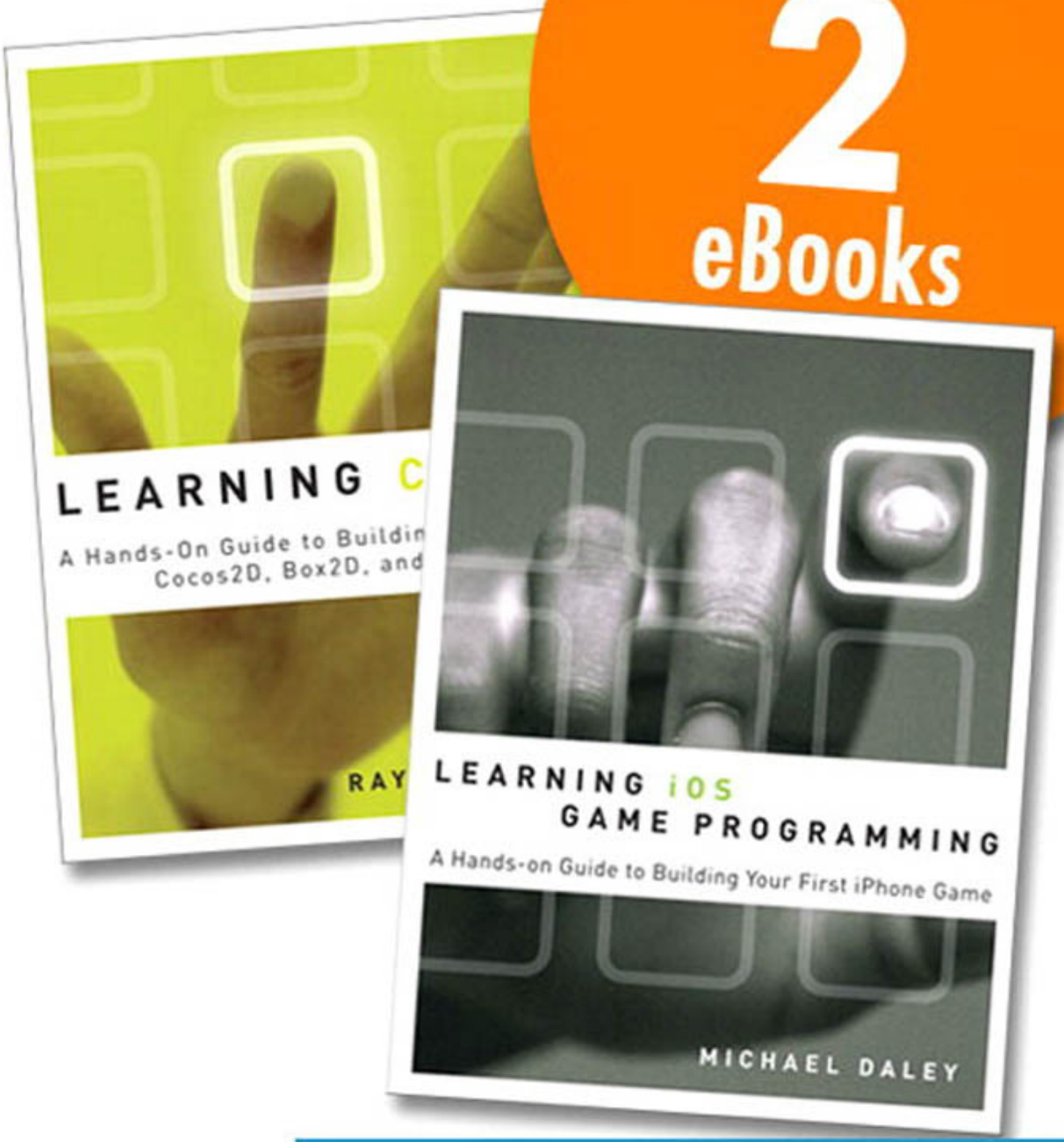

THE iOS GAME PROGRAMMING COLLECTION

The iOS Game Programming Collection

Addison-Wesley

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Note from the Publisher

The *iOS Game Programming Collection* consists of two bestselling eBooks:

- *Learning iOS Game Programming: A Hands-On Guide to Building Your First iPhone Game*
- *Learning Cocos2D: A Hands-on Guide to Building iOS Games with Cocos2D, Box2D, and Chipmunk*

This collection walks you through the steps to develop games for the iPhone, iPad, and iPod Touch. No game programming experience required! *Learning iOS Game Programming* is a beginner's guide to developing 2D apps for the iPhone. *Learning Cocos2D* shows how Cocos2D makes iPhone and iPad game programming fun and easy.

To simplify access to each book, we've appended "A" to pages of *Learning iOS Game Programming* and "B" to pages of *Learning Cocos2D*. This enabled us to produce a single, comprehensive table of contents and dedicated indexes so that you can easily link to the topics you want. We hope you find this collection useful!

—The editorial and production teams at Addison-Wesley Professional

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Learning iOS Game Programming

Praise for *Learning iOS Game Programming*

"An excellent introduction into the world of game development explaining every aspect of game design and implementation for the iPad, iPhone, and iPod touch devices. A great way for anyone interested in writing games to get started."

—Tom Bradley, Software Architect, Designer of TBXML

"A great developer and a great game. That's everything you can find in this book to learn how to write an awesome game for iPhone. Maybe you're the next AppStore hit!"

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"With *Learning iOS Game Programming*, you'll be writing your own games in no time. The code included is well explained and will save you hours of looking up obscure stuff in the documentation and online forums."

—Pablo Gomez Basanta, Founder, Shifting Mind

"I always thought that to teach others one has to be an expert and a person with an established reputation in the field. Michael Daley proved me wrong. He is teaching others while studying himself. Michael's passion in teaching and studying, ease of solutions to problems, and a complete game as a resulting project makes this book one of the best I have ever read."

—Eugene Snyetilov

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—Brandon Middleton, Creator of *Tic Tac Toe Ten*

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—Rod Strougo, Founder Prop Group

Learning iOS Game Programming

Michael Daley

Addison-Wesley

Upper Saddle River, NJ • Boston • Indianapolis • San Francisco
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Cape Town • Sydney • Tokyo • Singapore • Mexico City

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Dedicated to my mum, Jen

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Writing this book has been an amazing journey, and it's only through the efforts of many other people that you are reading this today. Without these people, I don't believe the book would have even been published, let alone become the valuable resource I believe it to be. For this reason, I would like to acknowledge those people who have supported me on this journey:

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- John Bloomfield is a professional web designer and is responsible for the design and administration of the 71Squared.com blog. Without his great work on the blog, Chuck would never have seen my tutorials, and the opportunity to write this book may never have arisen. John is also my oldest and closest friend, and even though he is now living on the other side of the world in Australia, it didn't stop him from supporting and contributing to this project.
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- Ryan Sumo is a freelance video game artist residing in Manila, The Philippines. He created all the artwork used in *Sir Lamorak's Quest* that gives the game its retro look. He is a true professional and a pleasure to work with. His rapid delivery of art and great feedback and suggestions really helped give the game its great look. If you ever run into Ryan in Manila and show him a copy of this book, he is sure to buy you a drink. Examples of Ryan's work can be found at **ryansumo.carbonmade.com**.
- Vince Webb is an award-winning composer currently enrolled on an undergraduate music course in London and is the creator of the music and sound effects used in *Sir Lamorak's Quest*. His ability to create an atmosphere with his music really took *Sir Lamorak's Quest* to a new level. Vince is currently working on a number of projects, and more information about him and his work can be found at www.vincewebb.com. Vince is a real talent, and I'm pleased to have had the opportunity to work with him.

- Games such as *Sir Lamorak's Quest* need a lot of testing, and through my **71Squared.co.uk** blog, I was able to get help from a great team of beta testers. These testers were all followers of the iPhone game development tutorials on the blog and provided fantastic feedback and suggestions. This feedback really helped polish the final product. Details of all those involved can be found in the credits in *Sir Lamorak's Quest: The Spell of Release* game.
- Saving the best for last, I want to thank my family. Developing *Sir Lamorak's Quest* and writing this book have taken a considerable amount of time. Throughout this period, my wife, Alison, and fantastic children, Caragh, Alex, and Matthew, have had to deal with me being locked away for hours and days at a time. Without their patience, love, and support, I would still be hunting for the game-development book of my dreams.

I certainly hope that you find this book to be the useful resource I believe it is, and I would appreciate any suggestions or feedback you have.

—Michael Daley
mike@71squared.com

About the Author

By day, **Michael Daley** works for the largest enterprise software company in the world supporting large corporate customers in communications. By night, Michael has taken on the task of learning how to build games for the iPhone. Michael started writing adventure games in BASIC on a Sinclair Spectrum 48k and progressed onto the Commodore 64 and the Amiga A500. Never having lost a passion for game programming, Michael got inspired to learn Objective-C when the iPhone came out, and he set out to learn how to build games for the iPhone.

Having written many games for his children over the years, the launch of the iPhone inspired him to create games for the platform that would be available to more than his children. Michael has a passion for learning new technologies and how to apply them. He's a true Apple fan, spending far too much time and money on the latest Apple equipment.

We Want to Hear from You!

As the reader of this book, you are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

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Email: chuck.toporek@pearson.com

Mail: Chuck Toporek
Senior Acquisitions Editor, Addison-Wesley
Pearson Education, Inc.
75 Arlington St., Ste. 300
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Preface

Writing a game can be a daunting task. Even if you're an experienced programmer, the design patterns, terminology, and thought processes can seem strange and unusual. Having spent most of my working life creating business applications, writing games has been a hobby that has seen me create many games my children have played and enjoyed over the years. With the release of the iPhone and iPod touch, it was time to unleash one of my creations on the world.

My first task was to find a good book on developing games on the iPhone. After a lot of research, I decided that the book I wanted just didn't exist, and having had great feedback on a number of online tutorials I had created, I decided to write my own book. This was a perfect opportunity for me to create the game programming book I've always wanted myself.

Over the years, I've read many game development books and have been left wanting. Although they provide information on the individual components required to make a game and include small examples, they never go all the way to creating a complete game good enough to publish. I've always believed that a good book should both tell the reader what is required to make a game but also demonstrate how those components can be implemented inside a complete game project.

> **Download the Game!**
>
> You can download *Sir Lamorak's Quest* from the App Store: **http://itunes.apple.com/us/app/sir-lamoraks-quest-the-spell/id368507448?mt=8**. The game is freely available, so go ahead and download the game, start playing around with it, and help Sir Lamorak escape from the castle!

So, this book not only describes the components and technology needed to create a game on the iPhone, but it does so through the creation of a complete game: *Sir Lamorak's Quest: The Spell of Release*. This game is currently available for free download from the App Store, and is the game you learn how to build as you work your way through this book.

This book describes the key components needed to create this 2D game. It covers both the technology, such as OpenGL ES and OpenAL, as well as the key game engine components required, including sprite sheets, animation, touch input, and sound.

Each chapter describes in detail a specific component within the game, along with the technology required to support it, be it a tile map editor, or some effect we're trying to create with OpenGL ES. Once an introduction to the functionality and technology is complete, the chapter then provides details on how the component has been implemented within *Sir Lamorak's Quest*. This combination of theory and real-world implementation helps to fill the void left by other game development books.

About Sir Lamorak's Quest

My game-playing experiences started when I was given a Sinclair Spectrum 48k for Christmas in 1982. I was hooked from that moment, and I have had a close relationship with computers ever since.

While thinking about the game I wanted to develop for this book, my mind kept wandering back to the games I played in the 1980s. They may not have been visually stunning, although at the time I was impressed, but they were fun to play.

I spent some time working on the design of the game, which included not only the features I wanted in the game, but also how it should be implemented on the iPhone. One key aspect of the game is that it should be casual—that is, the concept of the game should be simple and easy to pick up, and players should be able to start and stop the game easily without losing their progress.

I also wanted the controls to be easily recognizable and therefore decided to implement an onscreen joypad to control the main character. It was important, though, to allow the player to swap the position of this joypad so that both left- and right-handed players found the game comfortable.

As for the game play itself, I decided to take a number of design ideas from games I played in the '80s and went with a top-down scroller, in which the player is trapped in a haunted castle and has to find a magic spell so that he can escape.

Organization of This Book

There are 16 chapters in the book, each of which deals with a specific area of creating Sir Lamorak's Quest, as follows:

- *Chapter 1, "Game Design"*—This chapter describes the design considerations I made while designing *Sir Lamorak's Quest*. It provides an insight into the kind of thought process required when sitting down to create a game. It doesn't cover *every* possible design decision needed for all genres of games, but it does cover the important ones.
- *Chapter 2, "The Three Ts: Terminology, Technology, and Tools"*—Even experienced programmers can become confused by the three Ts used within game development.

This chapter runs through the common technology, terminology, and tools used to create *Sir Lamorak's Quest* and games in general. This chapter helps you understand the terms and technology covered throughout the book.

- *Chapter 3, "The Journey Begins"*—This is where we start to get our hands on some code and get the iPhone to render something to the screen. This chapter covers the process of creating our first project using the OpenGL ES template project within Xcode. The template is described in detail and sets the scene for the chapters that follow.
- *Chapter 4, "The Game Loop"*—The heartbeat of any game is the game loop. This loop is responsible for making sure that all the core elements of the game, such as AI and rendering, are done at the right time and in the right order. This may sound simple, but there are a number of different approaches to the game loop, and this chapter discusses them and details the approach taken *for Sir Lamorak's Quest*.
- *Chapter 5, "Image Rendering"*—Drawing images to the screen is a fundamental requirement for any game. This chapter provides an overview of OpenGL ES and runs through a number of classes created to simplify the creation and rendering of images to the screen.
- *Chapter 6, "Sprite Sheets"*—Sprite sheets are images that contain a number of smaller images. These sheets can be used to reduce the number of individual images held in memory and the number of different textures OpenGL ES needs to bind to improving performance. They are also commonly used when creating animated sprites. This chapter covers how to create sprite sheets that contain the images used in the game, regardless of whether they have fixed or variable dimensions.
- *Chapter 7, "Animation"*—Having created the means to store the different frames needed in an animation using sprite sheets, this chapter describes how separate images can be played in sequence to provide you with animation, such as the player character running.
- *Chapter 8, "Bitmap Fonts"*—The most common way to interact with your game's user is through the use of text. Being able to render instructions and information (such as the player's score or instructions on how to use the game) is important. This chapter describes how you can use open source tools to take any font and turn it into a bitmap font. Once the bitmap font is created, you'll see how to create a sprite sheet that contains all the images needed to render the characters in that font. It also details the `Bitmap` font class used in *Sir Lamorak's Quest*, which provides a simple API for rendering text to the screen.
- *Chapter 9, "Tile Maps"*—Tile maps allow large game worlds to be created from reusing a small number of tile images. This common approach has been used in the past to create large game worlds (think of the original *Super Mario Brothers* game

for Nintendo) when memory is limited, back in the early days of home game systems. This technique is still popular today, and this chapter describes the use of an open source tile-editing tool to create tile maps, along with a class that can render these maps to the screen.

- *Chapter 10, "The Particle Emitter"*—Many games have impressive effects, such as fire, explosions, smoke, and sparks. These are created using a particle system. The particle system is responsible for creating and controlling a number of particles; each has its own properties, such as size, shape, direction, color, and lifespan. During a particle's life cycle, its position, speed, color, and size are changed based on the particle's configuration. This chapter details how to create a particle system that can be used to generate any number of organic effects.
- *Chapter 11, "Sound"*—Giving the player feedback using sound is important in today's modern games. This chapter describes how the media player functionality of the iPhone, along with OpenAL, can be used to play a cool soundtrack in the game, as well as 3D (surround) sound effects.
- *Chapter 12, "User Input"*—This chapter describes how to use the iPhone's unique touch and accelerometer capabilities to control your game. It details how to capture and process multiple touches at the same time and also how data from the accelerometer can be used within your own games.
- *Chapter 13, "The Game Interface"*—In this chapter, we start to look at how the game interface for *Sir Lamorak's Quest* was implemented. This includes how to deal rotation events to make sure that the user interface is always oriented correctly. It also describes how to mix both OpenGL ES and UIKit interface controls.
- *Chapter 14, "Game Objects and Entities"*—As the player runs around the castle in *Sir Lamorak's Quest*, we want him to be able to find objects, pick them up, and fight baddies. This chapter describes how objects and entities have been implemented within *Sir Lamorak's Quest*.
- *Chapter 15, "Collision Detection"*—Having the player and baddies run through walls and doors would really spoil the game, so it's important to be able to register collisions between either the player and the map or objects and entities within the castle. This chapter describes different types of collision detection and how this has been implemented within *Sir Lamorak's Quest*.
- *Chapter 16, "Pulling It All Together"*—At this point, a great deal of ground has been covered. There is, however, a number of things you can do to the game to add polish. This chapter covers how to save the player's game state for when he quits or leaves the game when he has an incoming call. Chapter 16 also covers performance tuning using instruments and tips for getting your game beta tested.

Audience for This Book

This book has been written for people who are already programmers but who have never written computer games before. Although it assumes that you already have some experience with Objective-C, each chapter provides enough information on both Objective-C and other technologies so you can follow the concepts and implementations.

By the time you complete this book, you will have an in-depth understanding of the game engine that was built for *Sir Lamorak's Quest* and the key capabilities and considerations are needed to create a 2D game engine. This enables you to take the same game engine developed in this book and use it in your own games, or simply use the knowledge you have gained about creating games in general and use one of the many game engines available for the iPhone, such as Cocos2D.

Who This Book Is For

If you are already developing applications for the iPhone for other platforms, but want to make a move from utility applications to games, this book is for you. It builds on the development knowledge you already have and leads you into game development by describing the terminology, technology, and tools required, as well as providing real-world implementation examples.

Who This Book Isn't For

If you already have a grasp of the workflow required to create a game or you have a firm game idea that you know requires OpenGL ES for 3D graphics, this is not the book for you.

It is expected that before you read this book, you are already familiar with Objective-C, C, Xcode, and Interface Builder. Although the implementations described in this book have been kept as simple as possible and the use of C is limited, a firm foundation in these languages is required.

The following titles can help provide you with the grounding you need to work through this book:

- *Cocoa Programming for Mac OS X, Third Edition*, by Aaron Hillegass (Addison-Wesley, 2008).
- *Learning Objective-C 2.0*, by Robert Clair (Addison-Wesley, 2011).
- *Programming in Objective-C 2.0*, by Stephen G. Kochan (Addison-Wesley, 2009).
- *Cocoa Design Patterns*, by Erik M. Buck and Donald A. Yacktman (Addison-Wesley, 2009).

- *The iPhone Developer's Cookbook, Second Edition*, by Erica Sadun (Addison-Wesley, 2010).
- *Core Animation: Simplified Animation Techniques for Mac and iPhone Development*, by Marcus Zarra and Matt Long (Addison-Wesley, 2010).
- *iPhone Programming: The Big Nerd Ranch Guide*, by Aaron Hillegass and Joe Conway (Big Nerd Ranch, Inc., 2010).

These books, along with other resources you'll find on the web, will help you learn more about how to program for the Mac and iPhone, giving you a deeper knowledge about the Objective-C language and the Cocoa frameworks.

Download the Source Code

Access to information is not only limited to the book. The complete, fully commented source code to *Sir Lamorak's Quest* is also available for download on InformIT.com.

There is plenty of code to review throughout this book, along with exercises for you to try out, so it is assumed you have access to the Apple developer tools, such as Xcode and the iPhone SDK. Both of these can be downloaded from the Apple iPhone Dev Center.[2]

[2] Apple's iPhone DevCenter: developer.apple.com/iphone.

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6

Sprite Sheets

Chapter 5, "Image Rendering," was large and covered a number of complex concepts. Having done all that hard work, and with the classes in place for representing and rendering images, we can move on to the other components needed in the game engine for Sir Lamorak's Quest.

As the title suggests, this chapter is all about sprite sheets. If you remember from Chapter 2, "The Three Ts: Terminology, Technology, and Tools," a *sprite sheet* is a large image that contains a number of smaller images.

There are two key benefits to using sprite sheet, as follows:

- You reduce the number of times you need to ask OpenGL ES to bind to a new texture, which helps with performance.
- You gain the ability to easily define and reuse image elements of the game, even in animations.

This chapter reviews the `SpriteSheet` and `PackedSpriteSheet` classes and shows how to extract specific images from within a larger image sprite sheet.

Introduction to Sprite Sheets

As mentioned in Chapter 2, there are two different types of sprite sheets, as follows:

- Basic, where all the images in the sprite sheet have the same dimensions.
- Complex, where the images in the sprite sheet could all have different dimensions.

For *Sir Lamorak's Quest*, we are going to be using both kinds of sprite sheets. Although it is possible to merge both the simple and complex sprite sheet functionality into a single class, I have split them into two different classes to make things easier to understand. Basic sprite sheets are handled in a class called `SpriteSheet`, whereas the `PackedSpriteSheet` class handles complex sprite sheets.

> **Note**
>
> I use the term *packed* because you can place smaller sprite sheets within this larger sprite sheet, thus reducing the number of separate sprite sheets used in the game.

Another term for a sprite sheet is a *texture atlas*, but I will continue to use the old-school term of "sprite sheet" throughout this book.

Simple Sprite Sheet

The `SpriteSheet` class takes the image provided and chops it up into equally sized sub-images (sprites). The dimensions to be used when dividing up the sprite sheet will be provided when a new sprite sheet is instantiated. Information is also provided about any spacing that has been used within the provided sprite sheet image. Spacing is an important property within a sprite sheet. Without going into detail, when defining texture coordinates within an image for OpenGL ES, it is possible to sample a pixel beyond the edge of the texture you are defining. This can cause your textures to have an unwanted border that is made up of pixels from the image around the image defined with your texture coordinates. This is known as *texture bleeding*.

To reduce the risk of this happening, you can place a transparent border around each image within a sprite sheet. If OpenGL ES then goes beyond the edge of your texture, it will only sample a transparent pixel, and this should not interfere with the sprite you have defined. Zwoptex[1] enable you to specify the number of pixels you would like to use as a border around your sprites. Figure 6.1 shows a simple sprite sheet image with single pixel border between each sub-image. If you are drawing non-square triangles, the spacing may need to be more than one pixel to help eliminate texture bleeding.

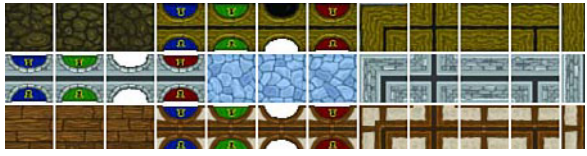


Figure 6.1 Sprite sheet with spacing between each sprite.

In terms of how we are going to access the sprites on a simple sprite sheet, we're going to use its grid location. A simple sprite sheet makes a nice grid because all the images are the

[1] Zwoptex (**www.zwoptexapp.com/flashversion/**) is a Flash-based sprite sheet builder. There is also a Cocoa-based version of this tool available. This Cocoa version generates output the same as the flash version, but was not available during the writing of this book.

same size. This makes it easy to retrieve a sprite by providing its row and column number. Figure 6.2 shows a sprite sheet of twelve columns and three rows with the sprite at location `{5, 1}` highlighted.

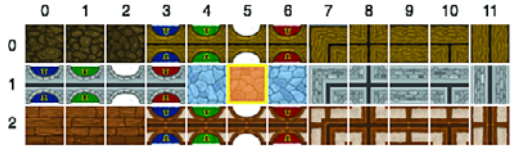


Figure 6.2 Sprite sheet grid with location {5, 1} highlighted.

Complex Sprite Sheets

The `PackedSpriteSheet` class takes an image and the name of the control file. The control file is parsed to obtain the location and size of every sprite within the sprite sheet image.

The control file is the key difference between a basic (`SpriteSheet`) and complex (`PackedSpriteSheet`) sprite sheet. With the basic sprite sheet, you can work out where each sprite is by performing a simple calculation using its grid position. This is harder to do with a complex sprite sheet because the sprites can be different sizes and are often placed randomly throughout the image to make the best use of space.

To help identify the coordinates of the sprites in a complex sprite sheet, the control file provides information on where each sprite is located inside the sprite sheet, along with its dimensions. The control file also gives each image a *key*, usually the name of the image file of the original sub-image, which then allows the `PackedSpriteSheet` class to reference each sprite. Figure 6.3 shows the complex sprite sheet that we use in *Sir Lamorak's Quest*.

Figure 6.3 Complex sprite sheet from *Sir Lamorak's Quest*.

As you can see from Figure 6.3, a complex sprite sheet has many images that are all different sizes and shapes—thus the need for a control file to make sense of it all.

You could create your own control file for these files, providing the information on the pixel locations within the image and its dimensions, but to be honest, that is a really tedious job. Luckily for us, there are tools that can help.

The Zwoptex tool (mentioned earlier, and discussed in Chapter 2) is one such tool. It not only produces a PNG image of the generated sprite sheet, but it also creates the control file you need to identify the individual images within.

Zwoptex has a number of different algorithms that can help pack images, but it also enables you to move the images around, making it possible for you to pack as many images as possible into a single sheet. There are some good algorithms out there for optimizing the packing of variably sized images, but you'll always get the best results doing this manually.

Figure 6.4 shows the flash version of Zwoptex editing the complex sprite sheet.

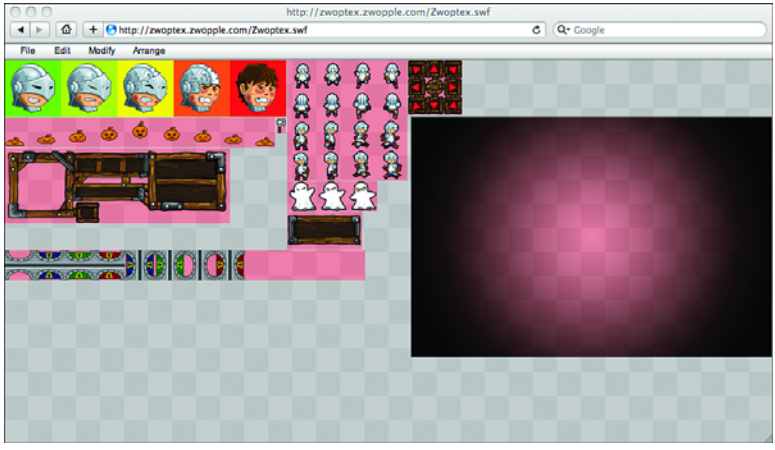


Figure 6.4 The Flash-based Zwoptex tool, used for editing a complex sprite sheet.

Zwoptex has three different outputs, as follows:

- A project file that stores your settings and images for a particular sprite sheet
- A PNG image of the sprite sheet
- A *plist* control file, which you can add to your game

The thing I like the most about Zwoptex is that it gave me the control file as a *plist* file. Although you can obviously handle raw XML if needed (or any other format, for that

matter), having a *plist* file makes things so much easier (and I like to take the easy route whenever possible).

Now that you know what Zwoptex is, let's show you how to use it.

Using Zwoptex

Using Zwoptex is really easy. Just point your browser to **www.zwoptexapp.com/flashversion/**. Once there, Zwoptex opens, and you can start creating your sprite sheet.

The first step is to import images. Start by going to the menu **File > Import Images** (see Figure 6.5), and you see an **Open File** panel for you to navigate to the file(s) you want to import.

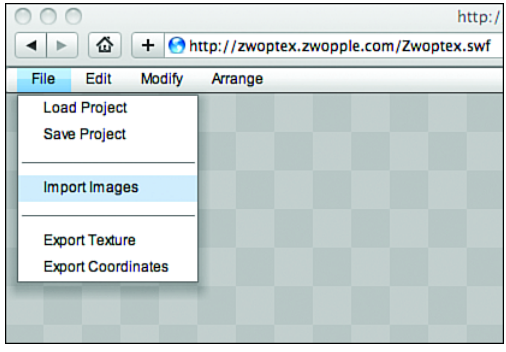


Figure 6.5 Import images into the sprite sheet.

After you select your images, hit the **Select** button to load the images into Zwoptex. All the images you've selected will be placed at the top-left corner of the screen, as shown in Figure 6.6.

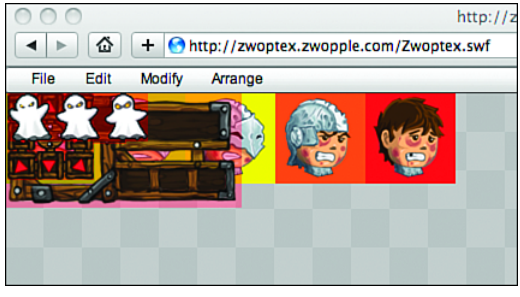


Figure 6.6 Zwoptex imports the images in the top-left corner of the canvas.

Now that you've placed the images in Zwoptex, there are a number of ways to arrange the sprites on the canvas. Under the **Arrange** menu, you will find different options for laying out the sprites. Figure 6.7 shows the sprites having been laid out using the **Complex By Width (no spacing)** option.

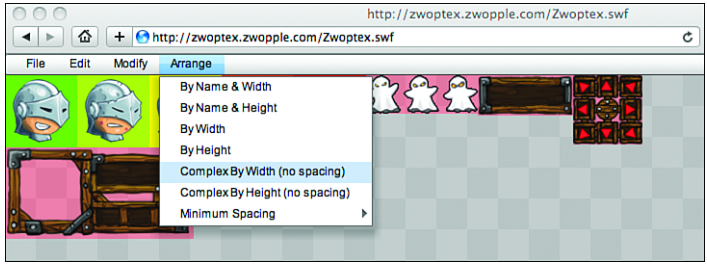


Figure 6.7 Sprite options menu and arranged sprites.

You can do this manually by clicking any sprite and moving it to the position you want. You can also use the **Modify** menu to change the size of the canvas to fit your needs.

By default, Zwoptex trims transparent edges from the imported images. This can be a problem, however, if the image you imported will be used as a simple sprite sheet. These images need to retain their original dimensions or the calculations used to define the position of each sprite will be incorrect.

Within the **Modify** menu is the option to **Untrim Selected Images**. This should be used to ensure that the images are returned to their original size. This is not necessary if the image won't be used as a sprite sheet.

Having arranged your sprites, you can then export both the image (texture) and the control file (coordinates). There are two options within the **File** menu that let you do this: **Export Texture** and **Export Coordinates**. Both options enable you to select the location where you would like the file(s) saved.

That's it! You now have a sprite sheet image file and its accompanying control file.

The SpriteSheet Class

Having looked at the basics of a sprite sheet, we can now look at our implementation of the `SpriteSheet` class. In Xcode, open the *CH06_SLQTSOR* project and look inside the `Game Engine` group. You will see a new group called *Sprite Sheet*, inside of which are the `SpriteSheet` classes header and implementation files.

Initialization

Inside the *SpriteSheet.m* file, you find the following class methods:

- `spriteSheetForImageNamed:spriteSize:spacing:margin: imageFilter`
- `spriteSheetForImage:sheetKey:spriteSize:spacing:margin:`

These methods are used to create new sprite sheets either from an image file or from an `Image` instance that has already been created. Notice that both of these are class methods. This means you don't need an instance of the `SpriteSheet` class to access them. Having also defined a static `NSDictionary` within the class, you can use these class methods to access the dictionary information that only has a single instance.

The idea is that a sprite sheet is cached when it is created. Whenever a new sprite sheet that either uses the same image file or key is requested, a reference to the sprite sheet already created is returned. This helps with performance when you have a large number of entities that share the same sprite sheet (for example, the `Door` class, which you will see soon).

These class methods still make use of the standard initializer methods; they just cache the sprite sheet returned by these methods for later use. Listing 6.1 shows the `spriteSheetForImageNamed:spriteSize:spacing:margin:imageFilter:` method.

Listing 6.1 **The spriteSheetForImageNamed:spriteSize:spacing:margin:imageFilter: Method**

```
static NSMutableDictionary *cachedSpriteSheets = nil;

+ (SpriteSheet*)spriteSheetForImageNamed:(NSString*)aImageName
      spriteSize:(CGSize)aSpriteSize spacing:(NSUInteger)aSpacing
      margin:(NSUInteger)aMargin imageFilter:(GLenum)aFilter {

    SpriteSheet *cachedSpriteSheet;

    if (!cachedSpriteSheets)
        cachedSpriteSheets = [[NSMutableDictionary alloc] init];

    if(cachedSpriteSheet = [cachedSpriteSheets objectForKey:aImageName])
        return cachedSpriteSheet;

    cachedSpriteSheet = [[SpriteSheet alloc]
        initWithImageNamed:aImageName spriteSize:aSpriteSize
        spacing:aSpacing margin:aMargin imageFilter:aFilter];
    [cachedSpriteSheets setObject:cachedSpriteSheet forKey:aImageName];
    [cachedSpriteSheet release];

    return cachedSpriteSheet;
}
```

The first line in Listing 6.1 defines a static `NSMutableDictionary`. This creates a single instance of `NSMutableDictionary` that the class methods use to cache the sprite sheets. This dictionary has been defined at the class level, which means that only a single copy of this dictionary will exist, regardless of how many `SpriteSheet` instances are created. This provides us with a single cache of the sprite sheets.

The rest of the class simply checks to see if an entry already exists in the dictionary for an image name passed in (using `spriteSheetForImageNamed`). If the other method passes in a ready-made image, the `sheetKey` provided is used.

If no match is found, a new sprite sheet is created and added to the dictionary. Otherwise, the matching entry from the dictionary is passed back to the caller.

The initializer used when an image name is provided is shown in Listing 6.2.

Listing 6.2 **SpriteSheet initWithImageNamed:spriteSize:spacing:margin:imageFilter Method**

```
- (id)initWithImageNamed:(NSString*)aImageFileName
    spriteSize:(CGSize)aSpriteSize spacing:(NSUInteger)aSpacing
    margin:(NSUInteger)aMargin imageFilter:(GLenum)aFilter {

    if (self = [super init]) {
        NSString *fileName = [[aImageFileName lastPathComponent]
            stringByDeletingPathExtension];

            self.image = [[Image alloc]
                initWithImageNamed:filename filter:aFilter];

            spriteSize = aSpriteSize;
            spacing = aSpacing;
            margin = 0;

            [self cacheSprites];
    }
    return self;
}
```

The start of the initializer method is standard, and we have seen it many times already. The first interesting action comes when we create an image instance of the image used as the sprite sheet.

We are using the `Image` class that we created in the last chapter, passing in the image name that has been provided along with the image filter.

Next, the sprite's size, spacing, and margin are defined. At this point, we branch off and call a private method, called `cacheSprites`, which caches the information for each sprite in this sprite sheet. Calculating this information only once is important to help performance. This information should never change during the lifetime of a sprite sheet, so there is no need to calculate each time we request a particular sprite.

We examine the `cacheSprites` method in a moment; first, there is another initializer method to look at, as shown in Listing 6.3.

Listing 6.3 **SpriteSheet initWithImage:spriteSize:spacing:margin Method**

```
- (id)initWithImage:(Image*)aImage spriteSize:(CGSize)aSpriteSize
      spacing:(NSUInteger)aSpacing margin:(NSUInteger)aMargin{
    if (self = [super init]) {
        self.image = aImage;

        spriteSize = aSpriteSize;
        spacing = aSpacing;
        margin = aMargin;

        [self cacheSprites];
    }
    return self;
}
```

The previous initializer took the name of an image file and created the image as part of creating the sprite sheet. This second initializer takes an image that's already been created. Not only is it useful to create a sprite sheet using an image instance that already exists, but it is also the method that's used when we create a sprite sheet from an image held in a complex (or packed) sprite sheet.

The only difference in this initializer from the last is that we set the sprite sheet's image to reference the `Image` instance that has been passed in. This method still calls the `cacheSprites` method, and that's the next method we discuss.

The `cacheSprites` method (shown in Listing 6.4) is a private method, as we only use it internally in the `SpriteSheet` class.

Listing 6.4 **SpriteSheet cacheSprites Method**

```
- (void)cacheSprites {

    horizSpriteCount = ((image.imageSize.width + spacing) + margin) /
        ((spriteSize.width + spacing) + margin);
    vertSpriteCount = ((image.imageSize.height + spacing) + margin) /
        ((spriteSize.height + spacing) + margin);

    cachedSprites = [[NSMutableArray alloc] init];
    CGPoint textureOffset;

    for(uint row=0; row < vertSpriteCount; row++) {
        for(uint column=0; column < horizSpriteCount; column++) {

            CGPoint texturePoint = CGPointMake((column *
```

```
                (spriteSize.width + spacing) + margin),
                (row * (spriteSize.height + spacing) + margin));

            textureOffset.x = image.textureOffset.x *
                image.fullTextureSize.width + texturePoint.x;
            textureOffset.y = image.textureOffset.y *
                image.fullTextureSize.height + texturePoint.y;
            CGRect tileImageRect = CGRectMake(textureOffset.x,
                textureOffset.y, spriteSize.width, spriteSize.height);

            Image *tileImage = [[image subImageInRect:tileImageRect]
                retain];

            [cachedSprites addObject:tileImage];

            [tileImage release];
        }
    }
}
```

The first two calculations work out how many sprites there are in the sprite image, and a new `NSMutableArray` is created. This array holds `Image` instances created for each image in the sprite sheet. Again, creating the images at this stage and caching them improves performance. This is not an activity you want to be performing in the middle of game play.

With the array created, we then loop through each row and column, creating a new image for each sprite. We use the information we have about the sprite sheet, such as size, spacing, and margin, to calculate where within the sprite sheet image each sprite will be. With this information, we are now able to use the `subImageInRect` method of the `Image` class to create a new image that represents just the sub-image defined.

Retrieving Sprites

Having set up the sprites on the sprite sheet, the next key activity is to retrieve sprites. We have already discussed that one of the key tasks of the `SpriteSheet` class is to return an `Image` class instance configured to render a single sprite from the sprite sheet, based on the grid location of the sprite.

The `spriteImageAtCoords:` method shown in Listing 6.5 implements the core mechanism for being able to retrieve a sprite.

Listing 6.5 **SpriteSheet spriteImageAtCoords: Method**

```
- (Image*)spriteImageAtCoords:(CGPoint)aPoint {

    if(aPoint.x > horizSpriteCount-1 || aPoint.y < 0 || aPoint.y >
        vertSpriteCount-1 ||
        aPoint.y < 0)
```

```
        return nil;

    int index = (horizSpriteCount * aPoint.y) + aPoint.x;

    return [cachedSprites objectAtIndex:index];
}
```

The first check we carry out in this class is on the coordinates that are being passed in. This method takes the coordinates for the sprite in a `CGPoint` variable. `CGPoint` has an `x` and `y` value that can be used to specify the grid coordinates in the sprite sheet.

When we know that the coordinates are within the sprite sheet, we use the coordinates of the sprite to calculate its location within the `NSMutableArray`. It's then a simple task of retrieving the image from that index and passing it back to the caller

That's it for this class. It's not that long or complex, but it does provide an important building block within our game engine.

PackedSpriteSheet Class

As mentioned earlier, the `PackedSpriteSheet` class is responsible for dealing with complex sprite sheets. These sprite sheets contain many variably sized images to which we want to get access. This often includes other sprite sheets. This class can be found in the same group within the *CH06_SLQTSOR* project, as before.

Initialization

This class uses the same caching technique as the `SpriteSheet` class. There is, however, only one initializer, which is shown in Listing 6.6.

Listing 6.6 **PackedSpriteSheet initWithImageNamed:controlFile:filter Method**

```
- (id)initWithImageNamed:(NSString*)aImageFileName
controlFile:(NSString*)aControlFile
      filter:(GLenum)aFilter {

    if (self = [super init]) {
        NSString *fileName = [[aImageFileName lastPathComponent]
            stringByDeletingPathExtension];

        image = [[[Image alloc] initWithImageNamed:fileName
            filter:aFilter] retain];

        sprites = [[NSMutableDictionary alloc] init];

        controlFile = [[NSDictionary alloc]
            initWithContentsOfFile:[[NSBundle mainBundle]
            pathForResource:aControlFile ofType:@"plist"]];
```

```
        [self parseControlFile:controlFile];
        [controlFile release];
    }
    return self;

}
```

Once inside the initializer, we create a new `Image` instance from the details passed in and allocate an `NSMutableDictionary` instance called `sprites` that will hold the details of the sprites in our packed sprite sheet.

The last section of the initializer grabs the contents of the control file that were passed in and loads it into an `NSDictionary` called `controlFile`. It is always assumed that the type of file is a *plist*, so the file type is hard coded. After we have the `controlFile` dictionary populated, we then parse the information inside that dictionary using the private `parseControlFile` method shown in Listing 6.7.

Listing 6.7 **PackedSpriteSheet parseControlFile: Method**

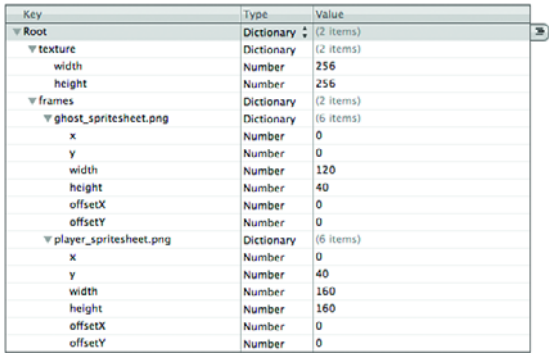
```
- (void)parseControlFile:(NSDictionary*)aControlFile {

    NSDictionary *framesDictionary = [controlFile objectForKey:@"frames"];

    for (NSString *frameDictionaryKey in framesDictionary) {

        NSDictionary *frameDictionary = [framesDictionary
            objectForKey:frameDictionaryKey];

        float x = [[frameDictionary objectForKey:@"x"] floatValue];
        float y = [[frameDictionary objectForKey:@"y"] floatValue];
        float w = [[frameDictionary objectForKey:@"width"] floatValue];
        float h = [[frameDictionary objectForKey:@"height"] floatValue];

        Image *subImage = [image subImageInRect:CGRectMake(x, y, w, h)];
        [sprites setObject:subImage forKey:frameDictionaryKey];
    }
}
```

Parsing the Control File

The `parseControlFile` method creates a dictionary from all the `frames` objects within the dictionary we passed in. There are several objects inside the *plist* file, as follows:

- Texture, which holds the dimensions of the texture.
- Frames, which hold objects keyed on the image's filename for each image in the sprite sheet.

An example of the *plist* file inside the Plist Editor can be seen in Figure 6.8.



Key	Type	Value
Root	Dictionary	(2 items)
texture	Dictionary	(2 items)
width	Number	256
height	Number	256
frames	Dictionary	(2 items)
ghost_spritesheet.png	Dictionary	(6 items)
x	Number	0
y	Number	0
width	Number	120
height	Number	40
offsetX	Number	0
offsetY	Number	0
player_spritesheet.png	Dictionary	(6 items)
x	Number	0
y	Number	40
width	Number	160
height	Number	160
offsetX	Number	0
offsetY	Number	0

Figure 6.8 Sprite sheet plist control file.

The details we want for the sprites are therefore held in the frame's objects.

Now that we have a dictionary called `frames`, we loop through each of them, extracting the information we need. For each frame we find, we assign another `NSDictionary` that contains the objects for the key we are dealing with. Remember that the key is a string that contains the name of the original image file that was embedded into the larger sprite sheet. This makes it easy later on to reference the image we need.

Once we have the information for the frame, we then add a new object to our `sprites` dictionary. The key is the name of the image file we have just read from the control file, and the object is an `Image` instance.

Getting a sub-image from the full sprite sheet image creates the `Image` instance. Again, we are just making use of functionality we have already built.

This process is repeated for each image in the sprite sheet control file, and we end up with a dictionary that contains an image representing each image in our packed sprite sheet.

Retrieving a Sprite

Having all our sprites in a dictionary now makes retrieving a sprite from our `PackedSpriteSheet` very simple. This is done using the `imageForKey` method. Listing 6.8 shows this method.

Listing 6.8 **PackedSpriteSheet imageForKey Method**

```
- (Image*)imageForKey:(NSString*)aKey {
    Image *spriteImage = [sprites objectForKey:aKey];
    if (spriteImage) {
        return [sprites objectForKey:aKey];
    }
```

```
    NSLog(@"ERROR - PackedSpriteSheet: Sprite could not be found for key
        '%@'", aKey);
    return nil;
}
```

We pass an `NSString` into this method containing the key to the sprite's dictionary that we created earlier. If you remember, the key is the filename of the image that was placed inside the packed sprite sheet. If an image is found for the key supplied, a reference to this image is returned. Otherwise, an error is logged, so we know that the sprite we wanted could not be found.

> **Note**
>
> Notice that, in some methods, an error is raised using `NSLog`. This is handy when debugging your game, but this is also a huge performance hog. To reduce the possibility of an `NSLog` message being called in the production code, it would be worth only generating the log messages when running in debug code.

Summary

In this chapter, we have reviewed the `SpriteSheet` and `PackedSpriteSheet` classes that continue to build out our game engine for *Sir Lamorak's Quest*. These classes enable us to retrieve sub-images from within a specified image in a number of ways:

- `SpriteSheet` **class:** As a new `Image` instance based on a sprite's grid location.
- `PackedSpriteSheet` **class:** As an `Image` reference based on a sprite's key (for example, the sub-image's original filename).

These important classes enable us to not only manage the number of textures we need, but also provide us with a mechanism for grabbing the images needed to create animation.

Classes such as `Image`, `SpriteSheet`, and `PackedSpriteSheet` are the building blocks that form the backbone of our game engine. Being comfortable with how they work and how they can be used enable you to get the most out of the game engine itself, as well as a clearer view of how to implement your own games. Although the game engine we are building for *Sir Lamorak's Quest* is not suited to all types of games, it provides you with the basis for any future games you want to develop. This enables you to take the game engine in new directions as your needs and experience grow.

The next chapter covers animation. It's not exactly Pixar Animation,[2] but animation nonetheless.

[2] Pixar Animation is an award-winning computer animation studio responsible for feature films such as *Toy Story*, *Monsters, Inc.*, and *Finding Nemo*, among many others.

Exercise

The example project that is provided with this chapter, *CH06_SLQTSOR*, displays three different images that have been taken from a single sprite sheet. These images are scaled, rotated, and colored using the features of the `Image` class covered in Chapter 5 to show that the `Image` instance returned is an entirely separate image in its own right.

The current project is using a couple of sprite sheets from *Sir Lamorak's Quest* that have been placed inside a complex sprite sheet.

Using this project as a guide, why not try to create your own basic sprite sheet or download one from the Internet? Once you have your sprite sheet, create a complex sprite sheet using Zwoptex and then render your sprites to the screen.

Here are the steps you need to follow:

1. Decide what fancy sprites you want to create.
2. Work out the dimensions each sprite is going to be (for example, 40×40 or 50×80) and any spacing you want to use.
3. Open up your favorite graphics package and draw your sprites, remembering to keep each sprite in a square that has the dimensions you decided.
4. Export your sprite sheet as a PNG file.
5. Open up the Zwoptex link (**www.zwoptexapp.com/flashversion/**), and add the sprite sheets that are included in the project along with your own.
6. Export the texture and coordinates from Zwoptex.
7. Add the two files you have just generated to the Xcode project. This can be done by right-clicking the Images group inside the Game Resources group and selecting **Add > Add Existing File**. Inside the panel that pops up, navigate to the file and select it. You should also select the Copy option to make sure the files are copied to the project folder.
8. Finally, follow the code example in the current project to import and start using your sprite sheet.
9. Once you are rendering your sprites, try to apply some image functions, such as scaling, rotation, and color.

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Learning Cocos2D

Praise for *Learning Cocos2D*

"If you're looking to create an iPhone or iPad game, *Learning Cocos2D* should be the first book on your shopping list. Rod and Ray do a phenomenal job of taking you through the entire process from concept to app, clearly explaining both how to do each step as well as why you're dong it."

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Learning Cocos2D

A Hands-On Guide to Building iOS Games with Cocos2D, Box2D, and Chipmunk

Rod Strougo
Ray Wenderlich

Addison-Wesley

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❖

Dedicated to my wife, Agata.
—Rod

Dedicated to my wife, Vicki.
—Ray

❖

Preface

So you want to be a game developer?

Developing games for the iPhone or iPad can be a lot of fun. It is one of the few things we can do to feel like a kid again. Everyone, it seems, has an idea for a game, and what better platform to develop for than the iPhone and iPad?

What stops most people from actually developing a game, though, is that game development covers a wide swath of computer science skills—graphics, audio, networking—and at times it can seem like you are drinking from a fire hose. When you are first getting started, becoming comfortable with Objective-C can seem like a huge task, especially if you start to look at things like OpenGL ES, OpenAL, and other lower-level APIs for your game.

Writing a game for the iPhone and iPad does not have to be that difficult—and it isn't. To help simplify the task of building 2D games, look no further than Cocos2D.

You no longer have to deal with low-level OpenGL programming APIs to make games for the iPhone, and you don't need to be a math or physics expert. There's a much faster and easier way—use a free and popular open source game programming framework called Cocos2D. Cocos2D is extremely fun and easy to use, and with it you can skip the low-level details and focus on what makes your game different and special!

This book teaches you how to use Cocos2D to make your own games, taking you step by step through the process of making an actual game that's on the App Store right now! The game you build in this book is called *Space Viking* and is the story of a kick-ass Viking transported to an alien planet. In the process of making the game, you get hands-on experience with all of the most important elements in Cocos2D and see how everything fits together to make a complete game.

> **Download the Game!**
>
> You can download *Space Viking*s from the App Store: *http://itunes.apple.com/us/app/space-vikings/id400657526mt=8*. The game is free, so go ahead and download it, start playing around with it, and see if you're good enough to get all of the achievements!

Think of this book as an epic-length tutorial, showing you how you can make a real game with Cocos2D from the bottom up. You'll be coding along with the book, and we explain things step by step. By the time you've finished reading and working

through this book, you'll have made a complete game. Best of all, you'll have the confidence and knowledge it takes to make your own.

Each chapter describes in detail a specific component within the game along with the technology required to support it, be it a tile map editor or some effect we're creating with Cocos2D, Box2D, or Chipmunk. Once an introduction to the functionality and technology is complete, the chapter provides details on how the component has been implemented within *Space Viking*. This combination of theory and real-world implementation helps to fill the void left by other game-development books.

What Is Cocos2D?

Cocos2D *(www.cocos2d-iphone.org)* is an open source Objective-C framework for making 2D games for the iOS and Mac OS X, which includes developing for the iPhone, iPod touch, the iPad, and the Mac. Cocos2D can either be included as a library to your project in Xcode or automatically added when you create a new game using the included Cocos2D templates.

Cocos2D uses OpenGL ES for graphics rendering, giving you all of the speed and performance of the graphics processor (GPU) on your device. Cocos2D includes a host of other features and capabilities, which you'll learn more about as you work through the tutorial in this book.

Cocos2D started life as a Python framework for doing 2D games. In late 2008, it was ported to the iPhone and rewritten in Objective-C. There are now additional ports of Cocos2D to Ruby, Java (Android), and even Mono (C#/.NET).

> **Note**
>
> Cocos2D has an active and vibrant community of contributors and supporters. The Cocos2D forums *(www.cocos2d-iphone.org/forum)* are very active and an excellent resource for learning and troubleshooting as well as keeping up to date on the latest developments of Cocos2D.

Why You Should Use Cocos2D

Cocos2D lets you focus on your core game instead of on low-level APIs. The App Store marketplace is very fluid and evolves rapidly. Prototyping and developing your game quickly is crucial for success in the App Store, and Cocos2D is the best tool for helping you quickly develop your game without getting bogged down trying to learn OpenGL ES or OpenAL.

Cocos2D also includes a host of utility classes such as the `TextureCache`, which automatically caches your graphics, providing for faster and smoother gameplay. `TextureCache` operates in the background and is one of the many functions of Cocos2D that you don't even have to know how to use; it functions transparently to

you. Other useful utilities include font rendering, sprite sheets, a robust sound system, and many more.

Cocos2D is a great prototyping tool. You can quickly make a game in as little as an hour (or however long it takes you to read Chapter 2). You are reading this book because you want to make games for the iPhone and iPad, and using Cocos2D is the quickest way to get there—bar none.

Cocos2D Key Features

Still unsure if Cocos2D is right for you? Well, check out some of these amazing features of Cocos2D that can make developing your next game a lot easier.

Actions

Actions are one of the most powerful features in Cocos2D. Actions allow you to move, scale, and manipulate sprites and other objects with ease. As an example, to smoothly move a space cargo ship across the screen 400 pixels to the right in 5 seconds, all the code you need is:

```
CCAction *moveAction = [CCMoveBy actionWithDuration:5.0f
                                  position:CGPointMake(400.0f,0.0f)];
[spaceCargoShipSprite runAction:moveAction];
```

That's it; just two lines of code! Figure P.1 illustrates the `moveAction` on the space cargo ship.

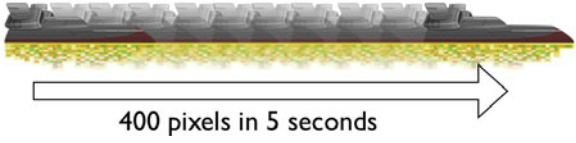

Figure P.1 Illustrating the effect of the moveAction on the Space Cargo Ship sprite

There are many kinds of built-in actions in Cocos2D: rotate, scale, jump, blink, fade, tint, animation, and more. You can also chain actions together and call custom callbacks for neat effects with very little code.

Built-In Font Support

Cocos2D makes it very easy to deal with text, which is important for games in menu systems, score displays, debugging, and more. Cocos2D includes support for embedded TrueType fonts and also a fast bitmap font-rendering system, so you can display text to the screen with just a few lines of code.

An Extensive Effects Library

Cocos2D includes a powerful particle system that makes it easy to add cool effects such as smoke, fire, rain, and snow to your games. Also, Cocos2D includes built-in effects, such as flip and fading, to transition between screens in your game.

Great for TileMap Games

Cocos2D includes built-in support for tile-mapped games, which is great when you have a large game world made up of small reusable images. Cocos2D also makes it easy to move the camera around to implement scrolling backgrounds or levels. Finally, there is support for parallax scrolling, which gives your game the illusion of 3D depth and perspective.

Audio/Sound Support

The sound engine included with Cocos2D allows for easy use of the power of OpenAL without having to dive into the lower level APIs. With Cocos2D's sound engine, you can play background music or sound effects with just a single line of code!

Two Powerful Physics Engines

Also bundled with Cocos2D are two powerful physics engines, Box2D and Chipmunk, both of which are fantastic for games. You can add a whole new level of realism to your games and create entire new gameplay types by using game physics—without having to be a math guru.

Important Concepts

Before we get started, it's important to make sure you're familiar with some important concepts about Cocos2D and game programming in general.

Sprite

You will see the term *sprite* used often in game development. A sprite is an image that can be moved independently of other images on the screen. A sprite could be the player character, an enemy, or a larger image used in the background. In practice, sprites are made from your PNG or PVRTC image files. Once loaded in memory, a sprite is converted into a texture used by the iPhone GPU to render onscreen.

Singleton

A *singleton* is a special kind of Objective-C class, which can have only one instance. An example of this is an iPhone app's Application Delegate class, or the Director class in Cocos2D. When you call a singleton instance in your code, you always get back the one instance of this class, regardless of which class called it.

OpenGL ES

OpenGL ES is a mobile version (ES stands for *Embedded Systems*) of the Open Graphics Language (OpenGL). It is the closest you can get on the iPhone or iPad to sending zeros and ones to the GPU. OpenGL ES is the fastest way to render graphics on the iPhone or iPad, and due to its origin, it is a low-level API. If you are new to game development, OpenGL ES can have a steep learning curve, but luckily you don't need to know OpenGL ES to use Cocos2D.

The two versions of OpenGL ES supported on the iPhone and iPad are 1.1 and 2.0. There are plans in the Cocos2D roadmap to support OpenGL ES 2.0, although currently only version 1.1 is supported.

Languages and Screen Resolutions

Cocos2D is written in Objective-C, the same language as Cocoa Touch and the majority of the Apple iOS APIs. In Objective-C it is important to understand some basic memory-management techniques, as it is a good foundation for you to become an efficient game developer on the iOS platform. Cocos2D supports all of the native resolutions on the iOS devices, from the original iPhone to the iPad to the retina display on the iPhone 4.

2D versus 3D

You first learn to walk before you can run. The same is true for game development; you have to learn how to make 2D games before diving into the deeper concepts of 3D games. There are some 3D effects and transitions in Cocos2D, such as a 3D wave effect and an orbit camera move; however, most of the functionality is geared toward 2D games and graphics.

Cocos2D is designed for 2D games (hence the 2D in the name), as are the tutorials and examples in this book. If you want to make 3D games, you should look into different frameworks, such as Unity, the Unreal Engine, or direct OpenGL.

The Game behind the Book: Space Viking

This book takes you through the process of creating a full-featured Cocos2D-based game for the iPhone and iPad. The game you build in this book is called *Space Viking*. If you want to try *Space Viking* now, you can download a free version of the game from the App Store *(http://itunes.apple.com/us/app/id400657526)* and install it on your iPhone, iPod touch, or iPad.

Of course, if you are more patient, you can build the game yourself and load it onto your device after working through the chapters in this book. There is no greater learning experience than having the ability to test a game as you're building it. Not only can you learn how to build a game, but you can also go back and tweak the code a bit to change things around to see what sort of effect something has on the gameplay. Good things come to those who wait.

This book teaches you how to use all of the features and capabilities of Cocos2D, but more important, how to apply them to a real game. By the time you are done, you will have the knowledge and experience needed to get your own game in the App Store. The concepts you learn from building *Space Viking* apply to a variety of games from action to puzzle.

Space Viking's Story

Every game starts in the depths of your imagination, with a character and storyline that gets transformed into a game. This is the story of *Space Viking*.

In the future, the descendants of Earth are forced into colonizing planets outside our own solar system. In order to create hospitable environments, huge interplanetary machines extract giant chunks of ice from Northern Europe and Greenland and send it across the galaxy to these planets. Unbeknown to the scientists, one of these chunks contains Ole the Viking, who eons ago fell into an icy river on his way home from defeating barbarian tribes. Encased in an icy tomb for centuries, Ole awakens thousands of years later—and light years from home—after being warmed by an alien sun, as shown in Figure P.2.

Figure P.2 Ole awakens on the alien planet

You get to play as Ole the Viking and battle the aliens on this strange world in hopes of finding a way to return Ole to his native land and time.

You control Ole's movement to the right and left by using the thumb joystick on the left side of the screen. On the right side are buttons for jumping and attacking. Ole starts out with only his fists. In later levels Ole finds his trusty mallet, and you use the accelerometer to control him in the physics levels.

Space Viking is an action and adventure game, with the emphasis on *action*. The goal was to create a real game from the ground up so you could learn not only Cocos2D but also how to use it in a real full-featured game. The idea for the game came from

concept art that Eric Stevens, a graphic artist and fellow game devotee, developed earlier when we were discussing game ideas to make next.

Space Viking consists of a number of levels, each of which demonstrates a specific area of Cocos2D or gameplay type. For example, the first level is a side-scrolling beat 'em up, and the fourth level is a mine cart racing level that shows off the game physics found in Box2D and Chipmunk. Our hope is that you can reuse parts of *Space Viking* to make your own game once you've finished this book! That's right: you can freely reuse the code in this book to build your own game.

Organization of This Book

The goal of this book is to teach you about game development using Cocos2D as you build *Space Viking* (and learn more about the quest and story of Ole the Viking). You start with a simple level and some basic game mechanics and work your way up to creating levels with physics and particle systems and finally to a complete game by the end of the book.

First you learn the basics of Cocos2D and build a small level with basic running and jumping movements for Ole. Part II shows you how to add animations, actions, effects, and even text to *Space Viking*. Part III takes the game further, adding more levels and scenes, sounds, and scrolling to the gameplay. In Part IV realism is brought into the game with the Box2D and Chipmunk physics engines. Finally in Part V, you learn how to add a particle system, add high scores, connect to social networks, and debug and optimize *Space Viking* to round out some best practices for the games you will build in the future.

There are 17 chapters and one appendix in the book, each dealing with a specific area of creating *Space Viking*.

- **Part I: Getting Started with Cocos2D**

  Learn how to get Cocos2D installed and start using it to create *Space Viking*. Learn how to add animations and movements to Ole and his enemies.

  - **Chapter 1: Hello, Cocos2D**

    This chapter covers how to install Cocos2D framework and templates in Xcode and some companion tools that make developing games easier. These tools are freely available and facilitate the creation of the elements used by Cocos2D.

  - **Chapter 2: Hello, Space Viking**

    Here you create the basic *Space Viking* game, which you build upon throughout the book. You start out with just a basic Cocos2D template and add the hero (Ole the Viking) to the scene. In the second part of this chapter, you add the methods to handle the touch inputs, including moving Ole around and making him jump.

- **Chapter 3: Introduction to Cocos2D Animations and Actions**

  In this chapter, you learn how to make the game look much more realistic by adding animations to Ole as he moves around the scene.

- **Chapter 4: Simple Collision Detection and the First Enemy**

  In this chapter, you learn how to implement simple collision detection and add the first enemy to your *Space Viking* game, so Ole can start to fight his way off the planet!

- **Part II: More Enemies and More Fun**

  Learn how to create more complex enemies for Ole to battle and in the process learn about Cocos2D actions and effects. Finish up with a live, onscreen debugging system using Cocos2D text capabilities.

  - **Chapter 5: More Actions, Effects, and Cocos2D Scheduler**

    Actions are a key concept in Cocos2D—they are an easy way to move objects around, make them grow or disappear, and much more. In this chapter, you put them in practice by adding power-ups and weapons to the level, and you learn some other important Cocos2D capabilities, such as effects and the scheduler.

  - **Chapter 6: Text, Fonts, and the Written Word**

    Most games have text in them at some point, and *Space Viking* is no exception. In this chapter, you learn how to add text to your games using the different methods available in Cocos2D.

- **Part III: From Level to Game**

  Learn how to expand the *Space Viking* level into a full game by adding menus, sound, and scrolling.

  - **Chapter 7: Main Menu, Level Completed, and Credits Scenes**

    Almost all games have more than one screen (or "scene," as it's called in Cocos2D); there's usually a main menu, main game scene, level completed, and credits scene at the very least. In this chapter, you learn how to create multiple scenes by implementing them in *Space Viking*!

  - **Chapter 8: Pump Up the Volume!**

    Adding sound effects and music to a game can make a huge difference. Cocos2D makes it really easy with the CocosDenshion sound engine, so in this chapter you give it a try!

  - **Chapter 9: When the World Gets Bigger: Adding Scrolling**

    A lot of games have a bigger world than can fit on one screen, so the world needs to scroll as the player moves through it. This can be tricky to get right, so this chapter shows you how by converting the beat-'em-up into a side-scroller, using Cocos2D tile maps for improved performance.

- **Part IV: Physics Engines**

  With the Box2D and Chipmunk physics engines that come with Cocos2D, you can add some amazing effects to your games, such as gravity, realistic collisions, and even ragdoll effects! In these chapters you get a chance to add some physics-based levels to *Space Viking*, from simple to advanced!

  - **Chapter 10: Basic Game Physics: Adding Realism with Box2D**

    Just as Cocos2D makes it easy to make games for the iPhone without knowing low-level OpenGL details, Box2D makes it easy to add physics to your game objects without having to be a math expert. In this chapter, you learn how to get started with Box2D by making a fun puzzle game where objects move according to gravity.

  - **Chapter 11: Intermediate Game Physics: Modeling, Racing, and Leaping**

    This chapter shows you some of the really neat stuff you can do with Box2D by making the start of a side-scrolling cart-racing game. In the process, you learn how to model arbitrary shapes, add joints to restrict movement of physics bodies, and much more!

  - **Chapter 12: Advanced Game Physics: Even Better than the Real Thing**

    In this chapter, you make the cart-racing level even more amazing by adding spikes to dodge and an epic boss fight at the end. You learn more about joints, how to detect collisions, and how to add enemy logic as well.

  - **Chapter 13: The Chipmunk Physics Engine (No Alvin Required)**

    The second physics engine that comes with Cocos2D, called Chipmunk, is similar to Box2D. This chapter shows you how to use Chipmunk, compares it to Box2D, and gives you hands-on practice by making a Metroid-style escape level.

- **Part V: Particle Systems, Game Center, and Performance**

  Learn how to quickly create and add particle systems to your games, how to integrate with Apple's Game Center for online leaderboards and achievements, and some performance tips and tricks to keep your game running fast.

  - **Chapter 14: Particle Systems: Creating Fire, Snow, Ice, and More**

    Using Cocos2D's particle system, you can add some amazing special effects to your game—extremely easily! In this chapter, you learn how to use particle systems to add some special effects to *Space Viking*, such as ship exhaust.

  - **Chapter 15: Achievements and Leaderboards with Game Center**

    With Apple's Game Center, you can easily add achievements and leaderboards to your games, which makes things more fun for players and also might help you sell more copies! This chapter covers how to set things up in *Space Viking*, step by step.

- **Chapter 16: Performance Optimizations**

  In this chapter, you learn how to tackle some of the most common challenges and issues you will face in optimizing and getting the most out of your Cocos2D game. You get hands-on experience debugging the most common performance issues and applying solutions.

- **Chapter 17: Conclusion**

  This final chapter recaps what you learned and describes where you can go next: into 3D, using Cocos2D on other platforms such as Android, and more advanced game-development topics.

- **Appendix: Principal Classes of Cocos2D**

  The Appendix provides an overview of the main classes you will be using and interacting with in Cocos2D.

By the time you've finished reading this book, you'll have practical experience making an awesome game from scratch! You can then take the concepts you've learned (and even some of the code!) and use it to turn your own game into a reality.

Audience for This Book

The audience for this book includes developers who are put off by game-making because they anticipate a long and complex learning curve. Many developers want to write games but don't know where to start with game development or the Cocos2D framework. This book is a hands-on guide, which takes you from the very beginning of using Cocos2D to applying the advanced physics concepts in Box2D and Chipmunk.

This book is targeted to developers interested in creating games for iOS devices, including the iPhone, iPad, and iPod touch. The book assumes a basic understanding of Objective-C, Cocoa Touch, and the Xcode tools. You are not expected to know any lower-level APIs (Core Audio, OpenGL ES, etc.), as these are used internally by Cocos2D.

Who This Book Is For

If you are already developing applications for the iPhone of other platform but want to make a move from utility applications to games, then this book is for you. It builds on the development knowledge you already have and leads you into game development by describing the terminology, technology, and tools required as well as providing real-world implementation examples.

Who This Book Isn't For

If you already have a grasp of the workflow required to create a game or you have a firm game idea that you know will require OpenGL ES for 3D graphics, then this is not the book for you.

It is expected that before you read this book you are already familiar with Objective-C, C, Xcode, and Interface Builder. While the implementations described in this book have been kept as simple as possible, and the use of C is limited, a firm foundation in these languages is required.

The following books can help provide you with the grounding you need to work through this book:

- *Cocoa Programming for Mac OS X, Third Edition,* by Aaron Hillegass (Addison-Wesley, 2008)
- *Learning Objective-C 2.0* by Robert Clair (Addison-Wesley, 2011)
- *Programming in Objective-C 2.0* by Stephen G. Kochan (Addison-Wesley, 2009)
- *Cocoa Design Patterns* by Erik M. Buck and Donald A. Yacktman (Addison-Wesley, 2009)
- *The iPhone Developer's Cookbook, Second Edition,* by Erica Sadun (Addison-Wesley, 2010)
- *Core Animation: Simplified Animation Techniques for Mac and iPhone Development* by Marcus Zarra and Matt Long (Addison-Wesley, 2010)
- *iPhone Programming: The Big Nerd Ranch Guide* by Aaron Hillegass and Joe Conway (Big Nerd Ranch, Inc., 2010)
- *Learning iOS Game Programming: A Hands-On Guide to Building Your First iPhone Game* by Michael Daley (Addison-Wesley, 2011)

These books, along with other resources you'll find on the web, will help you learn more about how to program for the Mac and iPhone, giving you a deeper knowledge about the Objective-C language and the Cocoa frameworks.

Source Code, Tutorial Videos, and Forums

Access to information is not limited only to the book. The complete, fully commented source code for *Space Viking* is also included, along with video tutorials (available at *http://cocos2Dbook.com*) that take you visually through the concepts of each chapter.

There is plenty of code to review throughout the book, along with exercises for you to try out, so it is assumed you have access to the Apple developer tools such as Xcode and the iPhone SDK. Both of these can be downloaded from the Apple iPhone Dev Center: *http://developer.apple.com/iphone*.

If you want to work with your fellow students as you work through the book, feel free to check out the book's forums at *http://cocos2dbook.com/forums/*.

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From Rod Strougo

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About the Authors

Rod Strougo is the founder and lead developer of the studio Prop Group at *www.prop.gr*. Rod's journey in physics and games started way back with an Apple][, writing games in Basic. From the early passion in games, Rod's career moved to enterprise software development, spending 10 years writing software for IBM and recently for a large telecom company. These days Rod enjoys helping others get started on their paths to making games. Originally from Rio de Janeiro, Brazil, Rod lives in Atlanta, Georgia, with his wife and sons.

Ray Wenderlich is an iPhone developer and gamer and the founder of Razeware, LLC. Ray is passionate about both making apps and teaching others the techniques to make them. He has written a bunch of tutorials about iOS development, available at *www.raywenderlich.com*.

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4

Simple Collision Detection and the First Enemy

In the previous chapter you learned the basics of Cocos2D animations and actions. You also started building a flexible framework for Space Viking. *In this chapter you go further and create the first enemy for Ole to do battle with. In the process you learn how to implement a simple system for collision detection and the artificial intelligence brain of the enemies in* Space Viking.

There is a significant amount of code necessary in this chapter to drive the behavior of Ole and the RadarDish. Take your time understanding how these classes work, as they are the foundation and models for the rest of the classes in Space Viking.

Ready to defeat the aliens?

Creating the Radar Dish and Viking Classes

From just a `CCSprite` to a fully animated character, Ole the Viking takes the plunge from simple to advanced from here on out. In this section you create the `RadarDish` and `Viking` classes to encapsulate the logic needed by each, including all of the animations. The `RadarDish` class is worth a close look, as all of the enemy characters in *Space Viking* are modeled after it.

Creating the RadarDish Class

In this first scene, there is a suspicious radar dish on the right side of the screen. It scans for foreign creatures such as Ole. Ole needs to find a way to destroy the radar dish before it alerts the enemy robots of his presence. Fortunately, Ole knows two ways to deal with such problems: his left and right fists. Create the new `RadarDish` class in Xcode by following these steps:

1. In Xcode, right-click on the *EnemyObjects* group.
2. Select **New File**, choose the **Cocoa Touch category** under iOS and **Objective-C class** as the file type, and click **Next.**

3. For the Subclass field, enter *GameCharacter* and click **Next**.
4. Enter *RadarDish* for the filename and click **Finish**.

Open the *RadarDish.h* header file and change the contents to match the code in Listing 4.1.

Listing 4.1 **RadarDish.h header file**

```
//  RadarDish.h
//  SpaceViking
//
#import <Foundation/Foundation.h>
#import "GameCharacter.h"

@interface RadarDish : GameCharacter {
    CCAnimation *tiltingAnim;
    CCAnimation *transmittingAnim;
    CCAnimation *takingAHitAnim;
    CCAnimation *blowingUpAnim;
    GameCharacter *vikingCharacter;

}
@property (nonatomic, retain) CCAnimation *tiltingAnim;
@property (nonatomic, retain) CCAnimation *transmittingAnim;
@property (nonatomic, retain) CCAnimation *takingAHitAnim;
@property (nonatomic, retain) CCAnimation *blowingUpAnim;

@end
```

Looking at Listing 4.1 you can see that the `RadarDish` class inherits from the `GameCharacter` class and that it defines four `CCAnimation` instance variables. There is also an instance variable to hold a pointer back to the `Viking` character.

Why the vikingCharacter Variable Is of Type GameCharacter and Not of Type Viking Class

If you look carefully at Listing 4.1, you will notice that the `vikingCharacter` instance variable is of type `GameCharacter` and not of type `Viking`. This is because the `RadarDish` class needs access only to the methods defined in `GameCharacter` and not to the full `Viking` class.

Having an instance variable of type `GameCharacter` here allows for the `RadarDish` class to not have to know anything further about the `Viking` object except that it is a `GameCharacter`. You are free to add features to the `Viking` class without fear that it will break any functionality in `RadarDish`. If you were to change the main character in a future version of *Space Viking*, the code would still

function fine, since that new main character class too would, presumably, be derived from the `GameCharacter` class.

Listings 4.2, 4.3, and 4.4 show the contents of the *RadarDish.m* implementation file. The `changeState` and `updateStateWithDelta` time methods are crucial to understand, as they are the most basic versions of what you will find in all of the characters in *Space Viking*. While reading this code, keep in mind that the `RadarDish` is a simple enemy that never moves or attacks the `Viking`. The `RadarDish` does take damage from the `Viking`, eventually blowing up by moving to a dead state. Listing 4.2 covers the top portion of the *RadarDish.m* implementation file, including the `changeState` method. Open the *RadarDish.m* implementation file and replace the code so that it matches the contents in Listings 4.2, 4.3, and 4.4.

Listing 4.2 **RadarDish.m implementation file (top portion)**

```
//  RadarDish.m
//  SpaceViking
#import "RadarDish.h"

@implementation RadarDish
@synthesize tiltingAnim;
@synthesize transmittingAnim;
@synthesize takingAHitAnim;
@synthesize blowingUpAnim;

- (void) dealloc{
    [tiltingAnim release];
    [transmittingAnim release];
    [takingAHitAnim release];
    [blowingUpAnim release];
    [super dealloc];
}

-(void)changeState:(CharacterStates)newState {
    [self stopAllActions];
    id action = nil;
    [self setCharacterState:newState];

    switch (newState) {
        case kStateSpawning:
            CCLOG(@"RadarDish->Starting the Spawning Animation");
            action = [CCAnimate actionWithAnimation:tiltingAnim
                                restoreOriginalFrame:NO];
            break;
```

```
        case kStateIdle:
            CCLOG(@"RadarDish->Changing State to Idle");
            action = [CCAnimate actionWithAnimation:transmittingAnim
                                restoreOriginalFrame:NO];
            break;

        case kStateTakingDamage:
            CCLOG(@"RadarDish->Changing State to TakingDamage");
            characterHealth =
             characterHealth - [vikingCharacter getWeaponDamage];
            if (characterHealth <= 0.0f) {
                [self changeState:kStateDead];
            } else {
                action = [CCAnimate actionWithAnimation:takingAHitAnim
                                    restoreOriginalFrame:NO];
            }
            break;

        case kStateDead:
            CCLOG(@"RadarDish->Changing State to Dead");
            action = [CCAnimate actionWithAnimation:blowingUpAnim
                                restoreOriginalFrame:NO];
            break;

        default:
            CCLOG(@"Unhandled state %d in RadarDish", newState);
            break;
    }
    if (action != nil) {
        [self runAction:action];
    }
}
```

The `changeState` method is called when the `RadarDish` needs to transition between states. In the beginning of this chapter you were introduced to state machines, and the `changeState` method is what allows for transitions to different states in the miniscule "brain" of the `RadarDish`. The `RadarDish` brain can exist in one of four states: spawning, idle, taking damage, or dead. In the listings that follow, you will see that the `RadarDish` is initialized in the spawning state when it is created, and then through the `updateStateWithDeltaTime` method it will move through the four states.

When the `updateStateWithDeltaTime` determines that the `RadarDish` needs to change its state, the `changeState` method is called. Looking at Listing 4.2, you can recap what the switch state is doing as follows:

- **Spawning** (`kStateSpawning`)

  Starts up the `RadarDish` with the tilting animation, which is the dish moving up and down.
- **Idle** (`kStateIdle`)

  Runs the transmitting animation, which is the `RadarDish` blinking.
- **Taking Damage** (`kStateTakingDamage`)

  Runs the taking damage animation, showing a hit to the `RadarDish`. The `RadarDish` health is reduced according to the type of weapon being used against it.
- **Dead** (`kStateDead`)

  The `RadarDish` plays a death animation of it blowing up. This state occurs once the `RadarDish` health is at or below zero.

The next section of the `RadarDish` implementation file is covered in Listing 4.3, showing the `updateStateWithDeltaTime` method.

Listing 4.3 **RadarDish.m implementation file (middle portion)**

```
-(void)updateStateWithDeltaTime:(ccTime)deltaTime
andListOfGameObjects:(CCArray*)listOfGameObjects {
    if (characterState == kStateDead)
        return;                                                    // 1

    vikingCharacter =
    (GameCharacter*)[[self parent]
      getChildByTag:kVikingSpriteTagValue];                        // 2


    CGRect vikingBoudingBox =
            [vikingCharacter adjustedBoundingBox];                 // 3
    CharacterStates vikingState = [vikingCharacter
                                   characterState];                // 4

    // Calculate if the Viking is attacking and nearby
    if ((vikingState == kStateAttacking) &&
        (CGRectIntersectsRect([self adjustedBoundingBox],
vikingBoudingBox))) {                                              // 5
        if (characterState != kStateTakingDamage) {
            // If RadarDish is NOT already taking Damage
            [self changeState:kStateTakingDamage];
            return;
        }
    }
```

```
    if (([self numberOfRunningActions] == 0) &&
        (characterState != kStateDead)) {
        CCLOG(@"Going to Idle");
        [self changeState:kStateIdle];                          // 6
        return;
    }
}
```

Now let's examine the numbered lines of the code:

1. Checks if the `RadarDish` is already dead. If it is, this method is short-circuited and returned. If the `RadarDish` is dead, there is nothing to update.
2. Gets the `Viking` character object from the `RadarDish` parent. All of *Space Viking*'s objects are children of the scene `SpriteBatchNode`, referred to here as the `parent`. The `Viking` in particular was added to the `SpriteBatchNode` with a particular `tag`, referred to by the constant `kVikingSpriteTagValue`. By obtaining a reference to the `Viking` object, the `RadarDish` can determine if the `Viking` is nearby and attacking the `RadarDish`. (Listing 4.3 contains the code that sets up the `kVikingSpriteTagValue` constant.)
3. Gets the `Viking` character's adjusted bounding box.
4. Gets the `Viking` character's state.
5. Determines if the `Viking` is nearby and attacking. If the adjusted bounding boxes for the `Viking` and the `RadarDish` overlap, and the `Viking` is in his attack phase, the `RadarDish` can be certain that the `Viking` is attacking it. The call to `changeState:kStateTakingDamage` will alter the `RadarDish` animation to reflect the attack and reduce the `RadarDish` character's health.
6. Resets the transmission animation on the `RadarDish`. If the `RadarDish` is not currently playing an animation, and it is not dead, it is reset to idle so that the transmission animation can restart.

The last part of the *RadarDish.m* implementation file is the longest but least complicated. There is an `initAnimations` method, which sets up all of the `RadarDish` animations, and an `init` method that initializes the `RadarDish` and sets up the starting values for the instance variables. Add the contents of Listing 4.4 to your *RadarDish.m* implementation file.

Listing 4.4 **RadarDish.m implementation file (bottom portion)**

```
-(void)initAnimations {
    [self setTiltingAnim:
     [self loadPlistForAnimationWithName:@"tiltingAnim"
      andClassName:NSStringFromClass([self class])]];
```

```
    [self setTransmittingAnim:
     [self loadPlistForAnimationWithName:@"transmittingAnim"
      andClassName:NSStringFromClass([self class])]];

    [self setTakingAHitAnim:
     [self loadPlistForAnimationWithName:@"takingAHitAnim"
      andClassName:NSStringFromClass([self class])]];

    [self setBlowingUpAnim:
     [self loadPlistForAnimationWithName:@"blowingUpAnim"
      andClassName:NSStringFromClass([self class])]];
}
-(id) init {
    if( (self=[super init]) ) {
        CCLOG(@"### RadarDish initialized");
        [self initAnimations];                                  // 1
        characterHealth = 100.0f;                               // 2
        gameObjectType = kEnemyTypeRadarDish;                   // 3
        [self changeState:kStateSpawning];                      // 4
    }
    return self;
}
@end
```

The `initAnimations` method calls the `loadPlistForAnimationWithName` method you declared in the `GameObject` class. The name of the animation to load is passed along with the class name. Note the convenience method `NSStringFromClass` is used to get an `NSString` from the class name, in this case `RadarDish`. The class name is used to find the correct plist file for the object, since the plist files have a name corresponding to the class. The following occurs in the `init` method:

1. Calls the `initAnimations` method, which sets up all of the animations for the `RadarDish`. The frame's coordinates and textures were already loaded and cached by Cocos2D when the texture atlas files (*scene1atlas.png* and *scene1atlas.plist*) were loaded by the `GameplayLayer` class.
2. Sets the initial health of the `RadarDish` to a value of 100.
3. Sets the `RadarDish` to be a `Game Object` of type `kEnemyTypeRadarDish`.
4. Initializes the state of the `RadarDish` to spawning. Looking back at Listing 4.2, you can see that this starts the tilting animation, which is followed by the transmitting animation when the `RadarDish` moves from spawning to an idle state.

There is a little more work left before you can have this chapter's game running on your device. You need to add the `Viking` class and make some changes to the `GameplayLayer` class. It is important to understand how the `updateStateWithDeltaTime` and the `changeState` methods in `RadarDish` control the state of the

AI brain. These same two methods are used to drive the brain of all of the other game characters, including Ole the Viking.

Creating the Viking Class

In the previous chapter, Ole the Viking was nothing more than a `CCSprite`. In this chapter you pull him out into his own class complete with animations and a state machine to transition him through his various states. If the `Viking` class code starts to look daunting, refer back to the `RadarDish` class: the Viking is simply a game character like the `RadarDish`, albeit with more functionality. Create the new `Viking` class in Xcode by:

1. In Xcode, right-click on the *GameObjects* group.
2. Select **Add > New File**, choose the **Cocoa Touch category** under iOS and **Objective-C class** as the file type, and click **Next.**
3. For the Subclass field, enter *GameCharacter* and click **Next.**
4. Enter *Viking* for the filename and click **Save**.

Open the *Viking.h* header file and change the contents to match the code in Listing 4.5.

Listing 4.5 **Viking.h header file**

```
//  Viking.h
//  SpaceViking
#import <Foundation/Foundation.h>
#import "GameCharacter.h"
#import "SneakyButton.h"
#import "SneakyJoystick.h"
typedef enum {
    kLeftHook,
    kRightHook
} LastPunchType;

@interface Viking : GameCharacter  {
    LastPunchType myLastPunch;
    BOOL isCarryingMallet;
    CCSpriteFrame *standingFrame;

    // Standing, breathing, and walking
    CCAnimation *breathingAnim;
    CCAnimation *breathingMalletAnim;
    CCAnimation *walkingAnim;
    CCAnimation *walkingMalletAnim;
```

```
    // Crouching, standing up, and Jumping
    CCAnimation *crouchingAnim;
    CCAnimation *crouchingMalletAnim;
    CCAnimation *standingUpAnim;
    CCAnimation *standingUpMalletAnim;
    CCAnimation *jumpingAnim;
    CCAnimation *jumpingMalletAnim;
    CCAnimation *afterJumpingAnim;
    CCAnimation *afterJumpingMalletAnim;

    // Punching
    CCAnimation *rightPunchAnim;
    CCAnimation *leftPunchAnim;
    CCAnimation *malletPunchAnim;

    // Taking Damage and Death
    CCAnimation *phaserShockAnim;
    CCAnimation *deathAnim;

    SneakyJoystick *joystick;
    SneakyButton *jumpButton ;
    SneakyButton *attackButton;

    float millisecondsStayingIdle;
}
// Standing, Breathing, Walking
@property (nonatomic, retain) CCAnimation *breathingAnim;
@property (nonatomic, retain) CCAnimation *breathingMalletAnim;
@property (nonatomic, retain) CCAnimation *walkingAnim;
@property (nonatomic, retain) CCAnimation *walkingMalletAnim;

// Crouching, Standing Up, Jumping
@property (nonatomic, retain) CCAnimation *crouchingAnim;
@property (nonatomic, retain) CCAnimation *crouchingMalletAnim;
@property (nonatomic, retain) CCAnimation *standingUpAnim;
@property (nonatomic, retain) CCAnimation *standingUpMalletAnim;
@property (nonatomic, retain) CCAnimation *jumpingAnim;
@property (nonatomic, retain) CCAnimation *jumpingMalletAnim;
@property (nonatomic, retain) CCAnimation *afterJumpingAnim;
@property (nonatomic, retain) CCAnimation *afterJumpingMalletAnim;

// Punching
@property (nonatomic, retain) CCAnimation *rightPunchAnim;
@property (nonatomic, retain) CCAnimation *leftPunchAnim;
@property (nonatomic, retain) CCAnimation *malletPunchAnim;
```

```
// Taking Damage and Death
@property (nonatomic, retain) CCAnimation *phaserShockAnim;
@property (nonatomic, retain) CCAnimation *deathAnim;

@property (nonatomic,assign) SneakyJoystick *joystick;
@property (nonatomic,assign) SneakyButton *jumpButton;
@property (nonatomic,assign) SneakyButton *attackButton;
@end
```

Listing 4.5 shows the large number of animations that are possible with the `Viking` character as well as instance variables to point to the onscreen joystick and button controls.

The key items to note are the `typedef enumerator` for the left and right punches, an instance variable to store what the last punch thrown was, and a `float` to keep track of how long the player has been idle. The code for the `Viking` implementation file is a bit on the lengthy side, hence it is broken up into four Listings, 4.6 through 4.9. Open the *Viking.m* implementation file and replace the code so that it matches the contents in Listings 4.6, 4.7, 4.8, and 4.9.

Listing 4.6 **Viking.m implementation file (part 1 of 4)**

```
//  Viking.m
//  SpaceViking
#import "Viking.h"

@implementation Viking
@synthesize joystick;
@synthesize jumpButton ;
@synthesize attackButton;

// Standing, Breathing, Walking
@synthesize breathingAnim;
@synthesize breathingMalletAnim;
@synthesize walkingAnim;
@synthesize walkingMalletAnim;
// Crouching, Standing Up, Jumping
@synthesize crouchingAnim;
@synthesize crouchingMalletAnim;
@synthesize standingUpAnim;
@synthesize standingUpMalletAnim;
@synthesize jumpingAnim;
@synthesize jumpingMalletAnim;
@synthesize afterJumpingAnim;
@synthesize afterJumpingMalletAnim;
// Punching
@synthesize rightPunchAnim;
```

```
@synthesize leftPunchAnim;
@synthesize malletPunchAnim;
// Taking Damage and Death
@synthesize phaserShockAnim;
@synthesize deathAnim;

- (void) dealloc {
    joystick = nil;
    jumpButton = nil;
    attackButton = nil;
    [breathingAnim release];
    [breathingMalletAnim release];
    [walkingAnim release];
    [walkingMalletAnim release];
    [crouchingAnim release];
    [crouchingMalletAnim release];
    [standingUpAnim release];
    [standingUpMalletAnim release];
    [jumpingAnim release];
    [jumpingMalletAnim release];
    [afterJumpingAnim release];
    [afterJumpingMalletAnim release];
    [rightPunchAnim release];
    [leftPunchAnim release];
    [malletPunchAnim release];
    [phaserShockAnim release];
    [deathAnim release];

    [super dealloc];
}

-(BOOL)isCarryingWeapon {
    return isCarryingMallet;
}

-(int)getWeaponDamage {
    if (isCarryingMallet) {
        return kVikingMalletDamage;
    }
    return kVikingFistDamage;
}
-(void)applyJoystick:(SneakyJoystick *)aJoystick forTimeDelta:(float)
deltaTime
{
    CGPoint scaledVelocity = ccpMult(aJoystick.velocity, 128.0f);
    CGPoint oldPosition = [self position];
    CGPoint newPosition =
```

```
    ccp(oldPosition.x +
        scaledVelocity.x * deltaTime,
        oldPosition.y);                                          // 1
    [self setPosition:newPosition];                              // 2

    if (oldPosition.x > newPosition.x) {
        self.flipX = YES;                                        // 3
    } else {
        self.flipX = NO;
    }
}

-(void)checkAndClampSpritePosition {
    if (self.characterState != kStateJumping) {
        if ([self position].y > 110.0f)
            [self setPosition:ccp([self position].x,110.0f)];
    }
    [super checkAndClampSpritePosition];
}
```

At the beginning of the *Viking.m* implementation file is the `dealloc` method. Far wiser Objective-C developers than this author have commented on the benefits of having your `dealloc` method up top and near your `synthesize` statements. The idea behind this move is to make sure you are deallocating any and all instance variables, therefore avoiding one of the main causes of memory leaks in Objective-C code.

Following the `dealloc` method, you have the `isCarryingWeapon` method, but since it is self-explanatory, move on to the `applyJoystick` method. This method is similar to the one back in Chapter 2, "Hello, Space Viking," Listing 2.10, but it has been modified to deal only with Ole's movement and removes the handling for the jump or attack buttons. The first change to `applyJoystick` is the creation of the `oldPosition` variable to track the `Viking`'s position before it is moved. Looking at the `applyJoystick` method in Listing 4.6, take a note of the following key lines:

1. Sets the new position based on the velocity of the joystick, but only in the x-axis. The `y` position stays constant, making it so Ole only walks to the left or right, and not up or down.
2. Moves the `Viking` to the new position.
3. Compares the old position with the new position, flipping the `Viking` horizontally if needed. If you look closely at the `Viking` images, he is facing to the right by default. If this method determines that the old position is to the right of the new position, Ole is moving to the left, and his pixels have to be flipped horizontally. If you don't flip Ole horizontally, he will look like he is trying to do the moonwalk when you move him to the left. It is a cool effect but not useful for your `Viking`.

Cocos2D has two built-in functions you will make use of frequently: `flipX` and `flipY`. These functions flip the pixels of a texture along the x- or y-axis, allowing you to display a mirror image of your graphics without having to have left- and right-facing copies of each image for each character. Figure 4.1 shows the effect of `flipX` on the `Viking` texture. This is a really handy feature to have, since it helps reduce the size of your application, and it keeps you from having to create images for every possible state.

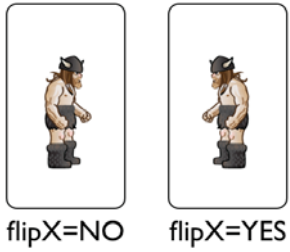

Figure 4.1 Effects of the flipX function on the Viking texture or graphic

The next section of the *Viking.m* implementation file covers the `changeState` method. As you learned with the `RadarDish` class, the `changeState` method is used to transition the character from one state to another and to start the appropriate animations for each state. Copy the contents of Listing 4.7 into your *Viking.m* class.

Listing 4.7 **Viking.m implementation file (part 2 of 4)**

```
#pragma mark -
-(void)changeState:(CharacterStates)newState {
    [self stopAllActions];
    id action = nil;
    id movementAction = nil;
    CGPoint newPosition;
    [self setCharacterState:newState];

    switch (newState) {
        case kStateIdle:
            if (isCarryingMallet) {
                [self setDisplayFrame:[[CCSpriteFrameCache
                      sharedSpriteFrameCache]
                      spriteFrameByName:@"sv_mallet_1.png"]];
            } else {
                [self setDisplayFrame:[[CCSpriteFrameCache
                      sharedSpriteFrameCache]
                      spriteFrameByName:@"sv_anim_1.png"]];
            }
            break;
```

```
case kStateWalking:
    if (isCarryingMallet) {
        action =
            [CCAnimate actionWithAnimation:walkingMalletAnim
                       restoreOriginalFrame:NO];
    } else {
        action =
            [CCAnimate actionWithAnimation:walkingAnim
                       restoreOriginalFrame:NO];
    }
    break;


case kStateCrouching:
    if (isCarryingMallet) {
        action =
            [CCAnimate actionWithAnimation:crouchingMalletAnim
                       restoreOriginalFrame:NO];
    } else {
        action =
            [CCAnimate actionWithAnimation:crouchingAnim
                       restoreOriginalFrame:NO];
    }
    break;

case kStateStandingUp:
    if (isCarryingMallet) {
        action =
            [CCAnimate actionWithAnimation:standingUpMalletAnim
                       restoreOriginalFrame:NO];

    } else {
        action =
            [CCAnimate actionWithAnimation:standingUpAnim
                       restoreOriginalFrame:NO];
    }
    break;

case kStateBreathing:
    if (isCarryingMallet) {
        action =
            [CCAnimate actionWithAnimation:breathingMalletAnim
                       restoreOriginalFrame:YES];
    } else {
        action =
            [CCAnimate actionWithAnimation:breathingAnim
                       restoreOriginalFrame:YES];
    }
    break;
```

```
case kStateJumping:
    newPosition = ccp(screenSize.width * 0.2f, 0.0f);
    if ([self flipX] == YES) {
        newPosition = ccp(newPosition.x * -1.0f, 0.0f);
    }
    movementAction = [CCJumpBy actionWithDuration:0.5f
                                         position:newPosition
                                           height:160.0f
                                            jumps:1];

    if (isCarryingMallet) {
        // Viking Jumping animation with the Mallet
        action = [CCSequence actions:
                  [CCAnimate
                      actionWithAnimation:crouchingMalletAnim
                      restoreOriginalFrame:NO],
                  [CCSpawn actions:
                   [CCAnimate
                      actionWithAnimation:jumpingMalletAnim
                      restoreOriginalFrame:YES],
                   movementAction,
                   nil],
                  [CCAnimate
                     actionWithAnimation:afterJumpingMalletAnim
                     restoreOriginalFrame:NO],
                  nil];
    } else {
        // Viking Jumping animation without the Mallet
        action = [CCSequence actions:
                  [CCAnimate
                      actionWithAnimation:crouchingAnim
                      restoreOriginalFrame:NO],
                  [CCSpawn actions:
                   [CCAnimate
                       actionWithAnimation:jumpingAnim
                       restoreOriginalFrame:YES],
                   movementAction,
                   nil],
                  [CCAnimate
                      actionWithAnimation:afterJumpingAnim
                      restoreOriginalFrame:NO],
                  nil];
    }
    break;

case kStateAttacking:
    if (isCarryingMallet == YES) {
```

```
                action = [CCAnimate
                             actionWithAnimation:malletPunchAnim
                             restoreOriginalFrame:YES];
            } else {
                if (kLeftHook == myLastPunch) {
                    // Execute a right hook
                    myLastPunch = kRightHook;
                    action = [CCAnimate
                                 actionWithAnimation:rightPunchAnim
                                 restoreOriginalFrame:NO];
                } else {
                    // Execute a left hook
                    myLastPunch = kLeftHook;
                    action = [CCAnimate
                                 actionWithAnimation:leftPunchAnim
                                 restoreOriginalFrame:NO];
                }
            }
            break;

        case kStateTakingDamage:
            self.characterHealth = self.characterHealth - 10.0f;
            action = [CCAnimate
                         actionWithAnimation:phaserShockAnim
                         restoreOriginalFrame:YES];
            break;

        case kStateDead:
            action = [CCAnimate
                         actionWithAnimation:deathAnim
                         restoreOriginalFrame:NO];
            break;

        default:
            break;
    }
    if (action != nil) {
        [self runAction:action];
    }
}
```

The first part of the `changeState` method stops any running actions, including animations. Any running actions would be a part of a previous state of the `Viking` and would no longer be valid. Following the first line, the `Viking` state is set to the new state value, and a `switch` statement is used to carry out the animations for the new state. A few items are important to note:

1. Method variables cannot be declared inside a `switch` statement, as they would be out of scope as soon as the code exited the `switch` statement. Your `id action` variable is declared above the `switch` statement but initialized inside the `switch` branches.
2. Most of the states have two animations: one for the `Viking` with the `Mallet` and one without. The `isCarryingMallet` Boolean instance variable is key in determining which animation to play.
3. An action in Cocos2D can be made up of other actions in that it can be a compound action. The `switch` branch taken when the `Viking` state is `kStateJumping` has a compound action made up of `CCSequence`, `CCAnimate`, `CCSpawn`, and `CCJumpBy` actions. The `CCJumpBy` action provides the parabolic movement for Ole the Viking, while the `CCAnimate` actions play the crouching, jumping, and landing animations. The `CCSpawn` action allows for more than one action to be started at the same time, in this case the `CCJumpBy` and `CCAnimate` animation action of Ole jumping. The `CCSequence` action ties it all together by making Ole crouch down, then jump, and finally land on his feet in sequence.
4. Taking a closer look at the `kStateTakingDamage switch` branch, you can see that after the animation completes, Ole reverts back to the frame that was displaying before the animation started. In this state transition, the `CCAnimate` action has the `restoreOriginalFrame` set to `YES`. The end effect of `restoreOriginalFrame` is that Ole will animate receiving a hit, and then return to looking as he did before the hit took place.

The first line of Listing 4.7 might be rather odd-looking: `#pragma mark`. The `pragma mark` serves as a formatting guide to Xcode and is not seen by the compiler. After the words `#pragma mark` you can place any text you would like displayed in the Xcode pulldown for this file. If you have just a hyphen (-), Xcode will create a separate section for that portion of the file. Using `pragma mark` can make your code easier to navigate. Figure 4.2 shows the effects of the `pragma mark` statements in the completed *Viking.m* file.

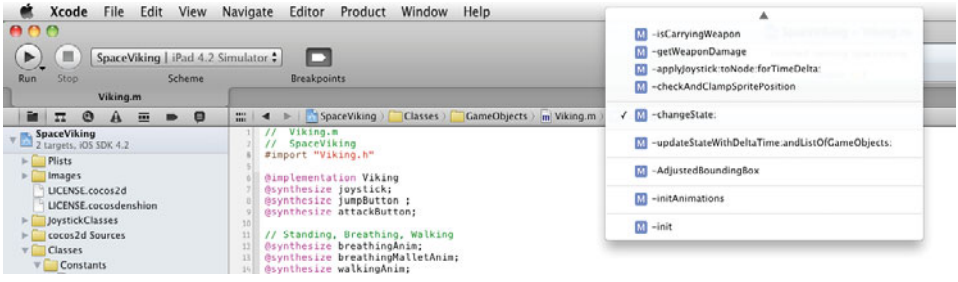

Figure 4.2 The effect of the pragma mark statements in the Xcode pulldown menus

The next section of the *Viking.m* file covers the `updateStateWithDeltaTime` and the `adjustedBoundingBox` methods. Copy the contents of Listing 4.8 into your *Viking.m* file immediately following the `changeState` method.

Listing 4.8 **Viking.m implementation file (part 3 of 4)**

```
#pragma mark -
-(void)updateStateWithDeltaTime:(ccTime)deltaTime
andListOfGameObjects:(CCArray*)listOfGameObjects {
    if (self.characterState == kStateDead)
        return; // Nothing to do if the Viking is dead

    if ((self.characterState == kStateTakingDamage) &&
       ([self numberOfRunningActions] > 0))
        return; // Currently playing the taking damage animation

    // Check for collisions
    // Change this to keep the object count from querying it each time
    CGRect myBoundingBox = [self adjustedBoundingBox];
    for (GameCharacter *character in listOfGameObjects) {
        // This is Ole the Viking himself
        // No need to check collision with one's self
        if ([character tag] == kVikingSpriteTagValue)
            continue;

        CGRect characterBox = [character adjustedBoundingBox];
        if (CGRectIntersectsRect(myBoundingBox, characterBox)) {
            // Remove the PhaserBullet from the scene
            if ([character gameObjectType] == kEnemyTypePhaser) {
                [self changeState:kStateTakingDamage];
                [character changeState:kStateDead];
            } else if ([character gameObjectType] ==
                       kPowerUpTypeMallet) {
                // Update the frame to indicate Viking is
                // carrying the mallet
                isCarryingMallet = YES;
                [self changeState:kStateIdle];
                // Remove the Mallet from the scene
                [character changeState:kStateDead];
            } else if ([character gameObjectType] ==
                        kPowerUpTypeHealth) {
                [self setCharacterHealth:100.0f];
                // Remove the health power-up from the scene
                [character changeState:kStateDead];
            }
        }
    }
```

```
    [self checkAndClampSpritePosition];
    if ((self.characterState == kStateIdle) ||
        (self.characterState == kStateWalking) ||
        (self.characterState == kStateCrouching) ||
        (self.characterState == kStateStandingUp) ||
        (self.characterState == kStateBreathing)) {

        if (jumpButton.active) {
            [self changeState:kStateJumping];
        } else if (attackButton.active) {
            [self changeState:kStateAttacking];
        } else if ((joystick.velocity.x == 0.0f) &&
                   (joystick.velocity.y == 0.0f)) {
            if (self.characterState == kStateCrouching)
                [self changeState:kStateStandingUp];
        } else if (joystick.velocity.y < -0.45f) {
            if (self.characterState != kStateCrouching)
                [self changeState:kStateCrouching];
        } else if (joystick.velocity.x != 0.0f) { // dpad moving
            if (self.characterState != kStateWalking)
                [self changeState:kStateWalking];
            [self applyJoystick:joystick
                   forTimeDelta:deltaTime];
        }
    }

    if ([self numberOfRunningActions] == 0) {
        // Not playing an animation
        if (self.characterHealth <= 0.0f) {
            [self changeState:kStateDead];
        } else if (self.characterState == kStateIdle) {
            millisecondsStayingIdle = millisecondsStayingIdle +
                                      deltaTime;
            if (millisecondsStayingIdle > kVikingIdleTimer) {
                [self changeState:kStateBreathing];
            }
        } else if ((self.characterState != kStateCrouching) &&
                   (self.characterState != kStateIdle)){
            millisecondsStayingIdle = 0.0f;
            [self changeState:kStateIdle];
        }
    }
}

#pragma mark -
-(CGRect)adjustedBoundingBox {
    // Adjust the bouding box to the size of the sprite
    // without the transparent space
```

```
    CGRect vikingBoundingBox = [self boundingBox];
    float xOffset;
    float xCropAmount = vikingBoundingBox.size.width * 0.5482f;
    float yCropAmount = vikingBoundingBox.size.height * 0.095f;

    if ([self flipX] == NO) {
        // Viking is facing to the rigth, back is on the left
        xOffset = vikingBoundingBox.size.width * 0.1566f;
    } else {
        // Viking is facing to the left; back is facing right
        xOffset = vikingBoundingBox.size.width * 0.4217f;
    }
    vikingBoundingBox =
    CGRectMake(vikingBoundingBox.origin.x + xOffset,
               vikingBoundingBox.origin.y,
               vikingBoundingBox.size.width - xCropAmount,
               vikingBoundingBox.size.height - yCropAmount);

    if (characterState == kStateCrouching) {
        // Shrink the bounding box to 56% of height
        // 88 pixels on top on iPad
        vikingBoundingBox = CGRectMake(vikingBoundingBox.origin.x,
        vikingBoundingBox.origin.y,
        vikingBoundingBox.size.width,
        vikingBoundingBox.size.height * 0.56f);
    }

    return vikingBoundingBox;
}
```

In the same manner as the `RadarDish` `updateStateWithDeltaMethod` worked, this method also returns immediately if the `Viking` is dead. There is no need to update a dead `Viking` because he won't be going anywhere.

If the `Viking` is in the middle of playing, the taking damage animation is played. This method again short-circuits and returns. The taking damage animation is blocking in that the player cannot do anything else while Ole the Viking is being shocked.

If the `Viking` is not taking damage or is dead, then the next step is to check what objects are coming in contact with the `Viking`. If there are objects in contact with the `Viking`, he checks to see if they are:

- Phaser: Changes the Viking state to taking damage.
- Mallet power-up: Gives Ole the Viking the mallet, a fearsome weapon.
- Health power-up: Ole's health is restored back to 100.

After checking for contacts, often called *collisions*, a quick call is made to the `checkAndClampSpritePosition` method to ensure that the `Viking` sprite stays within the boundaries of the screen.

The next `if` statement block checks the state of the joystick, jump, and attack buttons and changes the state of the `Viking` to reflect which controls are being pressed. The `if` statement executes only if the `Viking` is not currently carrying out a blocking animation, such as jumping.

Lastly the `Viking` class reaches a section of the `updateStateWithDeltaTime` method that handles what happens when there are no animations currently running. Cocos2D has a convenience method on `CCNodes` that reports back the number of actions running against a particular `CCNode` object. If you recall from the beginning of this chapter, all animations have to be run by a `CCAnimate` action. Once the animation for a state completes, the `numberOfRunningActions` will return zero for the `Viking`, and this block of code will reset the `Viking`'s state.

If the health is zero or less, the `Viking` will move into the dead state. Otherwise, if `Viking` is idle, a counter is incremented indicating how many seconds the player has been idle. Once that counter reaches a set limit, the `Viking` will play a heavy breathing animation. Finally, if the Viking is not already idle or crouching, he will move back into the idle state.

> **Note**
>
> The breathing animation is just a little bonus move to try to get the player to focus back on the game. If the joystick has been idle for more than 3 seconds, the `Viking` will let out a few deep breaths as if to say "Come on! I have aliens to fight here, let's get going!"

After the `updateStateWithDeltaTime` method, there is the `adjustedBoundingBox` method you declared inside the `GameObject` class. In Chapter 3, "Introduction to Cocos2D Animations and Actions," Figure 3.6 illustrated the transparent space in the `Viking` texture between the actual `Viking` and the edges of the image/texture. This method compensates for the transparent pixels by returning an adjusted bounding box that does not include the transparent pixels. The `flipX` parameter is used to determine which side the `Viking` is facing, as fewer pixels are trimmed off the back of the `Viking` image than the front.

The last part of the *Viking.m* implementation file sets up the animations inside the `initAnimations` method and the instance variables inside the `init` method. Once more, copy the contents of Listing 4.9 into your *Viking.m* implementation file immediately following the end of the `adjustedBoundingBox` method.

Listing 4.9 **Viking.m implementation file (part 4 of 4)**

```
#pragma mark -
-(void)initAnimations {

    [self setBreathingAnim:[self loadPlistForAnimationWithName:
@"breathingAnim" andClassName:NSStringFromClass([self class])]];

    [self setBreathingMalletAnim:[self loadPlistForAnimationWithName:
@"breathingMalletAnim" andClassName:NSStringFromClass([self class])]];
```

```
    [self setWalkingAnim:[self loadPlistForAnimationWithName:
@"walkingAnim" andClassName:NSStringFromClass([self class])]];

    [self setWalkingMalletAnim:[self loadPlistForAnimationWithName:
@"walkingMalletAnim" andClassName:NSStringFromClass([self class])]];

    [self setCrouchingAnim:[self loadPlistForAnimationWithName:
@"crouchingAnim" andClassName:NSStringFromClass([self class])]];

    [self setCrouchingMalletAnim:[self loadPlistForAnimationWithName:
@"crouchingMalletAnim" andClassName:NSStringFromClass([self class])]];

    [self setStandingUpAnim:[self loadPlistForAnimationWithName:
@"standingUpAnim" andClassName:NSStringFromClass([self class])]];

    [self setStandingUpMalletAnim:[self loadPlistForAnimationWithName:
@"standingUpMalletAnim" andClassName:NSStringFromClass([self class])]];

    [self setJumpingAnim:[self loadPlistForAnimationWithName:
@"jumpingAnim" andClassName:NSStringFromClass([self class])]];

    [self setJumpingMalletAnim:[self loadPlistForAnimationWithName:
@"jumpingMalletAnim" andClassName:NSStringFromClass([self class])]];

    [self setAfterJumpingAnim:[self loadPlistForAnimationWithName:
@"afterJumpingAnim" andClassName:NSStringFromClass([self class])]];

    [self setAfterJumpingMalletAnim:[self loadPlistForAnimationWithName:
@"afterJumpingMalletAnim" andClassName:NSStringFromClass([self class])]];

    // Punches
    [self setRightPunchAnim:[self loadPlistForAnimationWithName:
@"rightPunchAnim" andClassName:NSStringFromClass([self class])]];

    [self setLeftPunchAnim:[self loadPlistForAnimationWithName:
@"leftPunchAnim" andClassName:NSStringFromClass([self class])]];

    [self setMalletPunchAnim:[self loadPlistForAnimationWithName:
@"malletPunchAnim" andClassName:NSStringFromClass([self class])]];

    // Taking Damage and Death
    [self setPhaserShockAnim:[self loadPlistForAnimationWithName:
@"phaserShockAnim" andClassName:NSStringFromClass([self class])]];

    [self setDeathAnim:[self loadPlistForAnimationWithName:
@"vikingDeathAnim" andClassName:NSStringFromClass([self class])]];

}
```

```
#pragma mark -
-(id) init {
    if( (self=[super init]) ) {
        joystick = nil;
        jumpButton = nil;
        attackButton = nil;
        self.gameObjectType = kVikingType;
        myLastPunch = kRightHook;
        millisecondsStayingIdle = 0.0f;
        isCarryingMallet = NO;
        [self initAnimations];

    }
    return self;
}
@end
```

The `initAnimation` method, while quite long, is very basic in that it only initializes all of the `Viking` animations based on the display frames already loaded from the *scene1atlas.plist* file in the `GameplayLayer` class. The `init` method sets up the instance variables to their starting values.

Final Steps

The final step for this chapter is to make some changes to the `GameplayLayer` class so it loads the `RadarDish` and `Viking` onto the layer. Once these changes are made to the `GameplayLayer` files, you will have a working and playable version of *Space Viking* in your hands.

The GameplayLayer Class

The `GameplayLayer` class has a few changes to the header file. There is an additional `import` for the *CommonProtocols.h* file and the `vikingSprite` has been removed; instead there is a `CCSpriteBatchNode` called `sceneSpriteBatchNode`. Move your *GameplayLayer.h* and *GameplayLayer.m* files into the *Layers Group* folder in Xcode and ensure that your *GameplayLayer.h* header file has the same contents as Listing 4.10.

Listing 4.10 **GameplayLayer.h header file**

```
//  GameplayLayer.h
//  SpaceViking

#import <Foundation/Foundation.h>
#import "cocos2d.h"
#import "SneakyJoystick.h"
```

```
#import "SneakyButton.h"
#import "SneakyButtonSkinnedBase.h"
#import "SneakyJoystickSkinnedBase.h"
#import "Constants.h"
#import "CommonProtocols.h"
#import "RadarDish.h"
#import "Viking.h"

@interface GameplayLayer : CCLayer <GameplayLayerDelegate> {
    CCSprite *vikingSprite;
    SneakyJoystick *leftJoystick;
    SneakyButton *jumpButton;
    SneakyButton *attackButton;
    CCSpriteBatchNode *sceneSpriteBatchNode;
}

@end
```

The `initJoystickAndButtons` method of `GameplayLayer` stays the same as in Chapter 3. The rest of the `GameplayLayer` class requires changes to use the new `CCSpriteBatchNode` instance. Listings 4.11, 4.12, 4.13, and 4.14 cover the code for *GameplayLayer.m*. Replace the code in your *GameplayLayer.m* implementation file with the code in the next four listings.

Listing 4.11 **GameplayLayer.m implementation file (part 1 of 4)**

```
//  GameplayLayer.m
//  SpaceViking

#import "GameplayLayer.h"
@implementation GameplayLayer
- (void) dealloc {
    [leftJoystick release];
    [jumpButton release];
    [attackButton release];
    [super dealloc];
}

-(void)initJoystickAndButtons {
    CGSize screenSize = [CCDirector sharedDirector].winSize;        // 1
    // 2
    CGRect joystickBaseDimensions = CGRectMake(0, 0, 128.0f, 128.0f);
    CGRect jumpButtonDimensions = CGRectMake(0, 0, 64.0f, 64.0f);
    CGRect attackButtonDimensions = CGRectMake(0, 0, 64.0f, 64.0f);
    // 3
    CGPoint joystickBasePosition;
```

```
CGPoint jumpButtonPosition;
CGPoint attackButtonPosition;
// 4
if (UI_USER_INTERFACE_IDIOM() == UIUserInterfaceIdiomPad) {
    // The device is an iPad running iPhone 3.2 or later.
    CCLOG(@"Positioning Joystick and Buttons for iPad");
    joystickBasePosition = ccp(screenSize.width*0.0625f,
                               screenSize.height*0.052f);

    jumpButtonPosition = ccp(screenSize.width*0.946f,
                             screenSize.height*0.052f);

    attackButtonPosition = ccp(screenSize.width*0.947f,
                               screenSize.height*0.169f);
} else {
    // The device is an iPhone or iPod touch.
   CCLOG(@"Positioning Joystick and Buttons for iPhone");

    joystickBasePosition = ccp(screenSize.width*0.07f,
                               screenSize.height*0.11f);

    jumpButtonPosition = ccp(screenSize.width*0.93f,
                             screenSize.height*0.11f);

    attackButtonPosition = ccp(screenSize.width*0.93f,
                               screenSize.height*0.35f);
}

SneakyJoystickSkinnedBase *joystickBase =
[[[SneakyJoystickSkinnedBase alloc] init] autorelease];
joystickBase.position = joystickBasePosition;
joystickBase.backgroundSprite =
[CCSprite spriteWithFile:@"dpadDown.png"];
joystickBase.thumbSprite =
[CCSprite spriteWithFile:@"joystickDown.png"];
joystickBase.joystick = [[SneakyJoystick alloc]
                         initWithRect:joystickBaseDimensions];
leftJoystick = [joystickBase.joystick retain];
[self addChild:joystickBase];

SneakyButtonSkinnedBase *jumpButtonBase =
[[[SneakyButtonSkinnedBase alloc] init] autorelease];
jumpButtonBase.position = jumpButtonPosition;
jumpButtonBase.defaultSprite =
[CCSprite spriteWithFile:@"jumpUp.png"];
jumpButtonBase.activatedSprite =
[CCSprite spriteWithFile:@"jumpDown.png"];
```

```
    jumpButtonBase.pressSprite =
    [CCSprite spriteWithFile:@"jumpDown.png"];
    jumpButtonBase.button = [[SneakyButton alloc]
                             initWithRect:jumpButtonDimensions];
    jumpButton = [jumpButtonBase.button retain];
    jumpButton.isToggleable = NO;
    [self addChild:jumpButtonBase];

    SneakyButtonSkinnedBase *attackButtonBase = [[[SneakyButtonSkinnedBase
alloc] init] autorelease];
    attackButtonBase.position = attackButtonPosition;
    attackButtonBase.defaultSprite = [CCSprite spriteWithFile:
@"handUp.png"];
    attackButtonBase.activatedSprite = [CCSprite
spriteWithFile:@"handDown.png"];
    attackButtonBase.pressSprite = [CCSprite spriteWithFile:
@"handDown.png"];
    attackButtonBase.button = [[SneakyButton alloc] initWithRect:
attackButtonDimensions];
    attackButton = [attackButtonBase.button retain];
    attackButton.isToggleable = NO;
    [self addChild:attackButtonBase];
}
```

The `initJoystick` method remains unchanged from previous chapters. The directional pad (DPad) as well as the jump and attack buttons are set up and added to the `GameplayLayer`. The high `z` values ensure that the joystick controls appear on top of all the other graphical elements in the `GameplayLayer`.

Listing 4.12 **GameplayLayer.m implementation file (part 2 of 4)**

```
#pragma mark -
#pragma mark Update Method
-(void) update:(ccTime)deltaTime {
    CCArray *listOfGameObjects =
            [sceneSpriteBatchNode children];                    // 1
    for (GameCharacter *tempChar in listOfGameObjects) {        // 2
        [tempChar updateStateWithDeltaTime:deltaTime andListOfGameObjects:
                    listOfGameObjects];                         // 3
    }
}
```

The `update` method is the run loop for the entire `GameplayLayer`. The `CCSpriteBatchNode` object contains a list of all of the `CCSprites` for which it will handle the rendering, batching their OpenGL ES draw calls. The `update` method does the following:

1. Gets the list of all of the children CCSprites rendered by the CCSpriteBatchNode. In *Space Viking* this is a list of all of the GameCharacters, including the Viking and his enemies.
2. Iterates through each of the Game Characters, calls their updateStateWithDeltaTime method, and passes a pointer to the list of all Game Characters. If you look back at the updateStateWithDeltaTime code in *Viking.m*, you can see the list of Game Characters used to check for power-ups and phaser blasts. Power-ups and aliens with phaser beams are covered in the next chapter.
3. Calls the updateStateWithDeltaTime method on each of the Game Characters. This call allows for all of the characters to update their individual states to determine if they are colliding with any other objects in the game.

The next section of code in *GameplayLayer.m* (Listing 4.13) contains the methods for creating the enemies and a placeholder for creating the phaser blast.

Listing 4.13 **GameplayLayer.m implementation file (part 3 of 4)**

```
#pragma mark -
-(void)createObjectOfType:(GameObjectType)objectType
              withHealth:(int)initialHealth
              atLocation:(CGPoint)spawnLocation
              withZValue:(int)ZValue {

    if (objectType == kEnemyTypeRadarDish) {
        CCLOG(@"Creating the Radar Enemy");
        RadarDish *radarDish = [[RadarDish alloc] initWithSpriteFrameName:
@"radar_1.png"];
        [radarDish setCharacterHealth:initialHealth];
        [radarDish setPosition:spawnLocation];
        [sceneSpriteBatchNode addChild:radarDish
                               z:ZValue
                               tag:kRadarDishTagValue];
        [radarDish release];
    }

}

-(void)createPhaserWithDirection:(PhaserDirection)phaserDirection
andPosition:(CGPoint)spawnPosition {
    CCLOG(@"Placeholder for Chapter 5, see below");
    return;
}
```

The createObjectOfType method sets up the RadarDish object using the CCSpriteBatchNode and adds it to the layer. This method is expanded upon in

Chapter 5, "More Actions, Effects, and Cocos2D Scheduler," to include the other enemies in the *Space Viking* world.

The last code listing for *GameplayLayer.m* covers the `init` method. Copy the contents of Listing 4.14 into your *GameplayLayer.m* file.

Listing 4.14 **GameplayLayer.m implementation file (part 4 of 4)**

```
-(id)init {
    self = [super init];
    if (self != nil) {
        CGSize screenSize = [CCDirector sharedDirector].winSize;
        // enable touches
        self.isTouchEnabled = YES;

        srandom(time(NULL)); // Seeds the random number generator

    if (UI_USER_INTERFACE_IDIOM() == UIUserInterfaceIdiomPad) {
        [[CCSpriteFrameCache sharedSpriteFrameCache]
          addSpriteFramesWithFile:@"scene1atlas.plist"];           // 1
        sceneSpriteBatchNode =
         [CCSpriteBatchNode batchNodeWithFile:@"scene1atlas.png"]; // 2
    } else {
        [[CCSpriteFrameCache sharedSpriteFrameCache]
          addSpriteFramesWithFile:@"scene1atlasiPhone.plist"];     // 1
        sceneSpriteBatchNode =
         [CCSpriteBatchNode
          batchNodeWithFile:@"scene1atlasiPhone.png"];             // 2
    }
        [self addChild:sceneSpriteBatchNode z:0];                  // 3
        [self initJoystickAndButtons];                             // 4
        Viking *viking = [[Viking alloc]
            initWithSpriteFrame:[[CCSpriteFrameCache
                sharedSpriteFrameCache]
                spriteFrameByName:@"sv_anim_1.png"]];              // 5
        [viking setJoystick:leftJoystick];
        [viking setJumpButton:jumpButton];
        [viking setAttackButton:attackButton];
        [viking setPosition:ccp(screenSize.width * 0.35f,
                                screenSize.height * 0.14f)];
        [viking setCharacterHealth:100];

        [sceneSpriteBatchNode
            addChild:viking
                   z:kVikingSpriteZValue
                 tag:kVikingSpriteTagValue];                       // 6
```

```
        [self createObjectOfType:kEnemyTypeRadarDish
                      withHealth:100
                      atLocation:ccp(screenSize.width * 0.878f,
                                     screenSize.height * 0.13f)
                      withZValue:10];                                  // 7


        [self scheduleUpdate];                                         // 8
    }
    return self;
}
@end
```

Some key lines have been added since Chapter 2; they support the use of the `CCSpriteBatchNode` class and texture atlas:

1. Adds all of the frame dimensions specified in *scene1atlas.plist* to the Cocos2D Sprite Frame Cache. This will allow any `CCSprite` to be created by referencing one of the frames/images in the texture atlas. This line is also key in loading up the animations, since they reference `spriteFrames` loaded by the `CCSprite-FrameCache` here.
2. Initializes the `CCSpriteBatchNode` with the texture atlas image. The image *scene1atlas.png* becomes the master texture used by all of the `CCSprites` under the `CCSpriteBatchNode`. In *Space Viking* these are all of the `GameObjects` in the game, from the `Viking` to the `Mallet` power-up and the enemies.
3. Adds the `CCSpriteBatchNode` to the layer so it and all of its children (the `GameObjects`) are rendered onscreen.
4. Initializes the Joystick DPad and buttons.
5. Creates the `Viking` character using the already cached sprite frame of the `Viking` standing.
6. Adds the `Viking` to the `CCSpriteBatchNode`. The `CCSpriteBatchNode` does all of the rendering for the `GameObjects`. Therefore, the objects have to be added to the `CCSpriteBatchNode` and *not* to the layer. It is important to remember that the objects drawn from the texture atlas are added to the `CCSpriteBatchNode` and only the `CCSpriteBatchNode` is added to the `CCLayer`.
7. Adds the `RadarDish` to the `CCSpriteBatchNode`. The `RadarDish` health is set to 100 and the location as 87% of the screen width to the right (900 pixels from the left of the screen on the iPad) and 13% of the screen height (100 pixels from the bottom).

   The percentages are used instead of hard point values so that the same game will work on the iPhone, iPhone 4, and iPad. Although the screen width and height

ratios between the iPhones and iPad are a little different, they are close enough to work for the placement of objects in *Space Viking*.

8. Sets up a scheduler call that will fire the `update` method in *GameplayLayer.m* on every frame.

Now that you have added code to handle the `RadarDish`, the `Viking`, and the texture atlas, it is time to test out *Space Viking*. If you select **Run** from Xcode, you should see the *Space Viking* game in the iPad Simulator, as shown in Figure 4.3.

Figure 4.3 Space Viking with the RadarDish in place

Summary

If you made it through, great work—you've gotten a simple Cocos2D game working, and you've learned a lot in the process! You learned about texture atlases, actions, and animations. You utilized the texture atlas you created in the previous chapter to render all of the `GameObjects` in *Space Viking*. You created the enemy `RadarDish` and gave Ole the power to go over there and destroy it to bits. In the process you learned how to implement a simple state machine brain (AI) for the `RadarDish` and for the `Viking`. You have also set up the groundwork for *Space Viking* to have multiple enemies onscreen at once, each with its own AI state machines. The `CCArray` of objects you pass in `GameplayLayer` to each character on the `updateStateWithDeltaTime`

call will allow for the enemy objects to send messages to each other and even coordinate attacks against the `Viking`.

Since you just wrote so much code, you might want to take a few moments to examine the code in more detail and make sure you understand how it all fits together. It's important to make sure you understand how things work so far, since you'll be building more on top of what you've built here in the rest of the chapters.

In the next chapter, you will dive deeper into Cocos2D actions, learn to use some of the built-in effects, and add more enemies to *Space Viking*. When you are ready, turn the page and learn how to add a mean alien robot that shoots phaser beams.

Challenges

1. Try changing the `RadarDish` animation delay on the `takingAHitAnim` to `1.0f` seconds instead of `0.2f` in the *RadarDish.plist* file. What happens when you click **Run** and Ole attacks the `RadarDish`?
2. How would you add another instance of the `RadarDish` on the left side of the screen facing in the opposite direction?

> **Hint**
>
> You can use the `CCFlipX` action to flip the `RadarDish` pixels horizontally.

3. How would you detect when the `RadarDish` object is destroyed and alert the player that the level is complete?

> **Hint**
>
> You can extract the `RadarDish` object from the `sceneSpriteBatchNode` by using the unique `tag` assigned to the `RadarDish`.

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