface. The **outline view**—which appears on the left side of the canvas—lets you see a hierarchical representation of the objects in your storyboard.



The view hierarchy that you create graphically in a storyboard scene is effectively a "shrinkwrapped" set of Objective-C objects. At runtime, these shrinkwrapped objects are unarchived. The result is a hierarchy of instances of the relevant classes configured with the properties you've set visually using the various inspectors in the utility area.

Use Inspectors to Configure Views

When working with views in a storyboard, the **inspector pane** is an essential tool. The inspector pane appears in the utility area above the Object library.



Each of the inspectors provides important configuration options for elements in your interface. When you select an object, such as a view, in your storyboard, you can use each of the inspectors to customize different properties of that object.

- **File.** Lets you specify general information about the storyboard.
- **Quick Help.** Provides useful documentation about an object.
- **Identity.** Lets you specify a custom class for your object and define its accessibility attributes.
- **Attributes.** Lets you customize visual attributes of an object.
- **Size.** Lets you specify an object's size and Auto Layout attributes.
- **Connections.** Lets you create connections between your interface and source code.

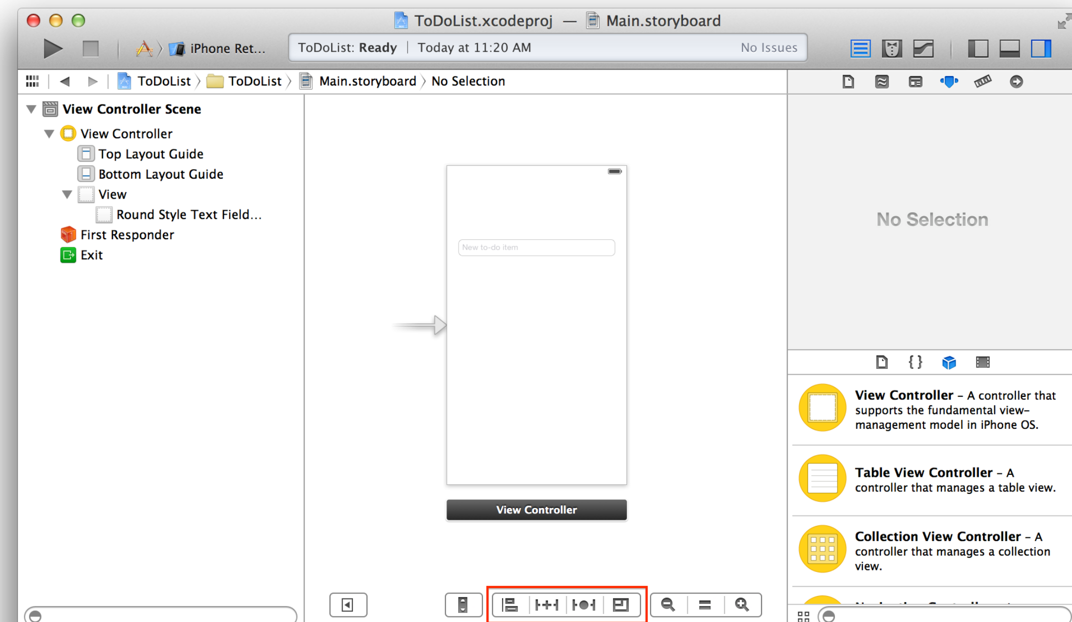
You began working with the Attributes inspector in the first tutorial. You'll continue using these inspectors throughout the rest of the tutorials to configure views and other objects in your storyboard. In particular, you'll use the Attributes inspector to configure your views, the Identity inspector to configure your view controllers, and the Connections inspector to create connections between your views and view controllers.

Use Auto Layout to Position Views

When you start positioning views in your storyboard, you need to consider a variety of situations. iOS apps run on a number of different devices, with various screen sizes, orientations, and languages. Instead of designing a static interface, you want it to be dynamic and to seamlessly respond to changes in screen size, device orientation, localization, and metrics.

To help you use views to create a versatile interface, Xcode offers a tool called Auto Layout. **Auto Layout** is a system for expressing relationships between views in your app's user interface. Auto Layout lets you define these relationships in terms of constraints on individual views or between sets of views.

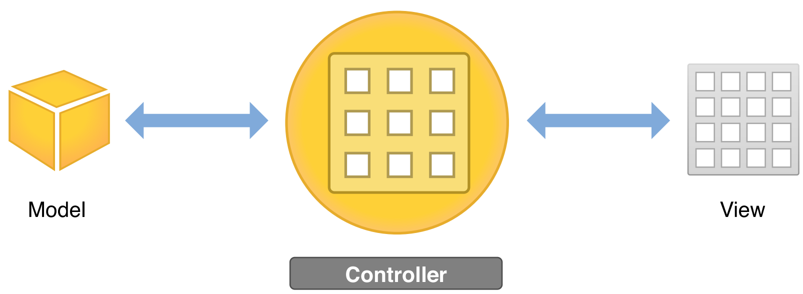
The Auto Layout menu, which resides in the bottom-right area of your canvas, has four segments. You use this menu to add various types of constraints to views on your canvas, resolve layout issues, and determine constraint resizing behavior.



You'll work briefly with Auto Layout in the second tutorial to add support for landscape mode to your ToDoList app.

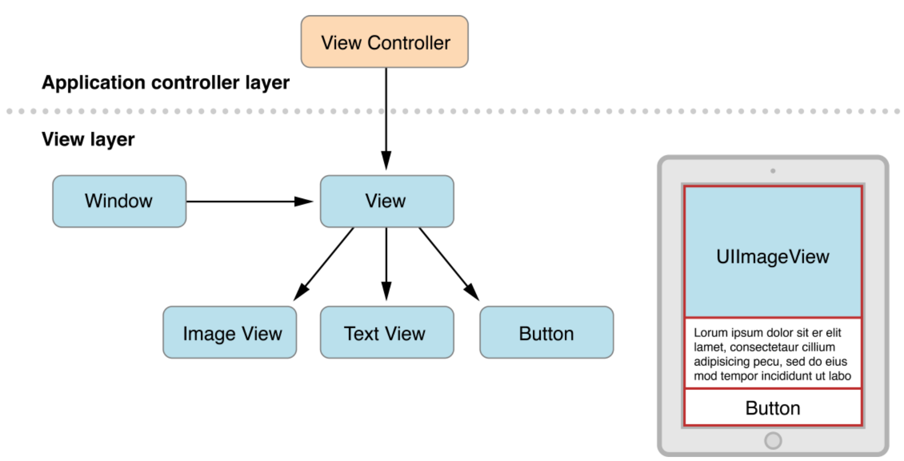
Defining the Interaction

After you lay out your user interface, you need to let users interact with it. This is where controllers come in. **Controllers** support your views by responding to user actions and populating the views with content. Controller objects are a conduit through which views learn about changes in the data model, and vice versa. Views are notified of changes in model data through the app's controllers, and controllers communicate user-initiated changes—for example, text entered in a text field—to model objects. Whether they're responding to user actions or defining navigation, controllers implement your app's behavior.



View Controllers

After you've built a basic view hierarchy, your next step is to control the visual elements and respond to user input. In an iOS app, you use a **view controller** (`UIViewController`) to manage a content view with its hierarchy of subviews.



A view controller isn't part of the view hierarchy and it's not an element in your interface. Instead, it manages the view objects in the hierarchy and provides them with behavior. Each content view hierarchy that you build in your storyboard needs a corresponding view controller, responsible for managing the interface elements and performing tasks in response to user interaction. This usually means writing a custom `UIViewController` subclass for each content view hierarchy. If your app has multiple content views, you use a different custom view controller class for each content view.

View controllers play many roles. They coordinate the flow of information between the app's data model and the views that display that data, manage the life cycle of their content views, and handle orientation changes when the device is rotated. But perhaps their most obvious role is to respond to user input.

You also use view controllers to implement transitions from one type of content to another. Because iOS apps have a limited amount of space in which to display content, view controllers provide the infrastructure needed to remove the views from one view controller and replace them with the views of another.

To define interaction in your app, make your view controller files communicate with the views in your storyboard. You do this by defining connections between the storyboard and source code files through actions and outlets.

Actions

An **action** is a piece of code that's linked to some kind of event that can occur in your app. When that event takes place, the code gets executed. You can define an action to accomplish anything from manipulating a piece of data to updating the user interface. You use actions to drive the flow of your app in response to user or system events.

You define an action by creating and implementing a method with an `IBAction` return type and a `sender` parameter.

```
- (IBAction)restoreDefaults:(id)sender;
```

The `sender` parameter points to the object that was responsible for triggering the action. The `IBAction` return type is a special keyword; it's like the `void` keyword, but it indicates that the method is an action that you can connect to from your storyboard in Interface Builder (which is why the keyword has the `IB` prefix). You'll learn more about how to link an `IBAction` action to an element in your storyboard in "Tutorial: Storyboards" (page 47).

Outlets

Outlets provide a way to reference objects from your interface—the objects you added to your storyboard—from source code files. You create an outlet by Control-dragging from a particular object in your storyboard to a view controller file. This creates a property for the object in your view controller file, which lets you access and manipulate that object from code at runtime. For example, in the second tutorial, you'll create an outlet for the text field in your ToDoList app to be able to access the text field's contents in code.

Outlets are defined as `IBOutlet` properties.

```
@property (weak, nonatomic) IBOutlet UITextField *textField;
```

The `IBOutlet` keyword tells Xcode that you can connect to this property from Interface Builder. You'll learn more about how to connect an outlet from a storyboard to source code in "Tutorial: Storyboards" (page 47).

Controls

A **control** is a user interface object such as a button, slider, or switch that users manipulate to interact with content, provide input, navigate within an app, and perform other actions that you define. Controls provide a way for your code to receive messages from the user interface.

When a user interacts with a control, a control event is created. A **control event** represents various physical gestures that users can make on controls, such as lifting a finger from a control, dragging a finger onto a control, and touching down within a text field.

There are three general categories of event types:

- **Touch and drag events.** Touch and drag events occur when a user interacts with a control with a touch or drag. There are several available touch event stages. When a user initially touches a finger on a button, for example, the Touch Down Inside event is triggered; if the user drags out of the button, the respective drag events are triggered. Touch Up Inside is sent when the user lifts a finger off the button while still within the bounds of the button's edges. If the user has dragged a finger outside the button before lifting the finger, effectively canceling the touch, the Touch Up Outside event is triggered.
- **Editing events.** Editing events occur when a user edits a text field.
- **Value-changed events.** Value-changed events occur when a user manipulates a control, causing it to emit a series of different values.

As you define the interactions, know the action that's associated with every control in your app and then make that control's purpose obvious to users in your interface.

Navigation Controllers

If your app has more than one content view hierarchy, you need to be able to transition between them. For this, you'll use a specialized type of view controller: a navigation controller (`UINavigationController`). A **navigation controller** manages transitions backward and forward through a series of view controllers, such as when a user navigates through email accounts, inbox messages, and individual emails in the iOS Mail app.

The set of view controllers managed by a particular navigation controller is called its navigation stack. The **navigation stack** is a last-in, first-out collection of custom view controller objects. The first item added to the stack becomes the **root view controller** and is never popped off the stack. Other view controllers can be pushed on or popped off the navigation stack.

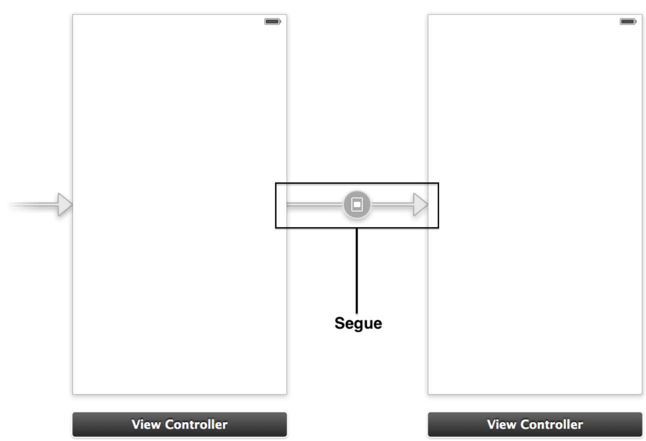
Although a navigation controller's primary job is to manage the presentation of your content view controllers, it's also responsible for presenting custom views of its own. Specifically, it presents a navigation bar—the view at the top of the screen that provides context about the user's place in the navigation hierarchy—which contains a back button and other buttons you can customize. Every view controller that's added to the navigation stack presents this navigation bar. You are responsible for configuring the navigation bar.

You generally don't have to do any work to pop a view controller off of the navigation stack; the back button provided by the navigation controller handles this for you. However, you do have to manually push a view controller onto the stack. You can do this using storyboards.

Use Storyboards to Define Navigation

So far, you've learned about using storyboards to create a single screen of content in your app. Now, you'll learn about using them to define the flow between multiple scenes in your app.

In the first tutorial, the storyboard you worked with had one scene. In most apps, a storyboard is composed of a sequence of scenes, each of which represents a view controller and its view hierarchy. Scenes are connected by **segues**, which represent a transition between two view controllers: the source and the destination.



There are several types of segues you can create:

- **Push.** A push segue adds the destination view controller to the navigation stack. Push segues may only be used when the source view controller is connected to a navigation controller.
- **Modal.** A modal segue is simply one view controller presenting another controller modally, requiring a user to perform some operation on the presented controller before returning to the main flow of the app. A modal view controller isn't added to a navigation stack; instead, it's generally considered to be a child of the presenting view controller. The presenting view controller is responsible for dismissing the modal view controller it created and presented.
- **Custom.** You can define your own custom transition by subclassing `UIStoryboardSegue`.
- **Unwind.** An unwind segue moves backward through one or more segues to return the user to an existing instance of a view controller. You use unwind segues to implement reverse navigation.

Instead of segues, scenes may also be connected by a **relationship**. For example, there's a relationship between the navigation controller and its root view controller. In this case, the relationship represents the containment of the root view controller by the navigation controller.

When you use a storyboard to plan the user interface for your app, it's important to make sure that one of the view controllers is marked as being the **initial view controller**. At runtime, this is the view controller whose content view will be displayed the first time the app is launched and from which you can transition to other view controllers' content views as necessary.

Now that you've learned the basics of working with views and view controllers in storyboards, it's time to incorporate this knowledge into your ToDoList app in the next tutorial.

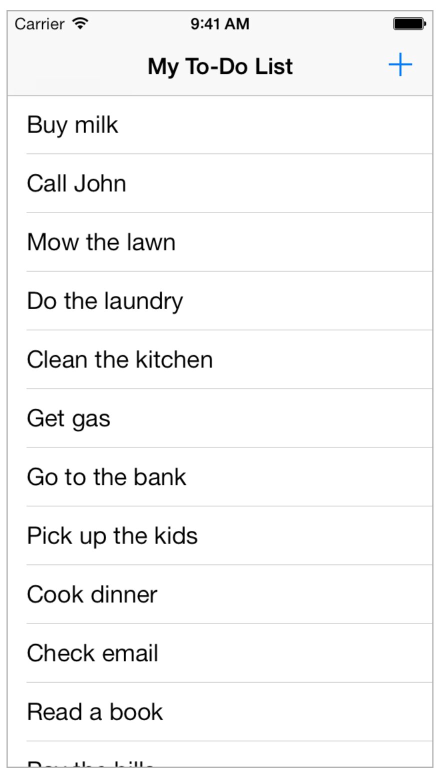
Tutorial: Storyboards

This tutorial builds on the project you created in the first tutorial (“Tutorial: Basics” (page 8)). You’ll put to use what you learned about views, view controllers, actions, and navigation. Following the interface-first design process, you’ll also create some of the key user interface flows for your ToDoList app and add behavior to the scene you’ve already created.

This tutorial teaches you how to:

- Adopt Auto Layout to add flexibility to your user interface
- Use storyboards to define app content and flow
- Manage multiple view controllers
- Add actions to elements in your user interface

After you complete all the steps in this tutorial, you’ll have an app that looks something like this:

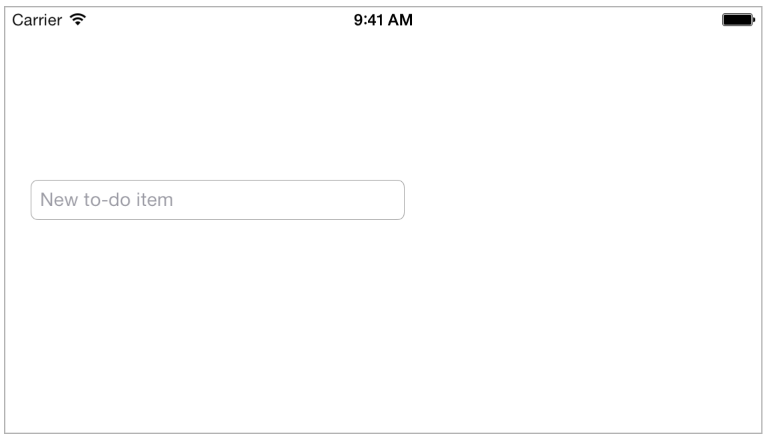


Adopt Auto Layout

The add-to-do-item scene is configured to work in portrait mode because that's how you created it. So what happens if a user rotates the device? Try it out by running your app in Simulator.

To rotate in iOS Simulator

1. Launch your app in iOS Simulator.
2. Choose Hardware > Rotate Left (or press Command–Left Arrow).



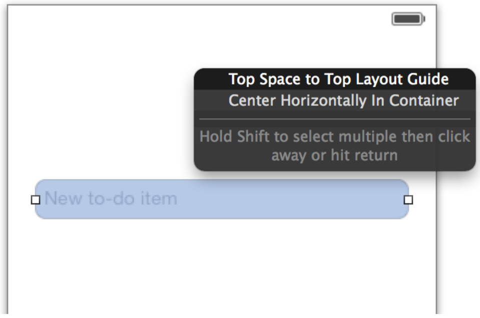
As you see, the text field doesn't look quite right. It stops about halfway across the screen. The text field should stretch all the way across the screen, as it does in portrait mode. Fortunately, Xcode has a powerful built-in layout engine called Auto Layout. With Auto Layout you describe your intent for the positioning of elements in a scene and then let the layout engine determine how best to implement that intent. You describe your intent using **constraints**—rules that explain where one element should be located relative to another, or what size it should be, or which of two elements should shrink first when something reduces the space available for each of them. For the add-to-do-item scene, two sets of constraints are needed—one to position the text field and the other to set its size.

Setting these constraints can easily be accomplished in Interface Builder.

To position the text field using Auto Layout

1. In the project navigator, select `Main.storyboard`.
2. In your storyboard, select the text field.
3. On the canvas, Control-drag from the text field toward the top of the scene, ending in the empty space around the text field. This space is the text field's superview.

A shortcut menu appears in the location where you release the drag.



4. Choose “Top Space to Top Layout Guide” from the shortcut menu.

   A spacing constraint is created between the top of the text field and the navigation bar.

   If a different shortcut menu appears, perhaps with a menu item such as “Leading Space to Container,” this is because instead of dragging vertically to the top of the screen, you dragged in a different direction. Xcode uses the direction you drag in as a way to understand what kind of constraints you’re trying to make, and it uses the start and end points of the drag to understand which objects are being related by the constraints. Go ahead and experiment with different dragging directions to see what constraints are available.

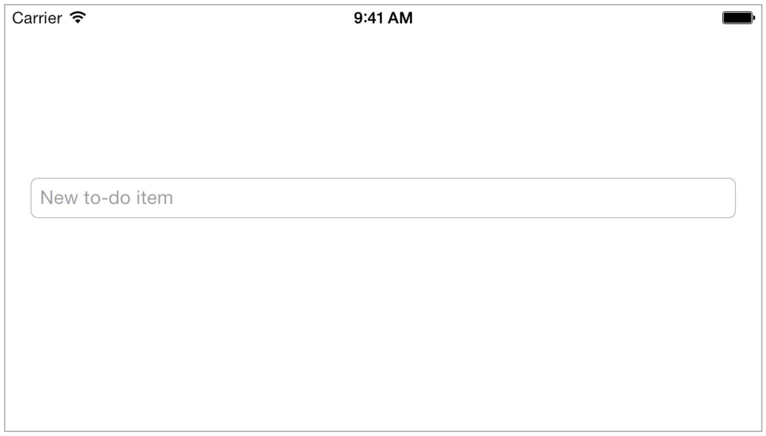
5. When you’re done experimenting, Control-drag from the text field to the right, ending in the superview, to create a “Trailing Space to Container” constraint.

6. Control-drag from the text field to the left, ending in its superview, to create a “Leading Space to Container” constraint.

These constraints specify that the distance between the edges of the text field and its superview shouldn’t change. This means that if the device orientation changes, the text field will automatically grow to satisfy these constraints.

Checkpoint: Run your app. If you rotate the device, the text field grows or shrinks to the appropriate size depending on the device’s orientation.

If you don't get the behavior you expect, use the Xcode Auto Layout debugging features to help you. With the text field selected, choose Editor > Resolve Auto Layout Issues > "Reset to Suggested Constraints" to have Xcode set up the constraints described by the steps above. Or choose Editor > Resolve Auto Layout Issues > Clear Constraints to remove all constraints on the text view, and then try following the steps above again.



Although your add item scene doesn't do much yet, the basic user interface is there and functional. Considering layout from the start ensures that you have a solid foundation to build upon.

Creating a Second Scene

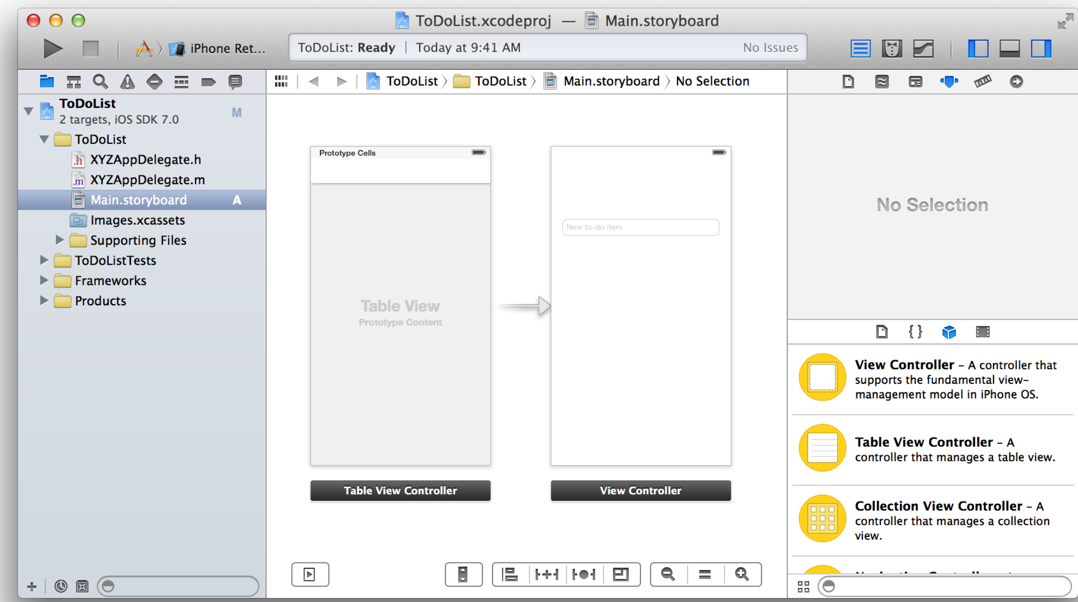
So far, you've been working with a single scene managed by a view controller that represents a page where you can add an item to your to-do list. Now it's time to create the scene that shows the entire to-do list. Fortunately, iOS comes with a powerful built-in class called a **table view** designed specifically to display a scrolling list of items.

To add a scene with a table view to your storyboard

1. In the project navigator, select `Main.storyboard`.
2. Open the Object library in the utility area. (To open the library with a menu command, choose View > Utilities > Show Object Library.)
3. Drag a Table View Controller object from the list and drop it on the canvas to the left of the add-to-do-item scene. If you need to, you can use the Zoom Out button in the lower right of the canvas to get enough space to drag it to.

   If you see a table view with content and nothing happens when you try to drag it to the canvas, you're probably dragging a table view rather than a table view controller. A table view is one of the things managed by a table view controller, but you want the whole package, so find the table view controller and drag it to the canvas.

You now have two scenes, one for displaying the list of to-do items and one for adding to-do items.

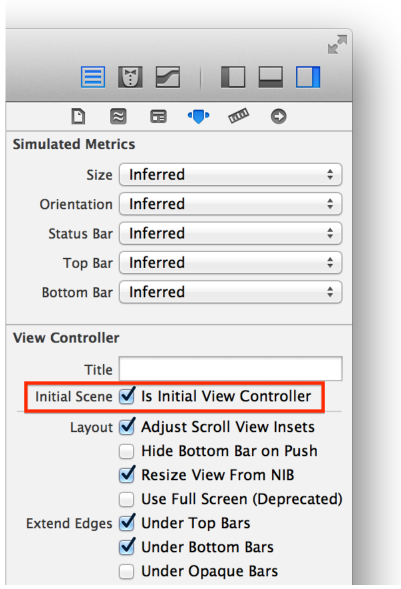


It makes sense to have the list be the first thing users see when they launch your app, so tell Xcode that's your intent by setting the table view controller as the first scene.

To set the table view controller as the initial scene

1. If necessary, open the outline view using the button in the lower left of the canvas.
2. In the outline view, select the newly added table view controller.
3. With the table view controller selected, open the Attributes inspector in the utility area.

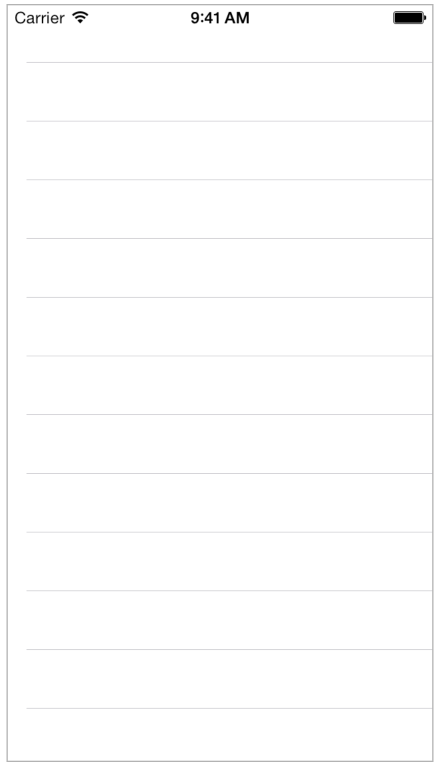
4. In the Attributes inspector, select the checkbox next to the Is Initial View Controller option.



Alternatively, you can drag the initial scene indicator from the `XYZAddToDoItemViewController` to the table view controller directly on the canvas.

The table view controller is set as the initial view controller in your storyboard, making it the first scene that loads on app launch.

Checkpoint: Run your app. Instead of the add-to-do-item scene with its text field, you should now see an empty table view—a screen with a number of horizontal dividers to separate it into rows, but with no content in each row.



Display Static Content in a Table View

Because you haven't learned about storing data yet, it's too early to create and store to-do items and display them in the table view. But you don't need real data to prototype your user interface. Xcode allows you to create static content in a table view in Interface Builder. This makes it a lot easier to see how your user interface will behave, and it's a valuable way to try out different ideas.

To create a static cell in your table view

1. In the outline view for your interface, select Table View under Table View Controller.
2. With the table view selected, open the Attributes inspector in the utility area.
3. In the Attributes inspector, choose Static Cells from the pop-up menu next to the Content option.

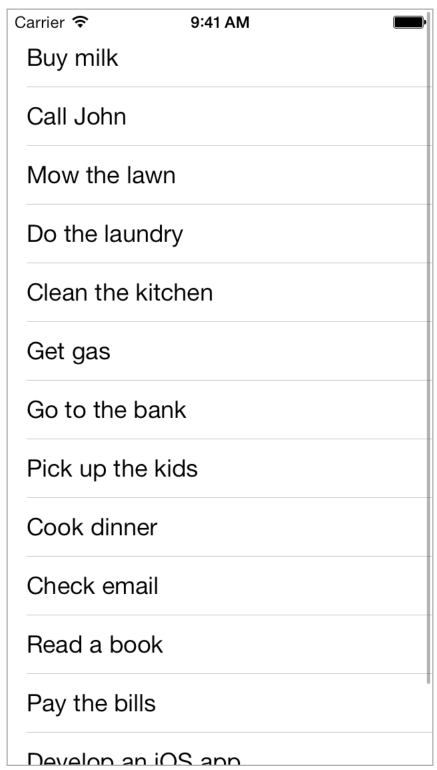
   Three empty table view cells appear in your table view.
4. In the outline view or on the canvas, select the top cell.
5. In the Attributes inspector, choose Basic from the pop-up menu next to the Style option.

The Basic style includes a label, so Xcode creates a label with the text “Title” in the table cell.

6. In the outline view or on the canvas, select the label.
7. In the Attributes inspector, change the text of the label from “Title” to “Mow the Lawn.” For the change to take effect, press Enter or click outside the utility area.

   Alternatively, you can edit a label by double-clicking it and editing the text directly.
8. Repeat steps 4–7 for the other cells, giving them text for other likely to-do items.
9. Create enough cells so that the items more than fill the screen. You can create new cells by copying and pasting them or by holding down the Option key when dragging a cell.

Checkpoint: Run your app. You should now see a table view with the preconfigured cells you added in Interface Builder. See how the new table view feels when you scroll it. Try rotating the simulated device—notice how the table view is already configured to lay out its contents properly. You get a lot of behavior for free by using a table view.



When you’re done, it’s time to provide a way to navigate from this table view, with its list of to-do items, to the first scene you created, where a user can create a new to-do item.

Add a Segue to Navigate Forward

You have two view controllers configured in the storyboard, but there's no connection between them. Transitions between scenes are called **segues**.

Before creating a segue, you need to configure your scenes. First, you'll wrap your `XYZToDoListViewController` in a navigation controller. Recall from "Defining the Interaction" (page 42) that navigation controllers provide a navigation bar and keep track of the navigation stack. You'll add a button to this navigation bar to transition to the `XYZAddToDoItemViewController` scene.

To add a navigation controller to your table view controller

1. In the outline view, select Table View Controller.
2. With the view controller selected, choose Editor > Embed In > Navigation Controller.

Xcode adds a new navigation controller to your storyboard, sets the initial scene to it, and creates a relationship between the new navigation controller and your existing table view controller. On the canvas, if you select the icon connecting the two scenes, you'll see that it's the root view controller relationship. This means that the view for the content displayed below the navigation bar will be your table view. The initial scene is set to the navigation controller because the navigation controller holds all of the content that you'll display in your app—it's the container for both the to-do list and the add-to-do-item scenes.

Checkpoint: Run your app. Above your table view you should now see extra space. This is the navigation bar provided by the navigation controller.

Now, you'll add a title (to the to-do list) and a button (to add additional to-do items) to the navigation bar.

To configure the navigation bar

1. In the outline view or on the canvas, select Navigation Item under Table View Controller.

   Navigation bars get their title from the view controller that the navigation controller currently displays—they don't themselves have a title. You set the title using the navigation item of your to-do list (the table view controller) rather than setting it directly on the navigation bar.

2. In the Attributes inspector, type `My To-Do List` in the Title field.
3. If necessary, open the Object library.
4. Drag a bar button item from the list to the far right of the navigation bar in the table view controller.

   A button containing the text "Item" appears where you dragged the bar button item.

5. In the outline view or on the canvas, select the bar button item.
6. In the Attributes inspector, find the Identifier option in the Bar Button Item section. Choose Add from the Identifier pop-up menu.

   The button changes to an Add button (+).

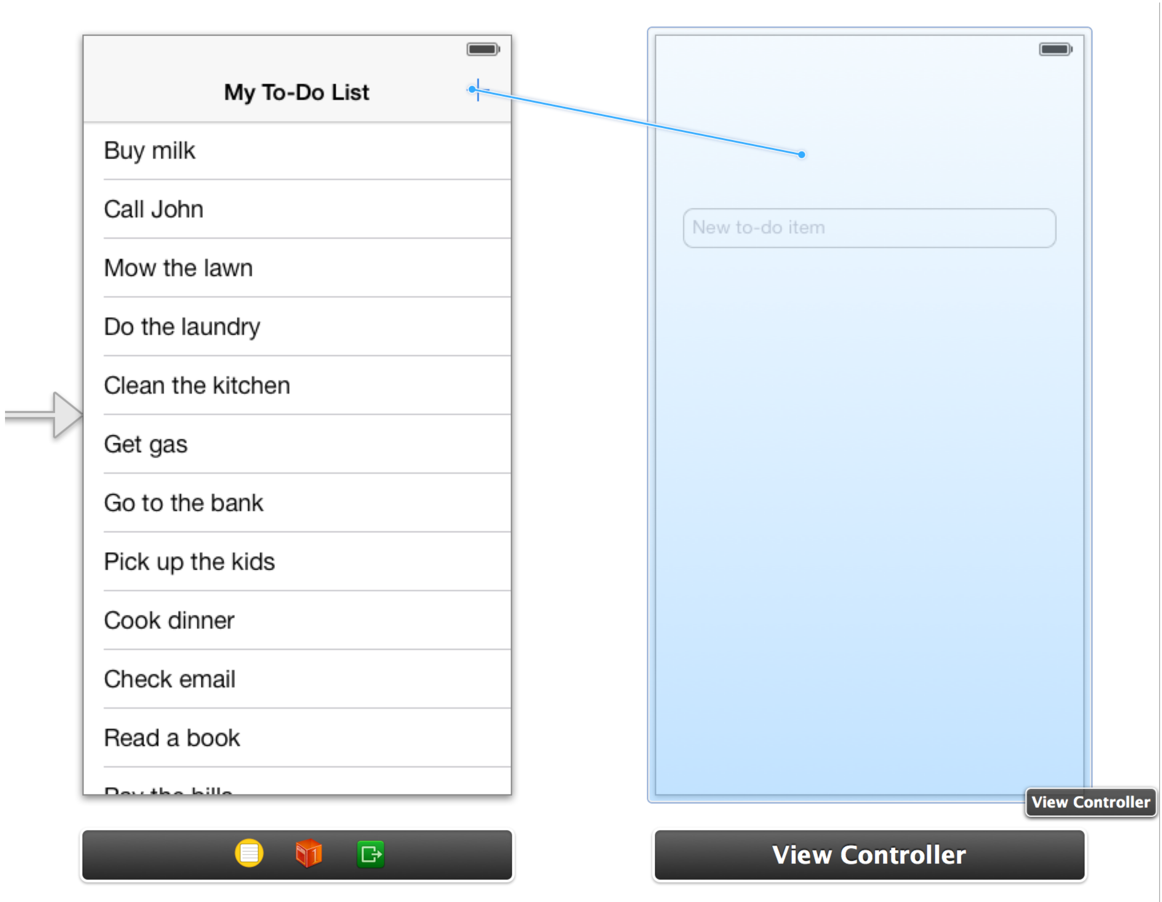
Checkpoint: Run your app. The navigation bar should now have a title and display an Add button. The button doesn't do anything yet. You'll fix that next.

You want the Add button to bring up the add-to-do-item scene. The scene is already configured—it was the first scene you created—but it's not connected to the other scenes. Xcode makes it easy to configure the Add button to bring up another scene when tapped.

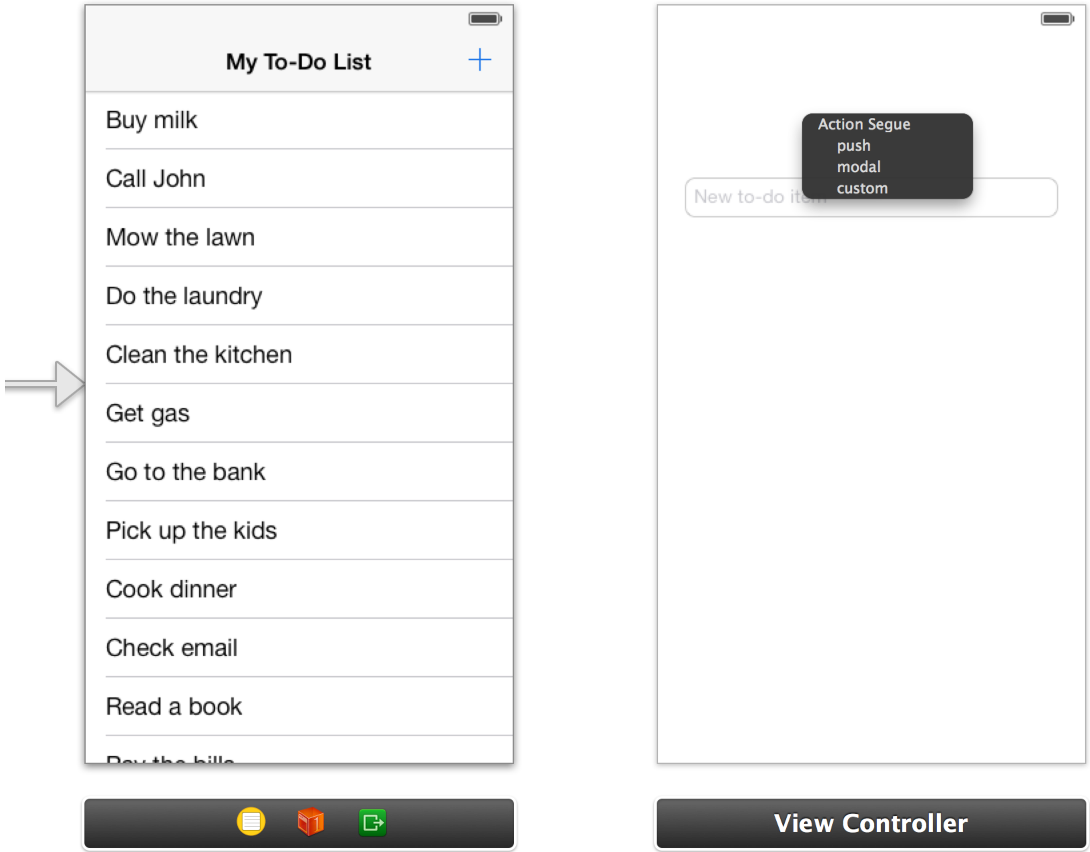
To configure the Add button

1. On the canvas, select the Add button.

2. Control-drag from the button to the add-to-do-item view controller.



A shortcut menu titled Action Segue appears in the location where the drag ended.

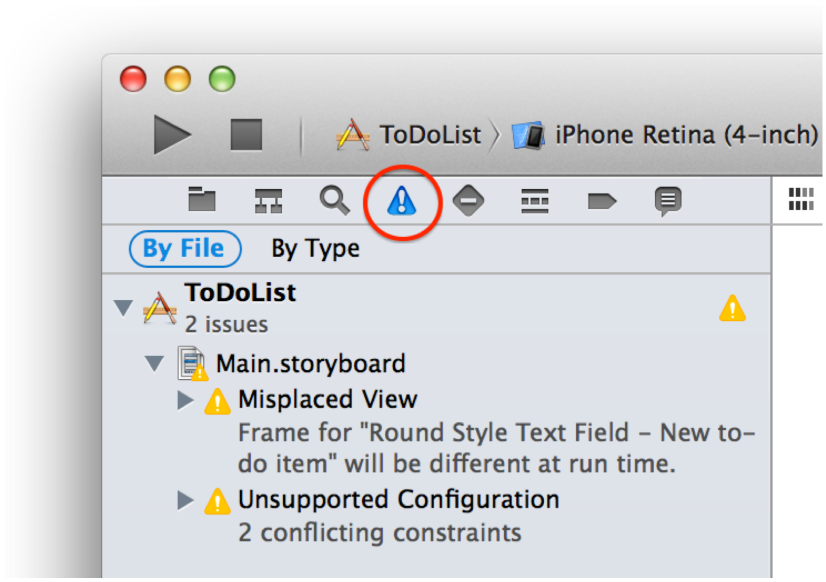


This is how Xcode allows you to choose what type of segue should be used to transition from the to-do list to the add-to-do-item view controller when the user taps the Add button.

3. Choose "push" from the shortcut menu.

Xcode sets up the segue and configures the add-to-do-item view controller to be displayed in a navigation controller—you'll see the navigation bar in Interface Builder.

At this point, you might notice a couple of warnings in your project. Go ahead and open the Issue navigator to see what's wrong.



Because you added the add-to-do-item scene to the navigation stack, it now displays a navigation bar. This bar caused the frame of your text field to move down, which means that the Auto Layout constraints you specified earlier are no longer satisfied. Fortunately, this is easy to fix.

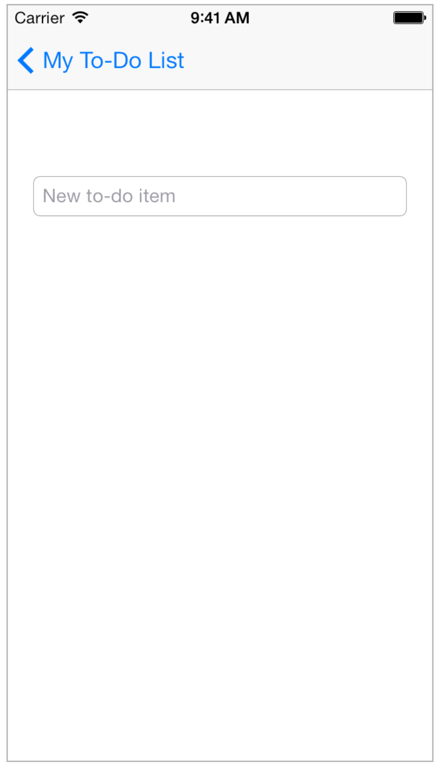
To update the Auto Layout constraints

1. In the outline view or on the canvas, select the text field.
2. On the canvas, open the Resolve Auto Layout Issues pop-up menu, and choose Update Constraints.

   Alternatively, you can choose Editor > Resolve Auto Layout Issues > Update Constraints.

   The constraints are updated and the Xcode warnings disappear.

Checkpoint: Run your app. You can click the Add button and navigate to the add-to-do-item view controller from the table view. Because you're using a navigation controller with a push segue, the backward navigation is handled for you. This means you can click the back button to get back to the table view.



The push navigation is working just as it's supposed to—but it's not quite what you want when adding items. Push navigation is designed for a drill-down interface, where you're providing more information about whatever the user selected. Adding an item, on the other hand, is a modal operation—the user performs some action that's complete and self-contained, and then returns from that scene to the main navigation. The appropriate method of presentation for this type of scene is a modal segue.

To change the segue style

1. In the outline view or on the canvas, select the segue from the table view controller to the add-to-do-item view controller.
2. In the Attributes inspector, choose Modal from the pop-up menu next to the Style option.

Because a modal view controller doesn't get added to the navigation stack, it doesn't get a navigation bar from the table view controller's navigation controller. However, you want to keep the navigation bar to provide the user with visual continuity. To give the add-to-do-item view controller a navigation bar when presented modally, embed it in its own navigation controller.

To add a navigation controller to the add-to-do-item view controller

1. In the outline view, select View Controller.
2. With the view controller selected, choose Editor > Embed In > Navigation Controller.

As before, Xcode adds a navigation controller and shows the navigation bar at the top of the view controller. Next, configure this bar to add a title to this scene as well as two buttons, Cancel and Done. Later, you'll link these buttons to actions.

To configure the navigation bar in the add-to-do-item view controller

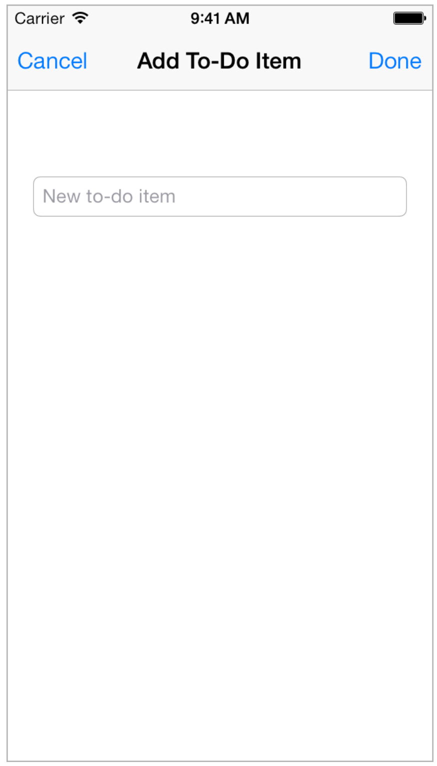
1. In the outline view or on the canvas, select Navigation Item under View Controller. If necessary, open the Attributes inspector .
2. In the Attributes inspector, type `Add To-Do Item` in the Title field.

   Xcode changes the description of the view controller from "View Controller" to "View Controller – Add To-Do Item" to make it easier for you to identify the scene. The description appears in the outline view.
3. Drag a bar button item from the Object library to the far right of the navigation bar in the add-to-do-item view controller.
4. In the Attributes inspector, choose Done from the pop-up menu next to the Identifier option.

   The button text changes to "Done."
5. Drag another bar button item from the Object library to the far left of the navigation bar in the add-to-do-item view controller.
6. In the Attributes inspector, choose Cancel from the pop-up menu next to the Identifier option.

   The button text changes to "Cancel."

Checkpoint: Run your app. Click the Add button. You still see the add item scene, but there's no longer a button to navigate back to the to-do list—instead, you see the two buttons you added, Done and Cancel. Those buttons aren't linked to any actions yet, so you can click them, but they don't do anything. Configuring the buttons to complete or cancel editing of the new to-do item—and bring the user back to the to-do list—is the next task.



Create Custom View Controllers

You've accomplished all of this configuration without needing to write any code. Configuring the completion of the add-to-do-item view controller requires some code, though, and you need a place to put it. Right now Xcode has configured both the add-to-do-item view controller and the table view controller as generic view controllers. To have a place for your custom code, you need to create subclasses for each of these view controllers and then configure the interface to use those subclasses.

First, you'll address the add-to-do-item view controller scene. The custom view controller class will be called `XYZAddToDoItemViewController`, because this view controller will control the scene that adds a new item to your to-do list.

To create a subclass of UIViewController

1. Choose File > New > File (or press Command-N).

2. On the left of the dialog that appears, select the Cocoa Touch template under iOS.
3. Select Objective-C Class, and click Next.
4. In the Class field, type `AddToDoItem` after the `XYZ` prefix.
5. Choose `UIViewController` in the "Subclass of" pop-up menu.

   The class title changes to "XYZAddToDoItemViewController." Xcode helps you by making it clear from the naming that you're creating a custom view controller. That's great, so leave the new name as is.
6. Make sure the "Targeted for iPad" and "With XIB for user interface" options are unselected.
7. Click Next.
8. The save location will default to your project directory. Leave that as is.
9. The Group option will default to your app name, ToDoList. Leave that as is.
10. The Targets section will default to having your app selected and the tests for your app unselected. That's perfect, so leave that as is.
11. Click Create.

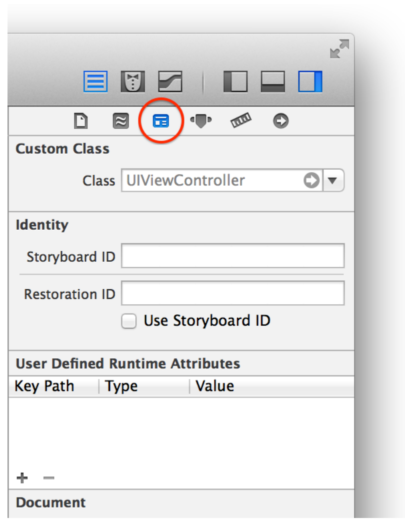
Now that you've created a custom view controller subclass, you need to tell your storyboard to use your custom class instead of the generic view controller. The storyboard file is a configuration of objects that's used at runtime by your app. The app machinery is smart enough to substitute your custom view controller for the generic view controller the storyboard starts with, but you need to tell the storyboard that that's what you want.

To identify your class as the view controller for a scene

1. In the project navigator, select `Main.storyboard`.
2. If necessary, open the outline view.
3. In the outline view, select the "View Controller – Add To-Do Item" view controller.

   Click the disclosure triangle next to the "View Controller – Add To-Do Item" scene to show the objects in your scene. The first one should be the view controller. Click it to select it. Notice that the scene row has a different icon from the view controller row.
4. With the view controller selected, open the Identity inspector in the utility area.

The **Identity inspector** appears at the top of the utility area when you click the third button from the left. It lets you edit properties of an object in your storyboard related to that object's identity, such as what class it is.



5. In the Identity inspector, open the pop-up menu next to the Class option.

   You'll see a list of all the view controller classes Xcode knows about. The last one in the list should be your custom view controller, `XYZAddToDoItemViewController`. Choose it to tell Xcode to use your view controller for this scene.

At runtime your storyboard will create an instance of `XYZAddToDoItemViewController`—your custom view controller subclass—instead of the generic `UIViewController`. Notice that Xcode changed the description of your add-to-do-item view controller scene from "View Controller – Add To-Do Item" to "Add To Do Item View Controller – Add To-Do Item." Xcode knows that you're now using a custom view controller for this scene, and it interprets the name of the custom class to make it easier to understand what's going on in the storyboard.

Now, do the same thing for the table view controller.

To create a subclass of UITableViewController

1. Choose File > New > File (or press Command-N).
2. On the left, select Cocoa Touch under iOS, then select Objective-C Class. If you haven't created any classes since the last steps in the tutorial, it's probably already selected for you.
3. Click Next.
4. In the Class field, type `ToDoList`. Notice that Xcode put the insertion point in between `XYZ`, your class prefix, and `ViewController`, the type of thing you're creating.
5. Choose `UITableViewController` in the "Subclass of" pop-up menu.
6. Make sure the "Targeted for iPad" and "With XIB for user interface" options are unselected.

7. Click Next.

   The save location will default to your project directory. Leave that as is.
8. The Group option will default to your app name, ToDoList. Leave that as is.
9. The Targets section will default to having your app selected and the tests for your app unselected. That's perfect, so leave that as is.
10. Click Create.

Once again, you need to make sure to configure your custom table view controller, `XYZToDoListViewController`, in your storyboard.

To configure your storyboard

1. In the project navigator, select `Main.storyboard`.
2. If necessary, open the outline view.
3. In the outline view, select the table view controller and open the Identity inspector in the utility area.
4. In the Identity inspector, choose `XYZToDoListViewController` from the pop-up menu next to the Class option.

Now, you're ready to add custom code to your view controllers.

Unwind a Segue to Navigate Back

In addition to push and modal segues, Xcode provides an **unwind segue**. This segue allows users to go from a given scene back to a previous scene, and it provides a place for you to add your own code that gets executed when users navigate between those scenes. You can use an unwind segue to navigate back from `XYZAddToDoItemViewController` to `XYZToDoListViewController`.

An unwind segue is created by adding an action method to the destination view controller (the view controller you want to unwind to). A method that can be unwound to must return an action (`IBAction`) and take in a storyboard segue (`UIStoryboardSegue`) as a parameter. Because you want to unwind back to `XYZToDoListViewController`, you need to add an action method with this format to the `XYZToDoListViewController` implementation.

To unwind back to XYZToDoListViewController

1. In the project navigator, open `XYZToDoListViewController.m`.
2. Add the following code below the `@implementation` line:

```
- (IBAction)unwindToList:(UIStoryboardSegue *)segue
{

}
```

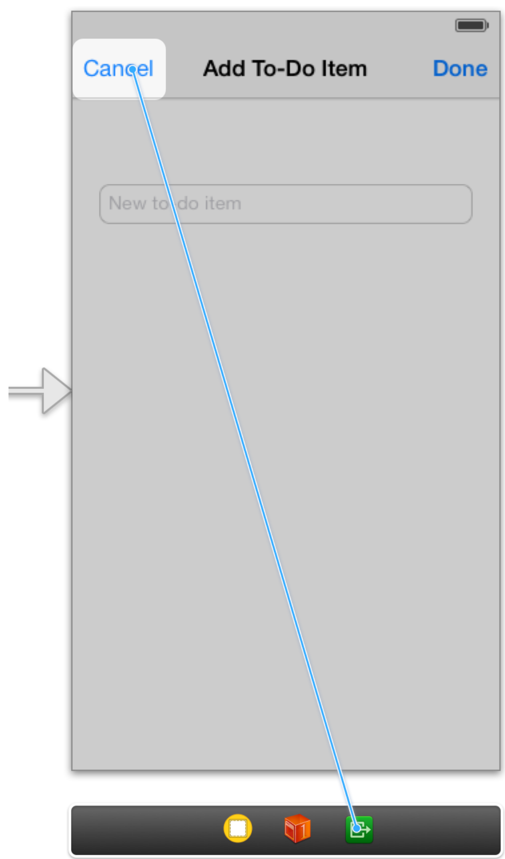
You can name the unwind action anything you want. Calling it `unwindToList:` makes it clear where the unwind will take you. For future projects, adopt a similar naming convention, one where the name of the action makes it clear where the unwind will go.

For now, leave this method implementation empty. Later, you'll use this method to retrieve data from the `XYZAddToDoItemViewController` to add an item to your to-do list.

To create the unwind segue, link the Cancel and Done buttons to the `unwindToList:` action through the Exit icon in the dock of the source view controller, `XYZAddToDoItemViewController`.

To link buttons to the unwindToList: action

1. In the project navigator, select `Main.storyboard`.
2. On the canvas, Control-drag from the Cancel button to the Exit item in the add-to-do-item scene dock.



If you don't see the Exit item in the scene dock but instead see the description of the scene, click the Zoom In button on the canvas until you see it.

A menu appears in the location where the drag ended.

3. Choose `unwindToList:` from the shortcut menu.

   This is the action you just added to the `XYZToDoListViewController.m` file. This means that when the Cancel button is tapped, the segue will unwind and this method will be called.

4. On the canvas, Control-drag from the Done button to the Exit item in the `XYZAddToDoItemViewController` scene dock.

5. Choose `unwindToList:` from the shortcut menu.

Notice that you used the same action for both the Cancel and the Done buttons. In the next tutorial, you'll distinguish between the two different cases when you write the code to handle the unwind segue.

Checkpoint: Now, run your app. At launch, you see a table view—but there's no data in it. You can click the Add button and navigate to `XYZAddToDoItemViewController` from `XYZToDoListViewController`. You can click the Cancel and Done buttons to navigate back to the table view.

So why doesn't your data show up? Table views have two ways of getting data—statically or dynamically. When a table view's controller implements the required `UITableViewDataSource` methods, the table view asks its view controller for data to display, regardless of whether static data has been configured in Interface Builder. If you look at `XYZToDoListViewController.m`, you'll notice that it implements three methods—`numberOfSectionsInTableView:`, `tableView:numberOfRowsInSection:`, and `tableView:cellForRowAtIndexPath:`. You can get your static data to display again by commenting out the implementations of these methods. Go ahead and try that out if you like.

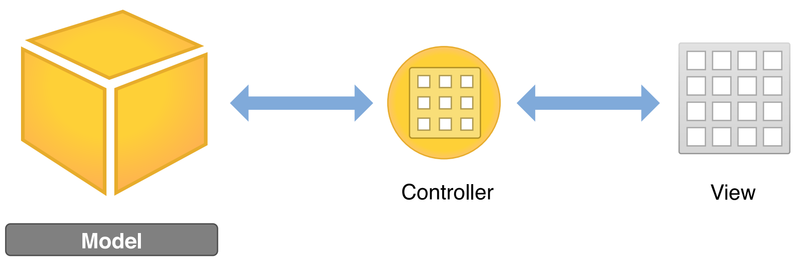
Recap

At this point, you've finished developing the interface for your app. You have two scenes—one for adding items to your to-do list and one for viewing the list—and you can navigate between them. Next, you'll implement the ability to have users add a new to-do item and have it appear in the list. The next module covers working with data to implement this behavior.

Implementing an App

Incorporating the Data

Your app's **data model** is composed of your data structures and (optionally) custom business logic needed to keep that data in a consistent state. You never want to design your data model in total isolation from your app's user interface. You do, however, want to implement your data model objects separately, without relying on the presence of specific views or view controllers. When you keep your data separate from your user interface, you'll find it easier to implement a universal app—one that can run on both iPad and iPhone—and easier to reuse portions of your code later.



Designing Your Model

If you simply need to store a small amount of data, Foundation framework classes may be your best option. Research existing Foundation classes to see what behaviors are available for you to use instead of attempting to implement the same thing on your own. For example, if your app only needs to keep track of a list of strings, you can rely on `NSArray` and `NSString` to do the job for you. You'll learn more about these and other Foundation classes in "Working with Foundation" (page 75).

If your data model requires custom business logic in addition to just storing data, you can write a custom class. Consider how you can incorporate existing framework classes into the implementation of your own classes. It's beneficial to use existing framework classes within your custom classes instead of trying to reinvent them. For example, a custom class might use `NSMutableArray` to store information—but define its own features for working with that information.

When you design your data model, here are some questions to keep in mind:

What types of data do you need to store? Whether you're storing text, documents, large images, or another type of information, design your data model to handle that particular type of content appropriately.

What data structures can you use? Determine where you can use framework classes and where you need to define classes with custom functionality.

How will you supply data to the user interface? Your model shouldn't communicate directly with your interface. To handle the interaction between the model and the interface, you'll need to add logic to your controllers.

Implementing Your Model

To write good, efficient code, you need to learn more about Objective-C and its capabilities. Although this guide teaches you how to build a simple app, you'll want to become familiar with the language before writing your own fully functional app.

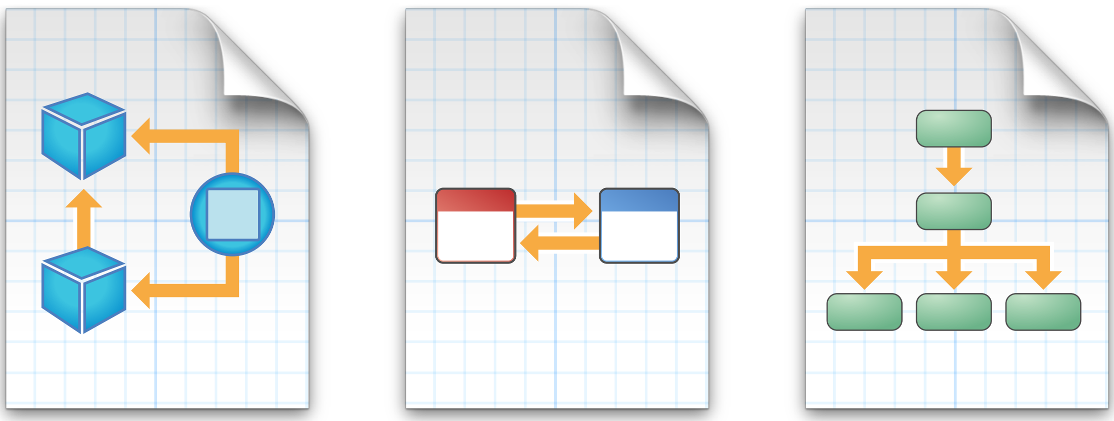
There are several good approaches to learning Objective-C. Some people learn the concepts by reading *Programming with Objective-C* and then writing a number of small test apps to solidify their understanding of the language and to practice writing good code.

Others jump right into programming and look for more information when they don't know how to accomplish something. If you prefer this approach, keep *Programming with Objective-C* as a reference and make it an exercise to learn concepts and apply them to your app as you develop it.

The most important goal in developing your first data model is to get something that works. Think carefully about the structure of your data model, but don't worry about making it perfect. Don't be afraid to iterate and refine your model after you begin implementing it.

Using Design Patterns

A **design pattern** solves a common software engineering problem. Patterns are abstract designs, not code. When you adopt a design, you adapt its general pattern to your specific needs. No matter what type of app you're creating, it's good to know the fundamental design patterns used in the frameworks. Understanding design patterns helps you use frameworks more effectively and allows you to write apps that are more reusable, more extensible, and easier to change.



MVC

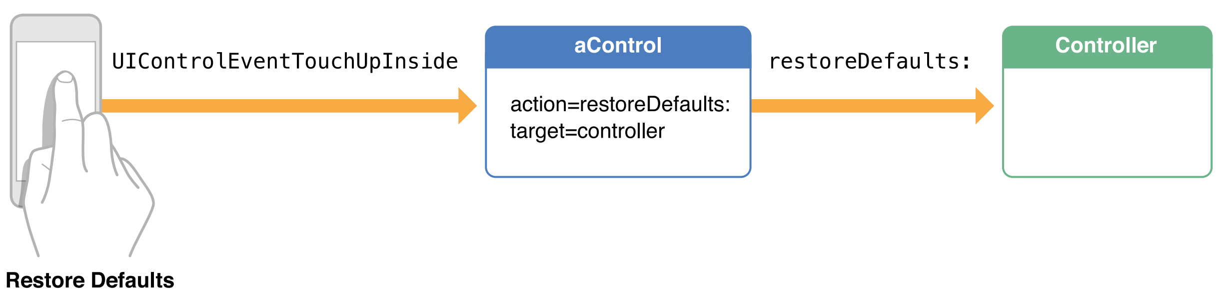
Model-View-Controller (MVC) is central to a good design for any iOS app. MVC assigns the objects in an app to one of three roles: model, view, or controller. In this pattern, models keep track of your app's data, views display your user interface and make up the content of an app, and controllers manage your views. By responding to user actions and populating the views with content, controllers serve as a gateway for communication between models and views.

As you've been building your ToDoList app, you've followed an MVC-centric design. The interface you built in storyboards makes up the view layer. `XYZAddToDoItemViewController` and `XYZToDoListViewController` are the controllers that manage your views. In "Tutorial: Add Data" (page 93), you'll be incorporating a data model to work with the views and controllers in your app. When you begin designing your own app, it's important to keep MVC at the center of your design.

Target-Action

Target-action is a conceptually simple design in which one object sends a message to another object when a specific event occurs. The **action message** is a selector defined in source code, and the **target**—the object that receives the message—is an object capable of performing the action, typically a view controller. The object that sends the action message is usually a control—such as a button, slider, or switch—that can trigger an event in response to user interaction such as tap, drag, or value change.

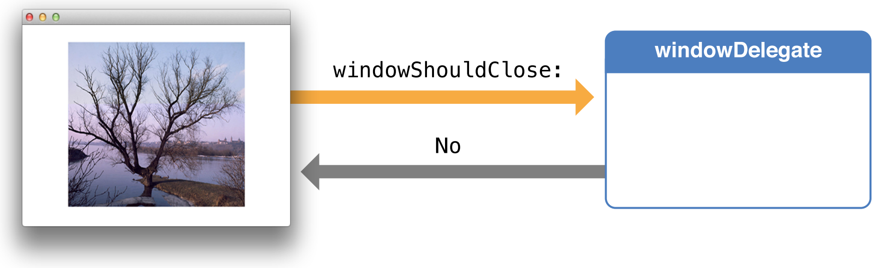
For example, imagine that you want to restore default settings in your app whenever a user taps the Restore Defaults button (which you create in your user interface). First, you implement an action, `restoreDefaults:`, to perform the logic to restore default settings. Next, you register the button's Touch Up Inside event to send the `restoreDefaults:` action method to the view controller that implements that method.



You've already used target-action in your ToDoList app. When a user taps the Done button in the `XYZAddToDoItemViewController`, it triggers the `unwindToList:` action. In this case, the Done button is the object sending the message, the target object is the `XYZToDoListViewController`, the action message is `unwindToList:`, and the event that triggers the action message to be sent is a user tapping the Done button. Target-action is a powerful mechanism for defining interaction and sending information between different parts of your app.

Delegation

Delegation is a simple and powerful pattern in which one object in an app acts on behalf of, or in coordination with, another object. The delegating object keeps a reference to the other object—the delegate—and at the appropriate time sends a message to it. The message informs the delegate of an event that the delegating object is about to handle or has just handled. The delegate may respond to the message by updating the appearance (or state) of itself or of other objects in the app, and in some cases it will return a value that affects how an impending event is handled.



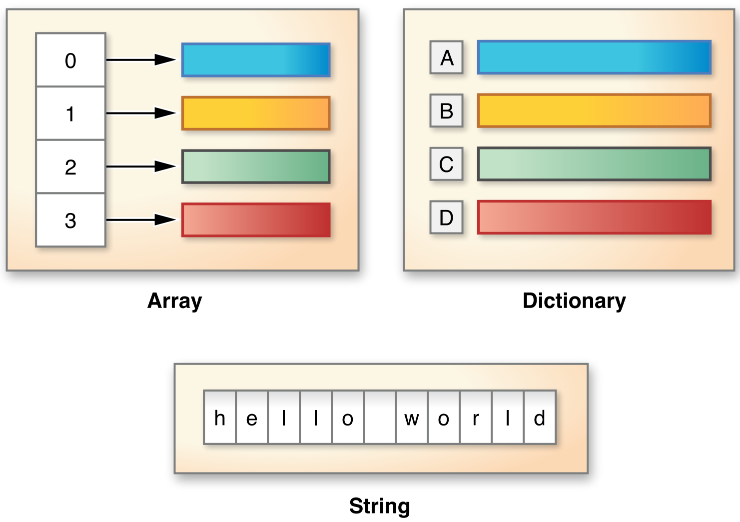
The delegate pattern is prevalent in existing framework classes, but you can also implement delegation between two custom objects in an app. A common design uses delegation as a means for allowing a child view controller to communicate some value (typically a user-entered value) to its parent view controller.

You haven't worked with delegation yet, but in "Tutorial: Add Data" (page 93), you'll see an example of it when you add additional behavior to your `XYZToDoListViewController` class.

These are a few of the most common design patterns that you'll encounter during iOS development, but there are many more. As you learn more about Objective-C, you'll spot other design patterns that you can apply in your app.

Working with Foundation

As you begin writing code for your app, you'll find that there are many Objective-C frameworks that you can take advantage of. Of particular importance is the **Foundation framework**, which provides basic services for all apps. The Foundation framework includes **value classes** representing basic data types such as strings and numbers, as well as **collection classes** for storing other objects. You'll be relying on value and collection classes to write much of the code for your ToDoList app.



Value Objects

The Foundation framework provides you with classes that generate value objects for strings, binary data, dates and times, numbers, and other values.

A **value object** is an object that encapsulates a primitive value (of a C data type) and provides services related to that value. You frequently encounter value objects as the parameters and return values of methods and functions that your app calls. Different parts of a framework—or even different frameworks—can exchange data by passing value objects.

Some examples of value objects in the Foundation framework are:

`NSString` and `NSMutableString`

`NSData` and `NSMutableData`

- `NSDate`
- `NSNumber`
- `NSValue`

Because value objects represent scalar values, you can use them in collections and wherever else objects are required. Value objects have an advantage over the primitive types they encapsulate: They let you perform certain operations on the encapsulated value simply and efficiently. The `NSString` class, for example, has methods for searching for and replacing substrings, for writing strings to files or (preferably) URLs, and for constructing file-system paths.

You create a value object from data of the primitive type (and then perhaps pass it in a method parameter). In your code, you later access the encapsulated data from the object. The `NSNumber` class provides the clearest example of this approach.

```
int n = 5; // Value assigned to primitive type
NSNumber *numberObject = [NSNumber numberWithInt:n]; // Value object created from
 primitive type
int y = [numberObject intValue]; // Encapsulated value obtained from value object
 (y == n)
```

Most value classes create their instances by declaring both initializers and class factory methods. **Class factory methods**—implemented by a class as a convenience for clients—combine allocation and initialization in one step and return the created object. For example, the `NSString` class declares a `string` class method that allocates and initializes a new instance of the class and returns it to your code.

```
NSString *string = [NSString string];
```

In addition to creating value objects and letting you access their encapsulated values, most value classes provide methods for simple operations such as object comparison.

Strings

Objective-C supports the same conventions for specifying strings as does C: Single characters are enclosed by single quotes, and strings of characters are surrounded by double quotes. But Objective-C frameworks typically don't use C strings. Instead, they use `NSString` objects.

The NSString class provides an object wrapper for strings, offering advantages such as built-in memory management for storing arbitrary-length strings, support for different character encodings (particularly Unicode), and utilities for string formatting. Because you commonly use such strings, Objective-C provides a shorthand notation for creating NSString objects from constant values. To use this NSString literal, just precede a double-quoted string with the at sign (@), as shown in the following examples:

```
// Create the string "My String" plus carriage return.
NSString *myString = @"My String\n";
// Create the formatted string "1 String".
NSString *anotherString = [NSString stringWithFormat:@"%d %@", 1, @"String"];
// Create an Objective-C string from a C string.
NSString *fromCString = [NSString stringWithCString:"A C string"
encoding:NSUTF8StringEncoding];
```

Numbers

Objective-C offers a shorthand notation for creating NSNumber objects, removing the need to call initializers or class factory methods to create such objects. Simply precede the numeric value with the at sign (@) and optionally follow it with a value type indicator. For example, to create NSNumber objects encapsulating an integer value and a double value, you could write the following:

```
NSNumber *myIntValue    = @32;
NSNumber *myDoubleValue = @3.22346432;
```

You can even use NSNumber literals to create encapsulated Boolean and character values.

```
NSNumber *myBoolValue = @YES;
NSNumber *myCharValue = @'V';
```

You can create NSNumber objects representing unsigned integers, long integers, long long integers, and float values by appending the letters U, L, LL, and F, respectively, to the notated value. For example, to create an NSNumber object encapsulating a float value, you can write the following:

```
NSNumber *myFloatValue = @3.2F
```

Collection Objects

Most **collection objects** in Objective-C code are instances of one of the basic collection classes—`NSArray`, `NSSet`, and `NSDictionary`. These classes are used to manage groups of objects, so any item you want to add to a collection must be an instance of an Objective-C class. If you need to add a scalar value, you must first create a suitable `NSNumber` or `NSValue` instance to represent it.

Any object you add to a collection will be kept alive at least as long as the collection is kept alive. That's because collection classes use strong references to keep track of their contents. In addition to keeping track of their contents, each of the collection classes makes it easy to perform certain tasks, such as enumeration, accessing specific items, or finding out whether a particular object is part of the collection.

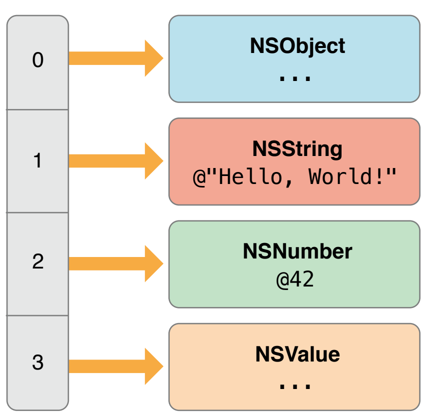
The contents of the `NSArray`, `NSSet`, and `NSDictionary` classes are set at creation. Because they can't be changed over time, they're called **immutable**. Each one also has a subclass that's **mutable** to allow you to add or remove objects at will. Different types of collections organize their contained objects in distinctive ways:

- `NSArray` and `NSMutableArray`—An array is an ordered collection of objects. You access an object by specifying its position (that is, its index) in the array. The first element in an array is at index 0 (zero).
- `NSSet` and `NSMutableSet`—A set stores an unordered collection of objects, with each object occurring only once. You generally access objects in the set by applying tests or filters to objects in the set.
- `NSDictionary` and `NSMutableDictionary`—A dictionary stores its entries as key-value pairs; the key is a unique identifier, usually a string, and the value is the object you want to store. You access this object by specifying the key.

Arrays

An **array** (`NSArray`) is used to represent an ordered list of objects. The only requirement is that each item be an Objective-C object—there's no requirement for each object to be an instance of the same class.

To maintain order in the array, each element is stored at a zero-based index.



Creating Arrays

As with the value classes described earlier in this chapter, you can create an array through allocation and initialization, class factory methods, or array literals.

There are a variety of different initialization and factory methods available, depending on the number of objects.

```
+ (id)arrayWithObject:(id)anObject;
+ (id)arrayWithObjects:(id)firstObject, ...;
- (id)initWithObjects:(id)firstObject, ...;
```

Because the `arrayWithObjects:` and `initWithObjects:` methods both take a `nil`-terminated, variable number of arguments, you must include `nil` as the last value.

```
NSArray *someArray =
[NSArray arrayWithObjects:someObject, someString, someNumber, someValue, nil];
```

This example creates an array like the one shown earlier. The first object, `someObject`, will have an array index of `0`; the last object, `someValue`, will have an index of `3`.

It's possible to truncate the list of items unintentionally if one of the provided values is `nil`.

```
id firstObject = @"someString";
id secondObject = nil;
id thirdObject = @"anotherString";
NSArray *someArray =
  [NSArray arrayWithObjects:firstObject, secondObject, thirdObject, nil];
```

In this case, `someArray` contains only `firstObject`, because `secondObject`, which is `nil`, is interpreted as the end of the list of items.

It's possible to create an array literal using a compact syntax.

```
NSArray *someArray = @[firstObject, secondObject, thirdObject];
```

When using this syntax, don't terminate the list of objects with `nil`—in fact, `nil` is an invalid value. For example, you'll get an exception at runtime if you try to execute the following code:

```
id firstObject = @"someString";
```

```
id secondObject = nil;
NSArray *someArray = @[firstObject, secondObject];
// exception: "attempt to insert nil object"
```

Querying Array Objects

After you've created an array, you can query it for information—such as how many objects it has or whether it contains a given item.

```
NSUInteger numberOfItems = [someArray count];

if ([someArray containsObject:someString]) {
    ...
}
```

You can also query the array for an item at a given index. If you attempt to request an invalid index, you'll get an out-of-bounds exception at runtime. To avoid getting an exception, always check the number of items first.

```
if ([someArray count] > 0) {
    NSLog(@"First item is: %@", [someArray objectAtIndex:0]);
}
```

This example checks to see whether the number of items is greater than zero. If it is, the Foundation function `NSLog` logs a description of the first item, which has an index of `0`.

As an alternative to using `objectAtIndex:`, you can also query the array using a subscript syntax, which is just like accessing a value in a standard C array. The previous example can be rewritten like this:

```
if ([someArray count] > 0) {
    NSLog(@"First item is: %@", someArray[0]);
}
```

Sorting Array Objects

The `NSArray` class offers a variety of methods to sort its collected objects. Because `NSArray` is immutable, each of these methods returns a new array containing the items in the sorted order.

For example, you can sort an array of strings by calling `compare:` on each string.

```
NSArray *unsortedStrings = @[@"gammaString", @"alphaString", @"betaString"];
NSArray *sortedStrings =
         [unsortedStrings sortedArrayUsingSelector:@selector(compare:)];
```

Mutability

Although the NSArray class itself is immutable, it can nevertheless contain mutable objects. For example, if you add a mutable string to an immutable array, like this:

```
NSMutableString *mutableString = [NSMutableString stringWithString:@"Hello"];
NSArray *immutableArray = @[mutableString];
```

there's nothing to stop you from mutating the string.

```
if ([immutableArray count] > 0) {
    id string = immutableArray[0];
    if ([string isKindOfClass:[NSMutableString class]]) {
        [string appendString:@" World!"];
    }
}
```

If you want to add or remove objects from an array after initial creation, use NSMutableArray, which adds a variety of methods to add, remove, or replace one or more objects.

```
NSMutableArray *mutableArray = [NSMutableArray array];
[mutableArray addObject:@"gamma"];
[mutableArray addObject:@"alpha"];
[mutableArray addObject:@"beta"];

[mutableArray replaceObjectAtIndex:0 withObject:@"epsilon"];
```

This example creates an array made up of the objects @"epsilon", @"alpha", and @"beta".

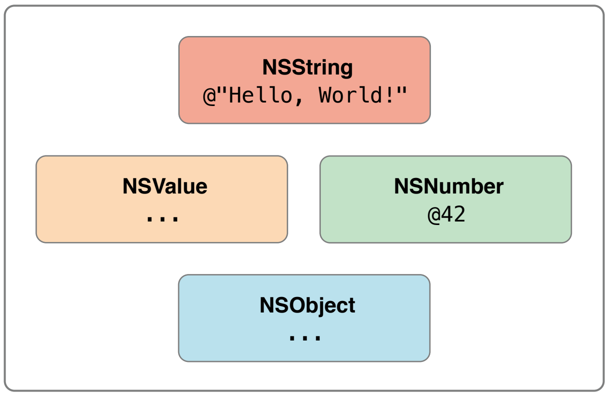
It's also possible to sort a mutable array in place, without creating a secondary array.

```
[mutableArray sortUsingSelector:@selector(caseInsensitiveCompare:)];
```

In this case, the contained items are sorted into the ascending, case-insensitive order `@"alpha"`, `@"beta"`, and `@"epsilon"`.

Sets

A **set** (`NSSet`) object is similar to an array, but it maintains an unordered group of distinct objects.



Because sets don't maintain order, they offer faster performance than arrays do when it comes to testing for membership.

Because the basic `NSSet` class is immutable, its contents must be specified at creation, using either allocation and initialization or a class factory method.

```
NSSet *simpleSet =
  [NSSet setWithObjects:@"Hello, World!", @42, aValue, anObject, nil];
```

As with `NSArray`, the `initWithObjects:` and `setWithObjects:` methods both take a `nil`-terminated, variable number of arguments. The name of the mutable `NSSet` subclass is `NSMutableSet`.

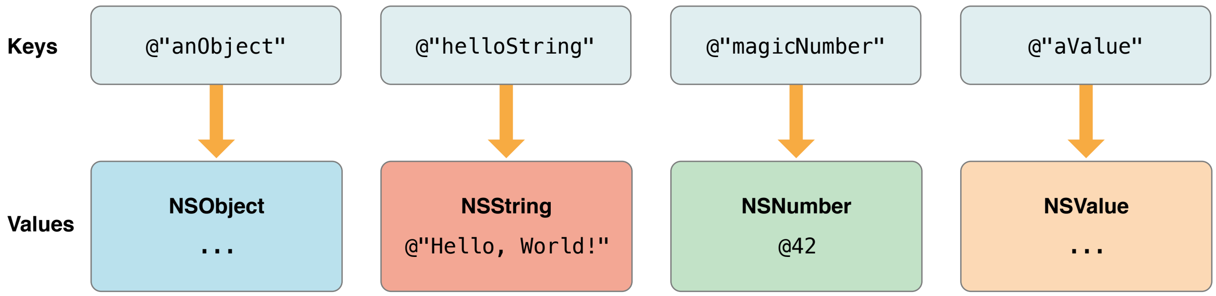
Sets store only one reference to an individual object, even if you try adding an object more than once.

```
    NSNumber *number = @42;
    NSSet *numberSet =
      [NSSet setWithObjects:number, number, number, number, nil];
    // numberSet only contains one object
```

Dictionaries

Rather than simply maintaining an ordered or unordered collection of objects, a **dictionary** (`NSDictionary`) stores objects associated with given keys, which can then be used for retrieval.

The best practice is to use string objects as dictionary keys.



Although you can use other objects as keys, keep in mind that each key is copied for use by a dictionary and so must support `NSCopying`. If you want to use key-value coding, however, you must use string keys for dictionary objects (to learn more, see *Key-Value Coding Programming Guide*).

Creating Dictionaries

You can create dictionaries using either allocation and initialization, or class factory methods, like this:

```
NSDictionary *dictionary = [NSDictionary dictionaryWithObjectsAndKeys:
               someObject, @"anObject",
         @"Hello, World!", @"helloString",
                      @42, @"magicNumber",
                someValue, @"aValue",
                      nil];
```

For the `dictionaryWithObjectsAndKeys:` and `initWithObjectsAndKeys:` methods, each object is specified before its key, and the list of objects and keys must be `nil` terminated.

Objective-C offers a concise syntax for dictionary literal creation.

```
NSDictionary *dictionary = @{
              @"anObject" : someObject,
           @"helloString" : @"Hello, World!",
           @"magicNumber" : @42,
                @"aValue" : someValue
```

```
};
```

For dictionary literals, the key is specified before its object, and the list of objects and keys is not `nil` terminated.

Querying Dictionaries

After you've created a dictionary, you can ask it for the object stored against a given key.

```
NSNumber *storedNumber = [dictionary objectForKey:@"magicNumber"];
```

If the object isn't found, the `objectForKey:` method returns `nil`.

There's also a subscript syntax alternative to using `objectForKey:`.

```
NSNumber *storedNumber = dictionary[@"magicNumber"];
```

Mutability

If you need to add or remove objects from a dictionary after creation, use the `NSMutableDictionary` subclass.

```
[dictionary setObject:@"another string" forKey:@"secondString"];
[dictionary removeObjectForKey:@"anObject"];
```

Represent nil with NSNull

It's not possible to add `nil` to the collection classes described in this section because `nil` in Objective-C means "no object." If you need to represent "no object" in a collection, use the `NSNull` class.

```
NSArray *array = @[ @"string", @42, [NSNull null] ];
```

With `NSNull`, the `null` method always returns the same instance. Classes that behave in this way are called **singleton classes**. You can check to see whether an object in an array is equal to the shared `NSNull` instance like this:

```
for (id object in array) {
    if (object == [NSNull null]) {
        NSLog(@"Found a null object");
    }
```

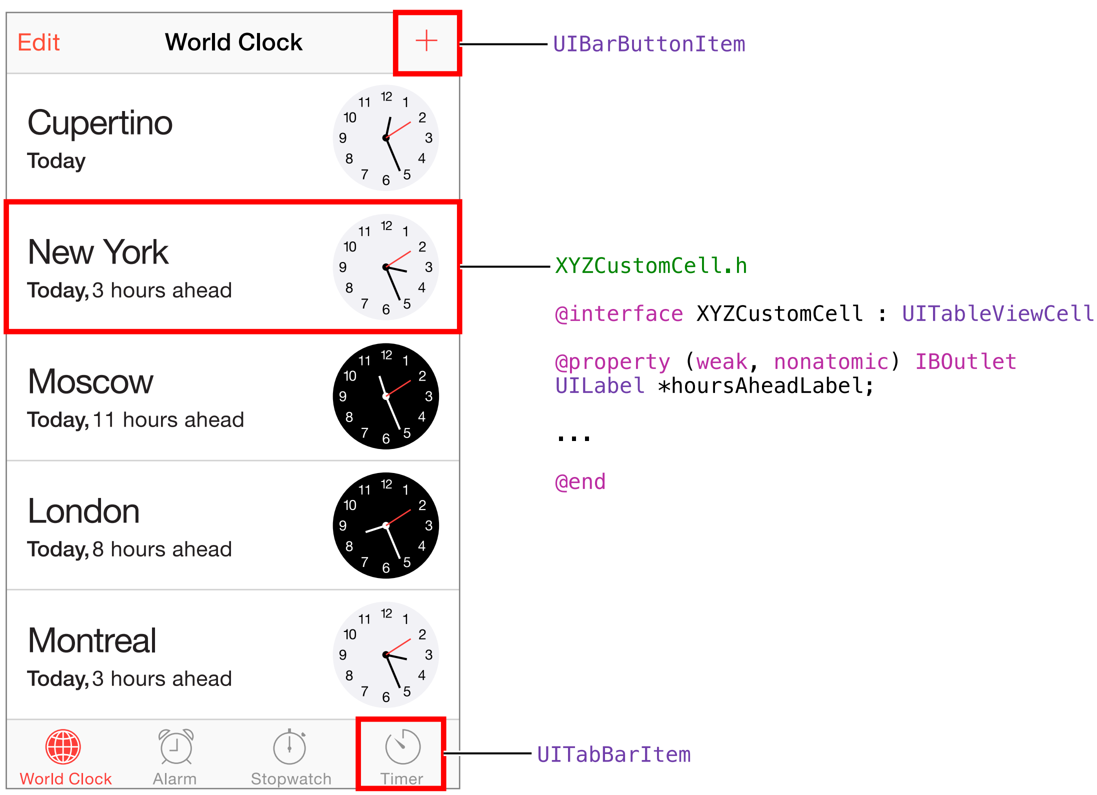
```
}
```

Although the Foundation framework contains many more capabilities than are described here, you don't need to know every single detail right away. If you do want to learn more about Foundation, take a look at *Foundation Framework Reference* . For now, you have enough information to continue implementing your ToDoList app, which you'll do by writing a custom data class.

Writing a Custom Class

As you develop iOS apps, you'll find many occasions when you need to write your own custom classes. Custom classes are useful when you need to package custom behavior together with data. In a custom class, you can define your own behaviors for storing, manipulating, and displaying your data.

For example, consider the World Clock tab in the iOS Clock app. The cells in this table view need to display more content than a standard table view cell. This is a good opportunity to implement a subclass that extends the behavior of `UITableViewCell` to let you display additional custom data for a given table view cell. If you were designing this custom class, you might add outlets for a label to display the hours ahead information and an image view to display the custom clock on the right of the cell.



This chapter teaches you what you need to know about Objective-C syntax and class structure to finish implementing the behavior of your ToDoList app. It discusses the design of `XYZToDoItem`, the custom class that will represent a single item on your to-do list. In the third tutorial, you'll actually implement this class and add it to your app.

Declaring and Implementing a Class

The specification of a class in Objective-C requires two distinct pieces: the interface and the implementation. The **interface** specifies exactly how a given type of object is intended to be used by other objects. In other words, it defines the public interface between instances of the class and the outside world. The **implementation** includes the executable code for each method declared in the interface.

An object should be designed to hide the details of its internal implementation. In Objective-C, the interface and implementation are usually placed in separate files so that you need to make only the interface public. As with C code, you define header files and source files to separate public declarations from the implementation details of your code. Interface files have a `.h` extension, and implementation files have a `.m` extension. (You'll actually create these files for the `XYZToDoItem` class in "Tutorial: Add Data" (page 93)—for now, just follow along as all of the pieces are introduced.)

Interface

The Objective-C syntax used to declare a class interface looks like this:

```
@interface XYZToDoItem : NSObject


@end
```

This example declares a class named `XYZToDoItem`, which inherits from `NSObject`.

The public properties and behavior are defined inside the `@interface` declaration. In this example, nothing is specified beyond the superclass, so the only behavior expected to be available on instances of `XYZToDoItem` is the behavior inherited from `NSObject`. All objects are expected to have a minimum behavior, so by default, they must inherit from `NSObject` (or one of its subclasses).

Implementation

The Objective-C syntax used to declare a class implementation looks like this:

```
#import "XYZToDoItem.h"


@implementation XYZToDoItem


@end
```

If you declare any methods in the class interface, you'll need to implement them inside this file.

Properties Store an Object's Data

Consider what information the to-do item needs to hold. You probably need to know its name, when it was created, and whether it's been completed. In your custom `XYZToDoItem` class, you'll store this information in **properties**.

Declarations for these properties reside inside the interface file (`XYZToDoItem.h`). Here's what they look like:

```
@interface XYZToDoItem : NSObject

@property NSString *itemName;
@property BOOL completed;
@property NSDate *creationDate;

@end
```

In this example, the `XYZToDoItem` class declares three public properties. These properties are available for full public access. With public access, other objects can both read and change the values of the properties.

You may decide to declare that a property shouldn't be changed (that is, that it should be read-only). To indicate whether a property is intended to be read-only—among other things—Objective-C property declarations include **property attributes**. For example, if you don't want the creation date of an `XYZToDoItem` to be changeable, you might update the `XYZToDoItem` class interface to look like this:

```
@interface XYZToDoItem : NSObject

@property NSString *itemName;
@property BOOL completed;
@property (readonly) NSDate *creationDate;

@end
```

Properties can be private or public. Sometimes it makes sense to make a property private so that other classes can't see or access it. For example, if you want to keep track of a property that represents the date an item was marked as completed without giving other classes access to this information, make the property private by putting it in a **class extension** at the top of your implementation file (`XYZToDoItem.m`).

```
#import "XYZToDoItem.h"
```

```
@interface XYZToDoItem ()
@property NSDate *completionDate;
@end

@implementation XYZToDoItem

@end
```

You access properties using getters and setters. A **getter** returns the value of a property, and a **setter** changes it. A common syntactical shorthand for accessing getters and setters is **dot notation**. For properties with read and write access, you can use dot notation for both getting and setting a property's value. If you have an object `toDoItem` of class `XYZToDoItem`, you can do the following:

```
toDoItem.itemName = @"Buy milk";                //Sets the value of itemName
NSString *selectedItemName = toDoItem.itemName;  //Gets the value of itemName
```

Methods Define an Object's Behavior

Methods define what an object can do. A **method** is a piece of code that you define to perform a task or subroutine in a class. Methods have access to data stored in the class and can use that information to perform some kind of operation.

For example, to give a to-do item (`XYZToDoItem`) the ability to get marked as complete, you can add a `markAsCompleted` method to the class interface. Later, you'll implement this method's behavior in the class implementation, as described in "Implementing Methods" (page 91).

```
@interface XYZToDoItem : NSObject

@property NSString *itemName;
@property BOOL completed;
@property (readonly) NSDate *creationDate;
- (void)markAsCompleted;

@end
```

The minus sign (-) at the front of the method name indicates that it is an **instance method**, which can be called on an object of that class. This minus sign differentiates it from class methods, which are denoted with a plus sign (+). **Class methods** can be called on the class itself. A common example of class methods are class factory methods, which you learned about in "Working with Foundation" (page 75). You can also use class methods to access some piece of shared information associated with the class.

The `void` keyword is used inside parentheses at the beginning of the declaration to indicate that the method doesn't return a value. In this case, the `markAsCompleted` method takes in no parameters. Parameters are discussed in more detail in "Method Parameters" (page 90).

Method Parameters

You declare methods with **parameters** to pass along some piece of information when you call a method.

For example, you can revise the `markAsCompleted` method from the previous code snippet to take in a single parameter that will determine whether the item gets marked as completed or uncompleted. This way, you can toggle the completion state of the item instead of setting it only as completed.

```
@interface XYZToDoItem : NSObject

@property NSString *itemName;
@property BOOL completed;
@property (readonly) NSDate *creationDate;
- (void)markAsCompleted:(BOOL)isComplete;

@end
```

Now, your method takes in one parameter, `isComplete`, which is of type `BOOL`.

When you refer to a method with a parameter by name, you include the colon as part of the method name, so the name of the updated method is now `markAsCompleted:`. If a method has multiple parameters, the method name is broken up and interspersed with the parameter names. If you wanted to add another parameter to this method, its declaration would look like this:

```
- (void)markAsCompleted:(BOOL)isComplete onDate:(NSDate *)date;
```

Here, the method's name is written as `markAsCompleted:onDate:`. The names `isComplete` and `date` are used in the implementation to access the values supplied when the method is called, as if these names were variables.

Implementing Methods

Method implementations use braces to contain the relevant code. The name of the method must be identical to its counterpart in the interface file, and the parameter and return types must match exactly.

Here is a simple implementation of the `markAsCompleted:` method you added to your `XYZToDoItem` class interface:

```
@implementation XYZToDoItem
- (void)markAsCompleted:(BOOL)isComplete {
    self.completed = isComplete;
}
@end
```

Like properties, methods can be private or public. Public methods are declared in the public interface and so can be seen and called by other objects. Their corresponding implementation resides in the implementation file and can't be seen by other objects. Private methods have only an implementation and are internal to the class, meaning they're only available to call inside the class implementation. This is a powerful mechanism for adding internal behavior to a class without allowing other objects access to it.

For example, say you want to keep a to-do item's `completionDate` updated. If the to-do item gets marked as completed, set `completionDate` to the current date. If it gets marked as uncompleted, set `completionDate` to `nil`, because it hasn't been completed yet. Because updating the to-do item's `completionDate` is a self-contained task, the best practice is to write its own method for it. However, it's important to make sure that other objects can't call this method—otherwise, another object could set the to-do item's `completionDate` to anything at any time. For this reason, you make this method private.

Now, update the implementation of `XYZToDoItem` to include the private method `setCompletionDate` that gets called inside `markAsCompleted:` to update the to-do item's `completionDate` whenever it gets marked as completed or uncompleted. Notice that you're not adding anything to the interface file, because you don't want other objects to see this method.

```
@implementation XYZToDoItem
- (void)markAsCompleted:(BOOL)isComplete {
    self.completed = isComplete;
    [self setCompletionDate];
}
- (void)setCompletionDate {
    if (self.completed) {
        self.completionDate = [NSDate date];
```

```
    } else {
        self.completionDate = nil;
    }
}
@end
```

At this point, you've defined a basic representation of a to-do list item using the `XYZToDoItem` class. `XYZToDoItem` stores information about itself—name, creation date, completion state—in the form of properties, and it defines what it can do—get marked as completed or uncompleted—using a method. This is the extent of the features you need to finish implementing your ToDoList app in the next tutorial. However, you can always experiment by adding your own properties and methods to the class to integrate new behavior into your app.

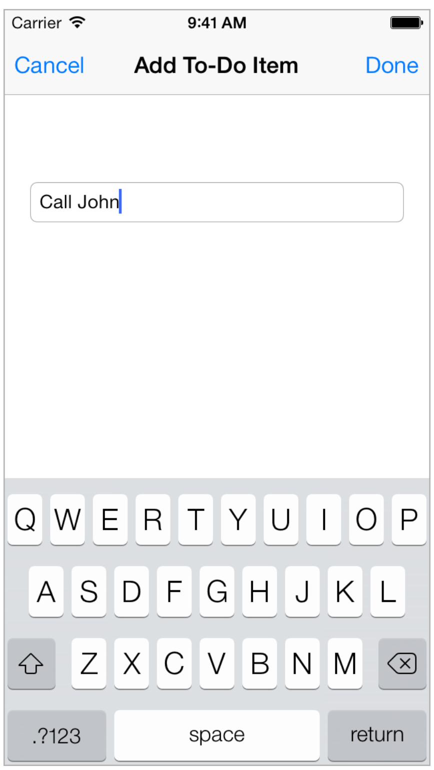
Tutorial: Add Data

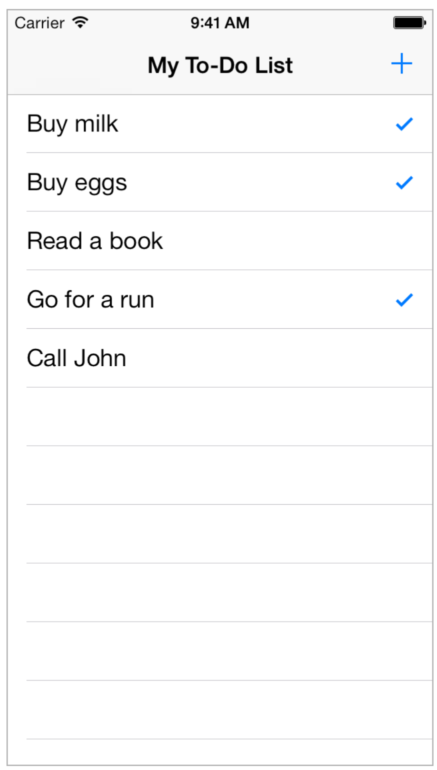
This tutorial builds on the project you created in the second tutorial ("Tutorial: Storyboards" (page 47)). You'll use what you learned about using design patterns, working with Foundation, and writing a custom class to add support for dynamic data to your ToDoList app.

This tutorial teaches you how to:

- Work with common Foundation classes
- Create custom data classes
- Implement a delegate and data source protocol
- Pass data between view controllers

After you complete all the steps in this tutorial, you'll have an app that looks something like this:





Create a Data Class

To get started, open your existing project in Xcode.

At this point, you have an interface and a navigation scheme for your ToDoList app using storyboards. Now, it's time to add data storage and behavior with model objects.

The goal of your app is to create a list of to-do items, so first you'll create a custom class, `XYZToDoItem`, to represent an individual to-do item. As you recall, the `XYZToDoItem` class was discussed in "Writing a Custom Class" (page 86).

To create the XYZToDoItem class

1. Choose File > New > File (or press Command-N).

   A dialog appears that prompts you to choose a template for your new file.

2. On the left, select Cocoa Touch under iOS.
3. Select Objective-C Class, and click Next.
4. In the Class field, type `ToDoItem` after the `XYZ` prefix.
5. Choose NSObject from the "Subclass of" pop-up menu.

   If you've been following along with the tutorials exactly, the Class title probably said `XYZToDoItemViewController` prior to this step. When you choose NSObject as the "Subclass of," Xcode knows you're making a normal custom class and removes the `ViewController` text that it was adding previously.

6. Click Next.
7. The save location defaults to your project directory. Leave that as is.
8. The Group option defaults to your app name, ToDoList. Leave that as is.
9. The Targets section defaults to having your app selected and the tests for your app unselected. That's perfect, so leave that as is.
10. Click Create.

The `XYZToDoItem` class is straightforward to implement. It has properties for its name, creation date, and whether the item has been completed. Go ahead and add these properties to the `XYZToDoItem` class interface.

To configure the XYZToDoItem class

1. In the project navigator, select `XYZToDoItem.h`.
2. Add the following properties to the interface so that the declaration looks like this:

```
@interface XYZToDoItem : NSObject

@property NSString *itemName;
@property BOOL completed;
@property (readonly) NSDate *creationDate;

@end
```

Checkpoint: Build your project by choosing Product > Build (or pressing Command-B). You're not using your new class for anything yet, but building it gives the compiler a chance to verify that you haven't made any typing mistakes. If you have, fix them by reading through the warnings or errors that the compiler provides, and then look back over the instructions in this tutorial to make sure everything looks the way it's described here.

Load the Data

You now have a class from which you can create and store the data for individual list items. You also need to keep a list of those items. The natural place to track this is in the `XYZToDoListViewController` class—view controllers are responsible for coordinating between the model and the view, so they need a reference to the model.

The Foundation framework includes a class, `NSMutableArray`, that works well for tracking lists of items. It's important to use a mutable array so that the user can add items to the array. The immutable version, `NSArray`, doesn't allow you to add items to it after it's initialized.

To use an array you need to both declare it and create it. You do this by allocating and initializing the array.

To allocate and initialize the array

1. In the project navigator, select `XYZToDoListViewController.m`.

   Because the array of items is an implementation detail of your table view controller, you declare it in the .m file instead of the .h file. This makes it private to your custom class.

2. Add the following property to the interface category Xcode created in your custom table view controller class. The declaration should look like this:

```
@interface XYZListViewController ()
```

```
@property NSMutableArray *toDoItems;

@end
```

3. Allocate and initialize the `toDoItems` array in the `viewDidLoad` method:

```
- (void)viewDidLoad
{
    [super viewDidLoad];
    self.toDoItems = [[NSMutableArray alloc] init];
}
```

The actual code for `viewDidLoad` includes some additional lines—inserted by Xcode when it created `XYZListViewController`—that are commented out. Feel free to leave them in.

At this point, you have an array that you can add items to. You'll do this in a separate method, `loadInitialData`, which you'll call from `viewDidLoad`. This code goes in its own method because it's a modular task, and you can improve code readability by making this method separate. In a real app this method would load the data from some sort of persistent store, such as a file. For now, the goal is to see how a table view works with custom data items, so you'll create some test data to experiment with.

Create an item in the way you created the array: Allocate and initialize. Then, give the item a name. This is the name that will be shown in the table view. Do this for a couple of items.

To load initial data

1. Add a new method, `loadInitialData`, below the `@implementation` line.

```
- (void)loadInitialData {
}
```

2. In this method, create a few list items, and add them to the array.

```
- (void)loadInitialData {
    XYZToDoItem *item1 = [[XYZToDoItem alloc] init];
    item1.itemName = @"Buy milk";
    [self.toDoItems addObject:item1];
```

```
    XYZToDoItem *item2 = [[XYZToDoItem alloc] init];
    item2.itemName = @"Buy eggs";
    [self.toDoItems addObject:item2];
    XYZToDoItem *item3 = [[XYZToDoItem alloc] init];
    item3.itemName = @"Read a book";
    [self.toDoItems addObject:item3];
}
```

3. Call the `loadInitialData` in the `viewDidLoad` method.

```
- (void)viewDidLoad
{
    [super viewDidLoad];
    self.toDoItems = [[NSMutableArray alloc] init];
    [self loadInitialData];
}
```

Checkpoint: Build your project by choosing Product > Build. You should see numerous errors for the lines of your `loadInitialData` method. The key to what's gone wrong is the first line, which should say "Use of undeclared identifier XYZToDoItem." This means that the compiler doesn't know about your `XYZToDoItem` when it's compiling `XYZToDoListViewController`. Compilers are very particular and need to be told explicitly what to pay attention to.

To tell the compiler to pay attention to your custom list item class

1. Find the `#import "XYZToDoListViewController.h"` line near the top of the `XYZToDoListViewController.m` file.
2. Add the following line immediately below it:

```
#import "XYZToDoItem.h"
```

Checkpoint: Build your project by choosing Product > Build. It should build without errors.

Display the Data

At this point, your table view has a mutable array that's prepopulated with some sample to-do items. Now you need to display the data in the table view.

You'll do this by making `XYZToDoListViewController` a data source of the table view. To make something a data source of the table view, it needs to implement the `UITableViewDataSource` protocol. It turns out that the methods you need to implement are exactly the ones you commented out in the second tutorial. To have a functioning table view requires three methods. The first of these is `numberOfSectionsInTableView:`, which tells the table view how many sections to display. For this app, you want the table view to display a single section, so the implementation is straightforward.

To display a section in your table

1. In the project navigator, select `XYZToDoListViewController.m`.
2. If you commented out the table view data source methods in the second tutorial, remove those comment markers now.
3. Find the section of the template implementation that looks like this.

```
- (NSInteger)numberOfSectionsInTableView:(UITableView *)tableView
{
#warning Potentially incomplete method implementation.
    // Return the number of sections.
    return 0;
}
```

   You want a single section, so you want to remove the warning line and change the return value from 0 to 1.

4. Change the `numberOfSectionsInTableView:` data source method to return a single section, like this:

```
- (NSInteger)numberOfSectionsInTableView:(UITableView *)tableView
{
    // Return the number of sections.
    return 1;
}
```

The next method, `tableView:numberOfRowsInSection:`, tells the table view how many rows to display in a given section. You have a single section in your table, and each to-do item should have its own row in the table view. That means that the number of rows should be the number of `XYZToDoItem` objects in your `toDoItems` array.

To return the number of rows in your table

1. In the project navigator, select `XYZToDoListViewController.m`.
2. Find the section of the template implementation that looks like this:

```
- (NSInteger)tableView:(UITableView *)tableView
numberOfRowsInSection:(NSInteger)section
{
#warning Incomplete method implementation.
    // Return the number of rows in the section.
    return 0;
}
```

   You want to return the number of list items you have. Fortunately, `NSArray` has a handy method called `count` that returns the number of items in the array, so the number of rows is `[self.toDoItems count]`.

3. Change the `tableView:numberOfRowsInSection:` data source method to return the appropriate number of rows.

```
- (NSInteger)tableView:(UITableView *)tableView
numberOfRowsInSection:(NSInteger)section
{
    // Return the number of rows in the section.
    return [self.toDoItems count];
}
```

The last method, `tableView:cellForRowAtIndexPath:`, asks for a cell to display for a given row. Up until now, you've been working with code only, but the cell to display for a row is very much part of your interface. Fortunately, Xcode makes it easy to design custom cells in Interface Builder. The first task is to design your cell and to tell the table view that instead of using static content, it's going to be using prototype cells with dynamic content.

To configure your table view

1. Open your storyboard.

2. Select the table view in the outline.
3. With the table view selected, open the Attributes inspector in the utility area.
4. In the Attributes inspector, change the table view's Content attribute from Static Cells to Dynamic Prototypes.

Interface Builder takes the static cells you configured and converts them all into prototypes. Prototype cells, as the name implies, are cells that are configured with text styles, colors, images, or other attributes as you want them to be displayed but that get their data from the data source at runtime. The data source loads a prototype cell for each row and then configures that cell to display the data for the row.

To load the correct cell, the data source needs to know what it's called, and that name must also be configured in the storyboard.

While you're setting the prototype cell name, you'll also configure another property—the cell selection style, which determines a cell's appearance when a user taps it. Set the cell selection style to None so that the cell won't be highlighted when a user taps it. This is the behavior you want your cells to have when a user taps an item in the to-do list to mark it as completed or uncompleted—a feature you'll implement later in this tutorial.

To configure the prototype cell

1. Select the first table view cell in your table.
2. In the Attributes inspector, locate the Identifier field and type `ListPrototypeCell`.
3. In the Attributes inspector, locate the Selection field and choose None.

You could also change the font or other attributes of the prototype cell. The basic configuration is easy to work with, so you'll keep that.

The next step is to teach your data source how to configure the cell for a given row by implementing `tableView:cellForRowAtIndexPath:`. This data source method is called by the table view when it wants to display a given row. For table views with a small number of rows, all rows may be onscreen at once, so this method gets called for each row in your table. But table views with a large number of rows display only a small fraction of their total items at a given time. It's most efficient for table views to only ask for the cell for rows that are being displayed, and that's what `tableView:cellForRowAtIndexPath:` allows the table view to do.

For any given row in the table, fetch the corresponding entry in the `toDoItems` array and then set the cell's text label to the item's name.

To display cells in your table

1. In the project navigator, select `XYZToDoListViewController.m`.

2. Find the `tableView:cellForRowAtIndexPath:` data source method. The template implementation looks like this:

```
- (UITableViewCell *)tableView:(UITableView *)tableView
cellForRowAtIndexPath:(NSIndexPath *)indexPath
{
    static NSString *CellIdentifier = @"Cell";
    UITableViewCell *cell = [tableView
dequeueReusableCellWithIdentifier:CellIdentifier forIndexPath:indexPath];


    // Configure the cell...


    return cell;
}
```

   The template performs several tasks. It creates a variable to hold the identifier for the cell, asks the table view for a cell with that identifier, adds a comment about where code to configure the cell should go, and then returns the cell.

   To make this code work for your app, you'll need to change the identifier to the one you set in the storyboard and then add code to configure the cell.

3. Change the cell identifier to the one you set in the storyboard. To avoid typos, copy and paste from the storyboard to the implementation file. The cell identifier line should now look like this:

```
static NSString *CellIdentifier = @"ListPrototypeCell";
```

4. Just before the return statement, add the following lines of code:

```
XYZToDoItem *toDoItem = [self.toDoItems objectAtIndex:indexPath.row];
cell.textLabel.text = toDoItem.itemName;
```

Your `tableView:cellForRowAtIndexPath:` method should look like this:

```
- (UITableViewCell *)tableView:(UITableView *)tableView
cellForRowAtIndexPath:(NSIndexPath *)indexPath
{
    static NSString *CellIdentifier = @"ListPrototypeCell";
```

```
    UITableViewCell *cell = [tableView
dequeueReusableCellWithIdentifier:CellIdentifier forIndexPath:indexPath];
    XYZToDoItem *toDoItem = [self.toDoItems objectAtIndex:indexPath.row];
    cell.textLabel.text = toDoItem.itemName;
    return cell;
}
```

Checkpoint: Run your app. The list of items you added in `loadInitialData` should show up as cells in your table view.

Mark Items as Completed

A to-do list isn't much good if you can never mark items as completed. Now, you'll add support for that. A simple interface would be to have the completion state toggle when the user taps the cell and to display completed items with a checkmark next to them. Fortunately, table views come with some built-in behavior that you can take advantage of to implement this simple interface—specifically, table views notify their delegate when the user taps a cell. So the task is to write the code that will respond to the user tapping a to-do item in the table.

Xcode already made `XYZToDoListViewController` the delegate of the table view when you configured it in the storyboard. All you have to do is implement the `tableView:didSelectRowAtIndexPath:` delegate method to respond to user taps and update your to-do list items appropriately.

When a cell gets selected, the table view calls the `tableView:didSelectRowAtIndexPath:` delegate method to see how it should handle the selection. In this method, you'll write code to update the to-do item's completion state.

To mark an item as completed or uncompleted

1. In the project navigator, select `XYZToDoListViewController.m`.
2. Add the following lines to the end of the file, just above the `@end` line:

```
#pragma mark - Table view delegate


- (void)tableView:(UITableView *)tableView
didSelectRowAtIndexPath:(NSIndexPath *)indexPath
{
```

```
}
```

Try typing the second line instead of just copying and pasting. You'll find that **code completion** is one of the great time-saving features of Xcode. When Xcode brings up the list of potential completions, scroll through the list until you find the one you want and then press Return. Xcode inserts the whole line for you.

3. You want to respond to taps but not actually leave the cell selected. Add the following code to deselect the cell immediately after selection:

```
[tableView deselectRowAtIndexPath:indexPath animated:NO];
```

4. Find the corresponding `XYZToDoItem` in your `toDoItems` array.

```
XYZToDoItem *tappedItem = [self.toDoItems objectAtIndex:indexPath.row];
```

5. Toggle the completion state of the tapped item.

```
tappedItem.completed = !tappedItem.completed;
```

6. Tell the table view to reload the row whose data you just updated.

```
[tableView reloadRowsAtIndexPaths:@[indexPath]
withRowAnimation:UITableViewRowAnimationNone];
```

Your `tableView:didSelectRowAtIndexPath:` method should look like this:

```
- (void)tableView:(UITableView *)tableView didSelectRowAtIndexPath:(NSIndexPath
*)indexPath
{
    [tableView deselectRowAtIndexPath:indexPath animated:NO];
    XYZToDoItem *tappedItem = [self.toDoItems objectAtIndex:indexPath.row];
    tappedItem.completed = !tappedItem.completed;
    [tableView reloadRowsAtIndexPaths:@[indexPath]
withRowAnimation:UITableViewRowAnimationNone];
}
```

Checkpoint: Run your app. The list of items you added in `loadInitialData` is visible as cells in your table view. But when you tap items, nothing seems to happen. Why not?

The reason is that you haven't configured the table view cell to display the completion state of an item. To do so, you need to go back to the `tableView:cellForRowAtIndexPath:` method and configure the cell to display an indicator when an item is completed.

One way to indicate that an item is completed is to put a checkmark next to it. Luckily, table view cells can have a cell accessory on the right side. By default, there's no accessory; however, you can change the cell to display a different accessory, one of which is a checkmark. All you have to do is set the cell accessory based on the completion state of the to-do item.

To display an item's completion state

1. Go to the `tableView:cellForRowAtIndexPath:` method.
2. Add the following code just below the line that sets the text label of the cell:

```
if (toDoItem.completed) {
    cell.accessoryType = UITableViewCellAccessoryCheckmark;
} else {
    cell.accessoryType = UITableViewCellAccessoryNone;
}
```

Your `tableView:cellForRowAtIndexPath:` method should now look like this:

```
- (UITableViewCell *)tableView:(UITableView *)tableView
cellForRowAtIndexPath:(NSIndexPath *)indexPath
{
    static NSString *CellIdentifier = @"ListPrototypeCell";
    UITableViewCell *cell = [tableView
dequeueReusableCellWithIdentifier:CellIdentifier forIndexPath:indexPath];
    XYZToDoItem *toDoItem = [self.toDoItems objectAtIndex:indexPath.row];
    cell.textLabel.text = toDoItem.itemName;
    if (toDoItem.completed) {
        cell.accessoryType = UITableViewCellAccessoryCheckmark;
    } else {
        cell.accessoryType = UITableViewCellAccessoryNone;
    }
```

```
    return cell;
}
```

Checkpoint: Run your app. The list of items you added in `loadInitialData` is visible as cells in your table view. When you tap an item, a checkmark should appear next to it. If you tap the same item again, the checkmark disappears.

Add New Items

The final step in creating the to-do list app's functionality is implementing the ability to add an item. When a user enters an item name in the text field on the `XYZAddToDoItemViewController` scene and taps the Done button, you want the view controller to create a new list item and pass it back to the `XYZToDoListViewController` to display in the to-do list.

First, you need to have a list item to configure. Just as with the table view, the view controller is the logical place to connect the interface to the model. Give the `XYZAddToDoItemViewController` a property to hold the new to-do item.

To add an XYZToDoItem to the XYZAddToDoItemViewController class

1. In the project navigator, select `XYZToDoListViewController.h`.

   Because you'll need to access the list item from your table view controller later on, it's important to make this a public property. That's why you declare it in the interface file, `XYZAddToDoItemViewController.h`, instead of in the implementation file, `XYZAddToDoItemViewController.m`.

2. Add an import declaration to the `XYZToDoItem` class above the `@interface` line.

   ```
   #import "XYZToDoItem.h"
   ```

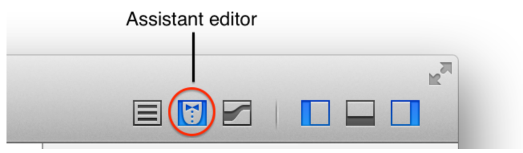
3. Add a `toDoItem` property to the interface.

   ```
   @interface XYZAddToDoItemViewController : UIViewController

   @property XYZToDoItem *toDoItem;

   @end
   ```

To get the name of the new item, the view controller needs access to the contents of the text field where the user enters the name. To do this, create a connection from the XYZAddToDoItemViewController class that connects to the text field in your storyboard.

To connect the text field to your view controller

1. In the outline view, select the XYZAddToDoItemViewController object.
2. Click the Assistant button in the upper right of the window's toolbar to open the assistant editor.

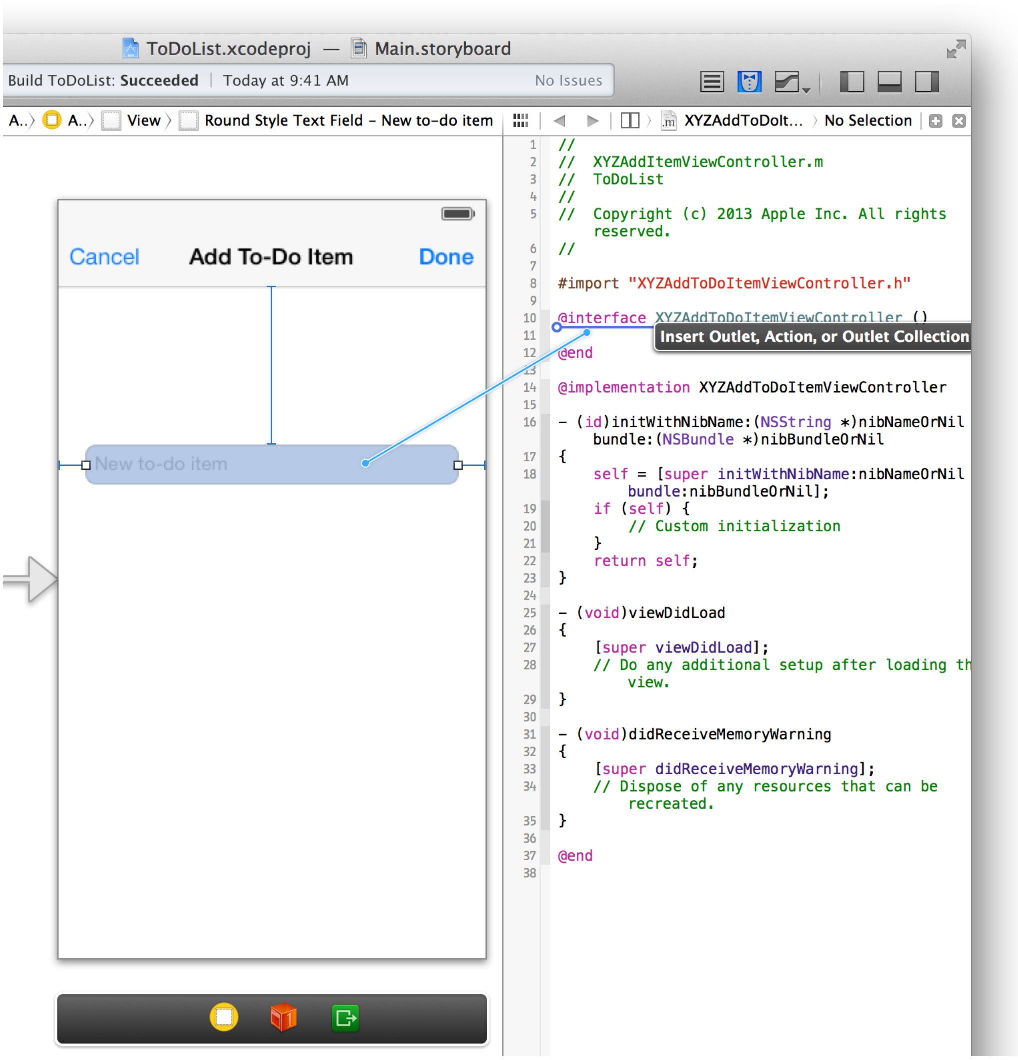


   The editor on the right should appear with XYZAddToDoItemViewController.m displayed. If it isn't displayed, click the filename in the editor on the right and choose XYZAddToDoItemViewController.m.

   The assistant editor allows you to have two files open at once, making it possible to perform operations between them—for example, tying a property in your source file with an object in your interface.

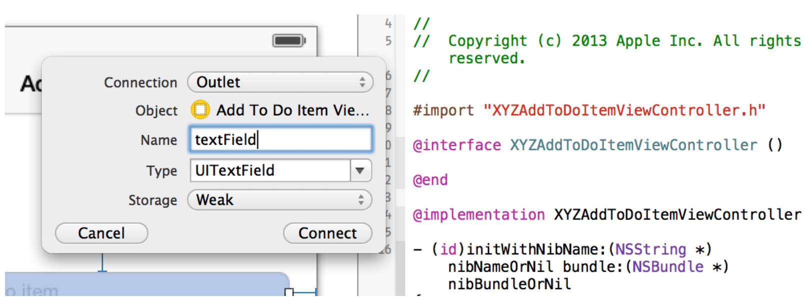
3. Select the text field in your storyboard.

4. Control-drag from the text field on your canvas to the code display in the editor on the right, stopping the drag at the line just below the `@interface` line in `XYZAddToDoItemViewController.m`.



5. In the dialog that appears, for Name, type `textField`.

   Leave the rest of the options as they are. Your dialog should look like this:



6. Click Connect.

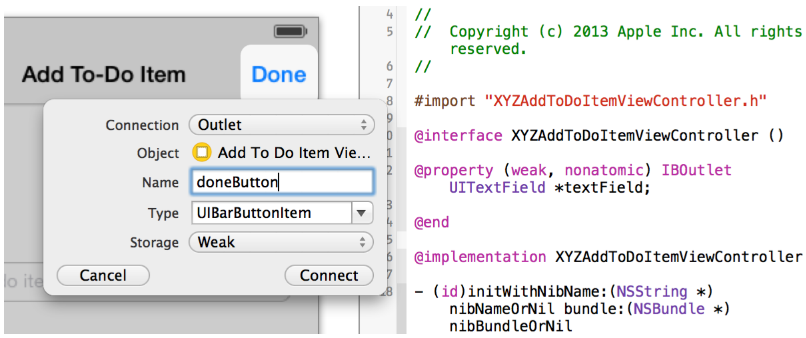
   Xcode adds the necessary code to `XYZAddToDoItemViewController.m` to store a pointer to the text field and configures the storyboard to set up that connection.

Additionally, you need to know when to create the item. You want to create the item only if the Done button was tapped. To do this, add the Done button as an outlet.

To connect the Done button to your view controller

1. In your storyboard, open the assistant editor, and set the rightmost window to `XYZAddToDoItemViewController.m`.
2. Select the Done button in your storyboard.
3. Control-drag from the Done button on your canvas to the code display in the editor on the right, stopping the drag at the line just below your `textField` property in `XYZAddToDoItemViewController.m`.
4. In the dialog that appears, for Name, type `doneButton`.

   Leave the rest of the options as they are. Your dialog should look like this:



5. Click Connect.

You now have a way to identify the Done button. Because you want to create an item when the Done button is tapped, you need to know when that happens.

When the user taps the Done button, it kicks off an unwind segue back to the to-do list—that's the interface you configured in the second tutorial. Before a segue executes, the system gives the view controller involved a chance to prepare by calling `prepareForSegue:`. This is exactly the point at which you want to check to see whether the user tapped the Done button, and if so, create a new to-do item. You can check which one of the buttons got tapped, and if it was the Done button, create the item.

To create an item after tapping the Done button

1. Select `XYZAddToDoItemViewController.m` in the project navigator.
2. Add the `prepareForSegue:` method below the `@implementation` line:

```
- (void) prepareForSegue:(UIStoryboardSegue *)segue sender:(id)sender
{
}
```

3. In the method, see whether the Done button was tapped.

   If it wasn't, instead of saving the item, you want the method to return without doing anything else.

```
if (sender != self.doneButton) return;
```

4. See whether there's text in the text field.

```
if (self.textField.text.length > 0) {
}
```

5. If there's text, create a new item and give it the name of the text in the text field. Also, ensure that the completed state is set to `NO`.

```
self.toDoItem = [[XYZToDoItem alloc] init];
self.toDoItem.itemName = self.textField.text;
self.toDoItem.completed = NO;
```

   If there isn't text, you don't want to save the item, so you won't do anything else.

Your `prepareForSegue:` method should look like this:

```
- (void) prepareForSegue:(UIStoryboardSegue *)segue sender:(id)sender
{
    if (sender != self.doneButton) return;
    if (self.textField.text.length > 0) {
        self.toDoItem = [[XYZToDoItem alloc] init];
        self.toDoItem.itemName = self.textField.text;
        self.toDoItem.completed = NO;
    }
}
```

Now that you've created a new item, you need to pass the item back to `XYZToDoListViewController` so that it can add the item to the to-do list. To accomplish this, you need to revisit the `unwindToList:` method that you wrote in the second tutorial. This method gets called when the `XYZAddToDoItemViewController` scene closes, which happens when the user taps either the Cancel or the Done button.

The `unwindToList:` method takes a segue as a parameter, like all methods that are used as targets for an unwind segue. The segue parameter is the segue that unwinds from `XYZAddToDoItemViewController` back to `XYZToDoListViewController`. Because a segue is a transition between two view controllers, it is aware of its source view controller—`XYZAddToDoItemViewController`. By asking the segue object for its source view controller, you can access any data stored in the source view controller in the `unwindToList:` method. In this case, you want to access `toDoItem`. If it's `nil`, the item was never created—either the text field had no text or the user tapped the Cancel button. If there's a value for `toDoItem`, you retrieve the item, add it to your `toDoItems` array, and display it in the to-do list by reloading the data in the table view.

To store and display the new item

1. In the project navigator, select `XYZToDoListViewController.m`.
2. Add an import declaration to the `XYZAddToDoItemViewController` class above the `@interface` line.

```
#import "XYZAddToDoItemViewController.h"
```

3. Find the `unwindToList:` method you added in the second tutorial.
4. In this method, retrieve the source view controller—the controller you're unwinding from, `XYZAddToDoItemViewController`.

```
XYZAddToDoItemViewController *source = [segue sourceViewController];
```

5. Retrieve the controller's to-do item.

```
XYZToDoItem *item = source.toDoItem;
```

   This is the item that was created when the Done button was tapped.

6. See whether the item exists.

```
if (item != nil) {
}
```

   If it's `nil`, either the Cancel button closed the screen or the text field had no text, so you don't want to save the item.

   If it does exist, add the item to your `toDoItems` array.

```
[self.toDoItems addObject:item];
```

7. Reload the data in your table.

   Because the table view doesn't keep track of its data, it's the responsibility of the data source—in this case, your table view controller—to notify the table view when there's new data for it to display.

```
[self.tableView reloadData];
```

Your `unwindToList:` method should look like this:

```
- (IBAction)unwindToList:(UIStoryboardSegue *)segue
{
    XYZAddToDoItemViewController *source = [segue sourceViewController];
    XYZToDoItem *item = source.toDoItem;
    if (item != nil) {
        [self.toDoItems addObject:item];
        [self.tableView reloadData];
    }
}
```

Checkpoint: Run your app. Now when you click the Add button (+) and create a new item, you should see it in your to-do list. Congratulations! You've created an app that takes input from the user, stores it in an object, and passes that object between two view controllers. This is the foundation of moving data between scenes in a storyboard-based app.

Recap

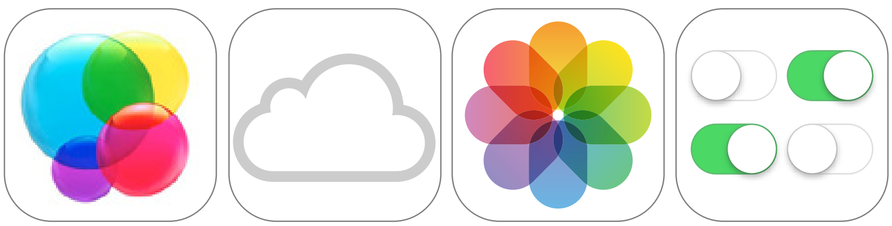
You're almost done with this introductory tour of developing apps for iOS. The final section gives you more information about how to find your away around the documentation, and it suggests some next steps you might take as you learn how to create more advanced apps.

Next Steps

iOS Technologies

You've just learned how to write an app with a simple user interface and basic behavior. At this point, you may be thinking about implementing additional behavior that will turn your project into a full-featured app.

As you consider which features you want to add, remember that you don't have to implement everything from scratch. iOS provides frameworks that define particular sets of functionality—from gaming and media to security and data management—which you can integrate into your app. You've already used the UIKit framework to design your app's user interface, and the Foundation framework to incorporate common data structures and behavior into your code. These are two of the most common frameworks used in iOS app development, but there are many more available to you.



This chapter is a high-level overview of technologies and frameworks that you might consider adopting in your app. Use this chapter as a starting point for possible technologies to explore. For a full overview of the technologies available in iOS, see *iOS Technology Overview* .

User Interface

iOS has many frameworks and technologies for creating and enhancing your app's user interface.

UIKit. The UIKit framework provides classes to create a touch-based user interface. Because all iOS apps are based on UIKit, you can't ship an app without this framework. UIKit provides the infrastructure for drawing to the screen, handling events, and creating common user interface elements. UIKit also organizes a complex app by managing the content that's displayed onscreen. For more information, see *UIKit Framework Reference* .

Core Graphics. Core Graphics—a low-level, C-based framework—is the workhorse for handling high-quality vector graphics, path-based drawing, transformations, images, data management, and more. Of course, the simplest and most efficient way to create graphics in iOS is to use prerendered images with the standard views and controls of the UIKit framework, letting iOS do the drawing. Because UIKit, a higher-level framework, also provides classes for custom drawing—including paths, colors, patterns, gradients, images, text, and transformations—use it instead of Core Graphics whenever possible. For more information, see *Core Graphics Framework Reference* .

Core Animation. Core Animation is a technology that allows you to make advanced animations and visual effects. UIKit provides animations that are built on top of the Core Animation technology. If you need advanced animations beyond the capabilities of UIKit, you can use Core Animation directly. The Core Animation interfaces are contained in the Quartz Core framework. Using Core Animation, you create a hierarchy of layer objects that you manipulate, rotate, scale, transform, and so forth. By using Core Animation's familiar view-like abstraction, you can create dynamic user interfaces without having to use low-level graphics APIs such as OpenGL ES. For more information, see *Core Animation Programming Guide* .

Games

You have a number of different technologies to explore when developing games for iOS.

Game Kit. The Game Kit framework provides leaderboards, achievements, and other features to add to your iOS game. For more information, see *Game Kit Framework Reference* .

Sprite Kit. The Sprite Kit framework provides graphics support for animating arbitrary textured images, or *sprites* . In addition to being a graphics engine, it also includes physics support to bring objects to life. Sprite Kit is a good choice for games and other apps that require complex animation chains. (For other kinds of user interface animation, use Core Animation instead.) For more information, see *Sprite Kit Programming Guide* .

OpenGL ES. OpenGL ES is a low-level framework that provides tools to support hardware-accelerated 2D and 3D drawing. Apple's implementation of the OpenGL ES standard works closely with the device hardware to provide high frame rates for full-screen, game-style apps. Because OpenGL ES is a low-level, hardware-focused API, it has a steep learning curve and a significant effect on the overall design of your app. (For apps that require high-performance graphics for more specialized uses, consider using Sprite Kit or Core Animation.) For more information, see *OpenGL ES Programming Guide for iOS* .

Game Controller. The Game Controller framework makes it easy to find controllers connected to a Mac or iOS device. When a controller is discovered on your device, your game reads control inputs as part of its normal gameplay. These controllers provide new ways for players to control your game. Apple has designed specifications for hardware controllers to ensure that all of the controllers have consistent sets of control elements that both players and game designers can rely on. For more information, see *Game Controller Framework Reference* .

Data

When working with your app's data, consider what capabilities are available to you in existing frameworks.

Core Data. The Core Data framework manages an app's data model. With Core Data, you create model objects, known as managed objects. You manage relationships between those objects and make changes to the data through the framework. Core Data takes advantage of the built-in SQLite technology to store and manage data efficiently. For more information, see *Core Data Framework Reference* .

Foundation. You worked with Foundation earlier in this guide. The Foundation framework defines a base layer of Objective-C classes. In addition to providing a set of useful primitive object classes, this framework introduces several paradigms that define behaviors not covered by the Objective-C language. Among other things, this framework includes classes representing basic data types, such as strings and numbers, and collection classes for storing other objects. For more information, see *Foundation Framework Reference* .

Media

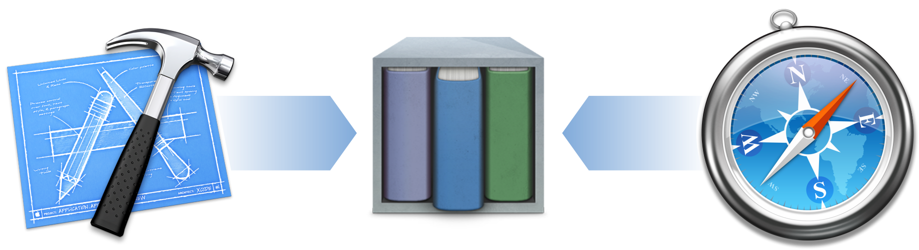
Media frameworks provide a number of capabilities for working with audio and video in your app.

AV Foundation. AV Foundation is one of several frameworks that you can use to play and create time-based audiovisual media. For example, you can use AV Foundation to examine, create, edit, or reencode media files. You can also use it to get input streams from devices and manipulate video during real-time capture and playback. For more information, see *AV Foundation Framework Reference* .

Finding Information

As you develop your app, you'll want the information you've learned—and more—at your fingertips. You can get all the information you need without leaving Xcode.

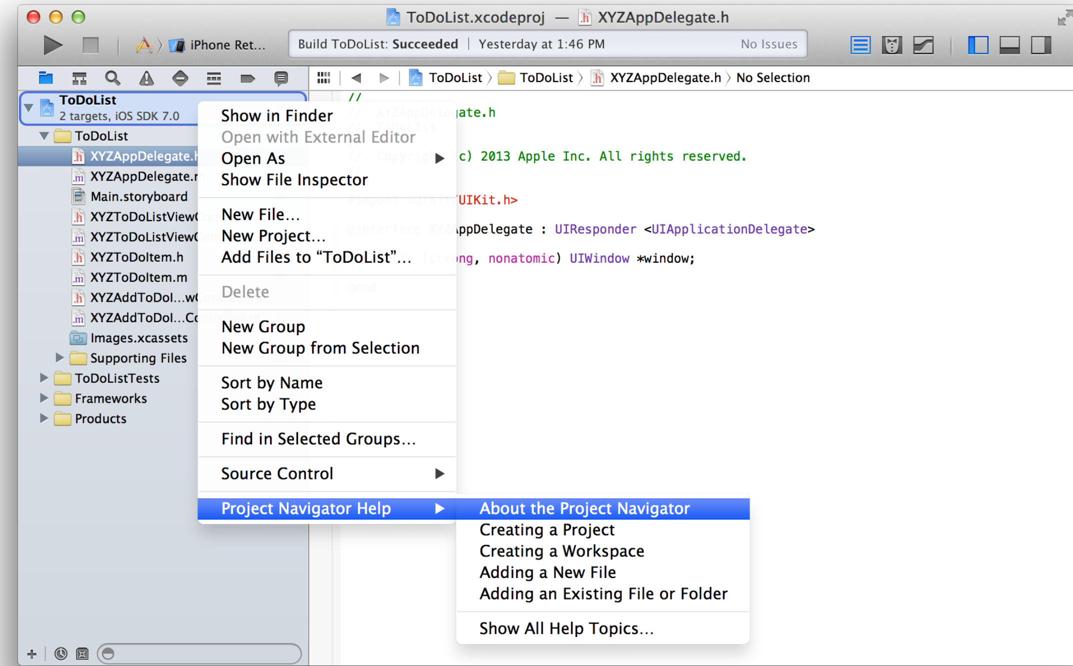
Xcode comes with a large documentation suite containing a number of different types of documents, including general and conceptual guides, framework and class references, and focused help articles. You can access this documentation in a number of ways, such as right-clicking on areas of Xcode to learn how to use them, opening the Quick Help pane in the main project window for context-aware code help, or searching in the Documentation Window to find guides and full API reference.



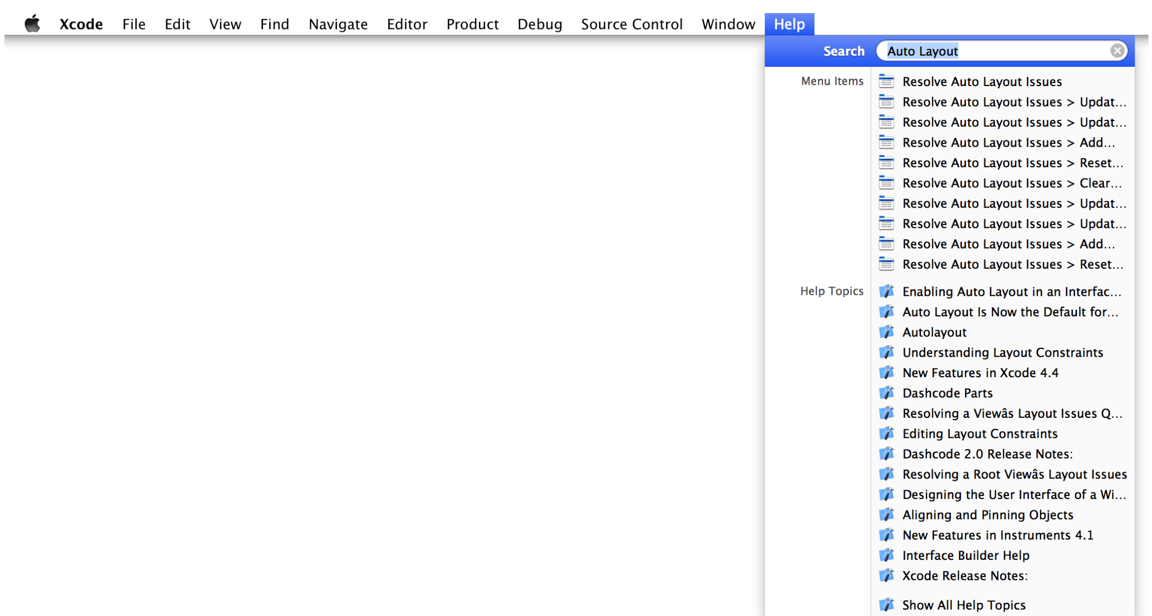
Use Contextual Help Articles for Xcode Guidance

To get help when using Xcode itself, take a look at help articles. **Help articles** show how to accomplish common tasks, such as creating a new class, setting a custom class in Interface Builder, and resolving issues with Auto Layout.

Depending on what you're trying to do, you can access some help articles by Control-clicking on a UI element in Xcode. Look for the last entry (in this image, Project Navigator Help) in the contextual menu.



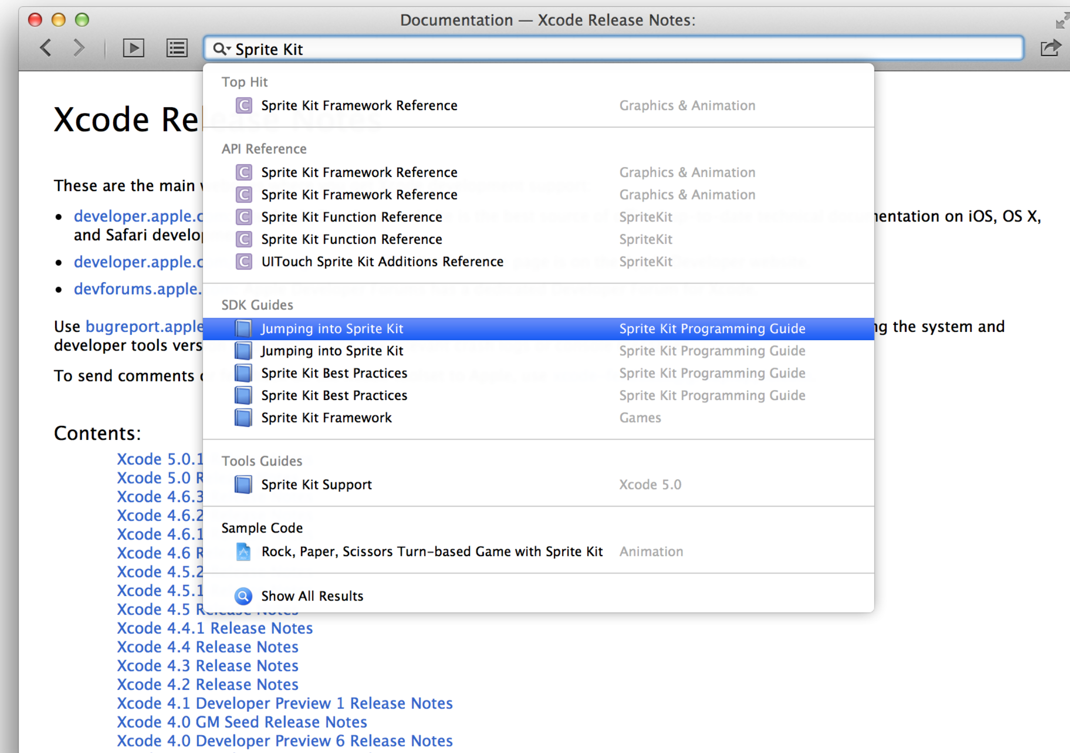
If you're looking for general help, or information about a task related to an element that doesn't support Control-clicking, you can also search for contextual help in the Xcode Help menu.



Use Guides for General and Conceptual Overviews

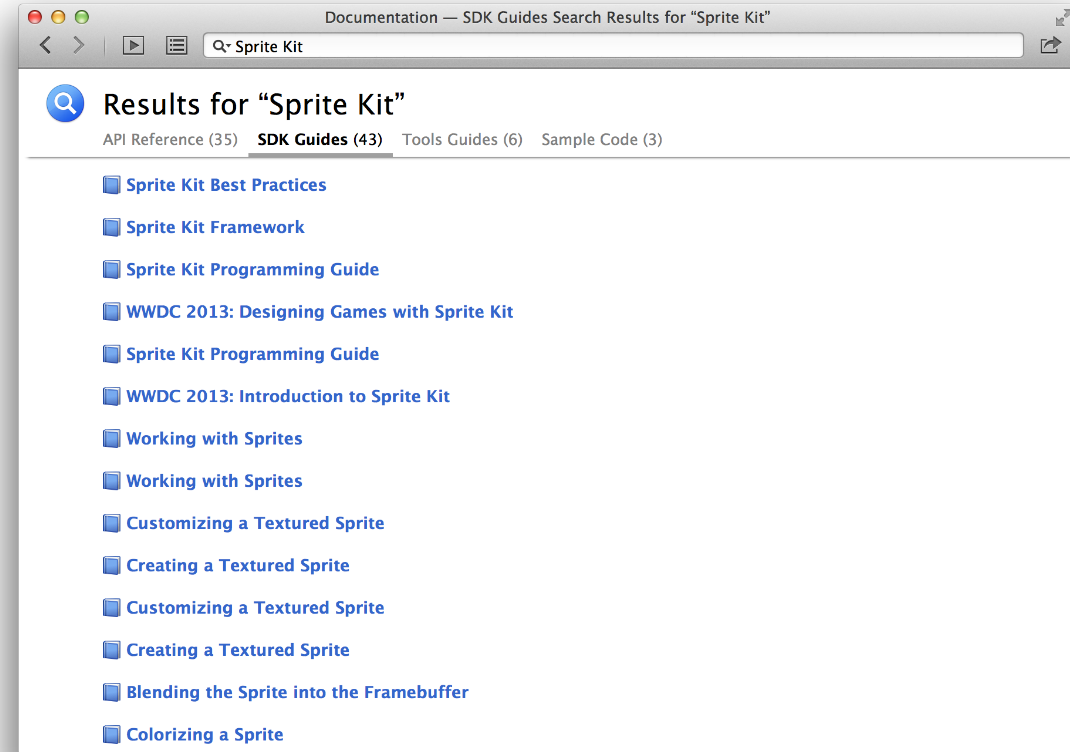
To learn about a new technology or to gain a deeper understanding of how the different classes in a framework work together, look at one of the **conceptual guides**. Most Cocoa frameworks and technologies have programming guides associated with them, such as *Sprite Kit Programming Guide*, *Programming with Objective-C*, and *Location and Maps Programming Guide*.

To view these documents in Xcode, use the **documentation viewer window**, which you can access by choosing Help > "Documentation and API Reference" (Option–Command–Question Mark). Simply type the name of a technology, such as Sprite Kit.



The results are ordered to be most helpful when you are writing code. This means that you'll see API reference entries listed first, and then SDK and Tools guides.

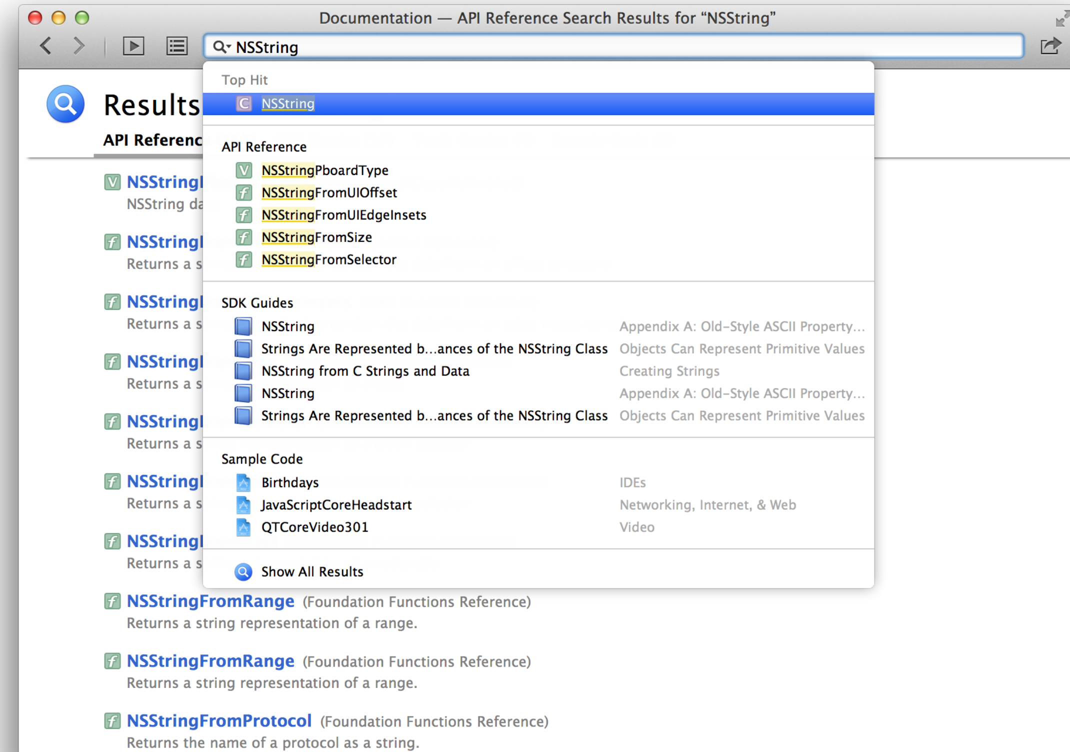
If a suitable result doesn't appear in the pop-up list, choose Show All Results to display a complete set of results that you can filter.



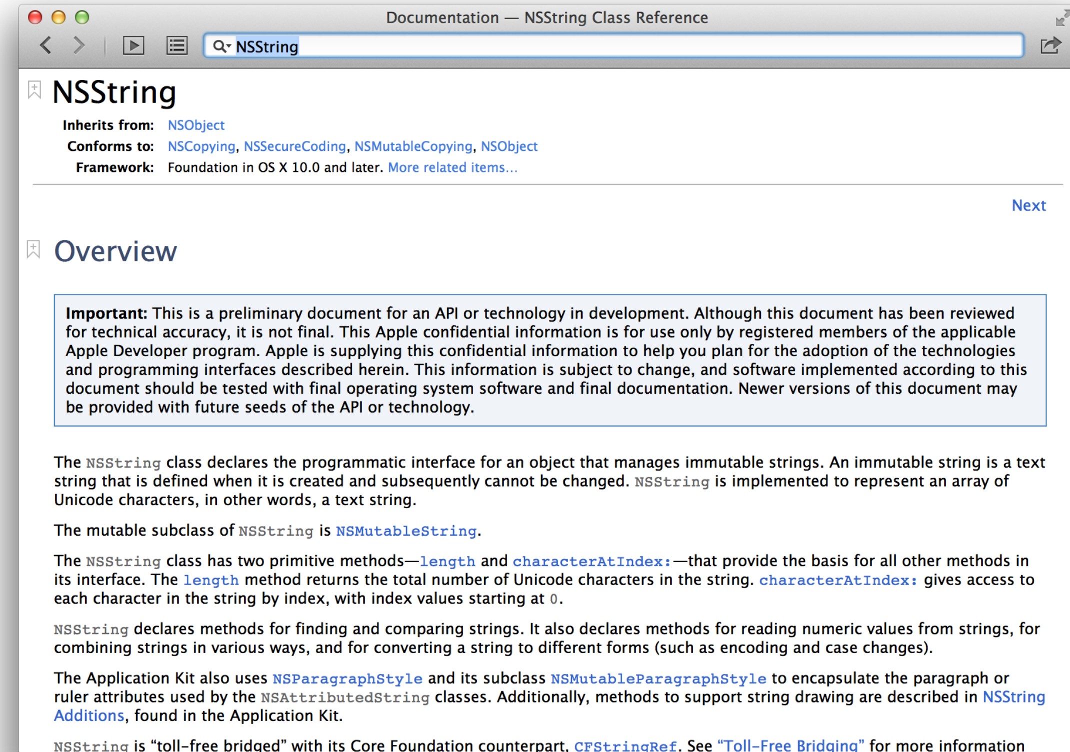
Use API Reference for Class Information

When you've read a guide to learn about the different parts of a technology and you start writing code that uses the technology, you'll probably find that you need to know more about what an individual class can do, or that you need to learn the correct way to call a particular method. This information is provided by **API reference** documents.

For example, for more information on the `NSString` class that you used in the earlier tutorials, just type the name of the class in the documentation viewer window's search field.



The top hit is usually the one you want; press Return to select it, and you see the API reference for that class.



Documentation — NSString Class Reference

NSString

NSString

Inherits from: NSObject
Conforms to: NSCopying, NSSecureCoding, NSMutableCopying, NSObject
Framework: Foundation in OS X 10.0 and later. More related items…

Next

Overview

Important: This is a preliminary document for an API or technology in development. Although this document has been reviewed for technical accuracy, it is not final. This Apple confidential information is for use only by registered members of the applicable Apple Developer program. Apple is supplying this confidential information to help you plan for the adoption of the technologies and programming interfaces described herein. This information is subject to change, and software implemented according to this document should be tested with final operating system software and final documentation. Newer versions of this document may be provided with future seeds of the API or technology.

The `NSString` class declares the programmatic interface for an object that manages immutable strings. An immutable string is a text string that is defined when it is created and subsequently cannot be changed. `NSString` is implemented to represent an array of Unicode characters, in other words, a text string.

The mutable subclass of `NSString` is `NSMutableString`.

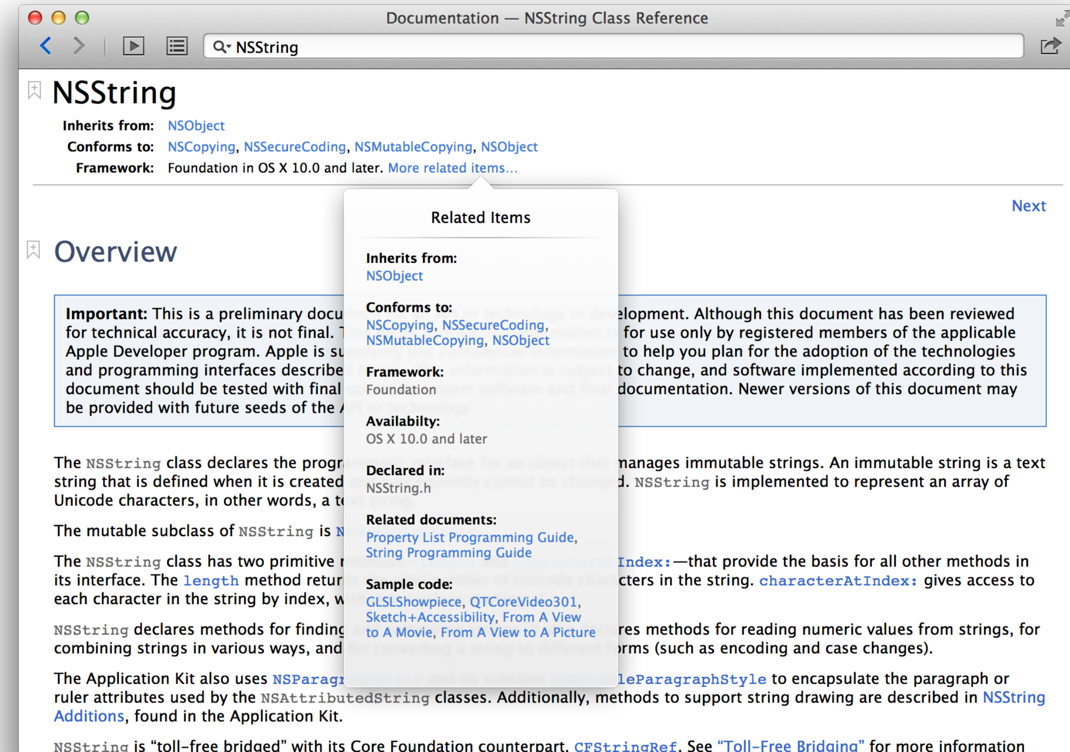
The `NSString` class has two primitive methods—`length` and `characterAtIndex:`—that provide the basis for all other methods in its interface. The `length` method returns the total number of Unicode characters in the string. `characterAtIndex:` gives access to each character in the string by index, with index values starting at `0`.

`NSString` declares methods for finding and comparing strings. It also declares methods for reading numeric values from strings, for combining strings in various ways, and for converting a string to different forms (such as encoding and case changes).

The Application Kit also uses `NSParagraphStyle` and its subclass `NSMutableParagraphStyle` to encapsulate the paragraph or ruler attributes used by the `NSAttributedString` classes. Additionally, methods to support string drawing are described in NSString Additions, found in the Application Kit.

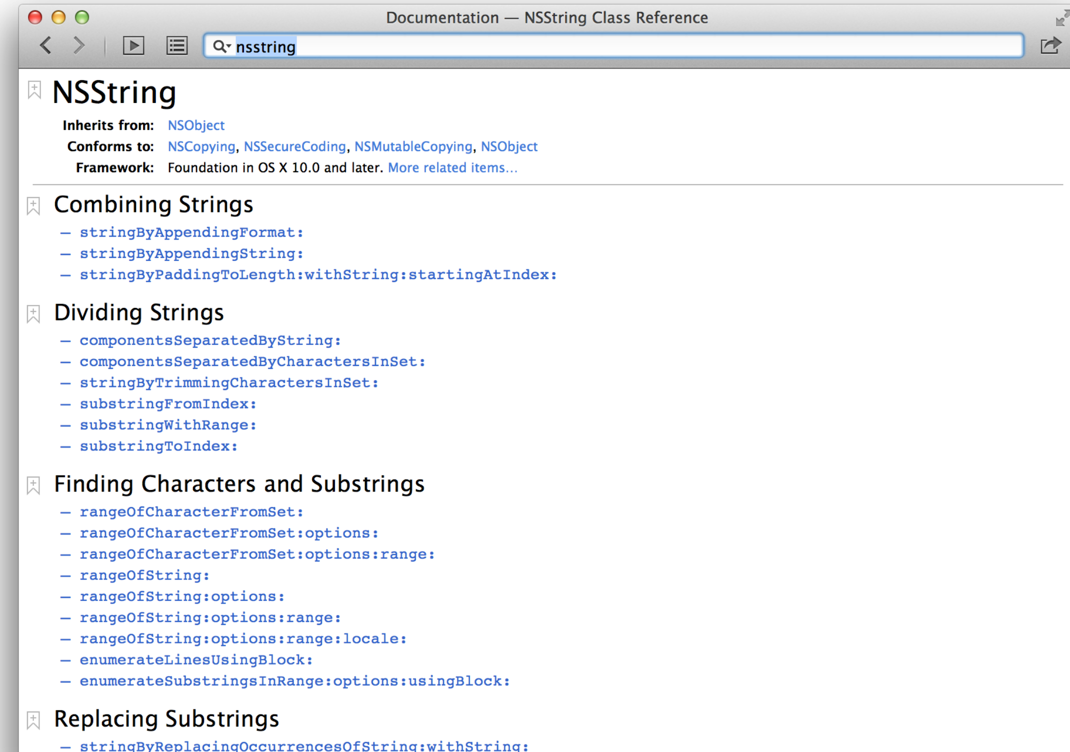
`NSString` is "toll-free bridged" with its Core Foundation counterpart, `CFStringRef`. See "Toll-Free Bridging" for more information

API reference documentation is designed to give you quick access to information about individual classes, including the list of methods the class provides, and information such as the parent class and adopted protocols. Click "More related items" to see to see general information about the class.



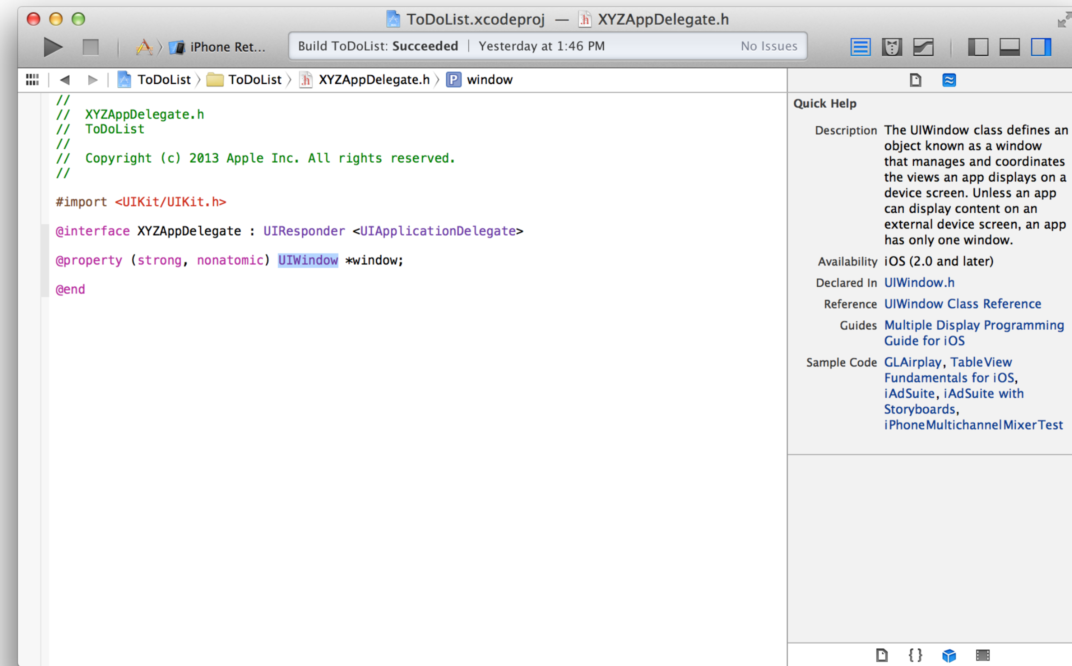
The Related Items popover also shows a list of related guides. For `NSString`, for example, you might want a more conceptual overview rather than delving into reference material, so you should read *String Programming Guide* .

In addition to describing a specific method or property, API reference documents also provide an overview of all the tasks that a class can perform.

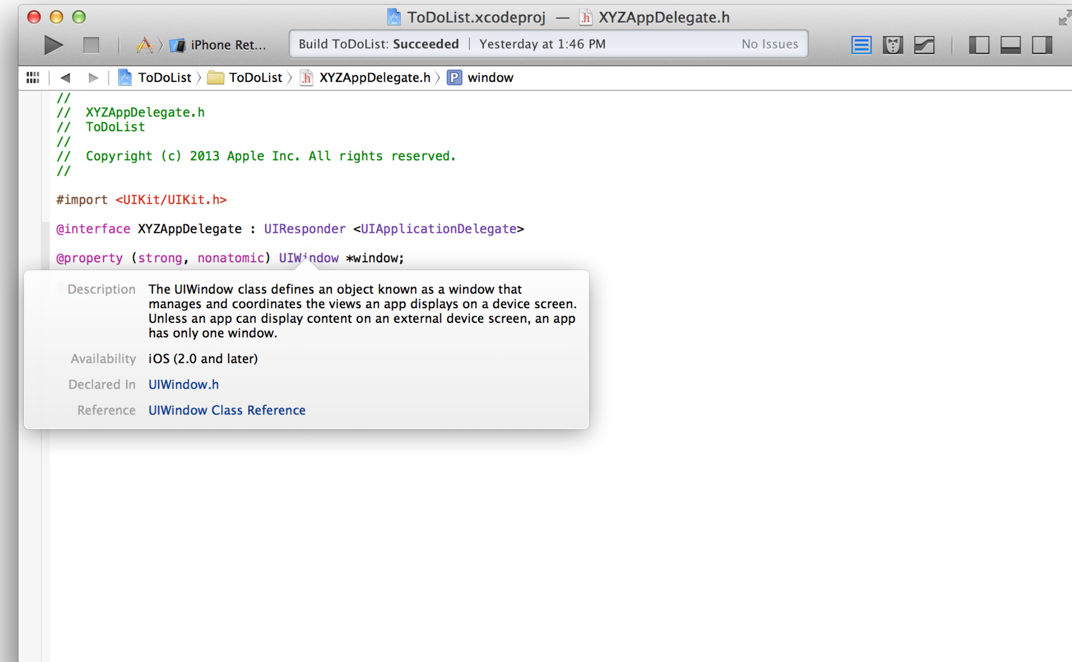


Use Quick Help for Contextual Source Code Information

When you're writing code in the source editor, you have easy access to API reference documentation in the Quick Help pane (choose View > Utilities > Show Quick Help Inspector). The **Quick Help** pane updates as you write code, showing information about the symbol you're currently typing.



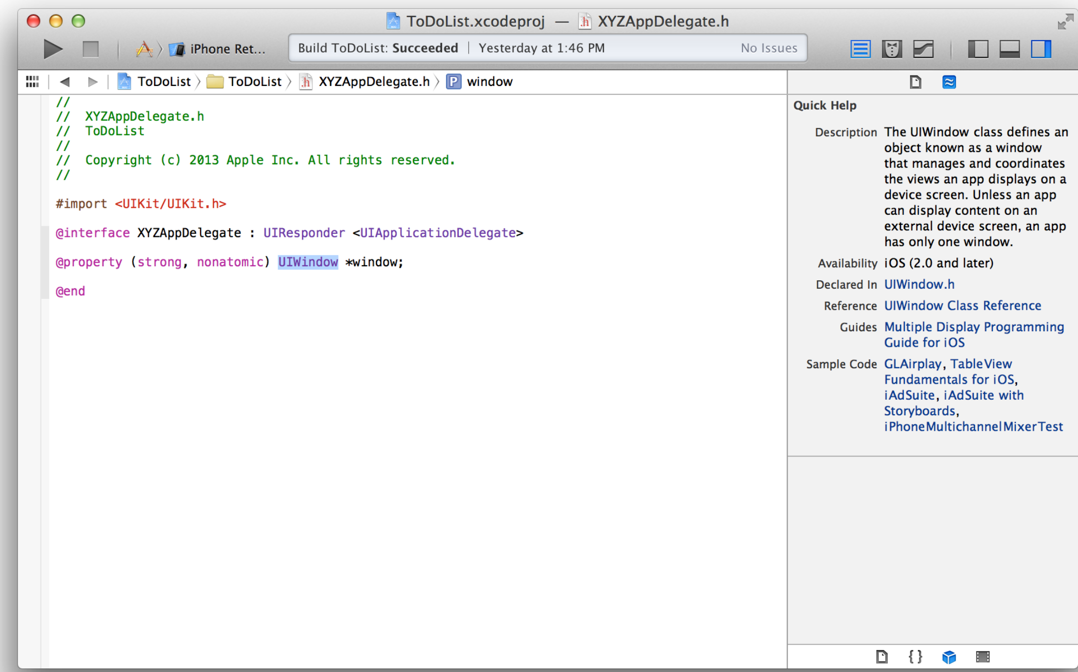
Alternatively, you can Option-Click a symbol in the source editor to display a pop-up window with the Quick Help information.



From the Quick Help pane or pop-up window, you can open the API Reference in the separate documentation viewer window, or you can view the original header file containing the declaration for the symbol you clicked.

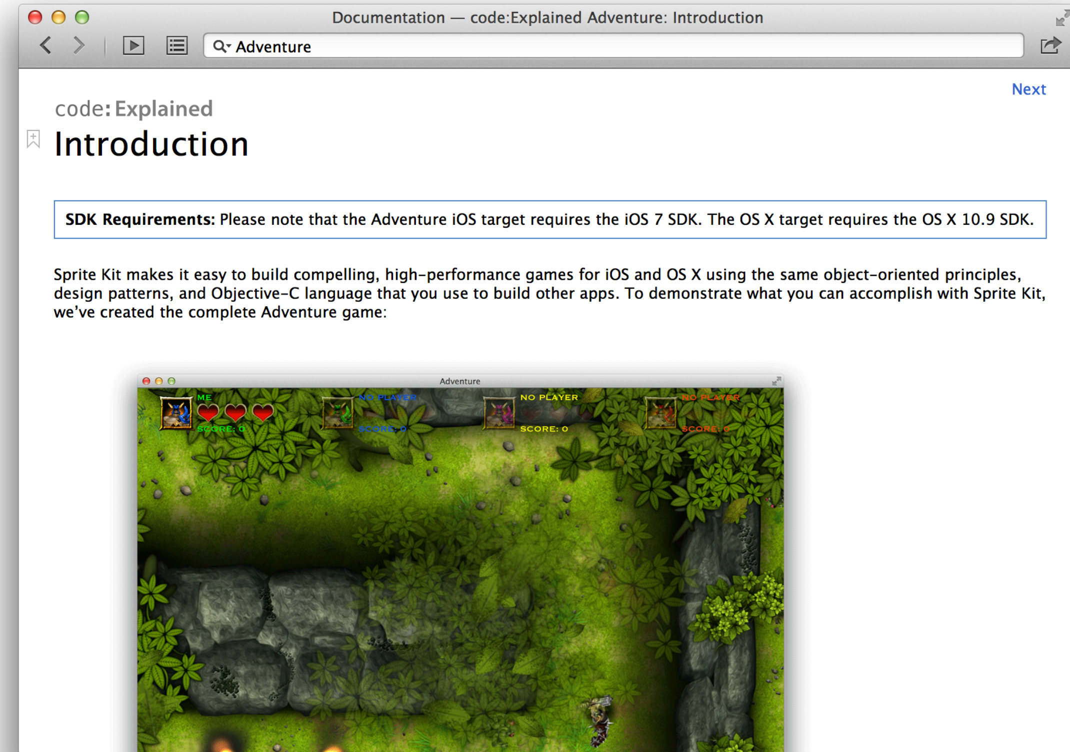
Use Sample Code to See Real-World Usage

In addition to written documentation, you also have access to a library of **sample code**. Whenever you look at quick help, or guides and reference in the documentation viewer window, you'll see entries showing relevant sample code projects for the given technology or class.



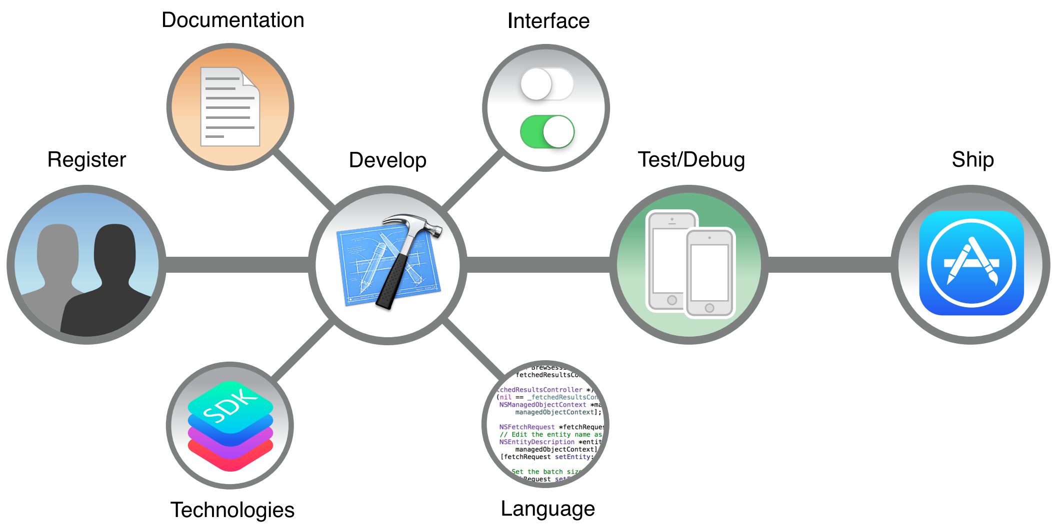
Click one of the sample code entries to download and open a project in Xcode so that you can examine the code.

In addition to having code comments throughout the project, some of the larger code samples also have accompanying documents. For example, the Sprite Kit Adventure project is accompanied by *code:Explained Adventure*.



Where to Go from Here

In *Start Developing iOS Apps Today*, you learned the basics of iOS app development. At this point, you're ready to start developing your first full-featured app. Although taking an app from a simple concept to the App Store isn't a small task, the process and practices you've learned in this document will guide you in the right direction.



Here are a few more pointers on where to go from here:

- **Register as a developer.**

  "Managing Accounts" in *App Distribution Guide* walks you through the process of registering as an Apple developer.

- **Learn to design beautiful app interfaces.**

  iOS Human Interface Guidelines teaches you how to make your app consistent with the user interface conventions for iOS.

- **Learn the language.**

  Programming with Objective-C describes how to define classes, send messages, encapsulate data, and accomplish a variety of other tasks with the Objective-C programming language.

- **Learn to develop great apps.**

  iOS App Programming Guide explains the essential things you must know and do when developing an iOS app.

- **Learn about the technologies available to you.**

iOS Technology Overview describes the frameworks and other technologies that are available to your app in iOS.

- **Access the documentation.**

  "Finding Information" (page 116) shows you how to make the most of the documentation available to you.

- **Debug and test your app.**

  "Debug Your App" in *Xcode Overview* teaches you how to thoroughly debug and test your app in Xcode.

- **Ship your app.**

  App Distribution Guide walks you through the process of provisioning devices for testing and submitting apps to the App Store.

Taking the ToDoList App to the Next Level

The to-do list app you just created benefits from numerous built-in behaviors. You can continue to experiment with this app to enhance your understanding, or you can start something new. If you do continue with the to-do list app, here are some areas to investigate:

- Your to-do list disappears when you quit and relaunch the app. You might want to explore ways to make the list persist over time.
- You're using the default appearance for all of the controls in your app. UIKit includes features for customizing the appearance of many controls. Explore different user interface options using this technology.
- You've given the user a way to add items to the list and mark them as completed, but there's no facility for deleting items. Table views have built-in behavior for supporting editing, including deletion and reordering of rows, which you might consider incorporating into your app.

As you continue developing iOS apps, you'll find that there are a vast number of concepts and technologies left to explore, including localization, accessibility, and appearance customization. Start by defining a direction that interests you. Remember to put concepts into practice as you learn them. When you encounter an interesting new technology, framework, or design pattern, don't be afraid to write a small app to test it out.

Although the breadth of what you can do may seem intimidating, by adopting the divide-and-conquer approach shown in this document, you'll find that you ship your first app quickly. After you have an app in the App Store, you can continue to incorporate additional features incrementally. There are always new ways to keep your customers engaged and looking forward to the next great thing.

Document Revision History

This table describes the changes to *Start Developing iOS Apps Today* .

Date	Notes
2013-10-22	Rewritten as a multipart tutorial to provide the fundamental skills needed to create an iOS app.

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