Stanford CS193p

Developing Applications for iOS
Spring 2016

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 not 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

```
addSubview(aView: UIView) // sent to aView's (soon to be) superview
removeFromSuperview()     // this is 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 designed 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 cfg = CGFloat(aDouble)`

- CGPoint

  Simply a `struct` with two `CGFloats` 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 `CGFloats` 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

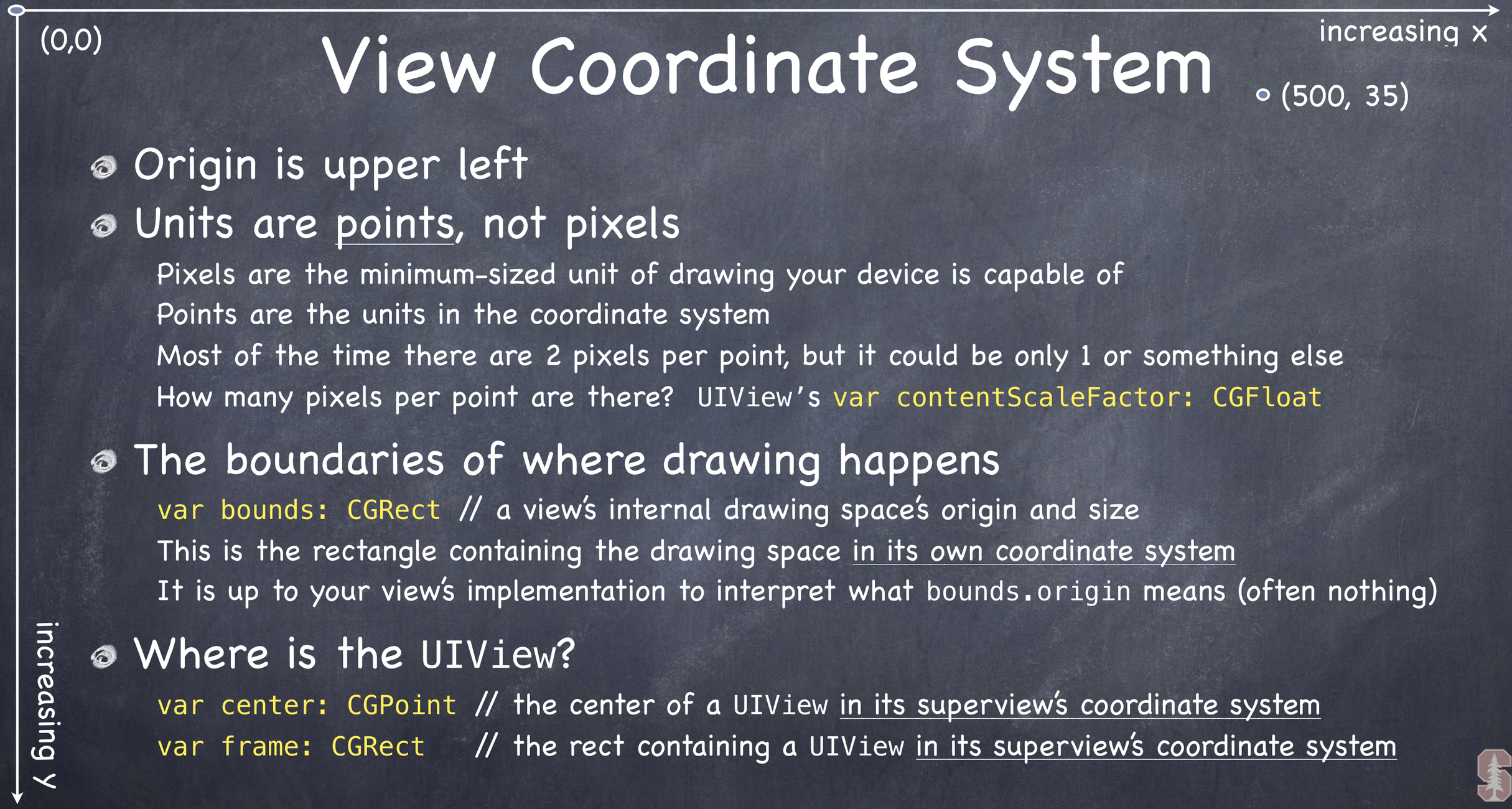
  A struct with a CGPoint and a CGSize in it …

```
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)

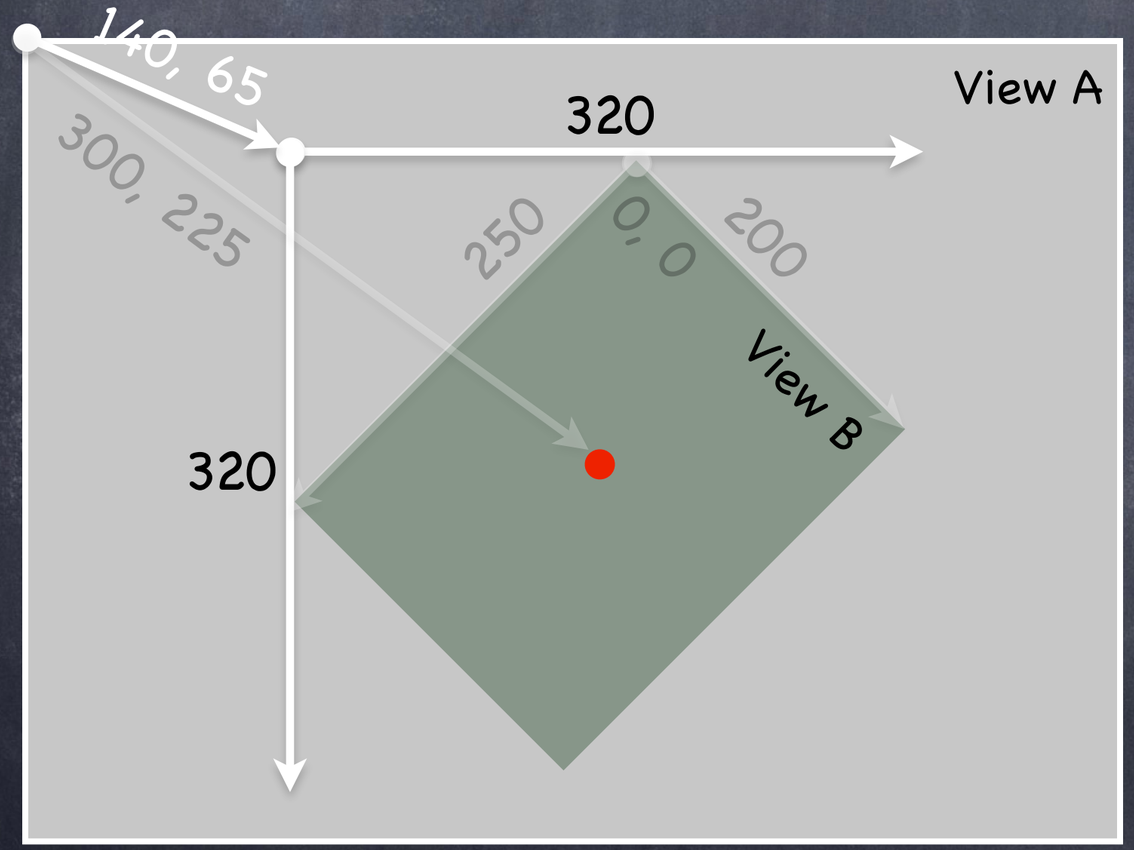


View Coordinate System

- 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 something else
  - 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

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)`

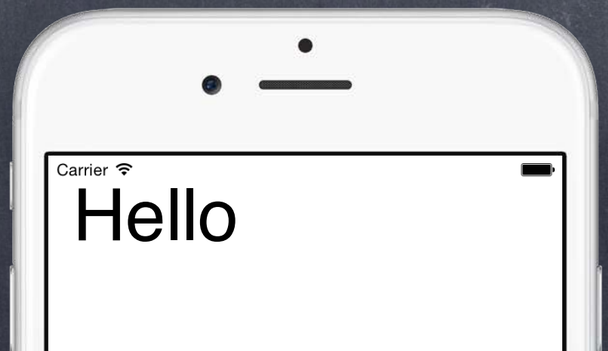
View B's middle in its own coordinates is …
`(bounds.midX, bounds.midY) = (100, 125)`

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 CGRectZero)
- 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 `drawRect:`
  - `override func drawRect(regionThatNeedsToBeDrawn: CGRect)`
  - You can draw outside the `regionThatNeedsToBeDrawn`, but it's never required to do so
  - The `regionThatNeedsToBeDrawn` is purely an optimization
  - It is our `UIView`'s `bounds` that describe the entire drawing area (the region is a subarea).
- NEVER call `drawRect`!! EVER! Or else!
  - Instead, if you view needs to be redrawn, let the system know that by calling ...
  - `setNeedsDisplay()`
  - `setNeedsDisplayInRect(regionThatNeedsToBeRedrawn: CGRect)`
  - iOS will then call your `drawRect` at an appropriate time

Custom Views

- So how do I implement my `drawRect`?

  You can use a C-like (non object-oriented) API called Core Graphics

  Or you can use the object-oriented `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 `drawRect`
  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

Custom Views

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  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 (`drawRect` 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.moveToPoint(CGPoint(80, 50))
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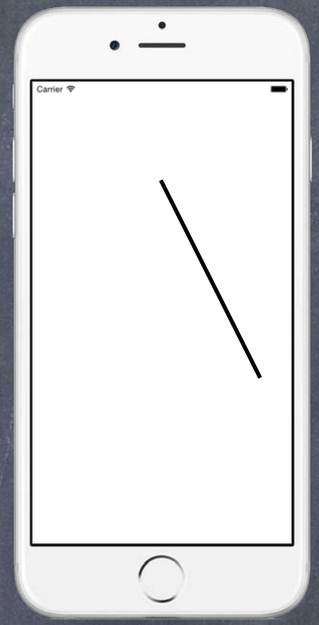

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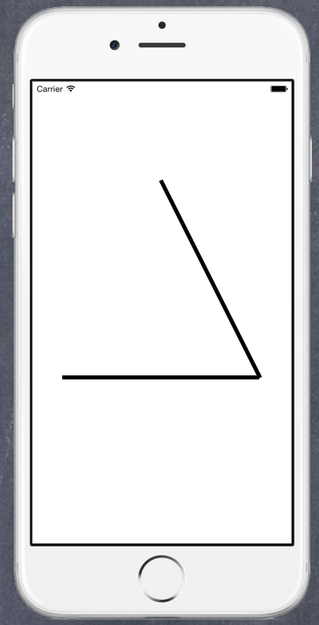

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- Close the path (if you want)

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path.closePath()
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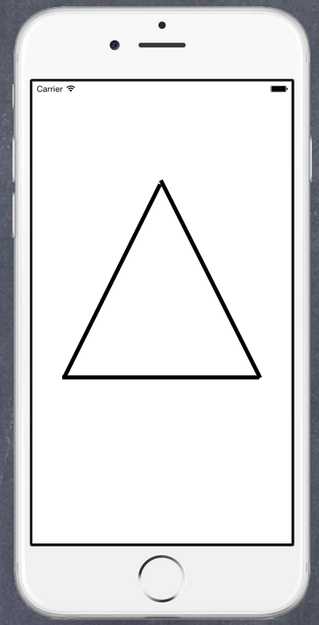

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- Now that you have a path, set attributes and stroke/fill

```
UIColor.greenColor().setFill() // note this is a method in UIColor, not UIBezierPath
UIColor.redColor().setStroke() // note this is a method in UIColor, not UIBezierPath
path.linewidth = 3.0           // note this is a property in UIBezierPath, not UIColor
```

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path.fill()                     // method in UIBezierPath
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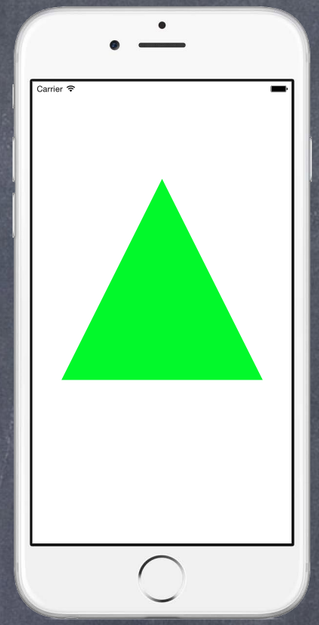

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path.linewidth = 3.0            // note this is a property in UIBezierPath, not UIColor
path.fill()                     // method in UIBezierPath
path.stroke()                   // method in UIBezierPath
```
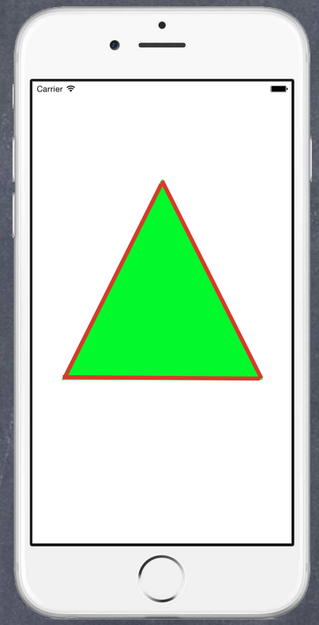



Drawing

- You can also draw common shapes with `UIBezierPath`

  ```
  let roundRect = UIBezierPath(roundedRect: aCGRect, cornerRadius: aCGFloat)
  let oval = UIBezierPath(ovalInRect: aCGRect)
  ```

  … 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 containsPoint(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 methods for standard colors, e.g. `let green = UIColor.greenColor()`
  - 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 transparentYellow = UIColor.yellowColor().colorWithAlphaComponent(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 `drawRect`
- To draw in `drawRect`, use `NSAttributedString`

```
let text = NSAttributedString("hello")
text.drawAtPoint(aCGPoint)
let textSize: CGSize = text.size // how much space the string will take up
```

- Mutability is done with `NSMutableAttributedString`
  - It is not 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("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: Dictionary, range: NSRange)
func addAttributes(attributes: Dictionary, range: NSRange)
```

Warning! This is a pre-Swift API. NSRange is not a Range.

And indexing into the string is using old-style indexing (not String.Index).

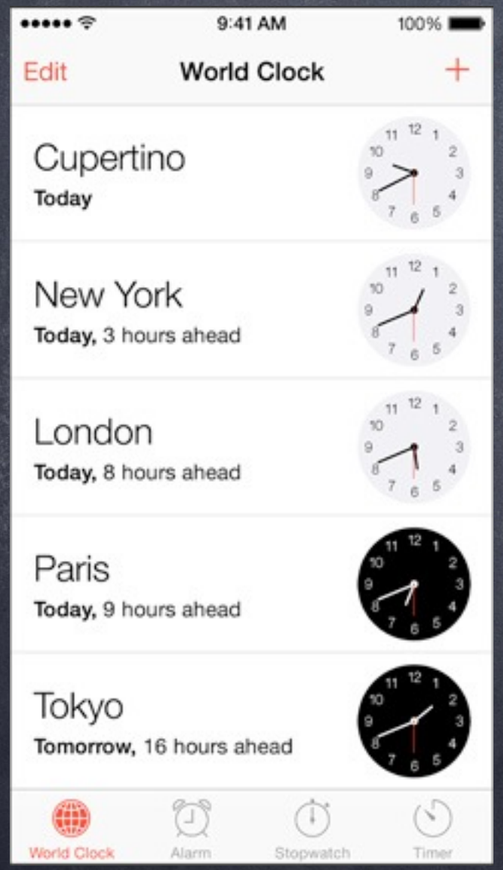
- Attributes

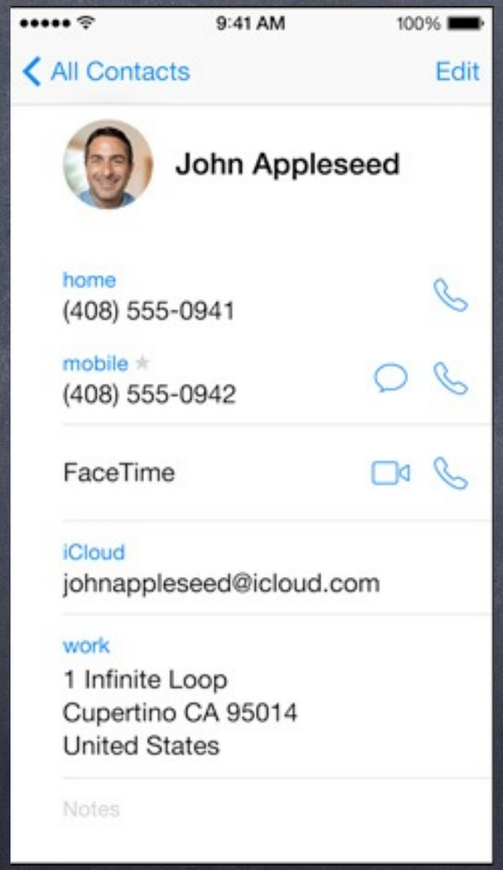
```
NSForegroundColorAttributeName : UIColor
NSStrokeWidthAttributeName : CGFloat
NSFontAttributeName : UIFont
```

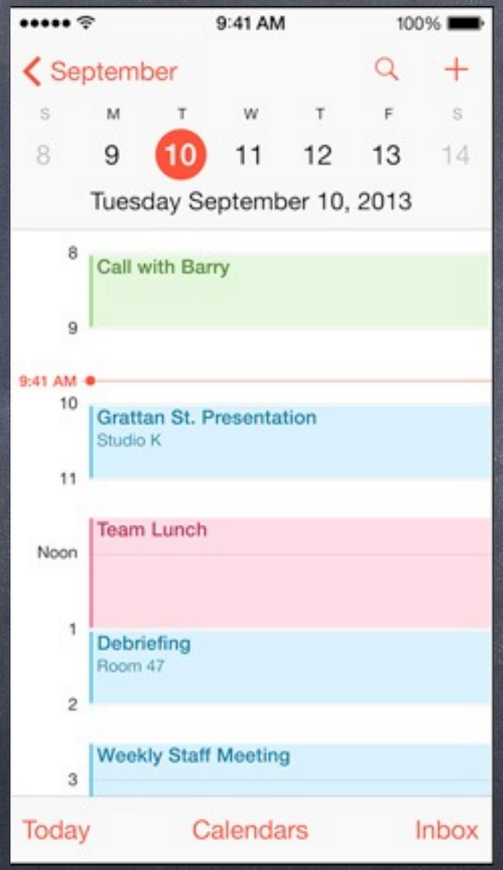
See the documentation under NSAttributedString(NSStringDrawing) for (many) more.

Fonts

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







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 …
  - `class func preferredFontForTextStyle(UIFontTextStyle) -> UIFont`
  - Some of the styles (see `UIFontDescriptor` documentation for more) …
  - `UIFontTextStyle.Headline`
  - `UIFontTextStyle.Body`
  - `UIFontTextStyle.Footnote`
- There are also "system fonts"
  - These appear usually on things like buttons
  - `class func systemFontOfSize(pointSize: CGFloat) -> UIFont`
  - `class func boldSystemFontOfSize(pointSize: CGFloat) -> UIFont`
  - Don't use these for your user's content. 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 drawRect …
- Creating a UIImage object
  - `let image: UIImage? = UIImage(named: "foo")` // note that its an Optional
  - You add foo.jpg to your project in the Images.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: anNSData)` // 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.drawAtPoint(aCGPoint)          // the upper left corner of the image put at aCGPoint
image.drawInRect(aCGRect)            // scales the image to fit aCGRect
image.drawAsPatternInRect(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 `drawRect` again (costly, but for certain content, better results) …
  - `.Redraw`