iOS Mobile Development

Today

- Views
  How to draw custom stuff on screen.
- Gestures
  How to react to user’s touch gestures.
- Demo
  SuperCard

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 <u>later</u> in the array are <u>on top</u> of those earlier
  - A view can clip its `subviews` to its `bounds` or not (switch for this in Xcode, or method in `UIView`).
- `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 often added to the view hierarchy using Xcode (more on this later).
- But it can be done in code as well
  `- (void)addSubview:(UIView *)aView;` // sent to aView's (soon to be) superview
  `- (void)removeFromSuperview;` // sent to the view that is being removed
- The top of this hierarchy for your MVC is the @property view!
  UIViewController's `@property (strong, nonatomic) UIView *view`
  It is <u>critical</u> to understand what this very simple @property is!
  This is the view whose bounds will be changed when autorotation happens, for example.
  This is the view you would programmatically add subviews to.
  All your MVC's View's UIView's eventually have this view as their parent (it's at the top).
  It is automatically hooked up for you when you drag out a View Controller in Xcode.

Initializing a UIView

- Yes, you might want to override UIView's designated initializer
  More common than overriding UIViewController's designated initializer (but still rare).

- But you will <u>also</u> want to set up stuff in awakeFromNib
  This is because initWithFrame: is <u>NOT</u> called for a UIView coming out of a storyboard!
  But awakeFromNib is. Same as we talked about with UIViewController.
  It's called "awakeFromNib" for historical reasons.

- Typical code ...

```
- (void)setup { … }
- (void)awakeFromNib { [self setup]; }
- (id)initWithFrame:(CGRect)aRect
{
    self = [super initWithFrame:aRect];
    [self setup];
    return self;
}
```

View Coordinates

- `CGFloat`
  Just a floating point number (depends on 64-bit or not), but we always use it for graphics.
- `CGPoint`
  C struct with two `CGFloat`s 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 `CGFloat`s 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), 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`.

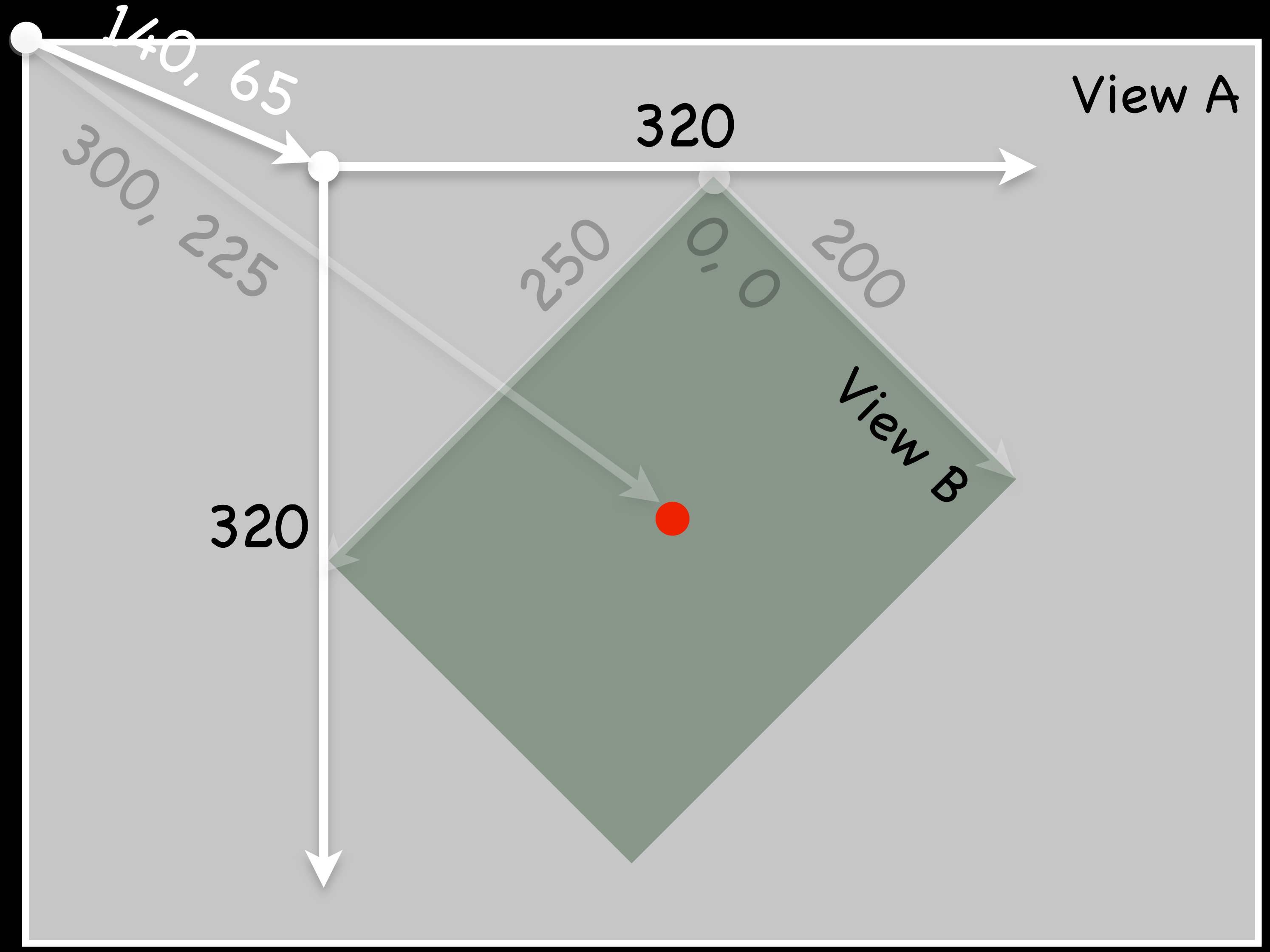
  ```
  @property CGPoint center;     // the center of your view in your superview's coordinate space
  @property CGRect frame;       // a rectangle in your superview's coordinate space which entirely
                                // contains your view's bounds.size
  ```

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
(bound.size.width/2+bounds.origin.x,
 bounds.size.height/2+bounds.origin.y)
which is (100,125) in this case.

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

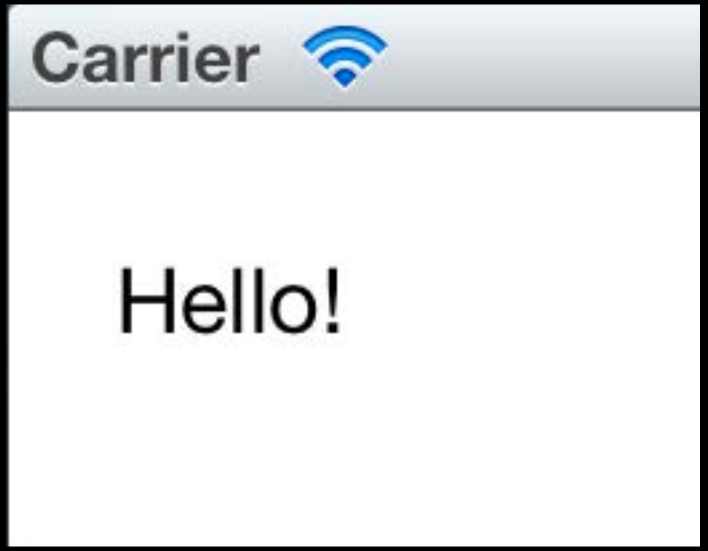
Creating Views

- Most often you create views in Xcode
  Of course, Xcode's palette knows nothing about a custom view class you might create.
  So you drag out a generic UIView from the palette and use the Identity 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).
  Can also use init (frame will be CGRectZero).

- Example

```
CGRect labelRect = CGRectMake(20, 20, 50, 30);
UILabel *label = [[UILabel alloc] initWithFrame:labelRect];
label.text = @"Hello!";
[self.view addSubview:label];   // Note self.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 in a bit. First we'll focus 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

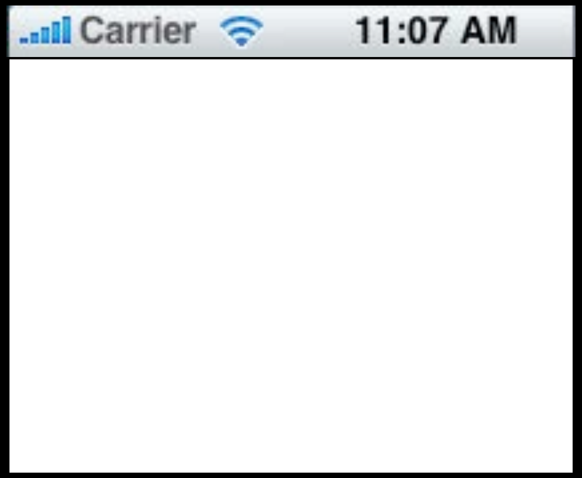
- So how do I implement my `drawRect:`?
  - Use the Core Graphics framework directly (a C API, not object-oriented).
  - Or we can use the object-oriented `UIBezierPath` class (we'll do it this way).
- Core Graphics Concepts
  - Get a context to draw into (iOS will prepare one each time your `drawRect:` is called)
  - Create paths (out of lines, arcs, etc.)
  - Set colors, fonts, textures, linewidths, linecaps, etc.
  - Stroke or fill the above-created paths
- `UIBezierPath`
  - Do all of the above, but capture it with an object.
  - Then ask the object to stroke or fill what you've created.

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?
  - `UIBezierPath` draws into the current context, so you don't need to get it if using that.
  - But if you're calling Core Graphics C functions directly, you'll need it (it's an argument to them).
  - Call the following C function inside your `drawRect:` method to get the current graphics context …
  - `CGContextRef context = UIGraphicsGetCurrentContext();`

Define a Path

- Begin the path
  ```
  UIBezierPath *path = [[UIBezierPath alloc] init];
  ```
- Move around, add lines or arcs to the path
  ```
  [path moveToPoint:CGPointMake(75, 10)];
  ```



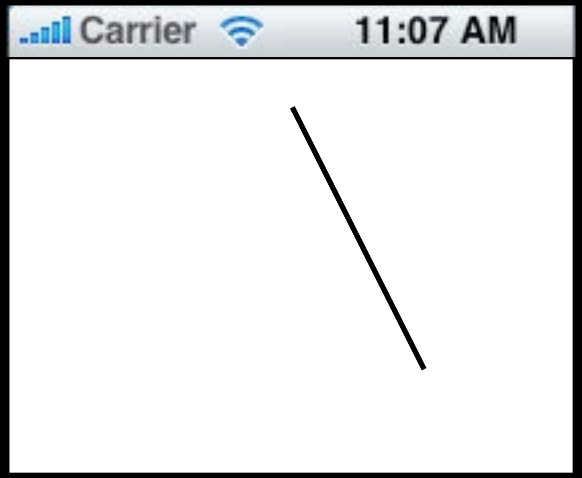
Define a Path

- Begin the path

```
UIBezierPath *path = [[UIBezierPath alloc] init];
```

- Move around, add lines or arcs to the path

```
[path moveToPoint:CGPointMake(75, 10)];
[path addLineToPoint:CGPointMake(160, 150)];
```



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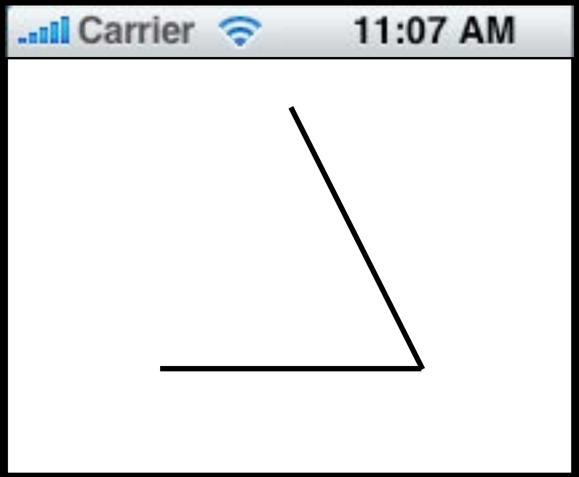

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UIBezierPath *path = [[UIBezierPath alloc] init];
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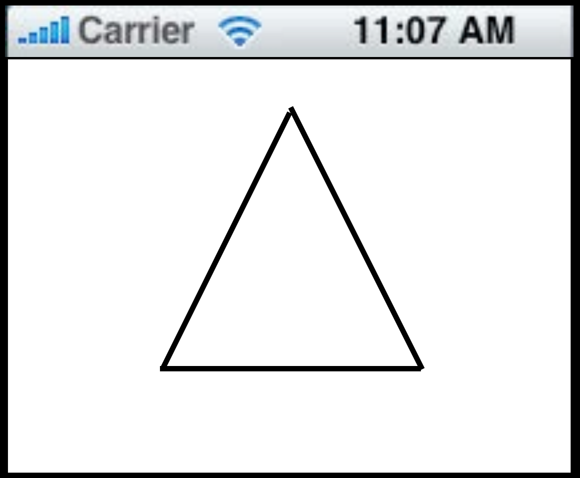
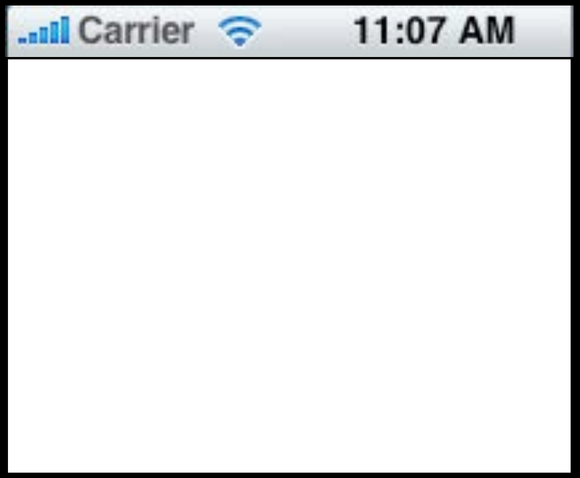
[path moveToPoint:CGPointMake(75, 10)];
[path addLineToPoint:CGPointMake(160, 150)];
[path addLineToPoint:CGPointMake(10, 150]);
```

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

```
[path closePath];    // not strictly required but triangle won't have all 3 sides otherwise
```



Define a Path



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  UIBezierPath *path = [[UIBezierPath alloc] init];
  ```
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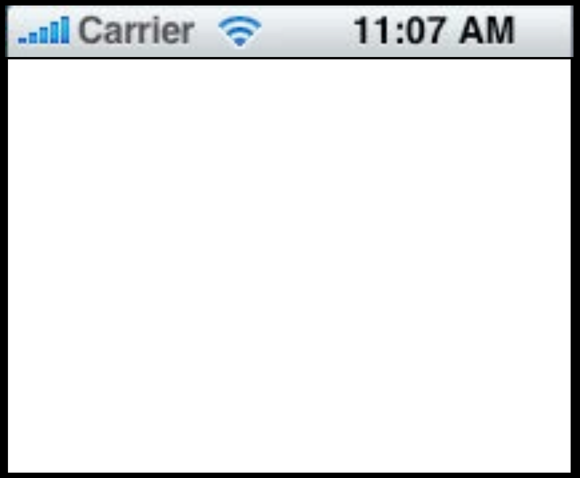
  ```
- Close the path (connects the last point back to the first)
  `[path closePath];` // not strictly required but triangle won't have all 3 sides otherwise
- Now that the path has been created, we can stroke/fill it
  Actually, nothing has been drawn yet, we've just created the `UIBezierPath`.

Define a Path



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  ```
- Now that the path has been created, we can stroke/fill it

  Actually, nothing has been drawn yet, we've just created the `UIBezierPath`.
  ```
  [[UIColor greenColor] setFill];
  [[UIColor redColor] setStroke];
  ```

Define a Path

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UIBezierPath *path = [[UIBezierPath alloc] init];
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- Move around, add lines or arcs to the path

```
[path moveToPoint:CGPointMake(75, 10)];
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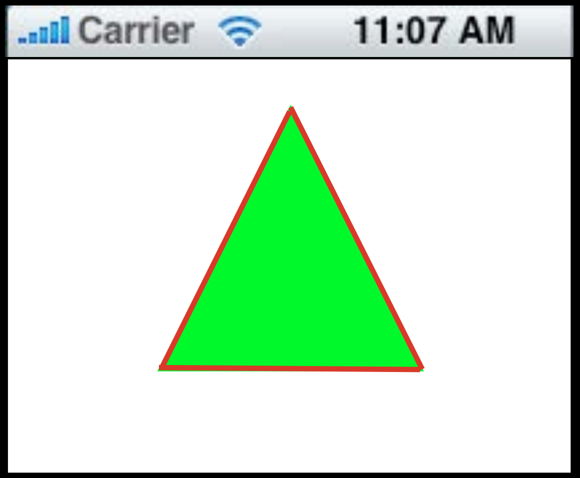

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[path closePath];    // not strictly required but triangle won't have all 3 sides otherwise
```

- Now that the path has been created, we can stroke/fill it

Actually, nothing has been drawn yet, we've just created the `UIBezierPath`.

```
[[UIColor greenColor] setFill];
[[UIColor redColor] setStroke];
[path fill]; [path stroke];
```

Graphics State

- Can also set graphics state

  e.g. `path.lineWidth = 2.0;`   // line width in points (not pixels)

- And draw rounded rects, ovals, etc.

```
UIBezierPath *roundedRect = [UIBezierPath bezierPathWithRoundedRect:(CGRect)bounds
                                                       cornerRadius:(CGFloat)radius];
```

  Note: the "casts" in the arguments are just to let you know the types (i.e. they're not required).

```
UIBezierPath *oval = [UIBezierPath bezierPathWithOvalInRect:(CGRect)bounds];
[roundedRect stroke];
[oval fill];
```

- You can use a `UIBezierPath` to "clip" your drawing

  `[roundedRect addClip];` // this would clip all drawing to be inside the roundedRect

Graphics State

- Drawing with transparency in UIView

  You know that UIColors can have alpha.
  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 transparent.
  If you don't, results are unpredictable (this is a performance optimization property, by the way).

  UIView's @property CGFloat alpha can make the entire view partially transparent.
  (you might use this to your advantage in your homework to show a "disabled" custom view)

View Transparency

- What happens when views overlap?
  - As mentioned before, `subviews` list order determine's 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.
  - Also this can be used to swap two (or more) views in and out depending on state.

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 save and restore context functions.

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

- We can use a UILabel as a subview to draw text in our view

  But there are certainly occasions where we want to draw text in our drawRect:.

- To draw in drawRect:, use NSAttributedString

  ```
  NSAttributedString *text = …;
  [text drawAtPoint:(CGPoint)p];  // NSAttributedString instance method added by UIKit
  ```

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

  ```
  CGSize textSize = [text size];  // another UIKit NSAttributedString instance method
  ```

  You might be disturbed that there are drawing methods in Foundation (a non-UI framework!).
  These NSAttributedString methods are defined in UIKit via a mechanism called categories.
  (so are the names of the attributes that define UI stuff (e.g. NSFontAttributeName)).
  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

- `UIImageView` is like `UILabel` for images
  But again, occasionally you want to draw an image in your `drawRect:`.
- Create a `UIImage` object from a file in your `Resources` folder
  `UIImage *image = [UIImage imageNamed:@“foo.jpg”];` // you did this in Matchismo
- 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);
```

Redraw on bounds change?

- By default, when your `UIView`'s `bounds` change, there is <u>no redraw</u>

  Instead, the "bits" of your view will be stretched or squished or moved.

- Often this is not what you want ...

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

  `@property (nonatomic) UIViewContentMode contentMode;`

  These content modes <u>move</u> the bits of your drawing to that location ...

  `UIViewContentMode{Left,Right,Top,Right,BottomLeft,BottomRight,TopLeft,TopRight}`

  These content modes <u>stretch</u> the bits of your drawing ...

  `UIViewContentModeScale{ToFill,AspectFill,AspectFit}` // bit stretching/shrinking

  This content mode calls `drawRect:` to redraw everything when the bounds changes ...

  `UIViewContentModeRedraw` // it is quite often that this is what you want

  Default is `UIViewContentModeScaleToFill` (stretch the bits to fill the bounds)

UIGestureRecognizer

- We've seen how to draw in our `UIView`, how do we get touches?
  We can get notified of the raw touch events (touch down, moved, up).
  Or we can react to certain, predefined "gestures." This latter is the way to go.
- Gestures are recognized by the class `UIGestureRecognizer`
  This class is "abstract." We only actually use "concrete subclasses" of it.
- There are two sides to using a gesture recognizer
  1. <u>Adding a gesture recognizer</u> to a `UIView` to ask it to recognize that gesture.
  2. Providing the implementation of <u>a method to "handle" that gesture</u> when it happens.
- Usually #1 is done by a Controller
  Though occasionally a `UIView` will do it to itself if it just doesn't make sense without that gesture.
- Usually #2 is provided by the `UIView` itself
  But it would not be unreasonable for the Controller to do it.
  Or for the Controller to decide it wants to handle a gesture differently than the view does.

UIGestureRecognizer

- Adding a gesture recognizer to a UIView from a Controller

```
- (void)setPannableView:(UIView *)pannableView // maybe this is a setter in a Controller
{
    _pannableView = pannableView;
    UIPanGestureRecognizer *pangr =
        [[UIPanGestureRecognizer alloc] initWithTarget:pannableView action:@selector(pan:)];
    [pannableView addGestureRecognizer:pangr];
}
```

This is a concrete subclass of UIGestureRecognizer that recognizes "panning" (moving something around with your finger).

There are, of course, other concrete subclasses (for swipe, pinch, tap, etc.).

UIGestureRecognizer

- Adding a gesture recognizer to a UIView from a Controller

```
- (void)setPannableView:(UIView *)pannableView // maybe this is a setter in a Controller
{
    _pannableView = pannableView;
    UIPanGestureRecognizer *pangr =
        [[UIPanGestureRecognizer alloc] initWithTarget:pannableView action:@selector(pan:)];
    [pannableView addGestureRecognizer:pangr];
}
```

Note that we are specifying the view itself as the target to handle a pan gesture when it is recognized.
Thus the view will be both the recognizer and the handler of the gesture.

The UIView does not <u>have</u> to handle the gesture. It could be, for example, the Controller that handles it.
The View would generally handle gestures to modify how the View is drawn.
The Controller would have to handle gestures that modified the Model.

UIGestureRecognizer

- Adding a gesture recognizer to a UIView from a Controller

```
- (void)setPannableView:(UIView *)pannableView // maybe this is a setter in a Controller
{
    _pannableView = pannableView;
    UIPanGestureRecognizer *pangr =
        [[UIPanGestureRecognizer alloc] initWithTarget:pannableView action:@selector(pan:)];
    [pannableView addGestureRecognizer:pangr];
}
```

This is the action method that will be sent to the target (the pannableView) during the handling of the recognition of this gesture.

This version of the action message takes one argument (which is the UIGestureRecognizer that sends the action), but there is another version that takes no arguments if you'd prefer.

We'll look at the implementation of this method in a moment.

UIGestureRecognizer

- Adding a gesture recognizer to a UIView from a Controller

```
- (void)setPannableView:(UIView *)pannableView // maybe this is a setter in a Controller
{
    _pannableView = pannableView;
    UIPanGestureRecognizer *pangr =
        [[UIPanGestureRecognizer alloc] initWithTarget:pannableView action:@selector(pan:)];
    [pannableView addGestureRecognizer:pangr];
}
```

If we don't do this, then even though the pannableView implements pan:, it would never get called because we would have never added this gesture recognizer to the view's list of gestures that it recognizes.

Think of this as "turning the handling of this gesture on."

UIGestureRecognizer

- Adding a gesture recognizer to a UIView from a Controller

```
- (void)setPannableView:(UIView *)pannableView // maybe this is a setter in a Controller
{
    _pannableView = pannableView;
    UIPanGestureRecognizer *pangr =
        [[UIPanGestureRecognizer alloc] initWithTarget:pannableView action:@selector(pan:)];
    [pannableView addGestureRecognizer:pangr];
}
```

Only UIView instances can <u>recognize</u> a gesture (because UIViews handle all touch input).
But any object can tell a UIView to recognize a gesture (by adding a recognizer to the UIView).
And any object can <u>handle</u> the recognition of a gesture (by being the target of the gesture's action).

UIGestureRecognizer

- How do we implement the target of a gesture recognizer?
  Each concrete class provides some methods to help you do that.
- For example, `UIPanGestureRecognizer` provides 3 methods:
```
- (CGPoint)translationInView:(UIView *)aView;
- (CGPoint)velocityInView:(UIView *)aView;
- (void)setTranslation:(CGPoint)translation inView:(UIView *)aView;
```
- Also, the base class, `UIGestureRecognizer` provides this `@property`:
  `@property (readonly) UIGestureRecognizerState state;`
  Gesture Recognizers sit around in the `state` `Possible` until they start to be recognized
  Then they either go to `Recognized` (for discrete gestures like a tap)
  Or they go to `Began` (for continuous gestures like a pan)
  At any time, the `state` can change to `Failed` (so watch out for that)
  If the gesture is continuous, it'll move on to the `Changed` and eventually the `Ended` state
  Continuous can also go to `Cancelled` state (if the recognizer realizes it's not this gesture after all)

UIGestureRecognizer

- So, given these methods, what would pan: look like?

```
- (void)pan:(UIPanGestureRecognizer *)recognizer
{
    if ((recognizer.state == UIGestureRecognizerStateChanged) ||
        (recognizer.state == UIGestureRecognizerStateEnded)) {




    }
}
```

We're going to update our view every time the touch moves (and when the touch ends). This is "smooth panning."

UIGestureRecognizer

- So, given these methods, what would pan: look like?

```
- (void)pan:(UIPanGestureRecognizer *)recognizer
{
    if ((recognizer.state == UIGestureRecognizerStateChanged) ||
        (recognizer.state == UIGestureRecognizerStateEnded)) {
        CGPoint translation = [recognizer translationInView:self];



    }
}
```

This is the cumulative distance this gesture has moved.

UIGestureRecognizer

- So, given these methods, what would pan: look like?

```
- (void)pan:(UIPanGestureRecognizer *)recognizer
{
    if ((recognizer.state == UIGestureRecognizerStateChanged) ||
        (recognizer.state == UIGestureRecognizerStateEnded)) {
        CGPoint translation = [recognizer translationInView:self];
        // move something in myself (I'm a UIView) by translation.x and translation.y
        // for example, if I were a graph and my origin was set by an @property called origin
        self.origin = CGPointMake(self.origin.x+translation.x, self.origin.y+translation.y);

    }
}
```

UIGestureRecognizer

- So, given these methods, what would pan: look like?

```
- (void)pan:(UIPanGestureRecognizer *)recognizer
{
    if ((recognizer.state == UIGestureRecognizerStateChanged) ||
        (recognizer.state == UIGestureRecognizerStateEnded)) {
        CGPoint translation = [recognizer translationInView:self];
        // move something in myself (I'm a UIView) by translation.x and translation.y
        // for example, if I were a graph and my origin was set by an @property called origin
        self.origin = CGPointMake(self.origin.x+translation.x, self.origin.y+translation.y);
        [recognizer setTranslation:CGPointZero inView:self];
    }
}
```

Here we are resetting the cumulative distance to zero.

Now each time this is called, we'll get the "incremental" movement of the gesture (which is what we want). If we wanted the "cumulative" movement of the gesture, we would not include this line of code.

UIGestureRecognizer

- So, given these methods, what would `pan:` look like?

```
- (void)pan:(UIPanGestureRecognizer *)recognizer
{
    if ((recognizer.state == UIGestureRecognizerStateChanged) ||
        (recognizer.state == UIGestureRecognizerStateEnded)) {
        CGPoint translation = [recognizer translationInView:self];
        // move something in myself (I'm a UIView) by translation.x and translation.y
        // for example, if I were a graph and my origin was set by an @property called origin
        self.origin = CGPointMake(self.origin.x+translation.x, self.origin.y+translation.y);
        [recognizer setTranslation:CGPointZero inView:self];
    }
}
```

Other Concrete Gestures

- UIPinchGestureRecognizer

  `@property CGFloat scale;` // note that this <u>is not</u> readonly (can reset each movement)

  `@property (readonly) CGFloat velocity;` // note that this <u>is</u> readonly; scale factor per second

- UIRotationGestureRecognizer

  `@property CGFloat rotation;` // <u>not</u> readonly; in radians

  `@property (readonly) CGFloat velocity;` // readonly; radians per second

- UISwipeGestureRecognizer

  This one you "set up" (w/the following) to find certain swipe types, then look for Recognized state

  `@property UISwipeGestureRecognizerDirection direction;` // what direction swipes you want

  `@property NSUInteger numberOfTouchesRequired;` // two finger swipes? or just one finger? more?

- UITapGestureRecognizer

  Set up (w/the following) then look for Recognized state

  `@property NSUInteger numberOfTapsRequired;` // single tap or double tap or triple tap, etc.

  `@property NSUInteger numberOfTouchesRequired;` // e.g., require two finger tap?

Demo

- SuperCard
  Let's make a lot better-looking playing card!
- What to watch for …
  Custom `UIView` with its own `drawRect:`
  `setNeedsDisplay`
  `UIBezierPath`
  Clipping
  Pushing and popping graphics context
  Drawing text with `NSAttributedString` and images with `UIImage`
  Document Outline and Size Inspector in Xcode
  Gestures recognizers hooked up in Xcode vs. programmatically
  Controller vs. View as gesture handler

Coming Up

- Next
  - Animation
  - Autolayout