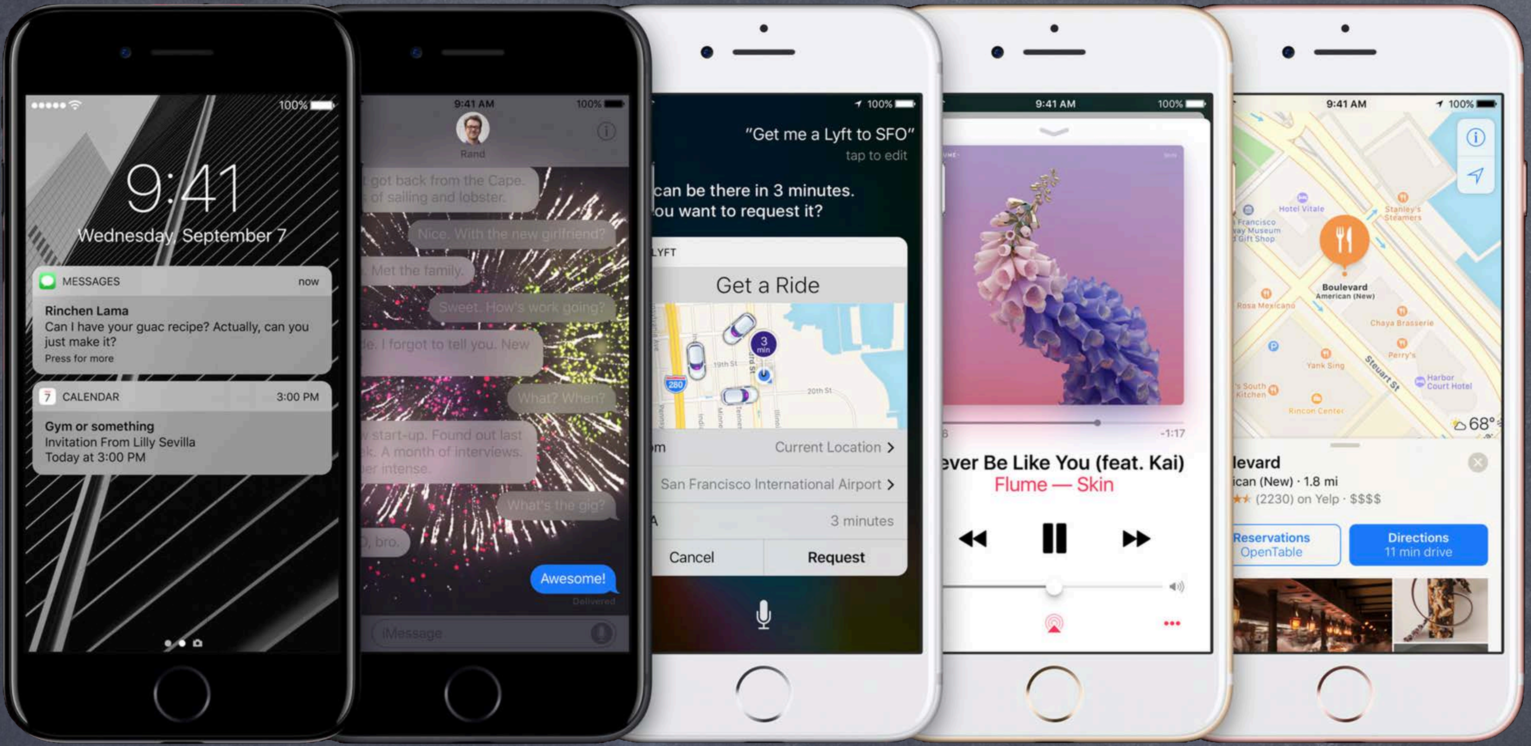


Stanford CS193p

Developing Applications for iOS

Winter 2017

Today

- Views
  - Custom Drawing
- Demo
  - FaceView

Views

- A view (i.e. `UIView` subclass) represents a rectangular area
  - Defines a coordinate space
  - For drawing
  - And for handling touch events
- Hierarchical
  - A view has only one superview … `var superview: UIView?`
  - But it can have many (or zero) subviews … `var subviews: [UIView]`
  - The order in the `subviews` array matters: those later in the array are on top of those earlier
  - A view can clip its `subviews` to its own `bounds` or not (the default is <u>not</u> to)
- `UIWindow`
  - The `UIView` at the very, very top of the view hierarchy (even includes status bar)
  - Usually only one `UIWindow` in an entire iOS application … it's all about views, not windows

Views

- The hierarchy is most often constructed in Xcode graphically
  - Even custom views are usually added to the view hierarchy using Xcode
- But it can be done in code as well
  - `func addSubview(_ view: UIView)` // sent to view's (soon to be) superview
  - `func removeFromSuperview()` // sent to the view you want to remove (not its superview)
- Where does the view hierarchy start?
  - The top of the (useable) view hierarchy is the Controller's `var view: UIView`.
  - This simple property is a very important thing to understand!
  - This view is the one whose bounds will change on rotation, for example.
  - This view is likely the one you will programmatically add subviews to (if you ever do that).
  - All of your MVC's View's UIViews will have this view as an ancestor.
  - It's automatically hooked up for you when you create an MVC in Xcode.

Initializing a UIView

- As always, try to avoid an `initializer` if possible
  - But having one in `UIView` is slightly more common than having a `UIViewController` initializer
- A `UIView`'s initializer is different if it comes out of a storyboard

```
init(frame: CGRect)   // initializer if the UIView is created in code
init(coder: NSCoder)  // initializer if the UIView comes out of a storyboard
```

- If you need an initializer, implement them both …

```
func setup() { … }

override init(frame: CGRect) {                   // a designated initializer
    super.init(frame: frame)
    setup()
}
required init(coder aDecoder: NSCoder) {   // a required initializer
    super.init(coder: aDecoder)
    setup()
}
```

Initializing a UIView

- Another alternative to initializers in UIView …

  `awakeFromNib()` // this is only called if the UIView came out of a storyboard
  This is not an initializer (it's called immediately after initialization is complete)
  All objects that inherit from NSObject in a storyboard are sent this
  Order is not guaranteed, so you cannot message any other objects in the storyboard here

Coordinate System Data Structures

- `CGFloat`

  Always use this instead of `Double` or `Float` for anything to do with a `UIView`'s coordinate system
  You can convert to/from a `Double` or `Float` using initializers, e.g., `let cgf = CGFloat(aDouble)`

- `CGPoint`

  Simply a `struct` with two `CGFloat`s in it: `x` and `y`.

```
var point = CGPoint(x: 37.0, y: 55.2)
point.y -= 30
point.x += 20.0
```

- `CGSize`

  Also a `struct` with two `CGFloat`s in it: `width` and `height`.

```
var size = CGSize(width: 100.0, height: 50.0)
size.width += 42.5
size.height += 75
```

Coordinate System Data Structures

- CGRect

A struct with a CGPoint and a CGSize in it …

```
struct CGRect {
    var origin: CGPoint
    var size: CGSize
}
let rect = CGRect(origin: aCGPoint, size: aCGSize) // there are other inits as well
```

Lots of convenient properties and functions on CGRect like …

```
var minX: CGFloat               // left edge
var midY: CGFloat               // midpoint vertically
intersects(CGRect) -> Bool // does this CGRect intersect this other one?
intersect(CGRect)               // clip the CGRect to the intersection with the other one
contains(CGPoint) -> Bool   // does the CGRect contain the given CGPoint?
```

… and many more (make yourself a CGRect and type . after it to see more)

(0,0)

increasing x

View Coordinate System

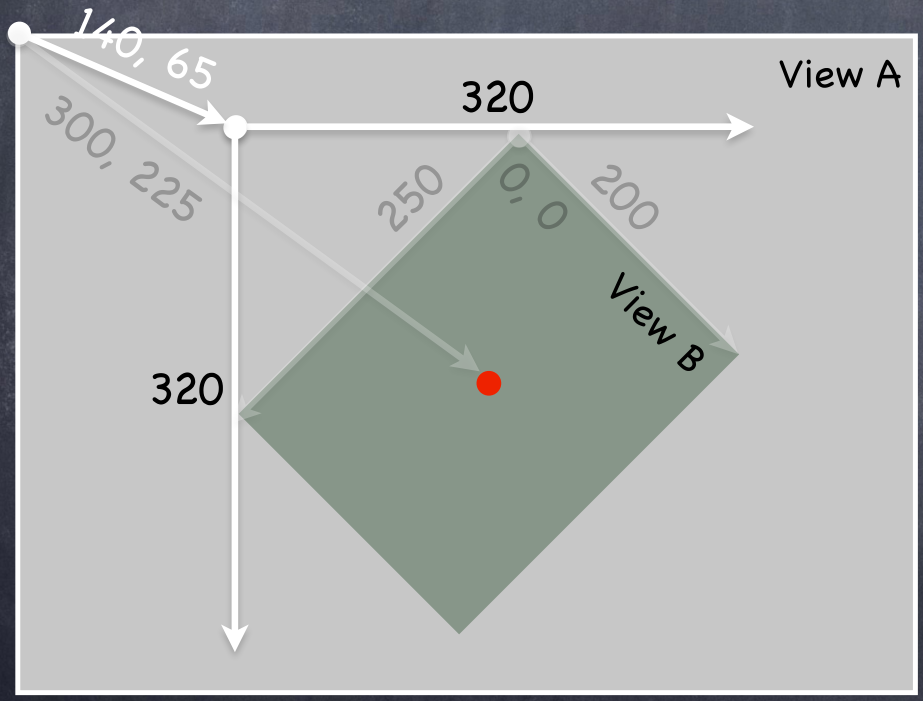
(500, 35)

- Origin is upper left
- Units are points, not pixels
  - Pixels are the minimum-sized unit of drawing your device is capable of
  - Points are the units in the coordinate system
  - Most of the time there are 2 pixels per point, but it could be only 1 or even 3
  - How many pixels per point are there? `UIView's var contentScaleFactor: CGFloat`
- The boundaries of where drawing happens
  - `var bounds: CGRect` // a view's internal drawing space's origin and size
  - This is the rectangle containing the drawing space in its own coordinate system
  - It is up to your view's implementation to interpret what `bounds.origin` means (often nothing)
- Where is the `UIView`?
  - `var center: CGPoint` // the center of a `UIView` in its superview's coordinate system
  - `var frame: CGRect` // the rect containing a `UIView` in its superview's coordinate system

increasing y

bounds vs frame

- Use frame and/or center to position a UIView
  - These are never used to draw inside a view's coordinate system
  - You might think frame.size is always equal to bounds.size, but you'd be wrong …



Views can be rotated (and scaled and translated)

View B's bounds = ((0,0),(200,250))
View B's frame = ((140,65),(320,320))
View B's center = (300,225)

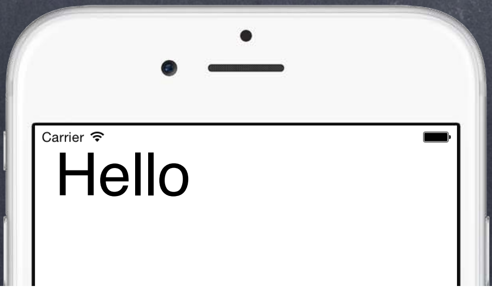
View B's middle in its own coordinates is …
(bounds.midX, bounds.midY) = (100, 125)

Views are rarely rotated, but don't misuse frame or center anyway by assuming that.

Creating Views

- Most often your views are created via your storyboard
  - Xcode's Object Palette has a generic UIView you can drag out
  - After you do that, you must use the Identity Inspector to changes its class to your subclass
- On rare occasion, you will create a UIView via code
  - You can use the frame initializer … `let newView = UIView(frame: myViewFrame)`
  - Or you can just use `let newView = UIView()` (frame will be `CGRect.zero`)
- Example

```
// assuming this code is in a UIViewController
let labelRect = CGRect(x: 20, y: 20, width: 100, height: 50)
let label = UILabel(frame: labelRect) // UILabel is a subclass of UIView
label.text = "Hello"
view.addSubview(label)
```



Custom Views

- When would I create my own `UIView` subclass?
  - I want to do some custom drawing on screen
  - I need to handle touch events in a special way (i.e. different than a button or slider does)
  - We'll talk about handling touch events in a bit. First we'll focus on drawing.
- To draw, just create a `UIView` subclass and override `draw(CGRect)`
  - `override func draw(_ rect: CGRect)`
  - You can draw outside the `rect`, but it's never required to do so.
  - The `rect` is purely an optimization.
  - It is our `UIView`'s `bounds` that describe the entire drawing area (the `rect` is a subarea).
- NEVER call `draw(CGRect)`!! EVER! Or else!
  - Instead, if you view needs to be redrawn, let the system know that by calling …
  - `setNeedsDisplay()`
  - `setNeedsDisplay(_ rect: CGRect)` // `rect` is the area that needs to be redrawn
  - iOS will then call your `draw(CGRect)` at an appropriate time

Custom Views

- So how do I implement my `draw(CGRect)`?
  - You can either get a drawing context and tell it what to draw, or …
  - You can create a path of drawing using `UIBezierPath` class (which is how we'll do it)
- Core Graphics Concepts
  1. You get a context to draw into (other contexts include printing, off-screen buffer, etc.)
     The function `UIGraphicsGetCurrentContext()` gives a context you can use in `draw(CGRect)`
  2. Create paths (out of lines, arcs, etc.)
  3. Set drawing attributes like colors, fonts, textures, linewidths, linecaps, etc.
  4. Stroke or fill the above-created paths with the given attributes
- `UIBezierPath`
  - Same as above, but captures all the drawing with a `UIBezierPath` instance
  - `UIBezierPath` automatically draws in the "current" context (`draw(CGRect)` sets this up for you)
  - `UIBezierPath` has methods to draw (lineto, arcs, etc.) and set attributes (linewidth, etc.)
  - Use `UIColor` to set stroke and fill colors
  - `UIBezierPath` has methods to `stroke` and/or `fill`

Defining a Path

- Create a UIBezierPath

```
let path = UIBezierPath()
```

- Move around, add lines or arcs to the path

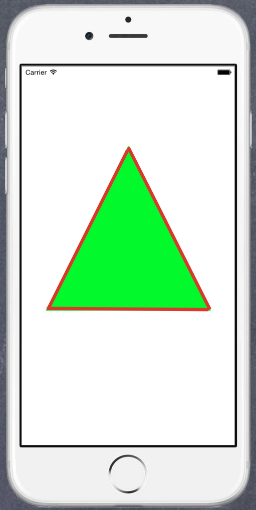
```
path.move(to: CGPoint(80, 50))
path.addLine(to: CGPoint(140, 150))
path.addLine(to: CGPoint(10, 150))
```

- Close the path (if you want)

```
path.close()
```

- Now that you have a path, set attributes and stroke/fill

```
UIColor.green.setFill()      // note setFill is a method in UIColor, not UIBezierPath
UIColor.red.setStroke()      // note setStroke is a method in UIColor, not UIBezierPath
path.linewidth = 3.0         // linewidth is a property in UIBezierPath, not UIColor
path.fill()                  // fill is a method in UIBezierPath
path.stroke()                // stroke method in UIBezierPath
```



Drawing

- You can also draw common shapes with `UIBezierPath`

```
let roundRect = UIBezierPath(roundedRect: CGRect, cornerRadius: CGFloat)
let oval = UIBezierPath(ovalIn: CGRect)
```

  … and others

- Clipping your drawing to a `UIBezierPath`'s path

  `addClip()`

  For example, you could clip to a rounded rect to enforce the edges of a playing card

- Hit detection

  `func contains(_ point: CGPoint) -> Bool` // returns whether the point is inside the path

  The path must be closed. The winding rule can be set with `usesEvenOddFillRule` property.

- Etc.

  Lots of other stuff. Check out the documentation.

UIColor

- Colors are set using `UIColor`
  - There are type (aka `static`) vars for standard colors, e.g. `let green = UIColor.green`
  - You can also create them from RGB, HSB or even a pattern (using `UIImage`)
- Background color of a `UIView`
  - `var backgroundColor: UIColor` // we used this for our Calculator buttons
- Colors can have alpha (transparency)
  - `let semitransparentYellow = UIColor.yellow.withAlphaComponent(0.5)`
  - Alpha is between 0.0 (fully transparent) and 1.0 (fully opaque)
- If you want to draw in your view with transparency …
  - You must let the system know by setting the `UIView` `var opaque = false`
- You can make your entire `UIView` transparent …
  - `var alpha: CGFloat`

View Transparency

- What happens when views overlap and have transparency?
  - As mentioned before, `subviews` list order determines who is in front
  - Lower ones (earlier in the array) can "show through" transparent views on top of them
  - Transparency is not cheap, by the way, so use it wisely
- Completely hiding a view without removing it from hierarchy
  - `var hidden: Bool`
  - A `hidden` view will draw nothing on screen and get no events either
  - Not as uncommon as you might think to temporarily hide a view

Drawing Text

- Usually we use a `UILabel` to put text on screen

  But there are certainly occasions where we want to draw text in our `draw(CGRect)`

- To draw in `draw(CGRect)`, use `NSAttributedString`

  ```
  let text = NSAttributedString(string: “hello”)
  text.draw(at: aCGPoint)
  let textSize: CGSize = text.size // how much space the string will take up
  ```

- Mutability is done with `NSMutableAttributedString`

  It is <u>not</u> like `String` (i.e. where `let` means immutable and `var` means mutable)

  You use a different class if you want to make a mutable attributed string …

  ```
  let mutableText = NSMutableAttributedString(string: “some string”)
  ```

- `NSAttributedString` is not a `String`, nor an `NSString`

  You can get its contents as an `String`/`NSString` with its `string` or `mutableString` property

Attributed String

- Setting attributes on an attributed string

  ```
  func setAttributes(_ attributes: [String:Any]?, range: NSRange)
  func addAttributes(_ attributes: [String:Any]?, range: NSRange)
  ```

  Warning! This is a pre-Swift API. `NSRange` is not a `Range`.
  And indexing into the attributed string is using `Int` indexing (not `String.Index`).
  It might be helpful to use `String`'s `utf16` `var` to get a `String.UTF16View`.
  A `UTF16View` represents the `String` as a sequence of 16 bit Unicode characters.
  The characters in a `UTF16View` will then "line up" with an attributed string's characters.
  But `UTF16View` is still indexed by `String.Index`.
  So you'll need to get the `UTF16View`'s `characters` and use `startIndex` with `index(offsetBy:)`.

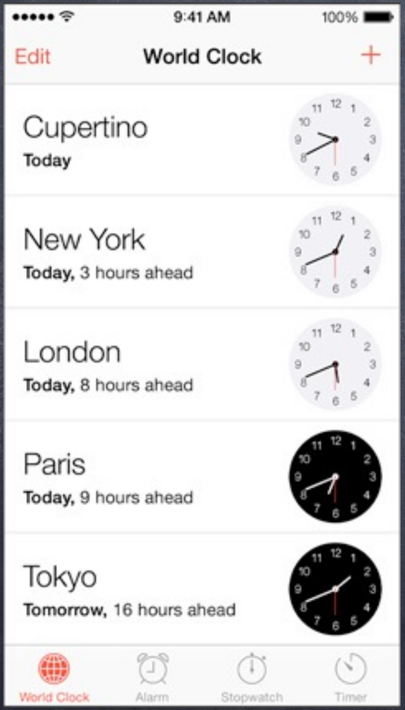
- Attributes

  ```
  NSForegroundColorAttributeName : UIColor
  NSStrokeWidthAttributeName : CGFloat
  NSFontAttributeName : UIFont
  ```

  See the documentation under `UIKit` for (many) more.

Fonts

- Fonts in iOS are very important to get right
  - They are fundamental to the look and feel of the UI



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Edit World Clock +

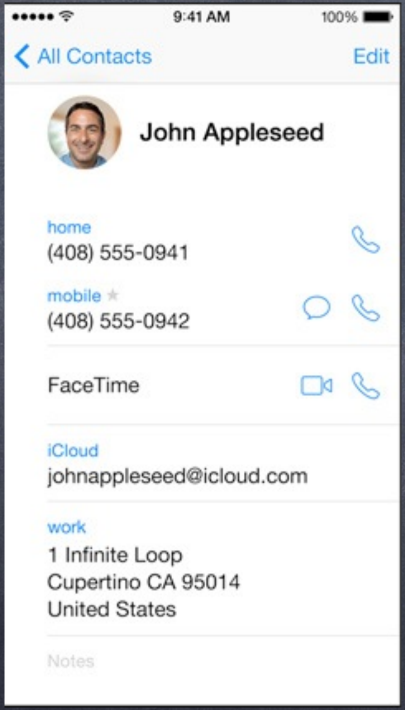
Cupertino
Today

New York
Today, 3 hours ahead

London
Today, 8 hours ahead

Paris
Today, 9 hours ahead

Tokyo
Tomorrow, 16 hours ahead



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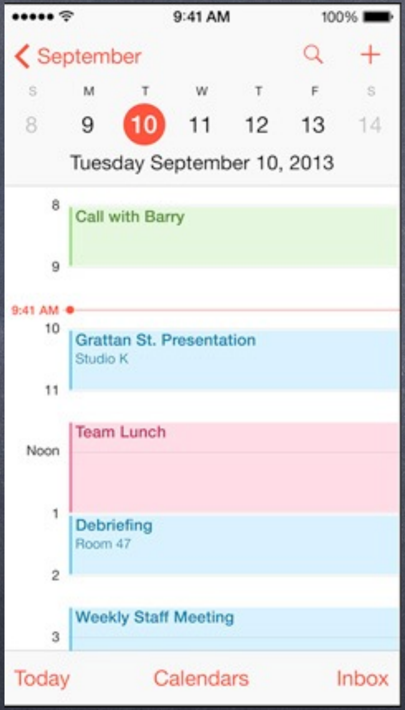

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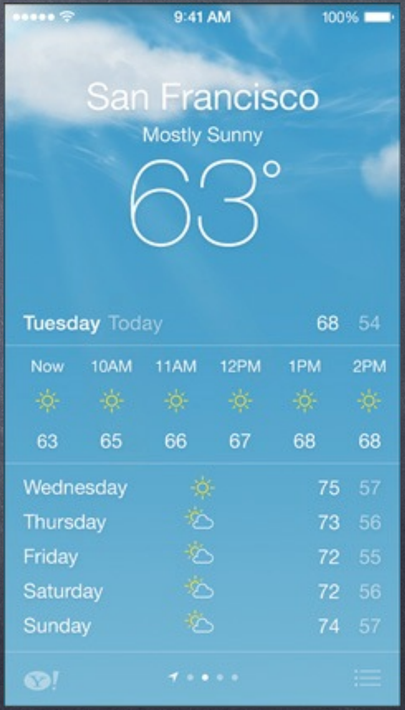
September

S	M	T	W	T	F	S
8	9	10	11	12	13	14

Tuesday September 10, 2013

8 Call with Barry
9
9:41 AM
10 Grattan St. Presentation
Studio K
11
Noon Team Lunch
1 Debriefing
Room 47
2
Weekly Staff Meeting
3



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San Francisco
Mostly Sunny
63°

Tuesday Today 68 54

Now	10AM	11AM	12PM	1PM	2PM
63	65	66	67	68	68

Wednesday	75	57
Thursday	73	56
Friday	72	55
Saturday	72	56
Sunday	74	57

Fonts

- The absolutely best way to get a font in code

  Get preferred font for a given text style (e.g. body, etc.) using this `UIFont` type method ...

  ```
  static func preferredFont(forTextStyle: UIFontTextStyle) -> UIFont
  ```

  Some of the styles (see `UIFontDescriptor` documentation for more) ...

  ```
  UIFontTextStyle.headline
                 .body
                 .footnote
  ```

- There are also "system fonts"

  These appear usually on things like buttons

  ```
  static func systemFont(ofSize: CGFloat) -> UIFont
  static func boldSystemFont(ofSize: CGFloat) -> UIFont
  ```

  Don't use these for your user's <u>content</u>. Use preferred fonts for that.

- Other ways to get fonts

  Check out `UIFont` and `UIFontDescriptor` for more, but you should not need that very often

Drawing Images

- There is a `UILabel`-equivalent for images
  - `UIImageView`
  - But, again, you might want to draw the image inside your `draw(CGRect)` …
- Creating a `UIImage` object
  - `let image: UIImage? = UIImage(named: “foo”)` // note that its an `Optional`
  - You add `foo.jpg` to your project in the `Assets.xcassets` file (we’ve ignored this so far)
  - Images will have different resolutions for different devices (all managed in `Images.xcassets`)
- You can also create one from files in the file system
  - (But we haven’t talked about getting at files in the file system … anyway …)
  - `let image: UIImage? = UIImage(contentsOfFile: aString)`
  - `let image: UIImage? = UIImage(data: aData)` // raw jpg, png, tiff, etc. image data
- You can even create one by drawing with Core Graphics
  - See documentation for `UIGraphicsBeginImageContext(CGSize)`

Drawing Images

- Once you have a UIImage, you can blast its bits on screen

```
let image: UIImage = …
image.draw(at point: aCGPoint)          // the upper left corner put at aCGPoint
image.draw(in rect: aCGRect)            // scales the image to fit aCGRect
image.drawAsPattern(in rect: aCGRect)   // tiles the image into aCGRect
```

Redraw on bounds change?

- By default, when a `UIView`'s bounds changes, there is no redraw

  Instead, the "bits" of the existing image are scaled to the new bounds size

- This is often not what you want ...

  Luckily, there is a `UIView` property to control this! It can be set in Xcode too.

  `var contentMode: UIViewContentMode`

- `UIViewContentMode`

  Don't scale the view, just place it somewhere ...

  `.left/.right/.top/.bottom/.topRight/.topLeft/.bottomRight/.bottomLeft/.center`

  Scale the "bits" of the view ...

  `.scaleToFill/.scaleAspectFill/.scaleAspectFit` // `.scaleToFill` is the default

  Redraw by calling `draw(CGRect)` again (costly, but for certain content, better results) ...

  `.redraw`