

CS193P - Lecture 5

iPhone Application Development

Views
Drawing
Animation

Announcements

- Assignment 1 grades are out. Contact Paul or Dave if you didn't get yours
- Contact Paul or Dave if you need a loaner iPod Touch
- Assignments 2A and 2B due Wednesday, 1/20

Questions from Monday?

- Model, View, Controller
- Interface Builder & Nibs
- Delegate
 - Allows one object to act on behalf of another object
- Target-Action

Today's Topics

- Views
- Drawing
- Text & Images
- Animation

Views

View Fundamentals

- Rectangular area on screen
- Draws content
- Handles events
- Subclass of UIResponder (event handling class)
- Views arranged hierarchically
 - every view has one **superview**
 - every view has zero or more **subviews**

View Hierarchy - UIWindow

- Views live inside of a window
- UIWindow is actually just a view
 - adds some additional functionality specific to top level view
- One UIWindow for an iPhone app
 - Contains the entire view hierarchy
 - Set up by default in Xcode template project

View Hierarchy - Manipulation

- Add/remove views in IB or using UIView methods
 - (void)**addSubview**:(UIView *)view;
 - (void)**removeFromSuperview**;
- Manipulate the view hierarchy manually:
 - (void)**insertSubview**:(UIView *)view **AtIndex**:(int)index;
 - (void)**insertSubview**:(UIView *)view **belowSubview**:(UIView *)view;
 - (void)**insertSubview**:(UIView *)view **aboveSubview**:(UIView *)view;
 - (void)**exchangeSubviewAtIndex**:(int)index
withSubviewAtIndex:(int)otherIndex;

View Hierarchy - Ownership

- Superviews retain their subviews
- Not uncommon for views to only be retained by superview
 - Be careful when removing!
 - Retain subview before removing if you want to reuse it
- Views can be temporarily hidden
`theView.hidden = YES;`

View-related Structures

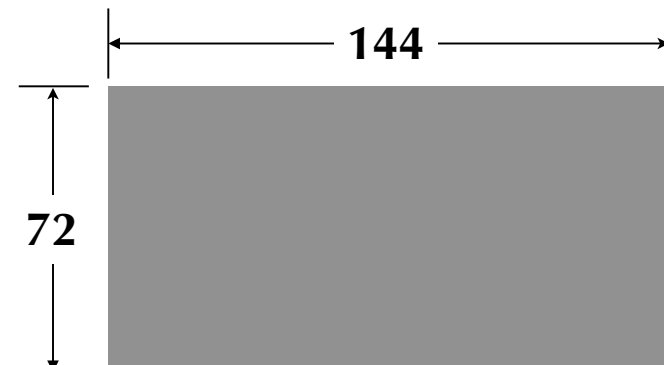
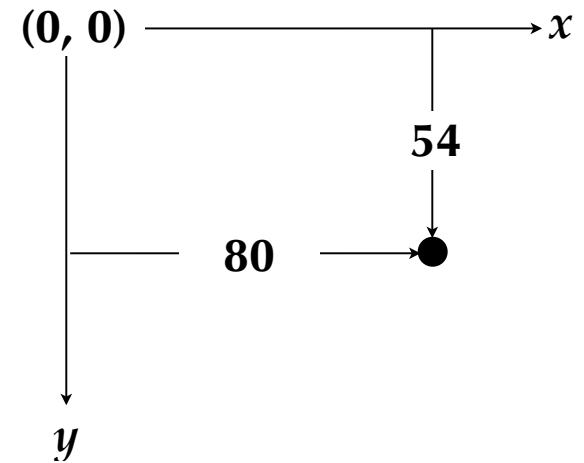
- CGPoint
 - location in space: { **x** , **y** }
- CGSize
 - dimensions: { **width** , **height** }
- CGRect
 - location and dimension: { **origin** , **size** }

Rects, Points and Sizes

CGRect	
<i>origin</i>	○ →
<i>size</i>	○ →

CGPoint	
<i>x</i>	80
<i>y</i>	54

CGSize	
<i>width</i>	144
<i>height</i>	72

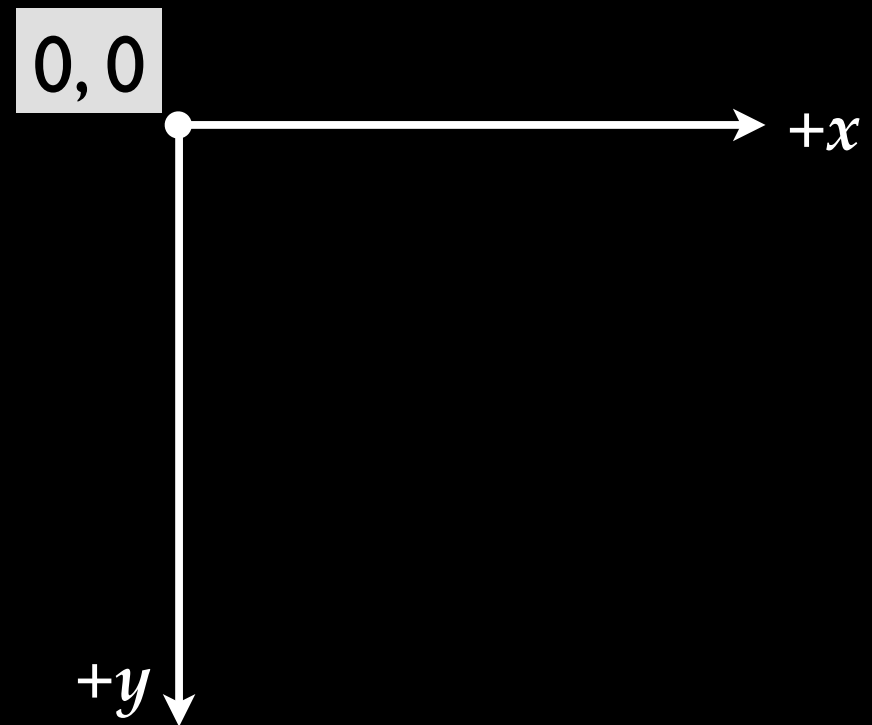


View-related Structure

Creation Function	Example
<code>CGPointMake (x, y)</code>	<pre>CGPoint point = CGPointMake (100.0, 200.0); point.x = 300.0; point.y = 30.0;</pre>
<code>CGSizeMake (width, height)</code>	<pre>CGSize size = CGSizeMake (42.0, 11.0); size.width = 100.0; size.height = 72.0;</pre>
<code>CGRectMake (x, y, width, height)</code>	<pre>CGRect rect = CGRectMake (100.0, 200.0, 42.0, 11.0); rect.origin.x = 0.0; rect.size.width = 50.0;</pre>

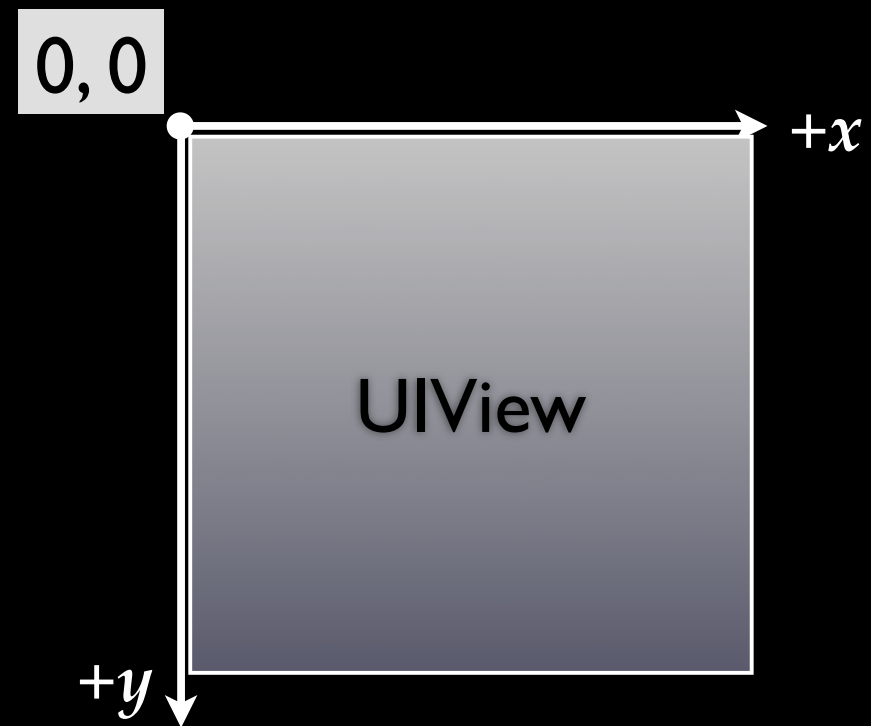
UIView Coordinate System

- Origin in upper left corner
- y axis grows downwards



UIView Coordinate System

- Origin in upper left corner
- y axis grows downwards



Location and Size

- View's location and size expressed in two ways
 - **Frame** is in superview's coordinate system
 - **Bounds** is in local coordinate system

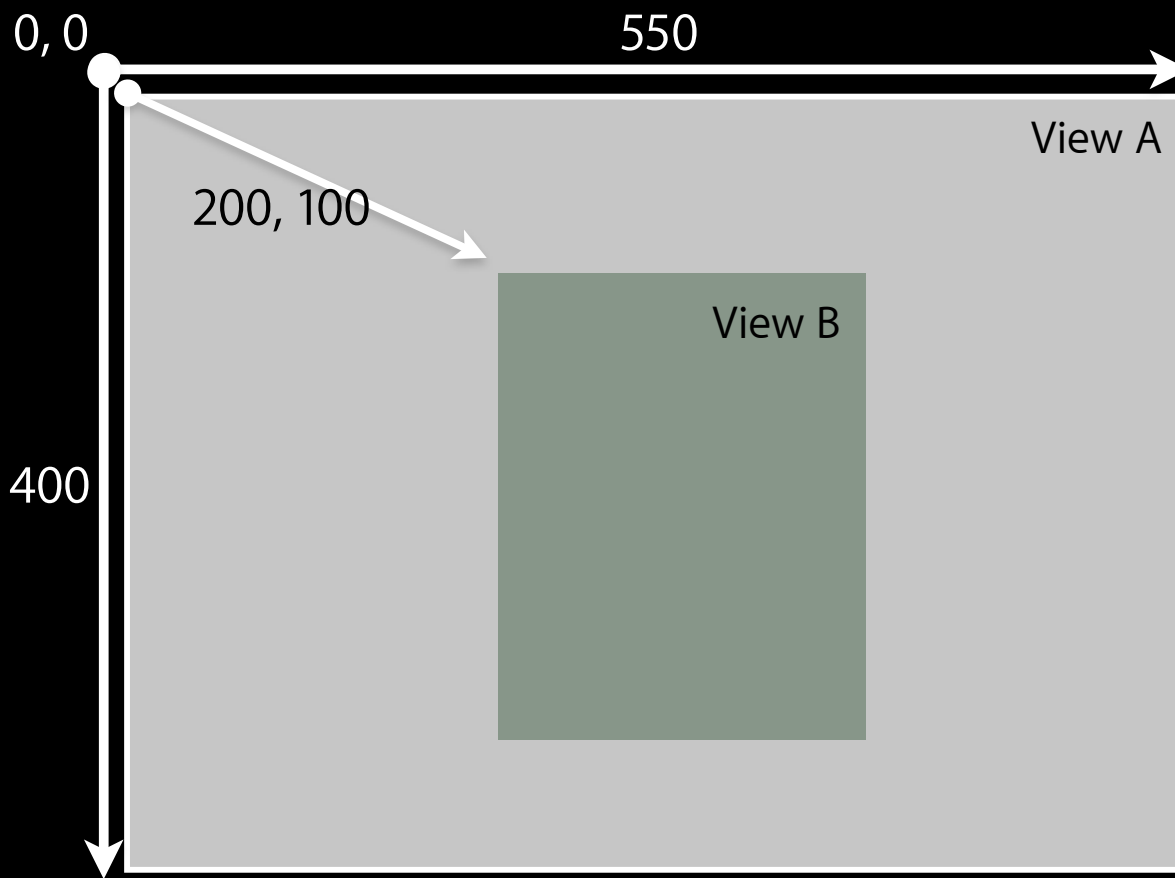


View A **frame**:
origin: 0, 0
size: 550 x 400

View A **bounds**:
origin: 0, 0
size: 550 x 400

Location and Size

- View's location and size expressed in two ways
 - **Frame** is in superview's coordinate system
 - **Bounds** is in local coordinate system

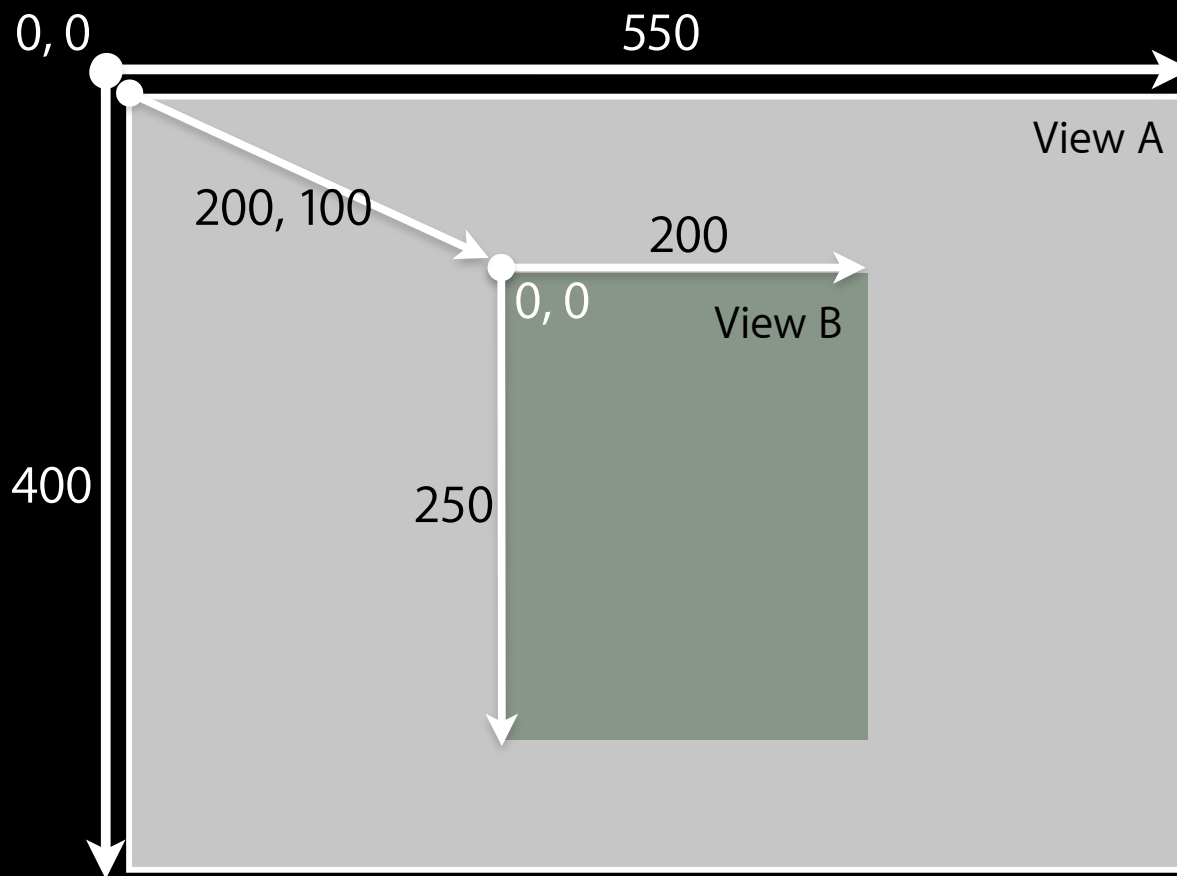


View A **frame**:
origin: 0, 0
size: 550 x 400

View A **bounds**:
origin: 0, 0
size: 550 x 400

Location and Size

- View's location and size expressed in two ways
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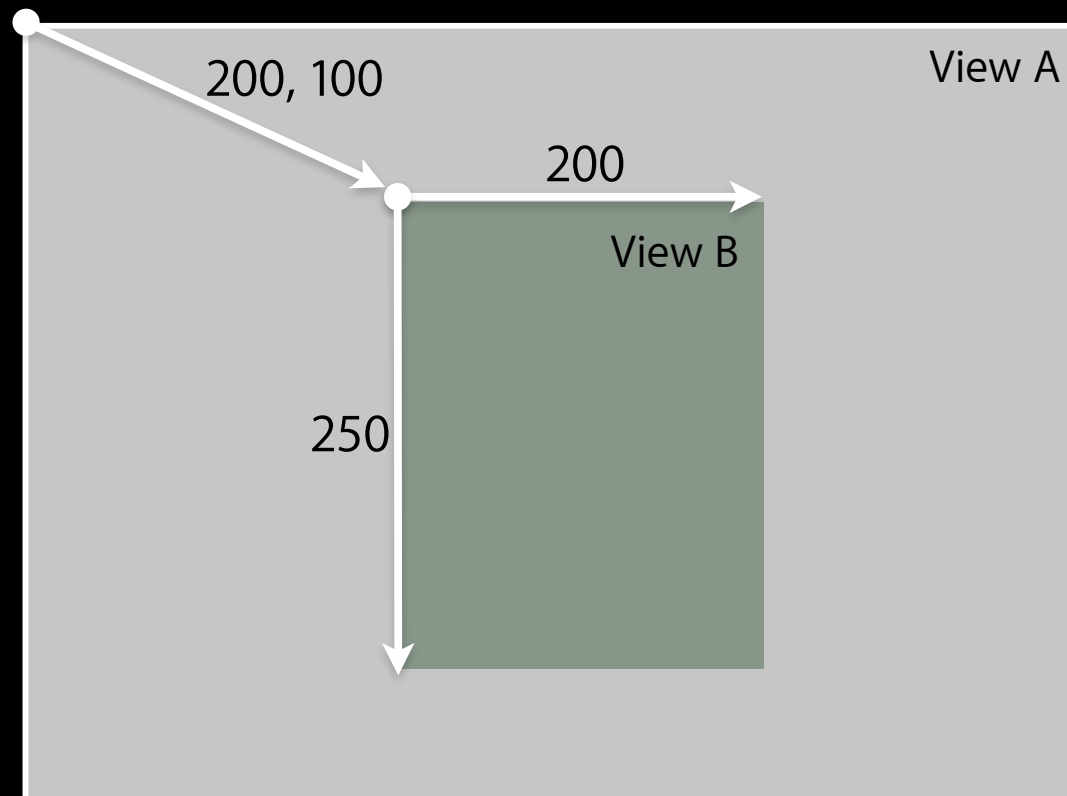
View A **frame**:
origin: 0, 0
size: 550 x 400

View A **bounds**:
origin: 0, 0
size: 550 x 400

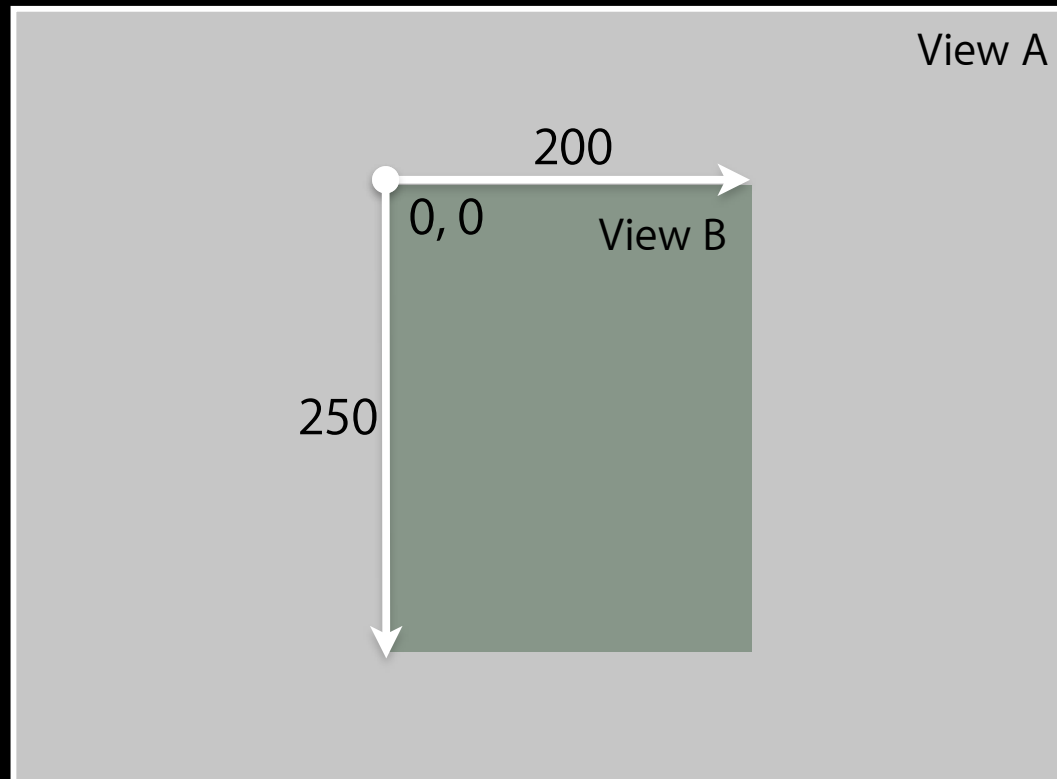
View B **frame**:
origin: 200, 100
size: 200 x 250

View B **bounds**:
origin: 0, 0
size: 200 x 250

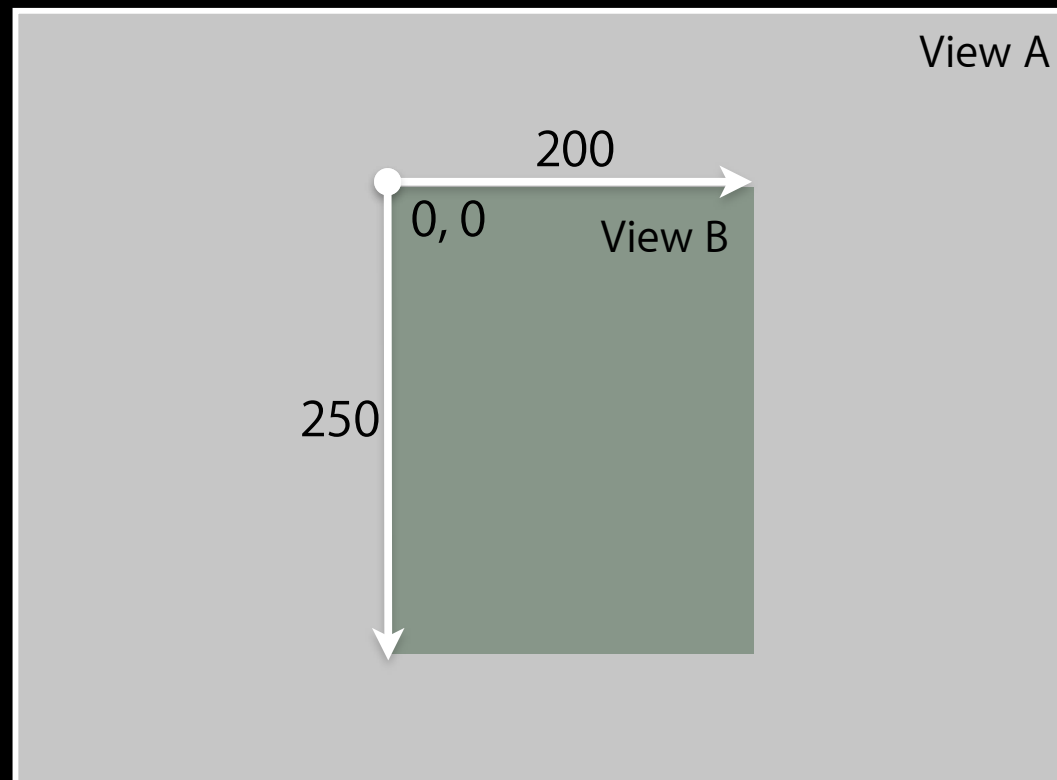
Frame is Computed



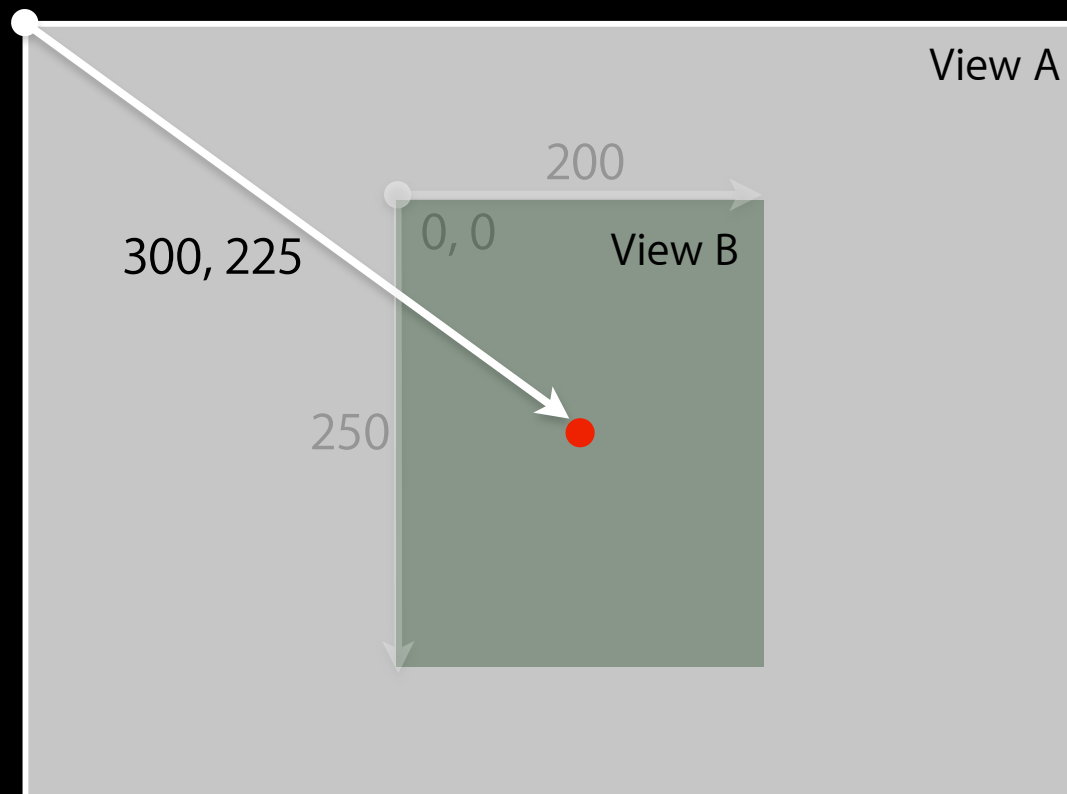
Bounds



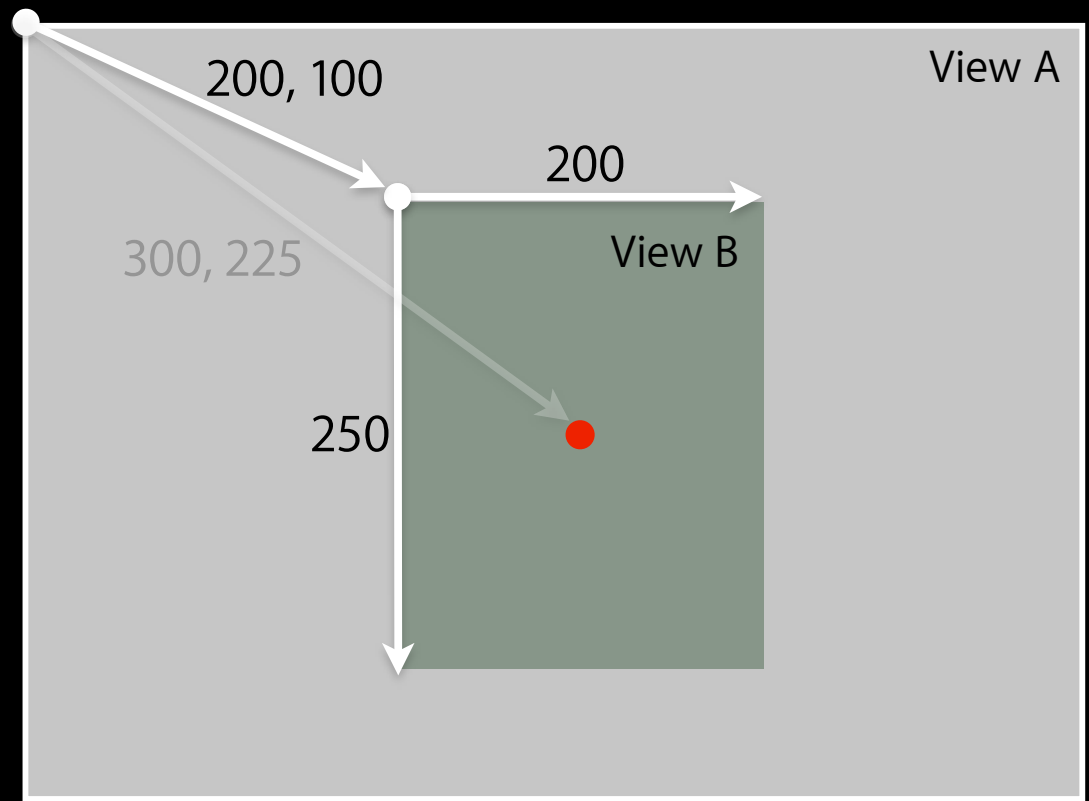
Center



Center

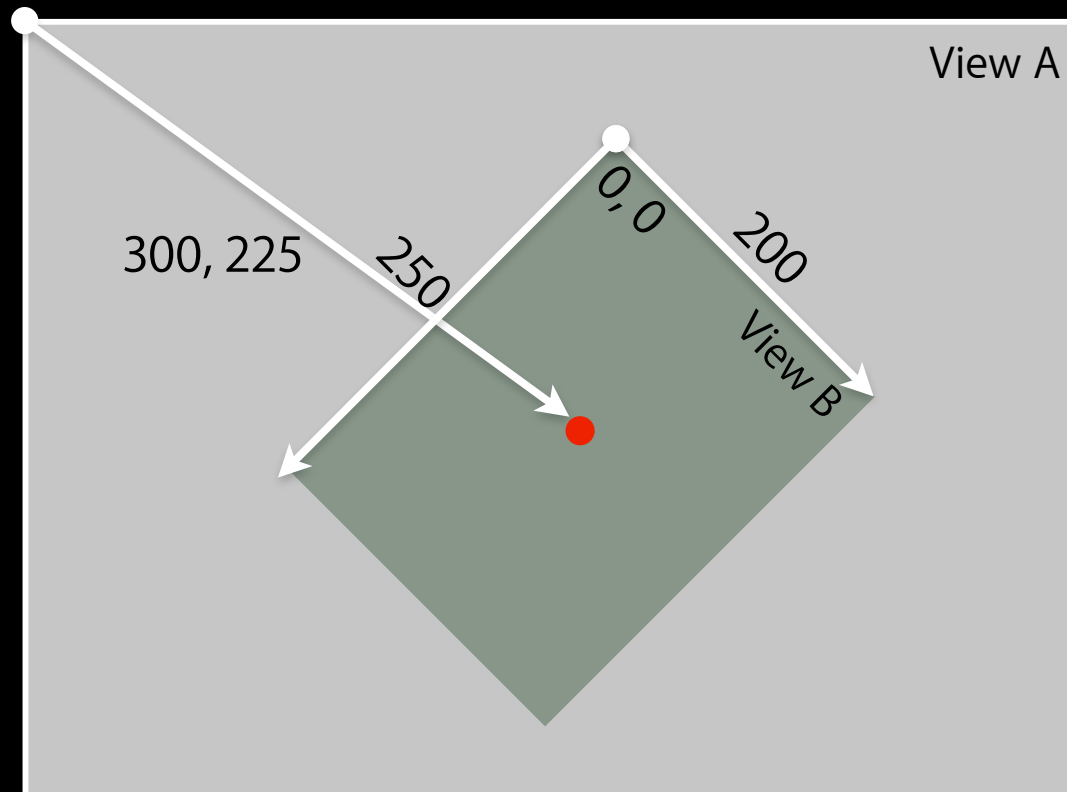


Frame



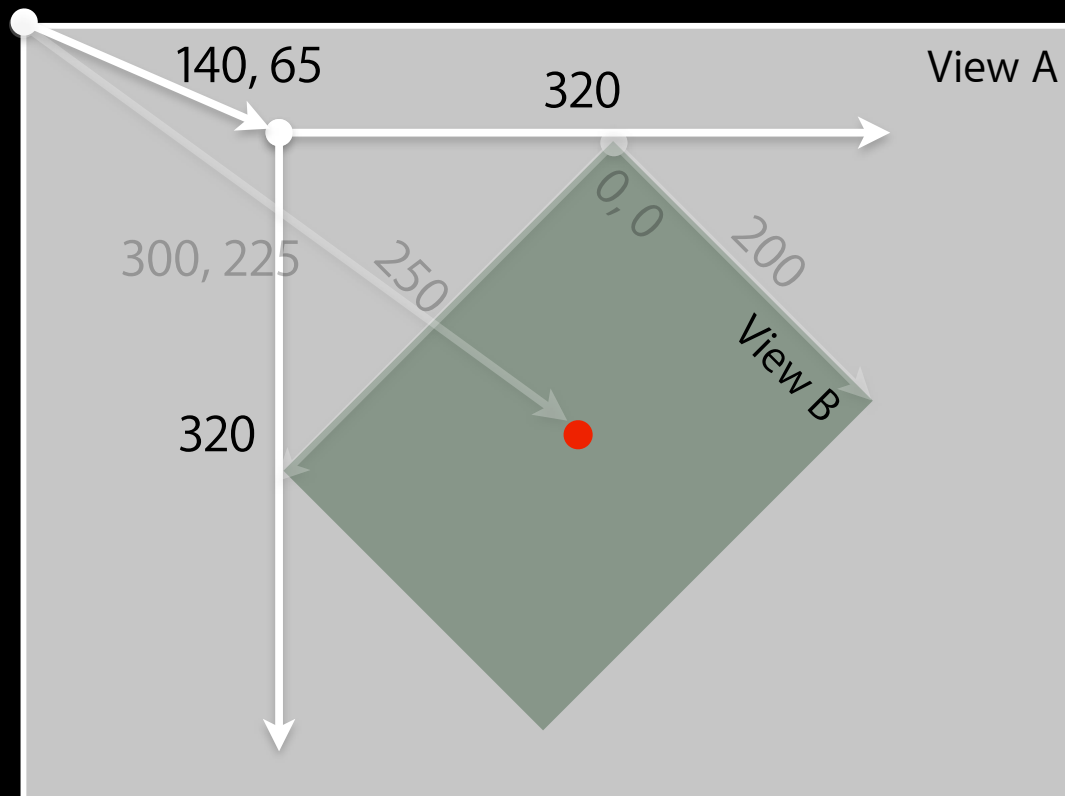
Transform

- 45° Rotation



Frame

- The smallest rectangle in the superview's coordinate system that fully encompasses the view itself



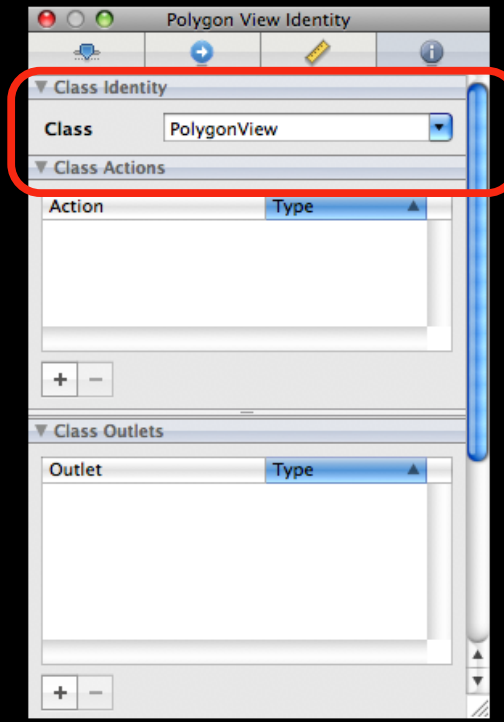
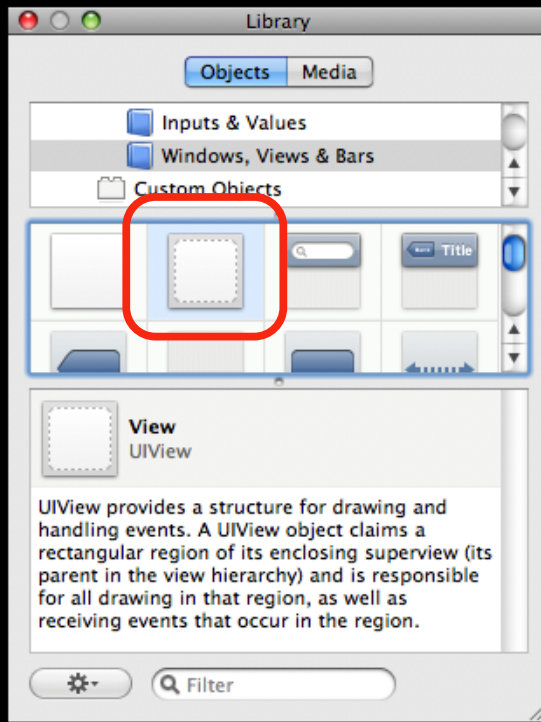
Frame and Bounds

- Which to use?
 - Usually depends on the context
- If you are *using* a view, typically you use frame
- If you are *implementing* a view, typically you use bounds
- Matter of perspective
 - From outside it's usually the frame
 - From inside it's usually the bounds
- Examples:
 - Creating a view, positioning a view in superview - use frame
 - Handling events, drawing a view - use bounds

Creating Views

Where do views come from?

- Commonly Interface Builder
- Drag out any of the existing view objects (buttons, labels, etc)
- Or drag generic UIView and set custom class



Manual Creation

- Views are initialized using -initWithFrame:

```
CGRect frame = CGRectMake(0, 0, 200, 150);
```

```
UIView *myView = [[UIView alloc] initWithFrame:frame];
```

- Example:

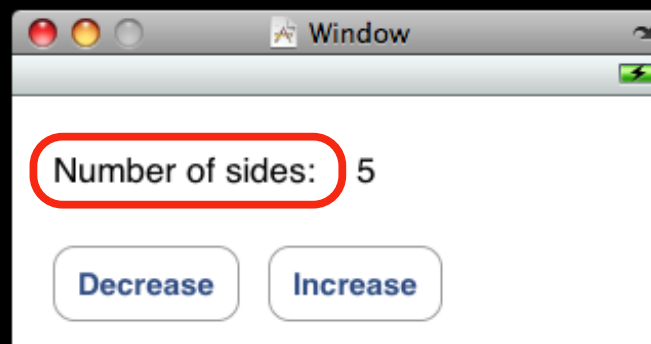
```
CGRect frame = CGRectMake(20, 45, 140, 21);
```

```
UILabel *label = [[UILabel alloc] initWithFrame:frame];
```

```
[window addSubview:label];
```

```
[label setText:@"Number of sides:"];
```

```
[label release]; // label now retained by window
```



Defining Custom Views

- Subclass UIView
- For custom drawing, you override:
 - (void)**drawRect**:(CGRect)rect;
- For event handling, you override:
 - (void)**touchesBegan**:(NSSet *)touches **withEvent**:(UIEvent *)event;
 - (void)**touchesMoved**:(NSSet *)touches **withEvent**:(UIEvent *)event;
 - (void)**touchesEnded**:(NSSet *)touches **withEvent**:(UIEvent *)event;
 - (void)**touchesCancelled**:(NSSet *)touches **withEvent**:(UIEvent *)event;

Drawing Views

- (void)drawRect:(CGRect)rect

- -[UIView drawRect:] does nothing by default
 - If not overridden, then backgroundColor is used to fill
- Override - drawRect: to draw a custom view
 - rect argument is area to draw
- When is it OK to call drawRect:?

Be Lazy

- drawRect: is invoked automatically
 - Don't call it directly!
- Being lazy is good for performance
- When a view needs to be redrawn, use:
 - (void)setNeedsDisplay;
- For example, in your controller:
 - (void)setNumberOfSides:(int)sides {
 numberOfSides = sides;
 [polygonView setNeedsDisplay];
}

CoreGraphics and Quartz 2D

- UIKit offers very basic drawing functionality

```
UIRectFill(CGRect rect);  
UIRectFrame(CGRect rect);
```

- CoreGraphics: Drawing APIs
- CG is a C-based API, not Objective-C
- CG and Quartz 2D drawing engine define simple but powerful graphics primitives
 - Graphics context
 - Transformations
 - Paths
 - Colors
 - Fonts
 - Painting operations

Graphics Contexts

- All drawing is done into an opaque graphics context
- Draws to screen, bitmap buffer, printer, PDF, etc.
- Graphics context setup automatically before invoking drawRect:
 - Defines current path, line width, transform, etc.
 - Access the graphics context within drawRect: by calling
`(CGContextRef)UIGraphicsGetCurrentContext(void);`
 - Use CG calls to change settings
- Context only valid for current call to drawRect:
 - Do not cache a CGContext!

CG Wrappers

- Some CG functionality wrapped by UIKit

- **UIColor**

- Convenience for common colors
- Easily set the fill and/or stroke colors when drawing

```
UIColor *redColor = [UIColor redColor];  
[redColor set];  
// drawing will be done in red
```

- **UIFont**

- Access system font
- Get font by name

```
UIFont *font = [UIFont systemFontOfSize:14.0];  
[myLabel setFont:font];
```

Simple drawRect: example

- Draw a solid color and shape

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

    [[UIColor grayColor] set];
    UIRectFill (bounds);

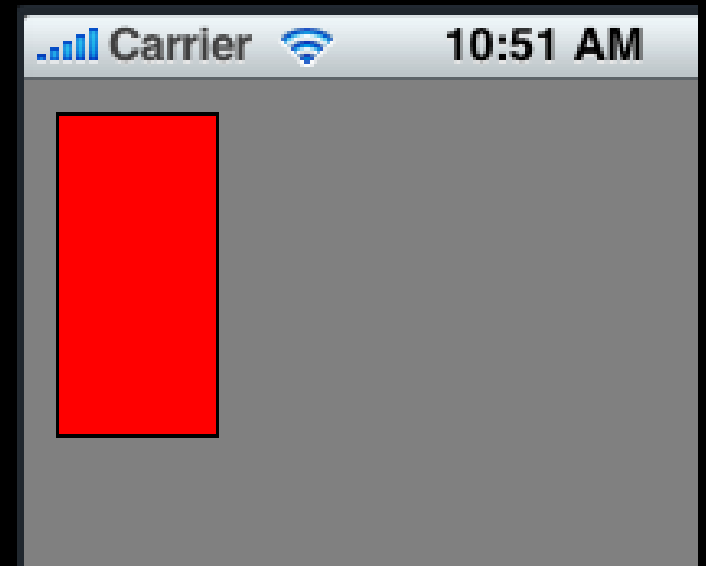
    CGRect square = CGRectMake (10, 10, 50, 100);
    [[UIColor redColor] set];
    UIRectFill (square);

    [[UIColor blackColor] set];
    UIRectFrame (square);
}
```

Simple drawRect: example

- Draw a solid color and shape

```
- (void)drawRect:(CGRect)rect {  
    CGRect bounds = [self bounds];  
  
    [[UIColor grayColor] set];  
    UIRectFill (bounds);  
  
    CGRect square = CGRectMake (10, 10, 50, 100);  
    [[UIColor redColor] set];  
    UIRectFill (square);  
  
    [[UIColor blackColor] set];  
    UIRectFrame (square);  
}
```



Drawing More Complex Shapes

- Common steps for drawRect: are
 - Get current graphics context
 - Define a path
 - Set a color
 - Stroke or fill path
 - Repeat, if necessary

Paths

- CoreGraphics paths define shapes
- Made up of lines, arcs, curves and rectangles
- Creation and drawing of paths are two distinct operations
 - Define path first, then draw it



CGPath

- Two parallel sets of functions for using paths
 - CGContext “convenience” throwaway functions
 - CGPath functions for creating reusable paths

CGContext	CGPath
CGContextMoveToPoint	CGPathMoveToPoint
CGContextAddLineToPoint	CGPathAddLineToPoint
CGContextAddArcToPoint	CGPathAddArcToPoint
CGContextClosePath	CGPathCloseSubPath
<i>And so on and so on ...</i>	

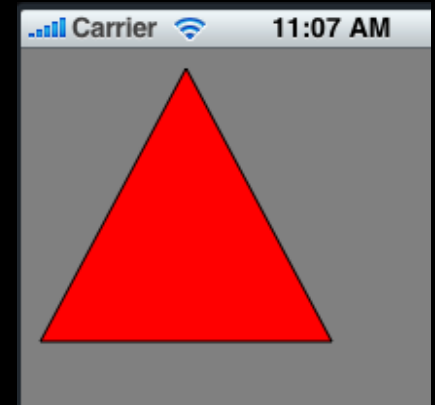
Simple Path Example

```
- (void)drawRect:(CGRect)rect {
    CGContextRef context = UIGraphicsGetCurrentContext();

    [[UIColor grayColor] set];
    UIRectFill ([self bounds]);

    CGContextBeginPath (context);
    CGContextMoveToPoint (context, 75, 10);
    CGContextAddLineToPoint (context, 10, 150);
    CGContextAddLineToPoint (context, 160, 150);
    CGContextClosePath (context);

    [[UIColor redColor] setFill];
    [[UIColor blackColor] setStroke];
    CGContextDrawPath (context, kCGPathFillStroke);
}
```



More Drawing Information

- [UIView Class Reference](#)
- [CGContext Reference](#)
- [“Quartz 2D Programming Guide”](#)
- [Lots of samples in the iPhone Dev Center](#)

Images & Text

UIImage

- UIKit class representing an image
- Creating UIImage:
 - Fetching image in application bundle
 - Use `+[UIImage imageNamed:(NSString *)name]`
 - Include file extension in file name, e.g. `@“myImage.jpg”`
 - Read from file on disk
 - Use `-[UIImage initWithContentsOfFile:(NSString *)path]`
 - From data in memory
 - Use `-[UIImage initWithData:(NSData *)data]`

Creating Images from a Context

- Need to dynamically generate a bitmap image
- Same as drawing a view
- General steps
 - Create a special CGContext with a size
 - Draw
 - Capture the context as a bitmap
 - Clean up

Bitmap Image Example

```
- (UIImage *)polygonImageOfSize:(CGSize)size {
    UIImage *result = nil;

    UIGraphicsBeginImageContext (size);

    // call your drawing code...

    result = UIGraphicsGetImageFromCurrentContext();

    UIGraphicsEndImageContext();

    return result;
}
```

Getting Image Data

- Given UIImage, want PNG or JPG representation

```
NSData *UIImagePNGRepresentation (UIImage * image);  
NSData *UIImageJPEGRepresentation (UIImage * image);
```

- UIImage also has a CGImage property which will give you a CGImageRef to use with CG calls

Drawing Text & Images

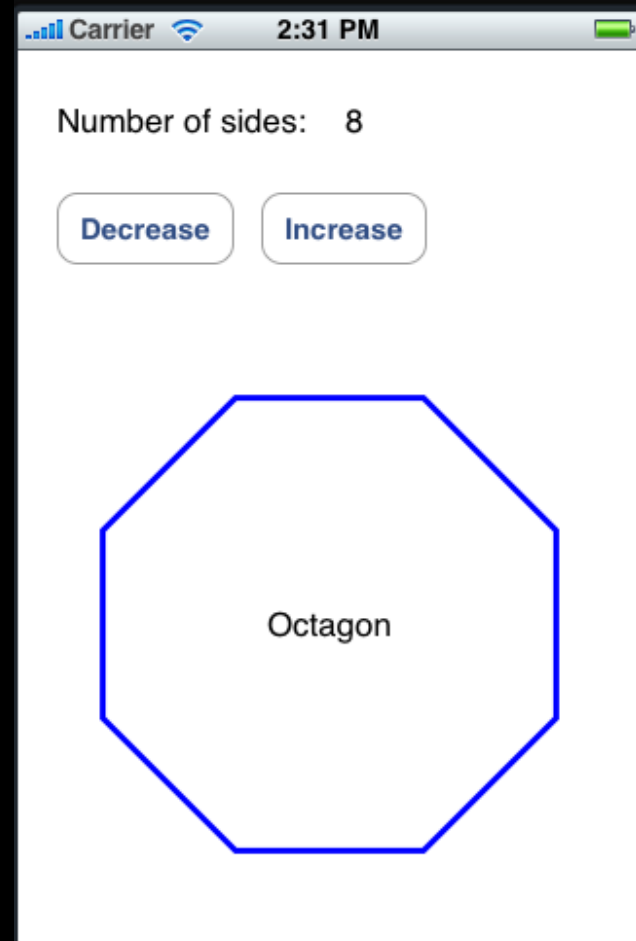
- You can draw UIImage in -drawRect:
 - [UIImage drawAtPoint:(CGPoint)point]
 - [UIImage drawInRect:(CGRect)rect]
 - [UIImage drawAsPatternInRect:(CGRect)rect]
- You can draw NSString in -drawRect:
 - [NSString drawAtPoint:(CGPoint)point withFont:(UIFont *)font]

But there is a better way!

Text, Images, and UIKit views

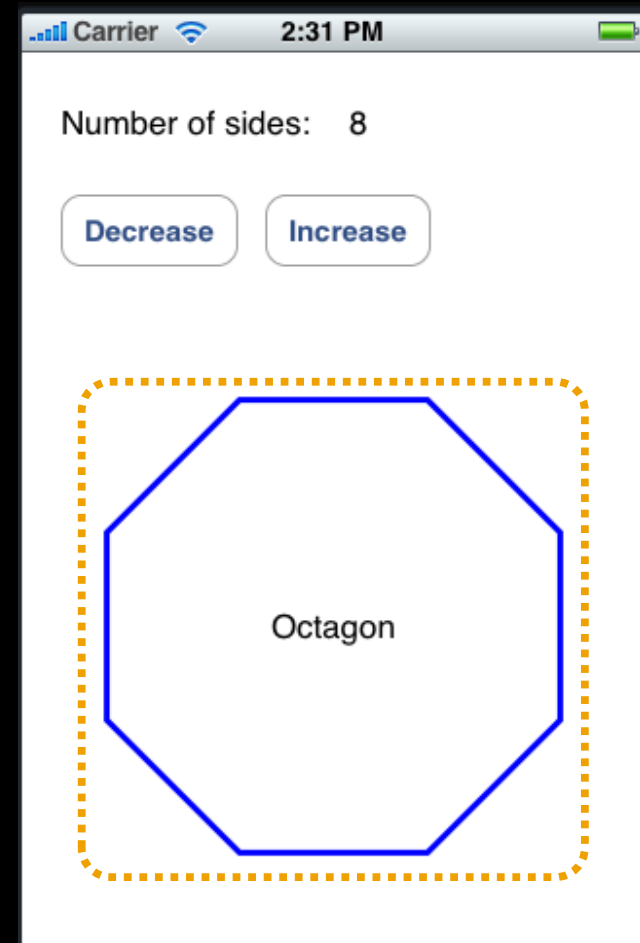
Constructing Views

- How do I implement this?



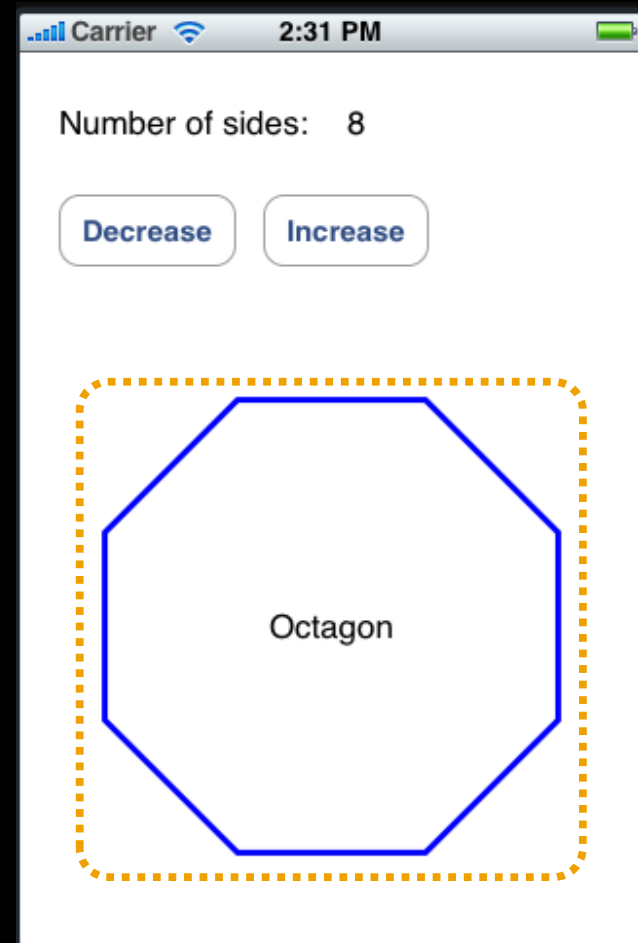
Constructing Views

- How do I implement this?
- Goal
 - PolygonView that displays shape as well as name



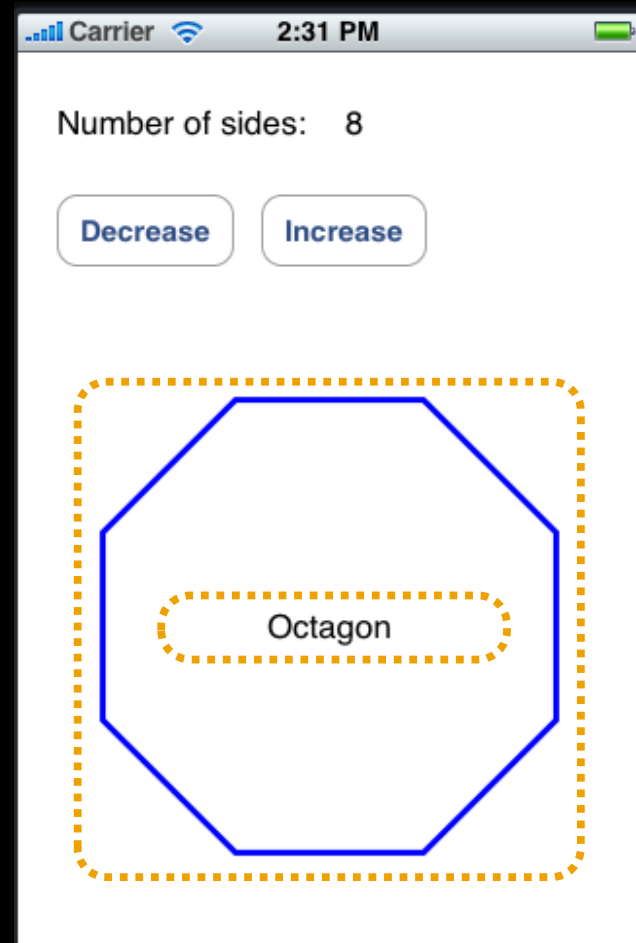
Constructing Views

- How do I implement this?
- Goal
 - PolygonView that displays shape as well as name
- Initial thought
 - Have PolygonView draw the text
 - Inefficient when animating



Constructing Views

- How do I implement this?
- Goal
 - PolygonView that displays shape as well as name
- Initial thought
 - Have PolygonView draw the text
 - Inefficient when animating
- Instead use UILabel!
 - Tastes great
 - Less filling



UILabel

- UIView subclass that knows how to draw text
- Properties include:
 - font
 - textColor
 - shadow (offset & color)
 - textAlignment

UIImageView

- UIView that draws UIImage
- Properties include:
 - image
 - animatedImages
 - animatedDuration
 - animatedRepeatCount
- contentMode property to align and scale image wrt bounds

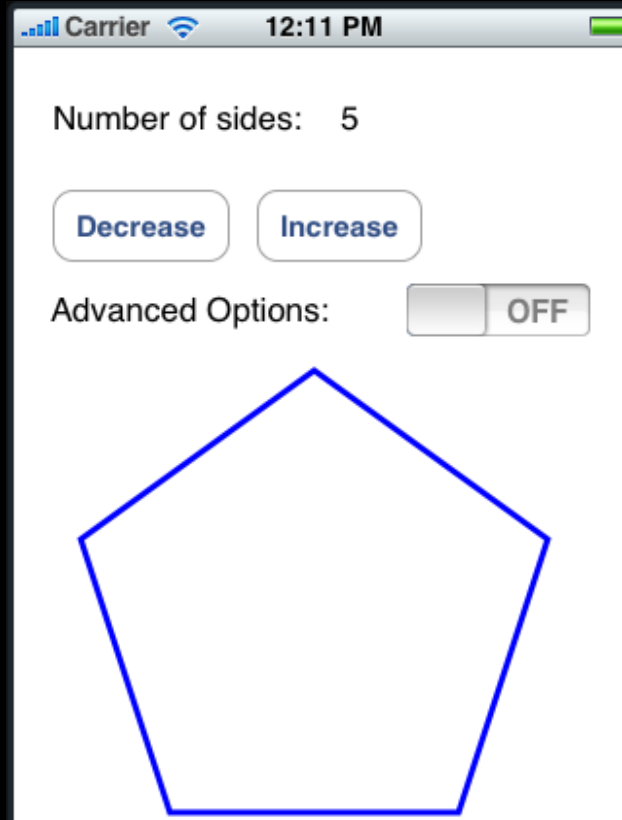
UIControl

- UIView with Target-Action event handling
- Properties include:
 - enabled
 - selected
 - highlighted
- UIButton: font, title, titleColor, image, backgroundImage
- UITextField: font, text, placeholder, textColor
- See UIKit headers for plenty more

View Properties & Animation

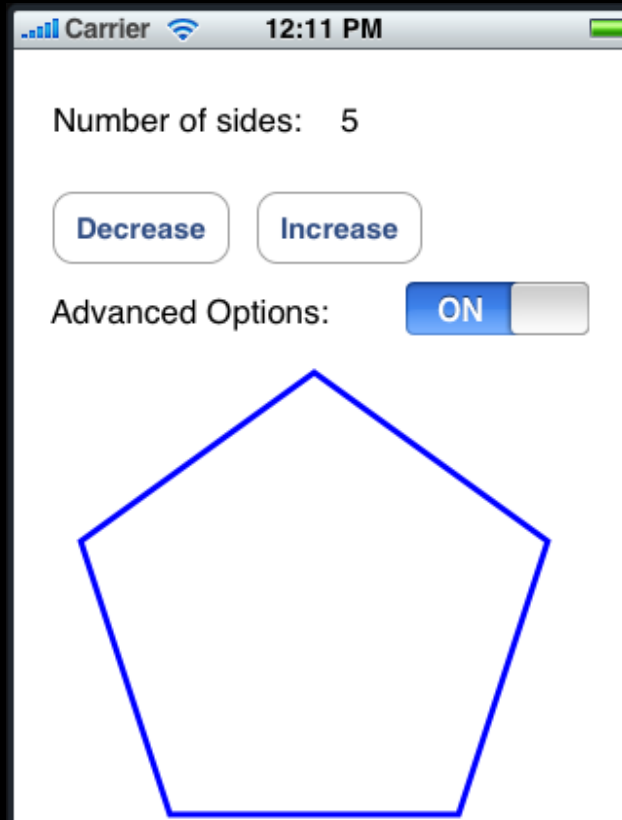
Animating Views

- What if you want to change layout dynamically?
- For example, a switch to disclose additional views...



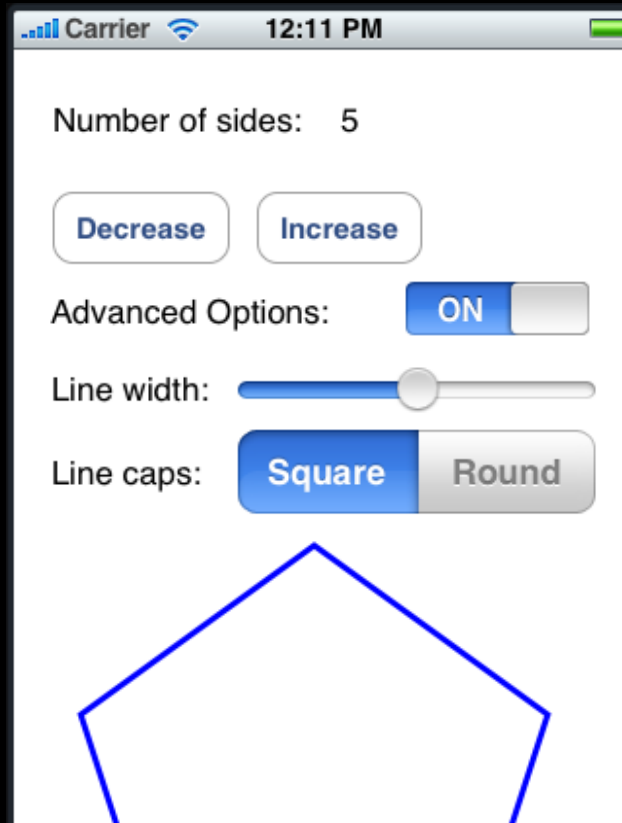
Animating Views

- What if you want to change layout dynamically?
- For example, a switch to disclose additional views...



Animating Views

- What if you want to change layout dynamically?
- For example, a switch to disclose additional views...



UIView Animations

- UIView supports a number of animatable properties
 - frame, bounds, center, alpha, transform
- Create “blocks” around changes to animatable properties
- Animations run asynchronously and automatically

Other Animation Options

- Additional animation options
 - delay before starting
 - start at specific time
 - curve (ease in/out, ease in, ease out, linear)
 - repeat count
 - autoreverses (e.g. ping pong back and forth)

View Animation Example

```
- (void)showAdvancedOptions {  
    // assume polygonView and optionsView  
    [UIView beginAnimations:@"advancedAnimations" context:nil];  
    [UIView setAnimationDuration:0.3];  
  
    // make optionsView visible (alpha is currently 0.0)  
    optionsView.alpha = 1.0;  
  
    // move the polygonView down  
    CGRect polygonFrame = polygonView.frame;  
    polygonFrame.origin.y += 200;  
    polygonView.frame = polygonFrame;  
  
    [UIView commitAnimations];  
}
```

Knowing When Animations Finish

- UIView animations allow for a delegate

```
[UIView setAnimationDelegate:myController];
```

- myController will have callbacks invoked before and after

```
- (void)animationWillStart:(NSString *)animationID  
    context:(void *)context;
```

```
- (void)animationDidStop:(NSString *)animationID  
    finished:(NSNumber *)finished  
    context:(void *)context;
```

- Can provide custom selectors if desired, for example

```
[UIView setAnimationWillStartSelector:  
    @selector(animationWillStart)];  
[UIView setAnimationDidStopSelector:  
    @selector(animationDidStop)];
```


How Does It Work?

- Is drawRect: invoked repeatedly?
- Do I have to run some kind of timer in order to drive the animation?
- Is it magic?

Core Animation

- Hardware accelerated rendering engine
- UIViews are backed by “layers”
- -drawRect: results are cached
 - Cached results used to render view
 - -drawRect: called only when contents change
 - Layers drawn from a separate render tree managed by separate process
- Property animations done automatically by manipulating layers

View Transforms

- Every view has a **transform** property
 - used to apply scaling, rotation and translation to a view
- Default “Identity transform”
- CGAffineTransform structure used to represent transform
- Use CG functions to create, modify transforms

CGAffineTransform Functions (just a small example set)

CGAffineTransformScale (transform, xScale, yScale)

CGAffineTransformRotate (transform, angle)

CGAffineTransformTranslate (transform, xDelta, yDelta)

More Animation Information

- *iPhone OS Programming Guide*
 - “Modifying Views at Runtime” section
- *Core Animation Programming Guide*

Assignment 3 Hints

Saving State Across App Launches

- NSUserDefaults to read and write prefs & state
- Singleton object:
 - + (NSUserDefaults *)**standardUserDefaults**;
- Methods for storing & fetching common types:
 - (int)**integerForKey**:(NSString *)key;
 - (void)**setInteger**:(int)value **forKey**:(NSString *)key;
 - (id)**objectForKey**:(NSString *)key;
 - (void)**setObject**:(id)value **forKey**:(NSString *)key;
- Find an appropriate time to store and restore your state

Questions?