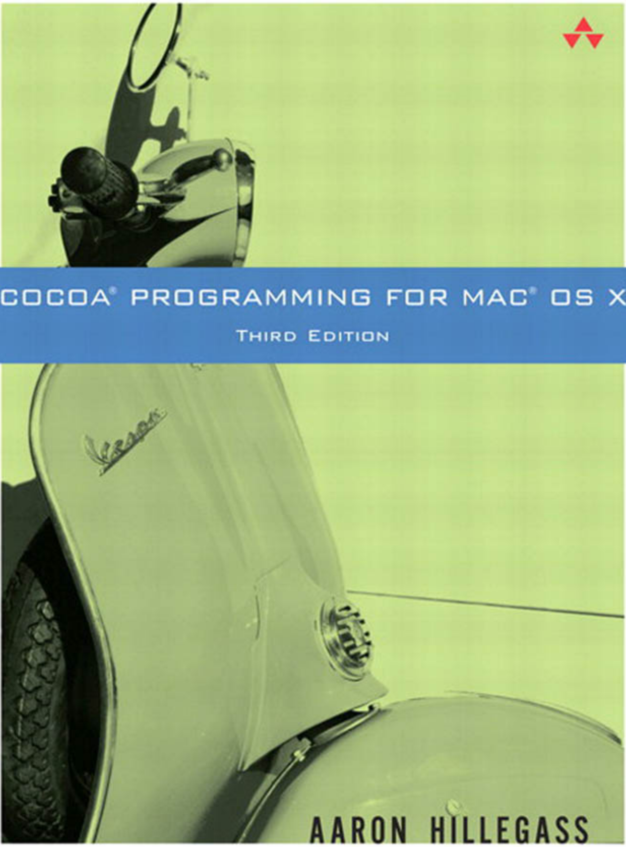

COCOA® PROGRAMMING FOR MAC® OS X

THIRD EDITION

AARON HILLEGASS

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PREFACE

If you are developing applications for the Mac, or are hoping to do so, this book is just the resource you need. Does it cover everything you will ever want to know about programming for the Mac? Of course it doesn't. But it does cover probably 80% of what you need to know. You can find the remaining 20%, the 20% that is unique to you, in Apple's online documentation.

This book, then, acts as a foundation. It covers the Objective-C language and the major design patterns of Cocoa. It will also get you started with the three most commonly used developer tools: Xcode, Interface Builder, and Instruments. After reading this book, you will be able to understand and utilize Apple's online documentation.

There is a lot of code in this book. Through that code, I will introduce you to the idioms of the Cocoa community. My hope is that by presenting exemplary code, I can help you to become not just a Cocoa developer, but a stylish Cocoa developer.

This third edition includes technologies introduced in Mac OS X 10.4 and 10.5. These include Xcode 3, Objective-C 2, Core Data, the garbage collector, and CoreAnimation.

This book is written for programmers who already know some C programming and something about objects. You are not expected to have any experience with Mac programming. It's a hands-on book and assumes that you have access to Mac OS X and the developer tools. The developer tools are free. If you bought a shrink-wrapped copy of Mac OS X, the installer for the developer tools was on the DVD. The tools can also be downloaded from the Apple Developer Connection Web site (http://developer.apple.com/).

I have tried to make this book as useful for you as possible, if not indispensable. That said, I'd love to hear from you if you have any suggestions for improving it.

Aaron Hillegass
book-comments@bignerdranch.com

Chapter 17
CUSTOM VIEWS

All visible objects in an application are either windows or views. In this chapter, you will create a subclass of **NSView**. From time to time, you may need to create a custom view to do custom drawing or event handling. Even if you do not plan to do custom drawing or event handling, you will learn a lot about how Cocoa works by learning how to create a new view class.

Windows are instances of the class **NSWindow**. Each window has a collection of views, each of which is responsible for a rectangle of the window. The view draws inside that rectangle and handles mouse events that occur there. A view may also handle keyboard events. You have worked with several subclasses of **NSView** already: **NSButton**, **NSTextField**, **NSTableView**, and **NSColorWell** are all views. (Note that a window is not a subclass of **NSView**.)

The View Hierarchy

Views are arranged in a hierarchy (Figure 17.1). The window has a content view that completely fills its interior. The content view usually has several subviews, each of which may have subviews of its own. Every view knows its superview, its subviews, and the window it lives on.

Here are the relevant methods from **NSView**:

```
- (NSView *)superview;
- (NSArray *)subviews;
- (NSWindow *)window;
```

Any view can have subviews, but most don't. The following five views commonly have subviews:

1. The content view of a window.
2. **NSBox**. The contents of a box are its subviews.

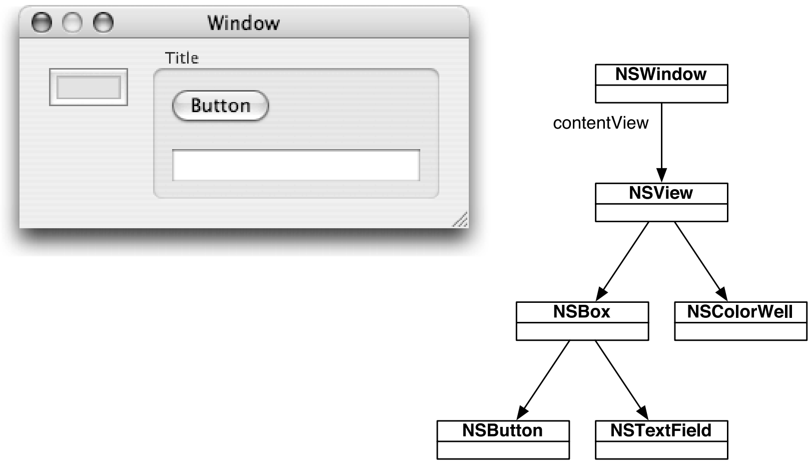
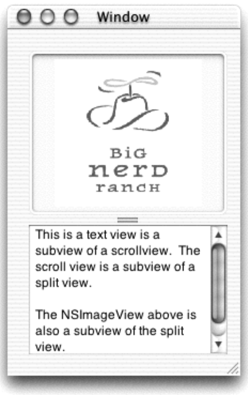


Figure 17.1 Views Hierarchy

3. **`NSScrollView`**. A view that appears in a scroll view is a subview of the scroll view. The scroll bars are also subviews of the scroll view.
4. **`NSSplitView`**. Each view in a split view is a subview (Figure 17.2).



This is a text view is a subview of a scrollview. The scroll view is a subview of a split view.

The NSImageView above is also a subview of the split view.

Figure 17.2 A Scroll View in a Split View

5. **`NSTabView`**. As the user chooses different tabs, different subviews are swapped in and out (Figure 17.3).

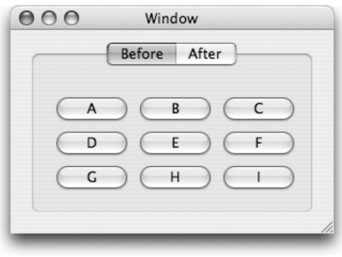


Figure 17.3 A Tab View

Getting a View to Draw Itself

In this section, you will create a very simple view that will appear and paint itself green. It will look like Figure 17.4.

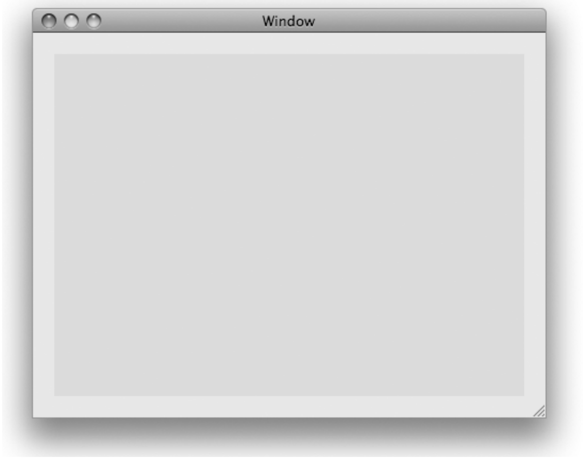


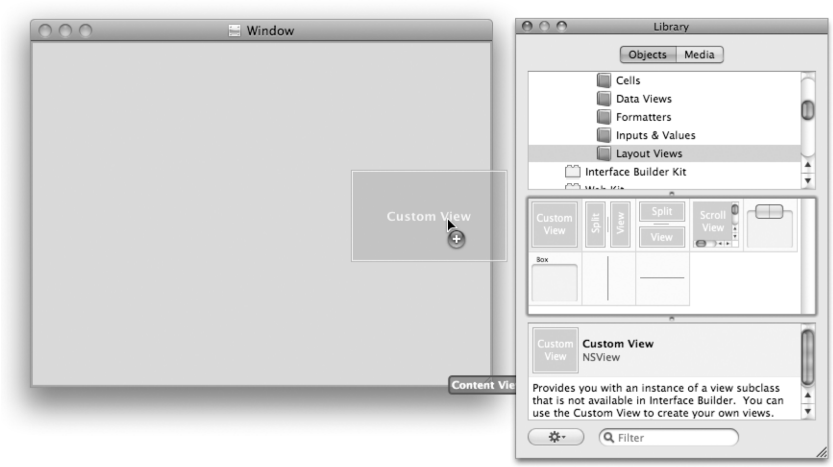
Figure 17.4 Completed Application

Create a new project of type Cocoa Application. Name the project ImageFun.

Using the File->New File menu item, create an Objective-C NSView subclass, and name it **`StretchView`**.

Create an Instance of a View Subclass

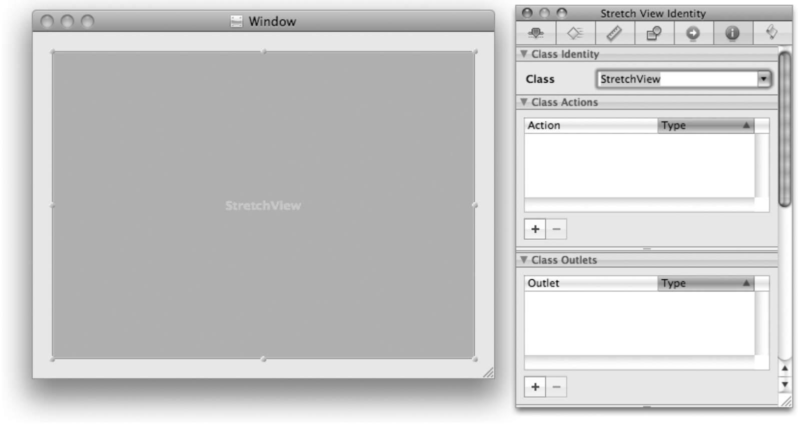
Open MainMenu.nib. Create an instance of your class by dragging out a CustomView placeholder from the Library (under Views & Cells -> Layout View) and dropping it on the window (Figure 17.5).



Custom View
NSView
Provides you with an instance of a view subclass that is not available in Interface Builder. You can use the Custom View to create your own views.

Figure 17.5 Drop a View on the Window

Resize the view to fill most of the window. Open the Info panel, and set the class of the view to be **`StretchView`** (Figure 17.6).

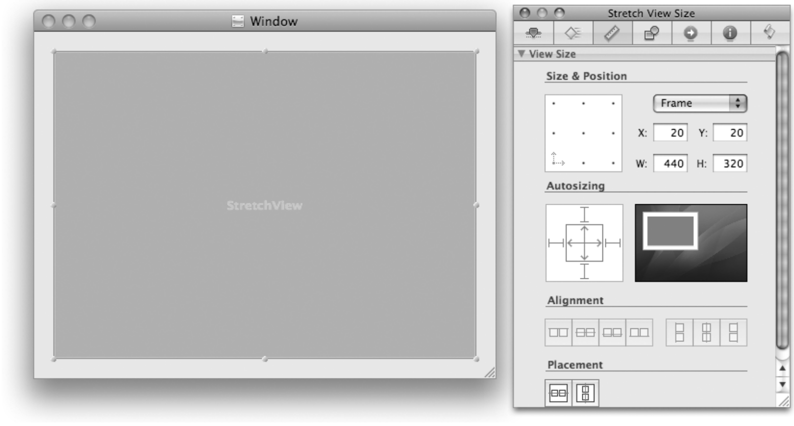


Class: StretchView

Figure 17.6 Set the Class of the View to StretchView

Size Inspector

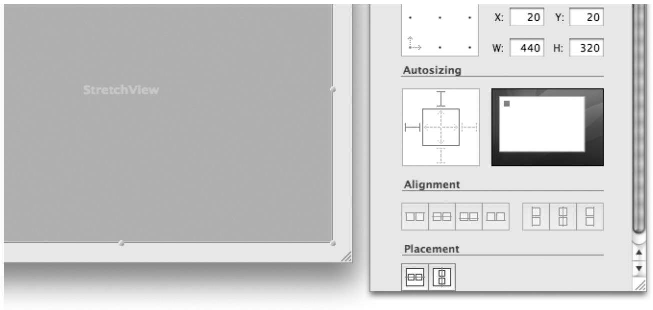
Your **`StretchView`** object is a subview of the window's content view. This point raises an interesting question: What happens to the view when the superview resizes? A page in the Info panel allows you to specify that behavior. Open the Size Info panel, and set it as shown in Figure 17.7. Now it will grow and shrink as necessary to keep the distance from its edges to the edges of its superview constant.



X: 20 Y: 20
W: 440 H: 320

Figure 17.7 Make the View Resize with the Window

If you wanted the view to stay the same height, you could let the distance between the bottom of the view and the bottom of the superview grow and shrink. You could also let the distance between the right edge of the view and the right edge of the window grow and shrink. In this exercise, you do not want this behavior. But if you did want the view to stick to the upper-left corner of the window, the Inspector would look like Figure 17.8.



X: 20 Y: 20
W: 440 H: 320

Figure 17.8 Not This!

Figure 17.9 is a complete diagram of what the Size Inspector means.

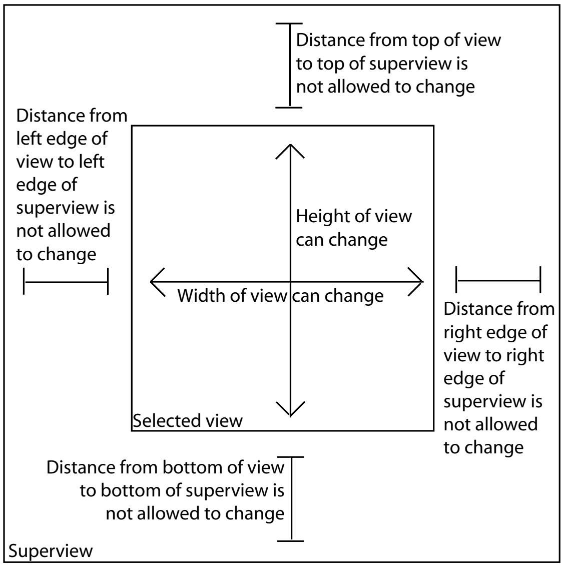

Distance from top of view to top of superview is not allowed to change
Distance from left edge of view to left edge of superview is not allowed to change
Height of view can change
Width of view can change
Distance from right edge of view to right edge of superview is not allowed to change
Selected view
Distance from bottom of view to bottom of superview is not allowed to change
Superview

Figure 17.9 What the Red Lines in the Size Inspector Mean

Save and close the nib file.

drawRect:

When a view needs to draw itself, it is sent the message **`drawRect:`** with the rectangle that needs to be drawn or redrawn. The method is called automatically—you never need to call it directly. Instead, if you know that a view needs redrawing, you send the view the **`setNeedsDisplay:`** message:

```
[myView setNeedsDisplay:YES];
```

This message informs `myView` that it is "dirty." After the event has been handled, the view will be redrawn.

Before calling **`drawRect:`**, the system *locks focus* on the view. Each view has its own graphics context, which includes the view's coordinate system, its current color, its current font, and the clipping rectangle. When the focus is locked on a view, the view's graphics context is active. When the focus is unlocked, the graphics context is no longer active. Whenever you issue drawing commands, they will be executed in the current graphics context.

You can use **`NSBezierPath`** to draw lines, circles, curves, and rectangles. You can use **`NSImage`** to create composite images on the view. In this example, you will fill the entire view with a green rectangle.

Open `StretchView.m` and add the following code to the **`drawRect:`** method:

```
- (void)drawRect:(NSRect)rect
{
    NSRect bounds = [self bounds];
    [[NSColor greenColor] set];
    [NSBezierPath fillRect:bounds];
}
```

As shown in Figure 17.10, `NSRect` is a struct with two members: `origin`, which is an `NSPoint`, and `size`, which is an `NSSize`.

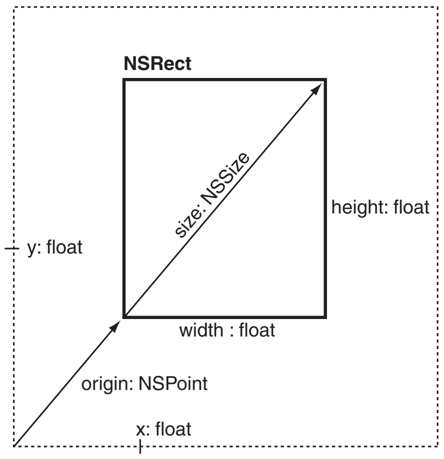


Figure 17.10 NSRect, NSSize, and NSPoint

`NSSize` is a struct with two members: `width` and `height` (both `floats`).

`NSPoint` is a struct with two members: `x` and `y` (both `floats`).

For performance reasons, structs are used in a few places instead of Objective-C classes. For completeness, here is the list of all the Cocoa structs that you are likely to use: `NSSize`, `NSPoint`, `NSRect`, `NSRange`, `NSDecimal`, and `NSAffineTransformStruct`. `NSRange` is used to define subranges. `NSDecimal` describes numbers with very specific precision and rounding behavior. `NSAffineTransformStruct` describes linear transformations of graphics.

Note that your view knows its location as an `NSRect` called `bounds`. In this method, you fetched the `bounds` rectangle, set the current color to green, and filled the entire `bounds` rectangle with the current color.

The `NSRect` that is passed as an argument to the view is the region that is "dirty" and needs redrawing. It may be less than the entire view. If you are doing very time-consuming drawing, redrawing only the dirty rectangle may speed up your application considerably.

Note that **`setNeedsDisplay:`** will trigger the entire visible region of the view to be redrawn. If you wanted to be more precise about which part of the view needs redrawing, you would use **`setNeedsDisplayInRect:`** instead:

```
NSRect dirtyRect;
dirtyRect = NSMakeRect(0, 0, 50, 50);
[myView setNeedsDisplayInRect:dirtyRect];
```

Build and run your app. Try resizing the window.

Drawing with NSBezierPath

If you want to draw lines, ovals, curves, or polygons, you can use **`NSBezierPath`**. In this chapter, you have already used the **`NSBezierPath`**'s **`fillRect:`** class method to color your view. In this section, you will use **`NSBezierPath`** to draw lines connecting random points (Figure 17.11).

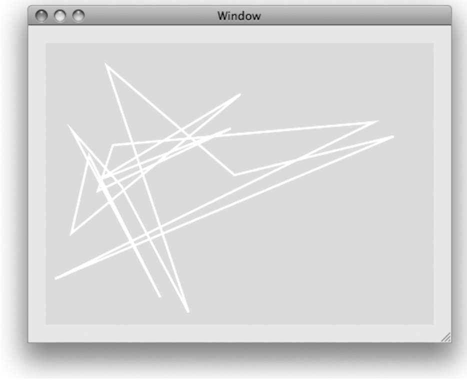


Figure 17.11 Completed Application

The first thing you will need is an instance variable to hold the instance of **NSBezierPath**. You will also create an instance method that returns a random point in the view. Open StretchView.h and make it look like this:

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

@interface StretchView : NSView
{
    NSBezierPath *path;
}
- (NSPoint)randomPoint;

@end
```

In StretchView.m, you will override **initWithFrame:**. As the designated initializer for **NSView**, **initWithFrame:** will be called automatically when an instance of your view is created. In your version of **initWithFrame:**, you will create the path object and fill it with lines to random points. Make StretchView.m look like this:

```
#import "StretchView.h"

@implementation StretchView

- (id)initWithFrame:(NSRect)rect
{
    if (![super initWithFrame:rect])
        return nil;

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

    // Create a path object
    path = [[NSBezierPath alloc] init];
    [path setLineWidth:3.0];
    NSPoint p = [self randomPoint];
    [path moveToPoint:p];
    int i;
    for (i = 0; i < 15; i++) {
        p = [self randomPoint];
        [path lineToPoint:p];
    }
    [path closePath];
    return self;
}
- (void)dealloc
{
    [path release];
    [super dealloc];
}
```

```
// randomPoint returns a random point inside the view
- (NSPoint)randomPoint
{
    NSPoint result;
    NSRect r = [self bounds];
    result.x = r.origin.x + random() % (int)r.size.width;
    result.y = r.origin.y + random() % (int)r.size.height;
    return result;
}

- (void)drawRect:(NSRect)rect
{
    NSRect bounds = [self bounds];

    // Fill the view with green
    [[NSColor greenColor] set];
    [NSBezierPath fillRect: bounds];

    // Draw the path in white
    [[NSColor whiteColor] set];
    [path stroke];
}

@end
```

Build and run your app. Pretty, eh?

Okay, now try replacing `[path stroke]` with `[path fill]`. Build and run it.

NSScrollView

In the art world, a larger work is typically more expensive than a smaller one of equal quality. Your beautiful view is lovely, but it would be more valuable if it were larger. How can it be larger yet still fit inside that tiny window? You are going to put it in a scroll view (Figure 17.12).

A scroll view has three parts: the document view, the content view, and the scroll bars. In this example, your view will become the document view and will be displayed in the content view, which is an instance of **`NSClipView`**.

Although this change looks tricky, it is very simple to make. In fact, it requires no code at all. Open `MainMenu.nib` in Interface Builder. Select the view, and choose Embed Objects in Scroll View from the Layout menu (Figure 17.13).

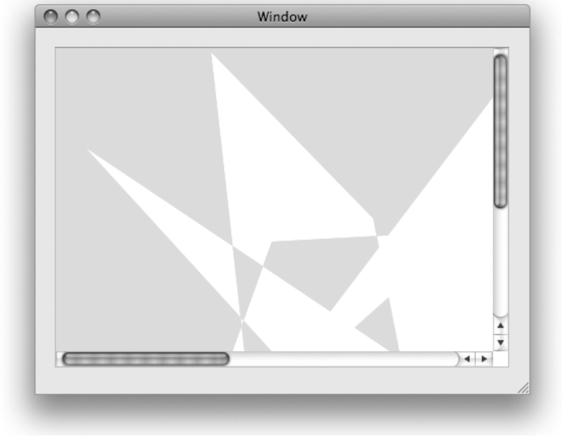


Figure 17.12 Completed Application

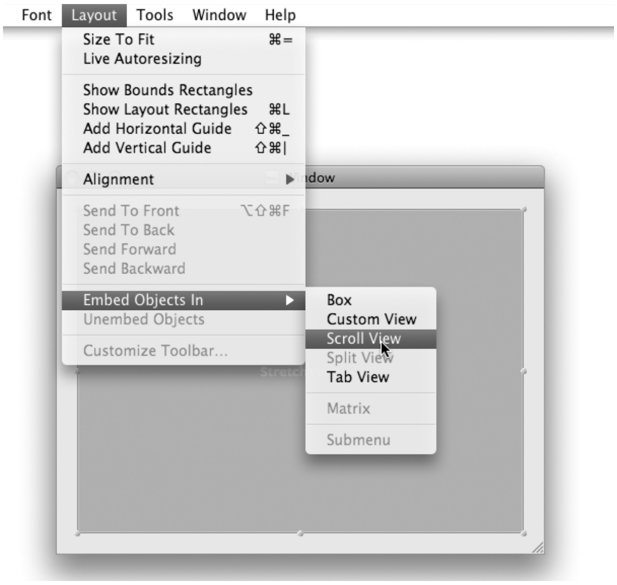
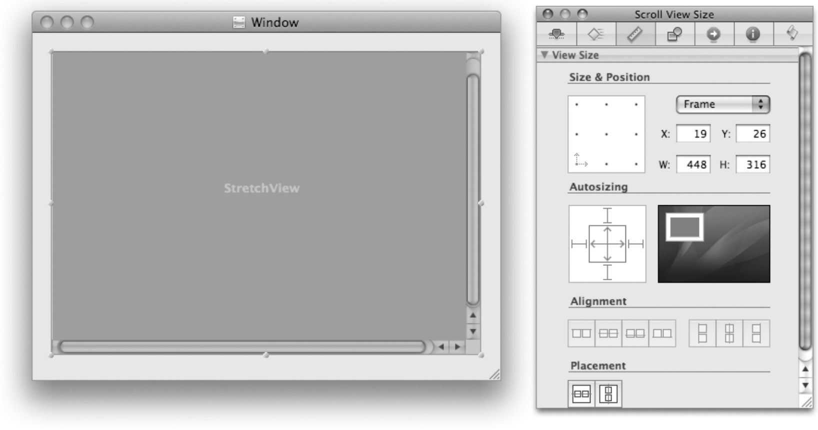


Figure 17.13 Embed the StretchView in a Scroll View

As the window resizes, you want the scroll view to resize, but you do not want your document to resize. Open the Size Inspector, select Scroll View, and set the Size Inspector so that it resizes with the window (Figure 17.14).

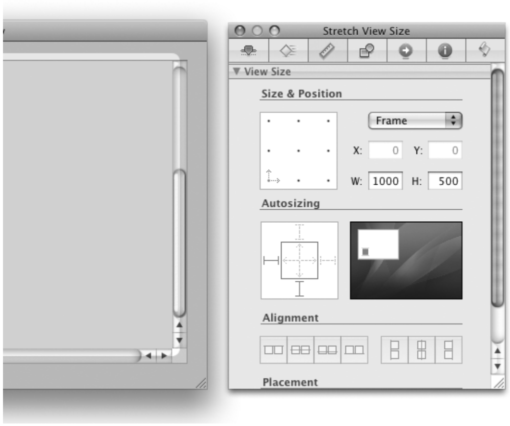


X: 19 Y: 26
W: 448 H: 316

Figure 17.14 Make Scroll View Resize with Window

Note the width and height of the view.

To select the document view, double-click inside the scroll view. You should see the title of the inspector change to Stretch View Size. Make the view about twice as wide and twice as tall as the scroll view. Set the Size Inspector so that the view will stick to the lower-left corner of its superview and not resize (Figure 17.15). Build the application and run it.



X: 0 Y: 0
W: 1000 H: 500

Figure 17.15 Make StretchView Larger and Nonresizing

Creating Views Programmatically

You will instantiate most of your views in Interface Builder. Every once in a while, you will need to create views programmatically. For example, assume that you have a pointer to a window and want to put a button on it. This code would create a button and put it on the window's content view:

```
NSView *superview = [window contentView];
NSRect frame = NSMakeRect(10, 10, 200, 100);
NSButton *button = [[NSButton alloc] initWithFrame:frame];
[button setTitle:@"Click me!"];
[superview addSubview:button];
[button release];
```

For the More Curious: Cells

`NSControl` inherits from **`NSView`**. With its graphics context, **`NSView`** is a relatively large and expensive object to create. When the **`NSButton`** class was created, the first thing someone did was to create a calculator with 10 rows and 10 columns of buttons. The performance was less than it could have been because of the 100 tiny views. Later, someone had the clever idea of moving the brains of the button into another object (not a view) and creating one big view (called an **`NSMatrix`**) that would act as the view for all 100 button brains. The class for the button brains was called **`NSButtonCell`** (Figure 17.16).

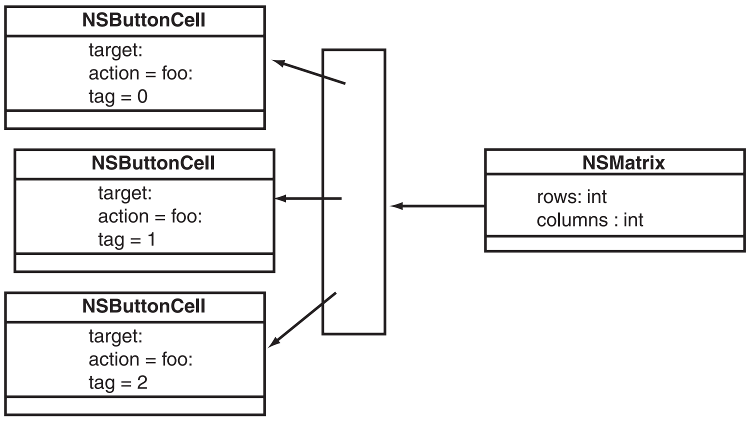


Figure 17.16 NSMatrix

In the end, **`NSButton`** became simply a view that had an **`NSButtonCell`**. The button cell does everything, and **`NSButton`** simply claims a space in the window (Figure 17.17).

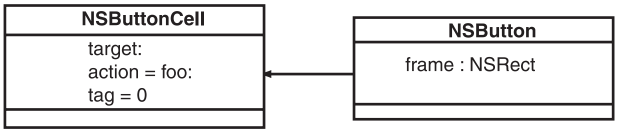
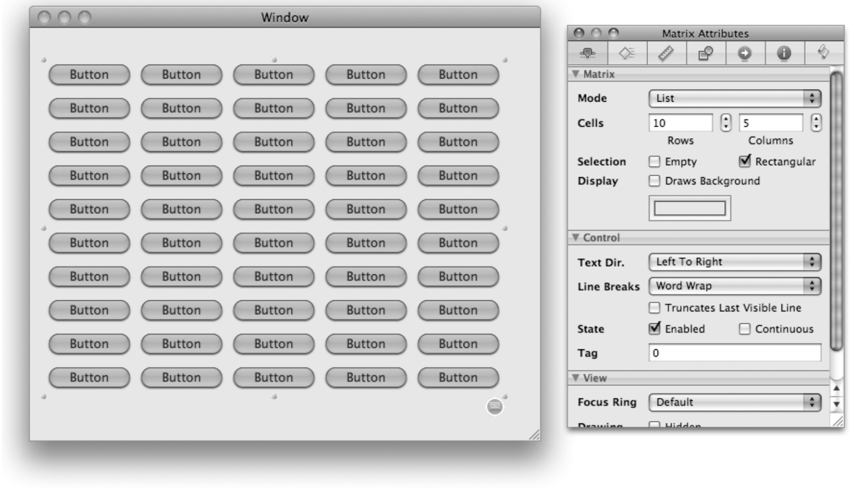


Figure 17.17 NSButton and NSButtonCell

Similarly, **`NSSlider`** is a view with an **`NSSliderCell`**, and **`NSTextField`** is a view with an **`NSTextFieldCell`**. **`NSColorWell`**, by contrast, has no cell.

To create an instance of **`NSMatrix`** in Interface Builder, you drop a control with a cell onto the window, choose Embed Objects In -> Matrix, and then Option-drag as if resizing until the matrix has the correct number of rows and columns (Figure 17.18).



Matrix Attributes

▼ Matrix

Mode: List

Cells: 10 Rows, 5 Columns

Selection: ☐ Empty ☑ Rectangular

Display: ☐ Draws Background

▼ Control

Text Dir.: Left To Right

Line Breaks: Word Wrap

☐ Truncates Last Visible Line

State: ☑ Enabled ☐ Continuous

Tag: 0

▼ View

Focus Ring: Default

Drawing: ☐ Hidden

Figure 17.18 A Matrix of Buttons

An **`NSMatrix`** has a target and an action. A cell may also have a target and an action. If the cell is activated, the cell's target and action are used. If the target and action of the selected cell are not set, the matrix's target and action will be used.

When dealing with matrices, you will often ask which cell was activated. Cells can also be given a tag:

```
- (IBAction)myAction:(id)sender {
    id theCell = [sender selectedCell];
    int theTag = [theCell tag];
    ...
}
```

The cell's tag can be set in Interface Builder.

Cells are used in several other types of objects. The data in an **NSTableView**, for example, is drawn by cells.

For the More Curious: isFlipped

Both PDF and PostScript use the standard Cartesian coordinate system, whereby *y* increases as you move up the page. Quartz follows this model by default. The origin is usually at the lower-left corner of the view.

For some types of drawing, the math becomes easier if the upper-left corner is the origin and *y* increases as you move down the page. We say that such a view is *flipped*.

To flip a view, you override **isFlipped** in your view class to return YES:

```
- (BOOL)isFlipped
{
    return YES;
}
```

While we are discussing the coordinate system, note that *x*- and *y*-coordinates are measured in *points*. A point is typically defined as 72.0 points = 1 inch. In reality, by default 1.0 point = 1 pixel on your screen. You can, however, change the size of a point by changing the coordinate system:

```
// Make everything in the view twice as large
NSSize newScale;
newScale.width = 2.0;
newScale.height = 2.0;
[myView scaleUnitSquareToSize:newScale];
[myView setNeedsDisplay:YES];
```

Challenge

`NSBezierPath` can also draw Bezier curves. Replace the straight lines with randomly curved ones. (*Hint:* Look in the documentation for **`NSBezierPath`**.)

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