

# Stanford CS193p

Developing Applications for iOS  
Fall 2011



# Views

- A view (i.e. `UIView` subclass) represents a rectangular area

Defines a coordinate space

- Draws and handles events in that rectangle

- Hierarchical

A view has only one superview – `(UIView *)superview`

But can have many (or zero) subviews – `(NSArray *)subviews`

Subview order (in `subviews` array) matters: those later in the array are on top of those earlier

- `UIWindow`

The `UIView` at the top of the view hierarchy

Only have one `UIWindow` (generally) in an iOS application

It's all about views, not windows



# Views

- The hierarchy is most often constructed in Xcode graphically  
Even custom views are added to the view hierarchy using Xcode (more on this later).
- But it can be done in code as well
  - `(void)addSubview:(UIView *)aView;`
  - `(void)removeFromSuperview;`

# View Coordinates

- **CGFloat**

Just a floating point number, but we always use it for graphics.

- **CGPoint**

C struct with two **CGFloats** in it: **x** and **y**.

```
CGPoint p = CGPointMake(34.5, 22.0);  
p.x += 20; // move right by 20 points
```

- **CGSize**

C struct with two **CGFloats** in it: **width** and **height**.

```
CGSize s = CGSizeMake(100.0, 200.0);  
s.height += 50; // make the size 50 points taller
```

- **CGRect**

C struct with a **CGPoint** **origin** and a **CGSize** **size**.

```
CGRect aRect = CGRectMake(45.0, 75.5, 300, 500);  
aRect.size.height += 45; // make the rectangle 45 points taller  
aRect.origin.x += 30; // move the rectangle to the right 30 points
```



(0,0)

increasing x

# Coordinates

◦ (400, 35)

- Origin of a view's coordinate system is upper left

- Units are "points" (not pixels)

Usually you don't care about how many pixels per point are on the screen you're drawing on. Fonts and arcs and such automatically adjust to use higher resolution.

However, if you are drawing something detailed (like a graph, hint, hint), you might want to know.

There is a `UIView` property which will tell you:

```
@property CGFloat contentScaleFactor; // returns pixels per point on the screen this view is on
```

This property is not (`readonly`), but you should basically pretend that it is for this course.

- Views have 3 properties related to their location and size

```
@property CGRect bounds; // your view's internal drawing space's origin and size
```

The `bounds` property is what you use inside your view's own implementation.

It is up to your implementation as to how to interpret the meaning of `bounds.origin`.

```
@property CGPoint center; // the center of your view in your superview's coordinate space
```

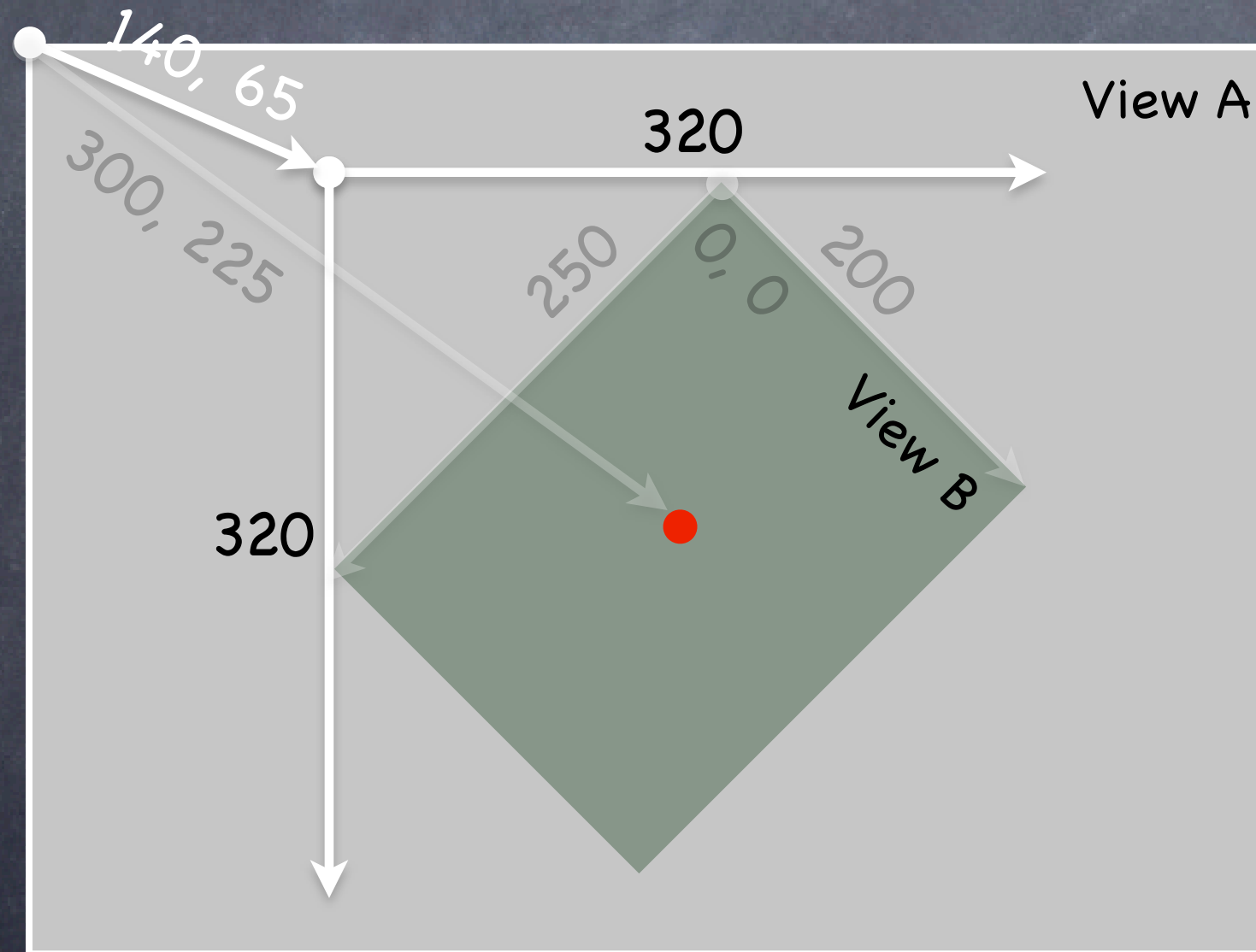
```
@property CGRect frame; // a rectangle in your superview's coordinate space which entirely  
// contains your view's bounds.size
```

increasing y

# Coordinates

## • Use **frame** and **center** to position the view in the hierarchy

These are used by superviews, never inside your **UIView** subclass's implementation.  
You might think **frame.size** is always equal to **bounds.size**, but you'd be wrong ...



Because views can be rotated  
(and scaled and translated too).

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 coordinate space is  
 $(\text{bound.size.width}/2 + \text{bounds.origin.x},$   
 $\text{bounds.size.height}/2 + \text{bounds.origin.y})$   
which is  $(100,125)$  in this case.

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



# Creating Views

- Most often you create views in Xcode

Of course, Xcode's palette knows nothing about a custom view class you might create. In that case, you drag out a generic `UIView` from the palette and use the Inspector to change the class of the `UIView` to your custom class (demo of this later).

- How do you create a `UIView` in code (i.e. not in Xcode)?

Just use `alloc` and `initWithFrame:` (`UIView`'s designated initializer).

- Example

```
CGRect labelRect = CGRectMake(20, 20, 50, 30);
UILabel *label = [[UILabel alloc] initWithFrame:labelRect];
label.text = @"Hello!";
[self.view addSubview:label]; // we'll talk about self.view later
                             // (it is a Controller's top-level view)
```



# Custom Views

- When would I want to 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 later. For now we're focussing on drawing.

- Drawing is easy ... create a **UIView** subclass & override 1 method

- **(void)drawRect:(CGRect)aRect;**

You can optimize by not drawing outside of **aRect** if you want (but not required).

- **NEVER** call **drawRect:!!** EVER! Or else!

Instead, let iOS know that your view's visual is out of date with one of these **UIView** methods:

- **(void)setNeedsDisplay;**

- **(void)setNeedsDisplayInRect:(CGRect)aRect;**

It will then set everything up and call **drawRect:** for you at an appropriate time

Obviously, the second version will call your **drawRect:** with only rectangles that need updates



# Custom Views

- So how do I implement my `drawRect:`?

Use the Core Graphics framework

- The API is C (not object-oriented)

- Concepts

Get a context to draw into (iOS will prepare one each time your `drawRect:` is called)

Create paths (out of lines, arcs, etc.)

Set colors, fonts, textures, linewidths, linecaps, etc.

Stroke or fill the above-created paths

# Context

- The context determines where your drawing goes

Screen (the only one we're going to talk about today)

Offscreen Bitmap

PDF

Printer

- For normal drawing, UIKit sets up the current context for you

But it is only valid during that particular call to `drawRect:`

A new one is set up for you each time `drawRect:` is called

So never cache the current graphics context in `drawRect:` to use later!

- How to get this magic context?

Call the following C function inside your `drawRect:` method to get the current graphics context ...

```
CGContextRef context = UIGraphicsGetCurrentContext();
```



# Define a Path

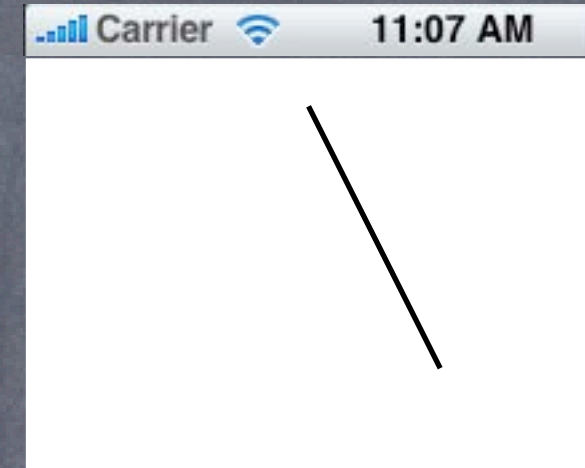
- Begin the path

```
CGContextBeginPath(context);
```

- Move around, add lines or arcs to the path

```
CGContextMoveToPoint(context, 75, 10);
```

```
CGContextAddLineToPoint(context, 160, 150);
```



# Define a Path

- Begin the path

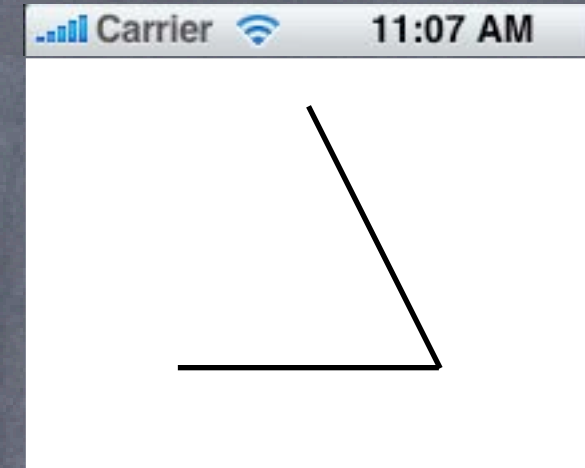
```
CGContextBeginPath(context);
```

- Move around, add lines or arcs to the path

```
CGContextMoveToPoint(context, 75, 10);
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CGContextAddLineToPoint(context, 160, 150);
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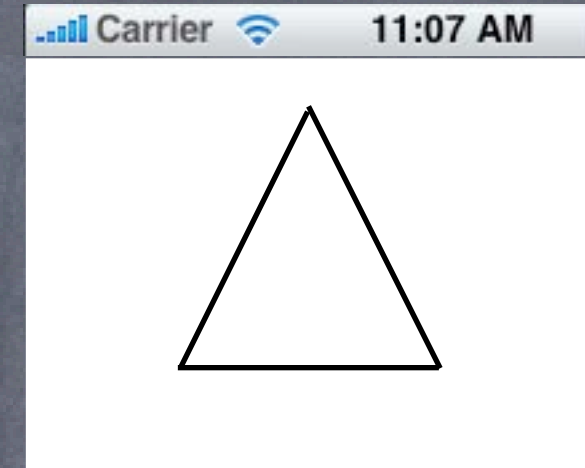
```
CGContextMoveToPoint(context, 75, 10);
```

```
CGContextAddLineToPoint(context, 160, 150);
```

```
CGContextAddLineToPoint(context, 10, 150);
```

- Close the path (connects the last point back to the first)

```
CGContextClosePath(context); // not strictly required
```



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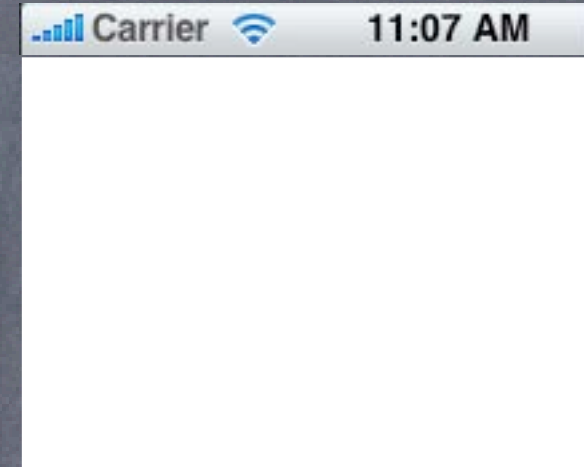
```
CGContextAddLineToPoint(context, 10, 150);
```

- Close the path (connects the last point back to the first)

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CGContextClosePath(context); // not strictly required
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- Actually the above draws nothing (yet)!

You have to set the graphics state and then fill/stroke the above path to see anything.





# Define a Path

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CGContextBeginPath(context);
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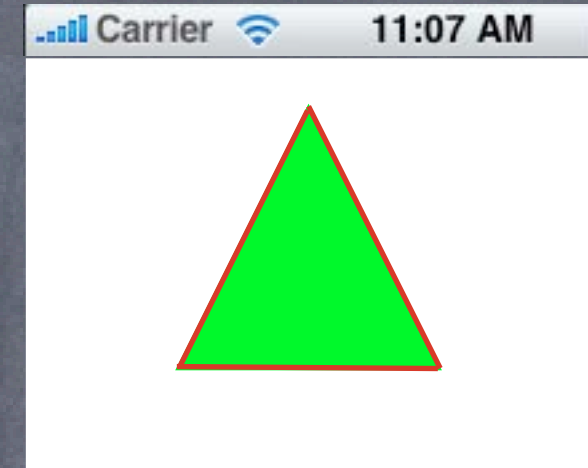
- Actually the above draws nothing (yet)!

You have to set the graphics state and then fill/stroke the above path to see anything.

```
[[UIColor greenColor] setFill]; // object-oriented convenience method (more in a moment)
```

```
[[UIColor redColor] setStroke];
```

```
CGContextDrawPath(context, kCGPathFillStroke); // kCGPathFillStroke is a constant
```



# Define a Path

- It is also possible to save a path and reuse it

Similar functions to the previous slide, but starting with `CGPath` instead of `CGContext`

We won't be covering those, but you can certainly feel free to look them up in the documentation



# Graphics State

- **UIColor** class for setting colors

```
UIColor *red = [UIColor redColor];    // class method, returns autoreleased instance
UIColor *custom = [[UIColor alloc] initWithRed:(CGFloat)red    // 0.0 to 1.0
                  blue:(CGFloat)blue
                  green:(CGFloat)green
                  alpha:(CGFloat)alpha]; // 0.0 to 1.0 (opaque)

[red setFill]; // fill color set in current graphics context (stroke color not set)
[custom set];  // sets both stroke and fill color to custom (would override [red setFill])
```

- Drawing with transparency in **UIView**

Note the **alpha** above. This is how you can draw with transparency in your **drawRect:**.

**UIView** also has a **backgroundColor** property which can be set to transparent values.

Be sure to set **@property BOOL opaque** to **NO** in a view which is partially or fully transparent.

If you don't, results are unpredictable (this is a performance optimization property, by the way).

The **UIView @property CGFloat alpha** can make the entire view partially transparent.

# View Transparency

- What happens when views overlap?

As mentioned before, `subviews` list order determines who's in front

Lower ones (earlier in `subviews` array) can "show through" transparent views on top of them

- Default drawing is opaque

Transparency is not cheap (performance-wise)

- Also, you can hide a view completely by setting `hidden` property

```
@property (nonatomic) BOOL hidden;
```

```
myView.hidden = YES;           // view will not be on screen and will not handle events
```

This is not as uncommon as you might think

On a small screen, keeping it de-cluttered by hiding currently unusable views make sense



# Graphics State

- Some other graphics state set with C functions, e.g. ...  
`CGContextSetLineWidth(context, 1.0);` // line width in points (not pixels)  
`CGContextSetFillPattern(context, (CGPatternRef)pattern, (CGFloat[])components);`

# Graphics State

## • Special considerations for defining drawing “subroutines”

What if you wanted to have a utility method that draws something

You don't want that utility method to mess up the graphics state of the calling method

Use push and pop context functions.

```
- (void)drawGreenCircle:(CGContextRef)ctxt {
    UIGraphicsPushContext(ctxt);
    [[UIColor greenColor] setFill];
    // draw my circle
    UIGraphicsPopContext();
}

- (void)drawRect:(CGRect)aRect {
    CGContextRef context = UIGraphicsGetCurrentContext();
    [[UIColor redColor] setFill];
    // do some stuff
    [self drawGreenCircle:context];
    // do more stuff and expect fill color to be red
}
```

# Drawing Text

- Use `UILabel` to draw text, but if you feel you must ...

- Use `UIFont` object in UIKit to get a font

```
UIFont *myFont = [UIFont systemFontOfSize:12.0];
```

```
UIFont *theFont = [UIFont fontWithName:@"Helvetica" size:36.0];
```

```
NSArray *availableFonts = [UIFont familyNames];
```

- Then use special `NSString` methods to draw the text

```
NSString *text = ...;
```

```
[text drawAtPoint:(CGPoint)p withFont:theFont]; // NSString instance method
```

How much space will a piece of text will take up when drawn?

```
CGSize textSize = [text sizeWithFont:myFont]; // NSString instance method
```

You might be disturbed that there is a Foundation method for drawing (which is a UIKit thing).

But actually these `NSString` methods are defined in UIKit via a mechanism called categories.

Categories are an Objective-C way to add methods to an existing class without subclassing.

We'll cover how (and when) to use this a bit later in this course.



# Drawing Images

- Use `UIImageView` to draw images, but if you feel you must ...

We'll cover `UIImageView` later in the course.

- Create a `UIImage` object from a file in your Resources folder

```
UIImage *image = [UIImage imageNamed:@"foo.jpg"];
```

- Or create one from a named file or from raw data

(of course, we haven't talked about the file system yet, but ...)

```
UIImage *image = [[UIImage alloc] initWithContentsOfFile:(NSString *)fullPath];
```

```
UIImage *image = [[UIImage alloc] initWithData:(NSData *)imageData];
```

- Or you can even create one by drawing with `CGContext` functions

```
UIGraphicsBeginImageContext(CGSize);
```

```
// draw with CGContext functions
```

```
UIImage *myImage = UIGraphicsGetImageFromCurrentContext();
```

```
UIGraphicsEndImageContext();
```

# Drawing Images

- Now blast the `UIImage`'s bits into the current graphics context

```
UIImage *image = ...;  
[image drawAtPoint:(CGPoint)p];           // p is upper left corner of the image  
[image drawInRect:(CGRect)r];             // scales the image to fit in r  
[image drawAsPatternInRect:(CGRect)patRect]; // tiles the image into patRect
```

- Aside: You can get a PNG or JPG data representation of `UIImage`

```
NSData *jpgData = UIImageJPEGRepresentation((UIImage *)myImage, (CGFloat)quality);  
NSData *pngData = UIImagePNGRepresentation((UIImage *)myImage);
```

# Next Time

## 👁 Tomorrow

Source Control

## 👁 Next Week

Protocols (a little more Objective C)

Demo of custom UIView

View Controller Lifecycle

Controllers of Controllers

Storyboarding

Universal Applications