Announcements

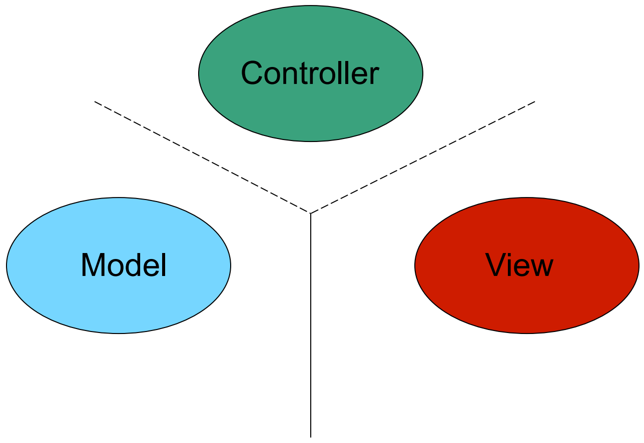
- **Lab 2 is due on Monday by 11:59 PM**
  - Email cse436ta@gmail.com

Today's Topics

- **MVC - from last class**
- **Views**
- **Drawing**
- **Text & Images**
- **Animation**

Model, View, Controller

Model, View, Controller



Model

- Manages the app data and state
- Not concerned with UI or presentation
- Often persists somewhere
- Same model should be reusable, unchanged in different interfaces

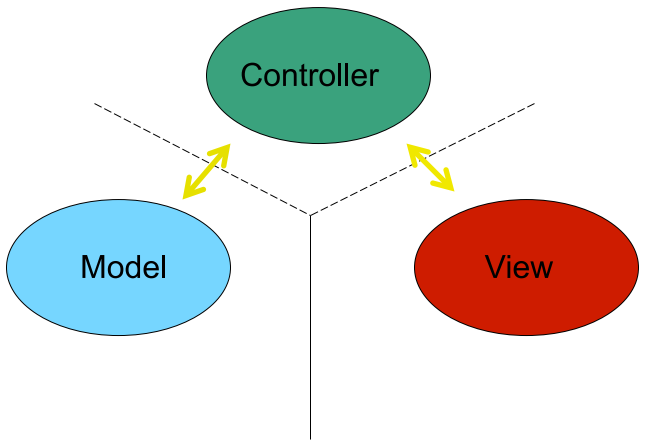
View

- Present the Model to the user in an appropriate interface
- Allows user to manipulate data
- Does not store any data
  - (except to cache state)
- Easily reusable & configurable to display different data

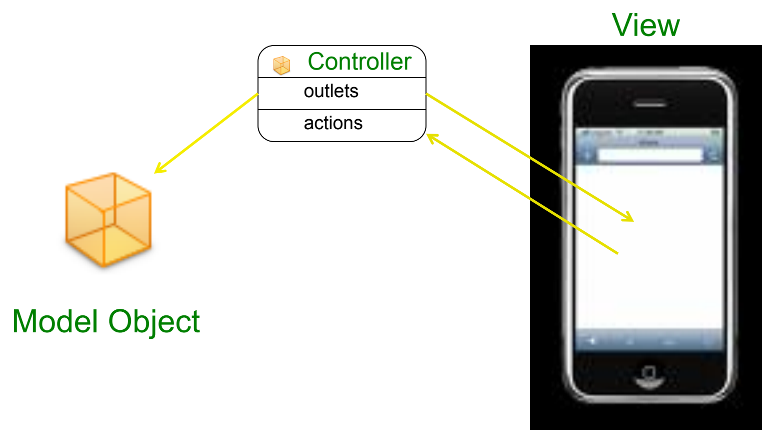
Controller

- Intermediary between Model & View
- Updates the view when the model changes
- Updates the model when the user manipulates the view
- Typically where the app logic lives

Model, View, Controller



Model, View, Controller



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

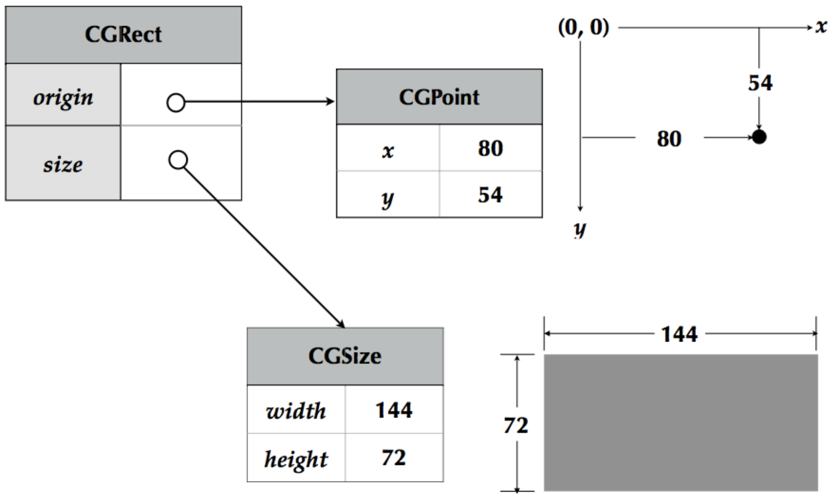
- Superviews retain their subviews
- Not uncommon for views to only be retained by superview
  - Be careful when removing!
  - Retain subview before removing if you want to reuse it
- Views can be temporarily hidden

  `theView.hidden = YES;`

View-related Structures

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

Rects, Points and Sizes



View-related Structure

Creation Function	Example

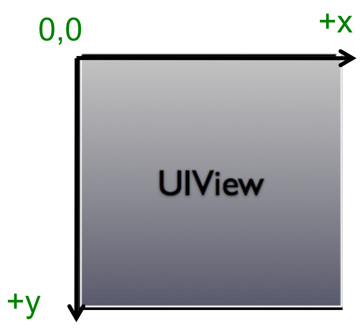
CGPointMake(x,y)	CGPoint point = CGPointMake (100.0, 200.0);
	
	point.x = 300.0;
	point.y = 30.0;

CGSizeMake(width, height)	CGSize size = CGSizeMake (42.0, 11.0);
	
	size.width = 100.0;
	size.height = 72.0;

CGRectMake(x,y,width, height)	CGRect rect = CGRectMake (100.0, 200.0, 42.0, 11.0);
	
	Rect.origin.x = 0.0;
	Rect.size.width = 50.0

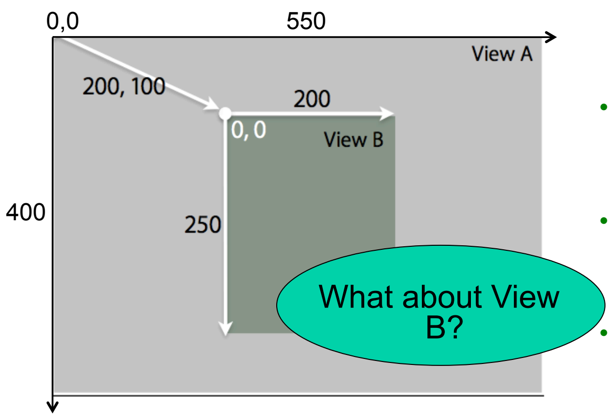
UIView Coordinate System

- 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**
- **View B frame:**
  - **Origin: 200, 100**
  - **Size 200 x 250**
- **View B bounds:**
  - **Origin: 0,0**
  - **Size: 200 x 250**

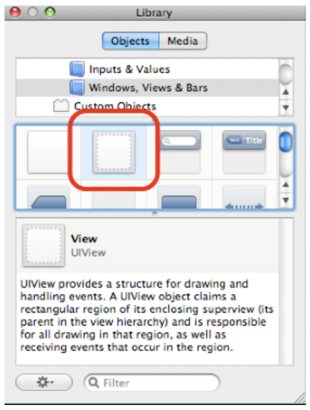
Frame and Bounds

- **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

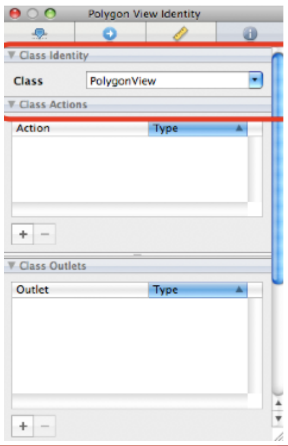
Creating Views

Where do views come from?

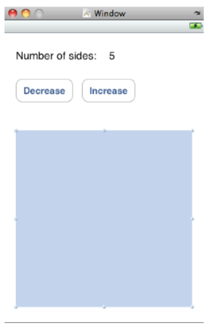
- Commonly Storyboard or Interface Builder
- Drag out any of the existing view objects (buttons, labels, etc)
- Or drag generic UIView and set custom class



UIView provides a structure for drawing and handling events. A UIView object claims a rectangular region of its enclosing superview (its parent in the view hierarchy) and is responsible for all drawing in that region, as well as receiving events that occur in the region.



Class PolygonView



Number of sides: 5

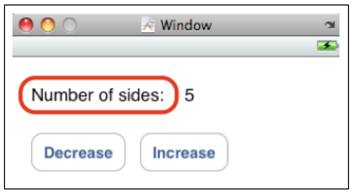
Manual Creation

- **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]; //retain count for label increased by 1
[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;

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];
}
```

Demo

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

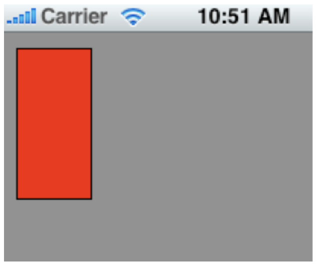
```
-(void)drawRect:(CGRect)rect {
  CGRect bounds = [self bounds];

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

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

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

What shape is this?

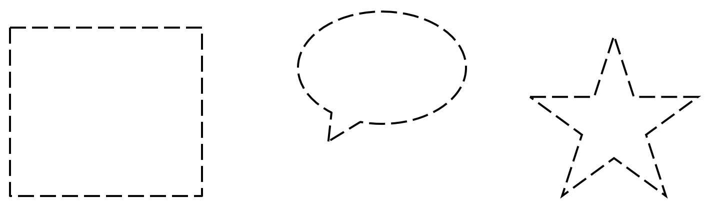


Drawing More Complex Shapes

- **Common steps for drawRect:**
  - 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
CGContextLineToPoint	CGPathAddLineToPoint
CGContextAddArcToPoint	CGPathAddArcToPoint
CGContextClosePath	CGPathCloseSubPath
And so on….	

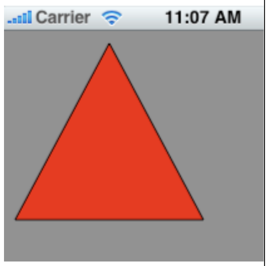
Simple Example

```
-(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);
}
```



What shape is this?

Demo - HelloPoly

More Drawing Information

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

Images & Text

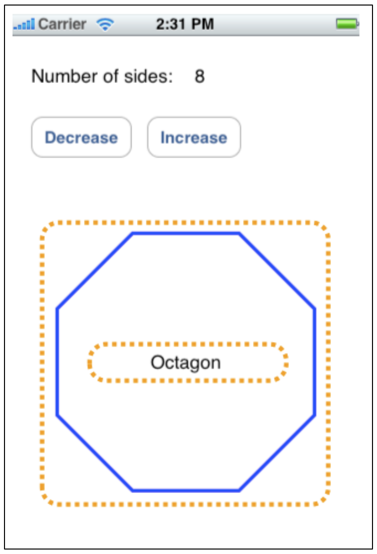
UIImage

- **UIKit class representing an image**
- **Creating UIImages:**
  - 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]

Text, Images, and UIKit views

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

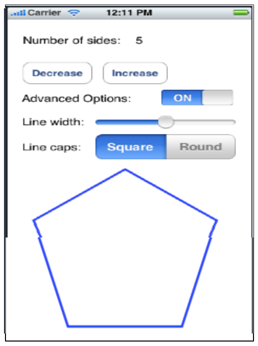
UIImageView

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

View Properties & Animation

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)];
```

Demo - Animation

How does it work?

- **Utilizes 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 maintained in separate hierarchy 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

CGAffineTransformFunctions(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

Previous Final Projects