CS2048: Introduction to iPhone Development

Lecture 2

Instructor: Daniel Hauagge

Announcements

- Clarification on dates
- Add date: Sep 5th
- Drop date: Sep 19th

Course Description

- Homework after each class
  - Extend app built in class
  - 1 weeks to finish, ~~grade is pass/fail~~ graded
  - ~~Must complete all assignments to pass~~
  - 1 late day, you can use it whenever you want

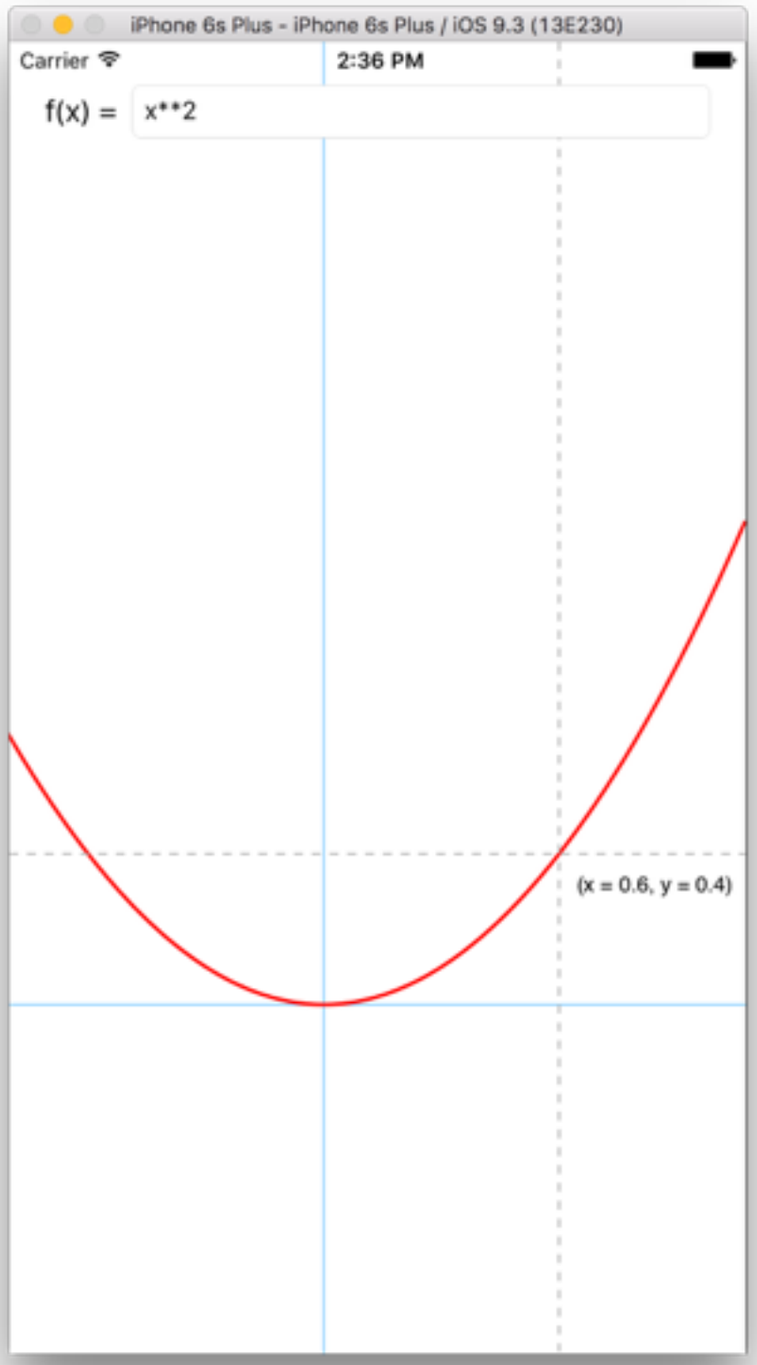
Announcements

- Final grade
  - 3 homework assignments
  - 1 final project: 4 weeks, open ended
- Grade: $\frac{\sum_{i=1}^{3} H_i + 2FP}{5}$
- Passing grade ≥ 50

Today

- Introduction to MVC
- Custom views
- Drawing with UIBezierPath
- Gesture Recognizers

App


iPhone 6s Plus - iPhone 6s Plus / iOS 9.3 (13E230)
Carrier
2:36 PM
f(x) =
x**2
(x = 0.6, y = 0.4)

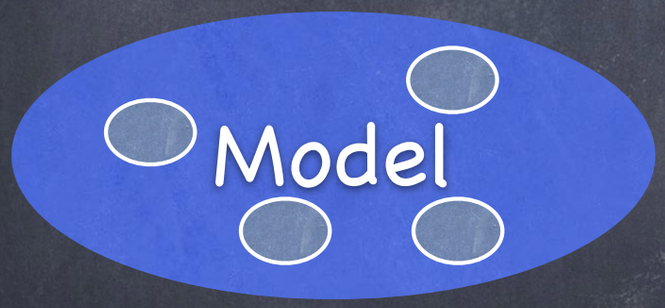
MVC

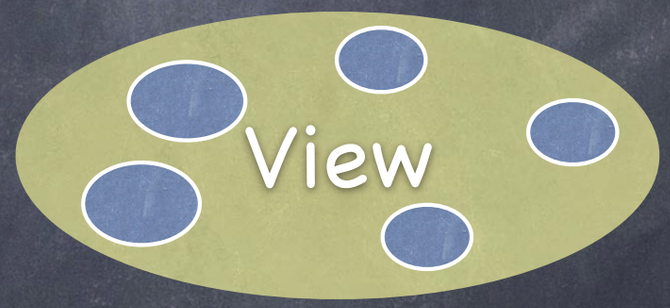
Model-View-Controller

MVC

- Software architectural pattern used throughout iOS
- Reduces coupling between
  - Display logic
  - Model (data)

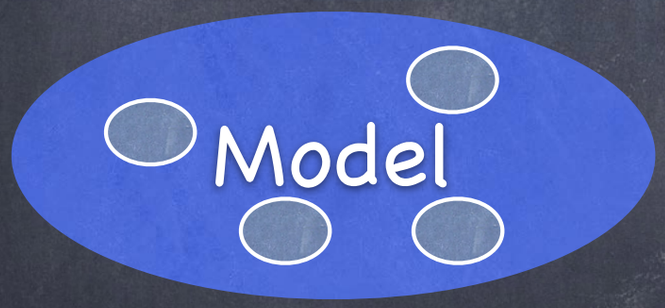
MVC

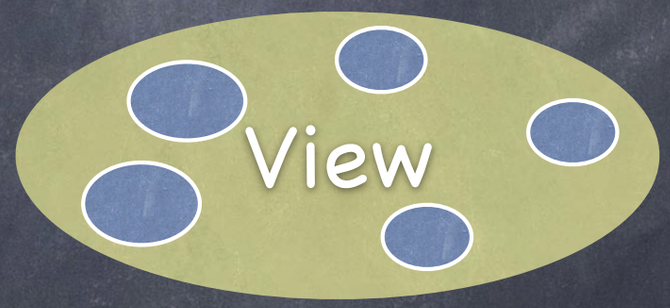




Divide objects in your program into 3 "camps."

MVC





Model = What your application is (but not how it is displayed)

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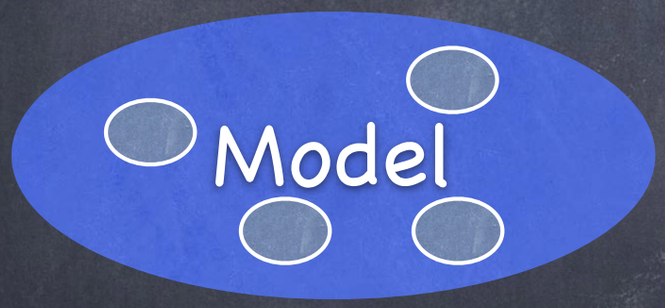

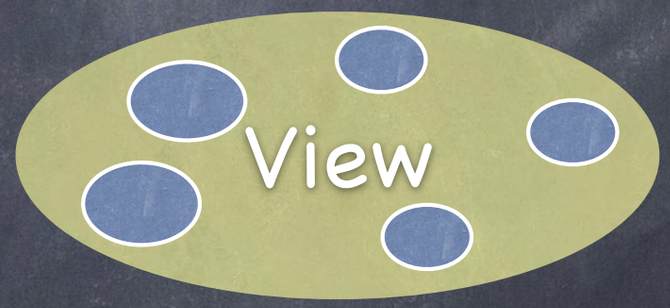

Controller = How your Model is presented to the user (UI logic)

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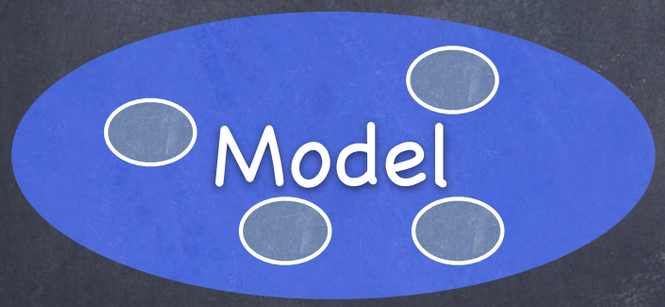

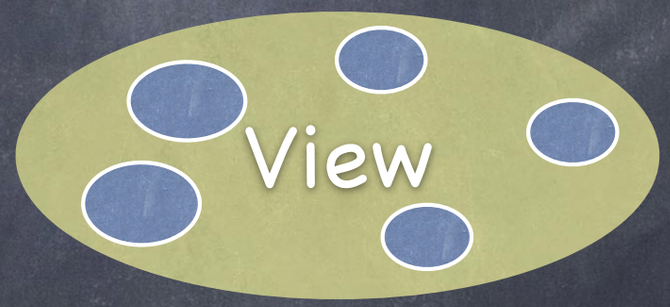

View = Your Controller's minions

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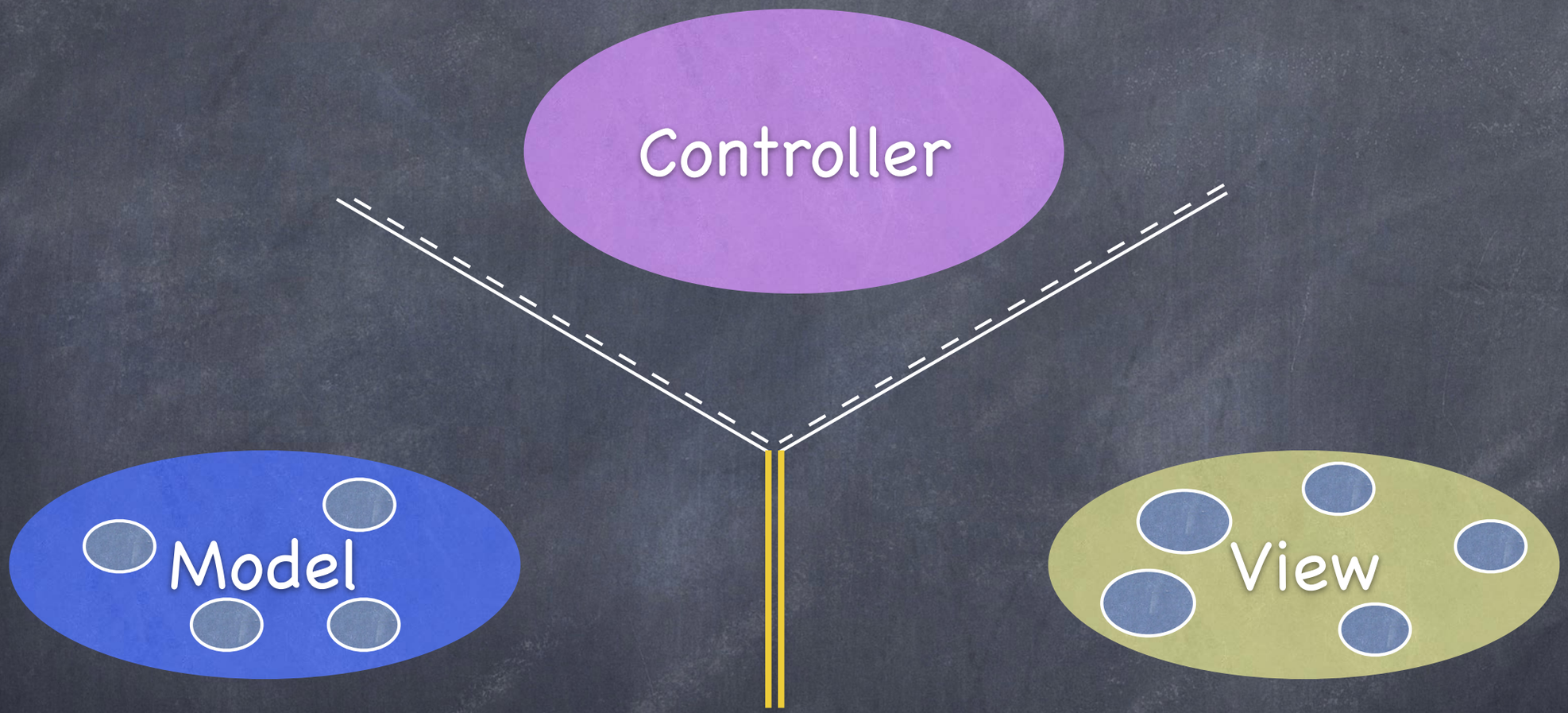
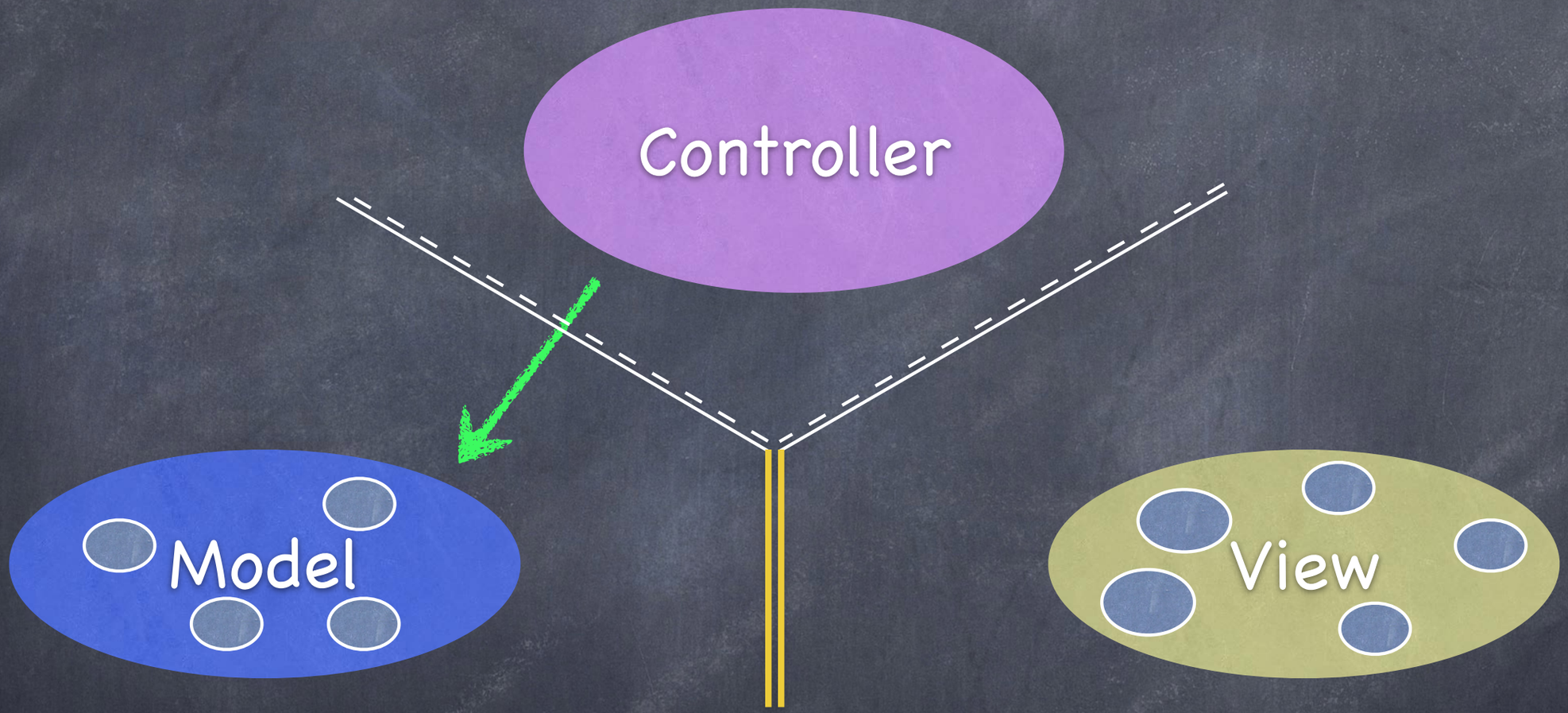


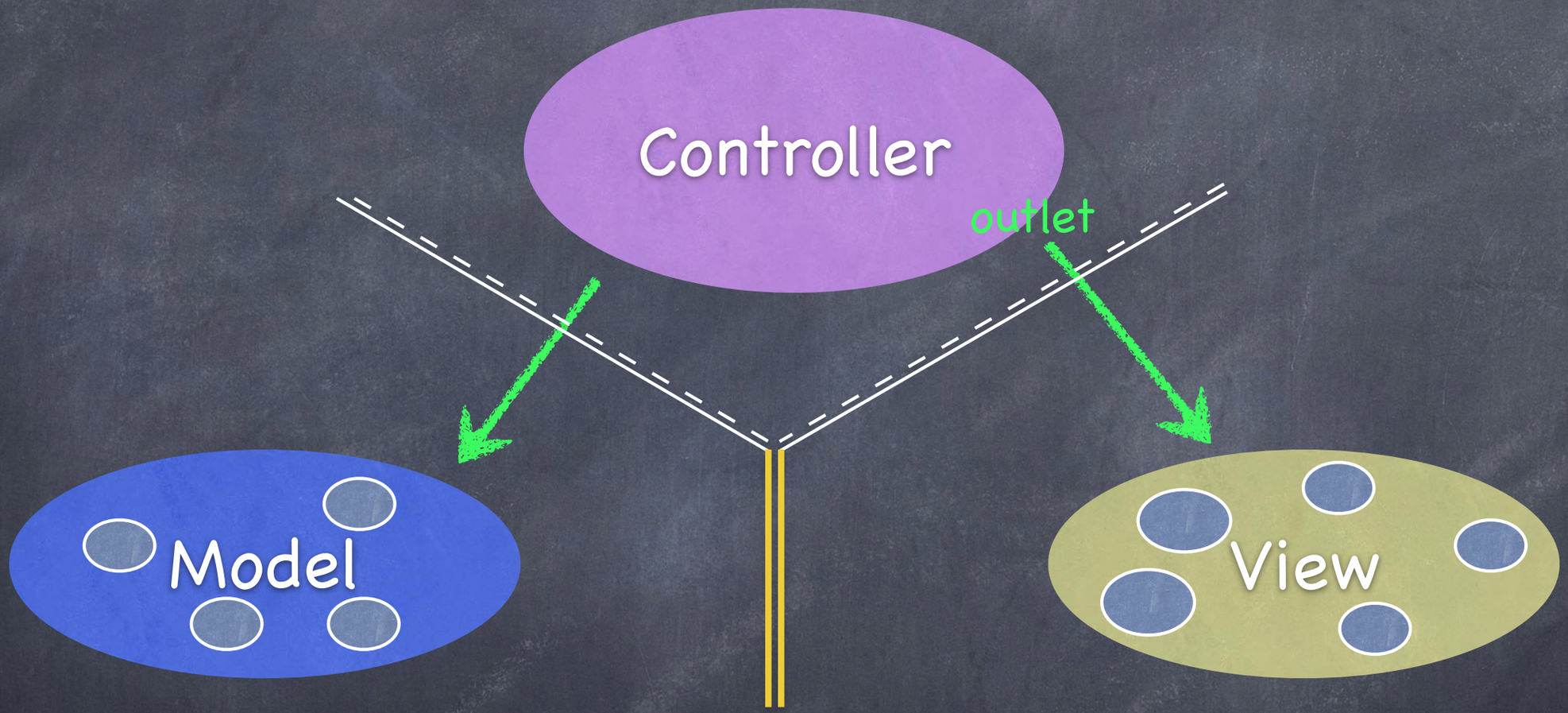
It's all about managing communication between camps

MVC



Controllers can always talk directly to their Model.

MVC



Controllers can also talk directly to their View.

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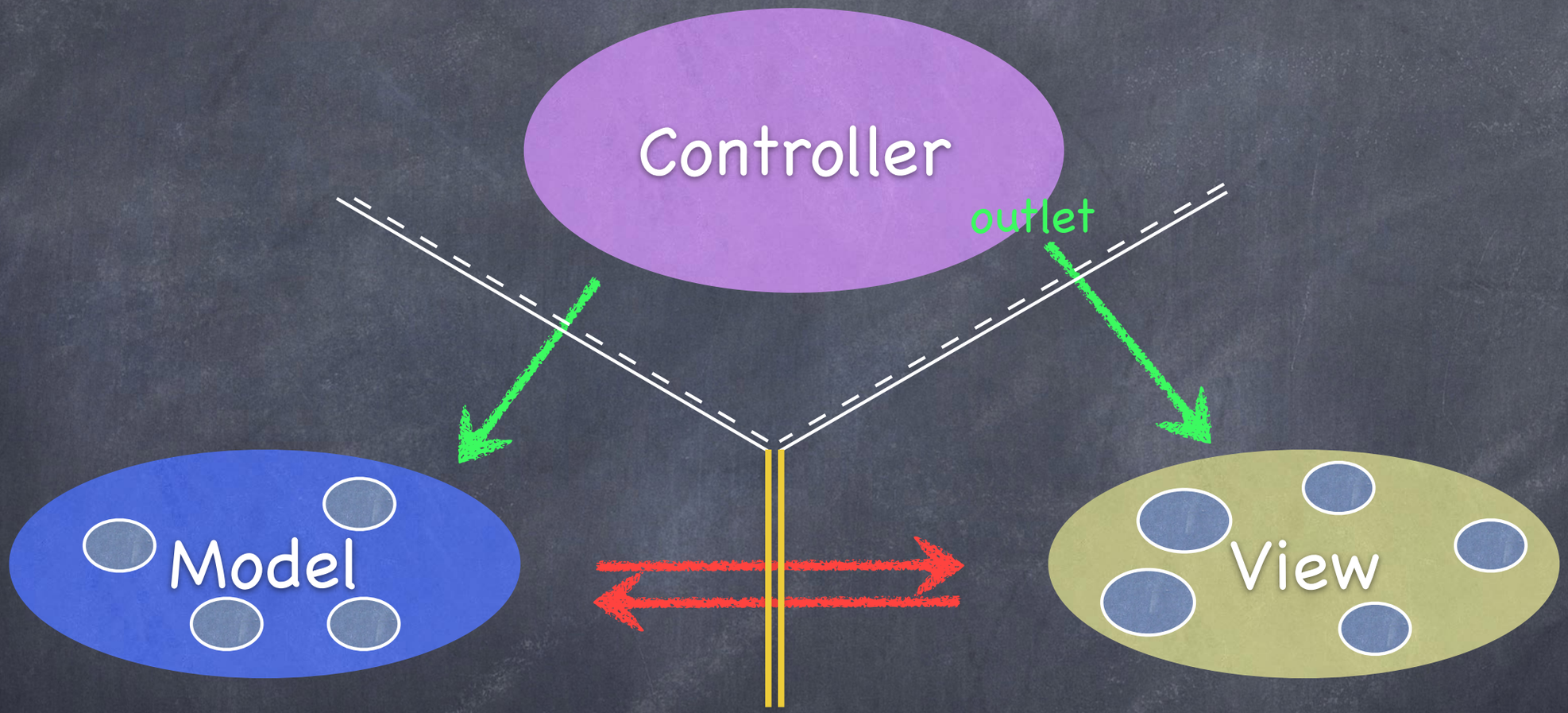

The Model and View should never speak to each other.

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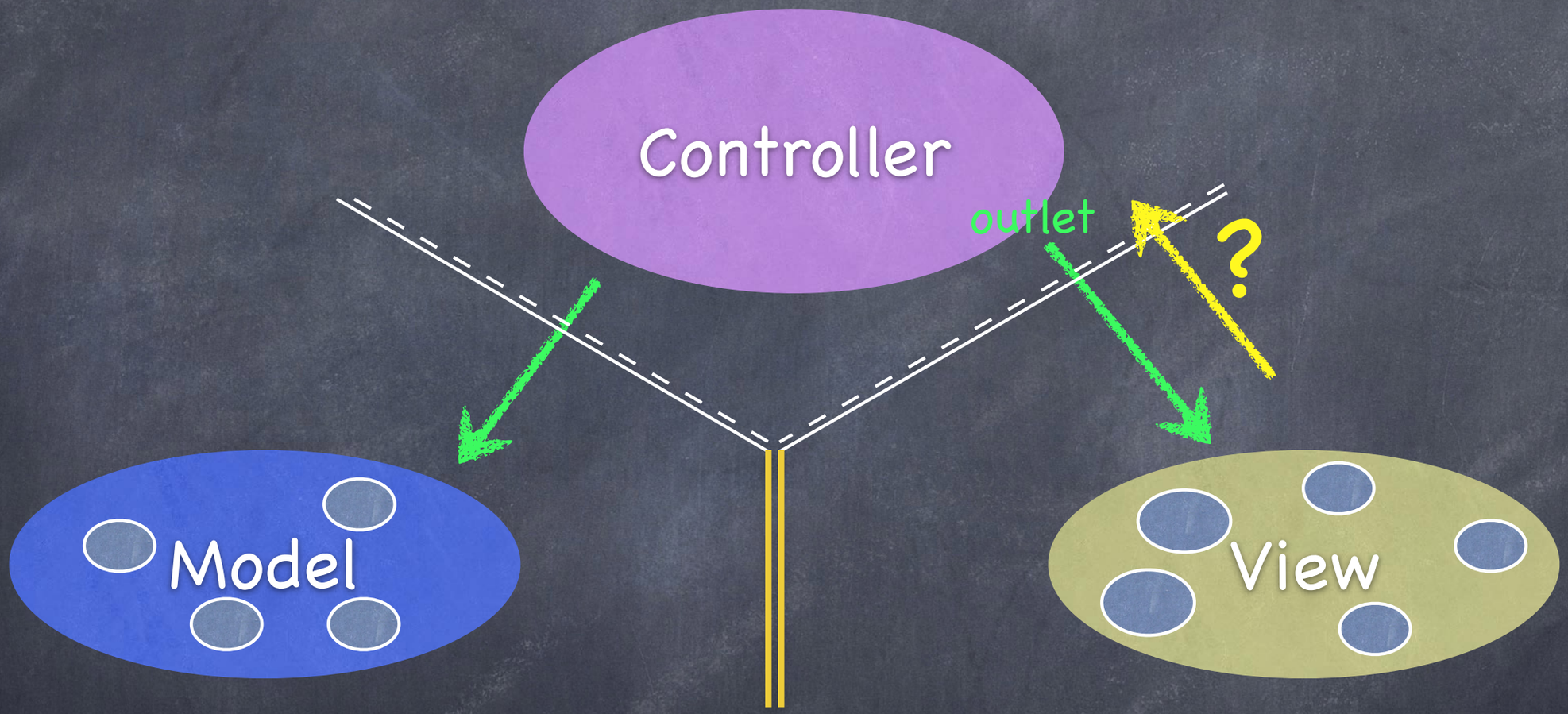

Can the View speak to its Controller?

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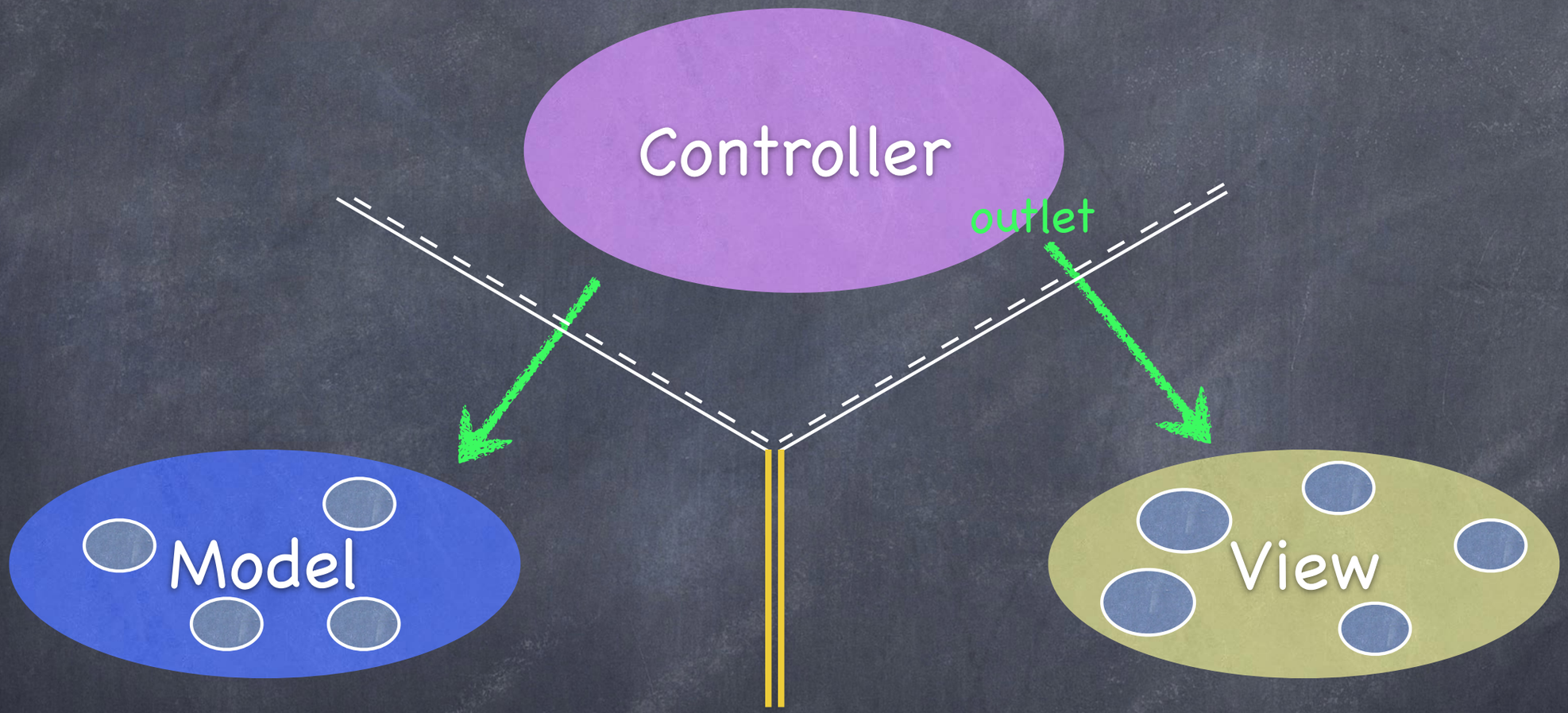

Sort of. Communication is "blind" and structured.

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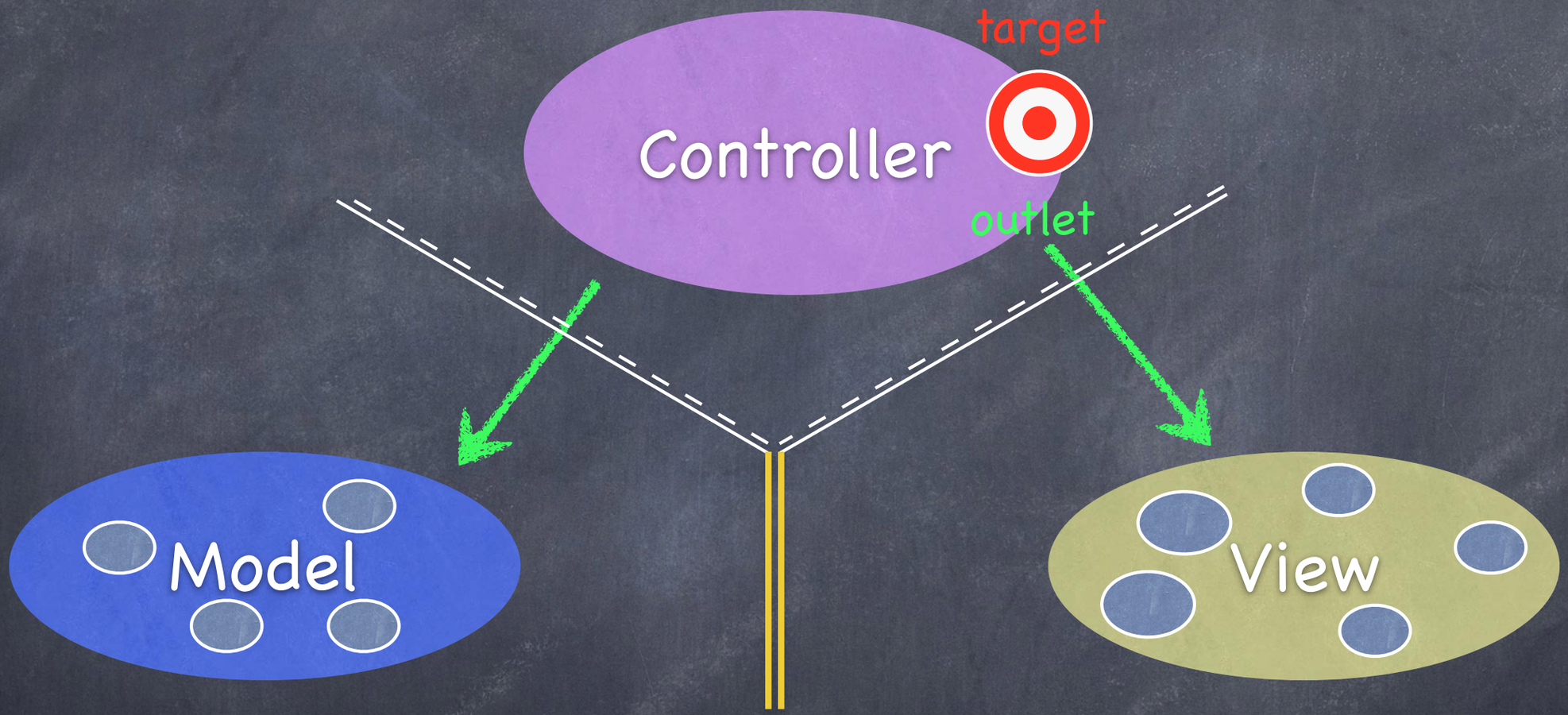
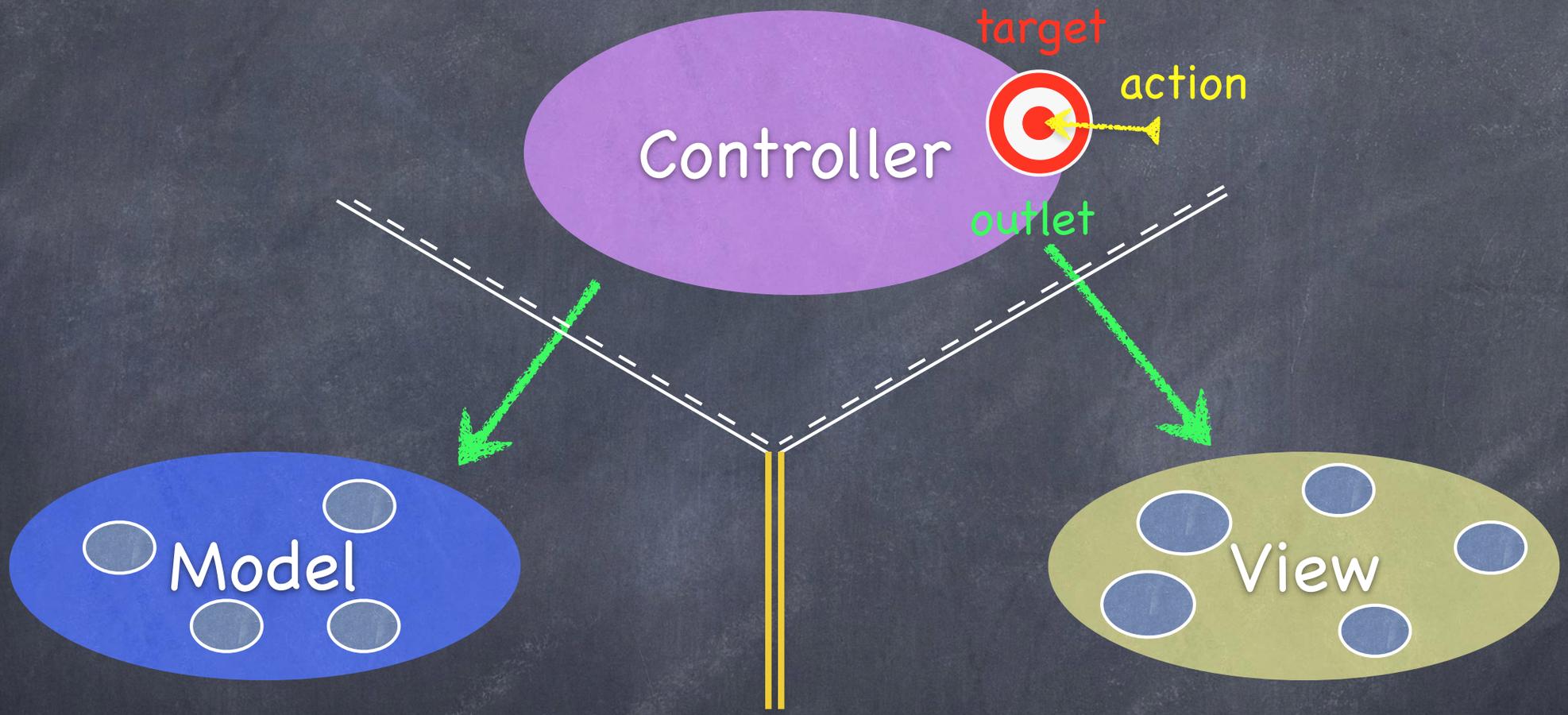


The Controller can drop a target on itself.

MVC



Then hand out an action to the View.

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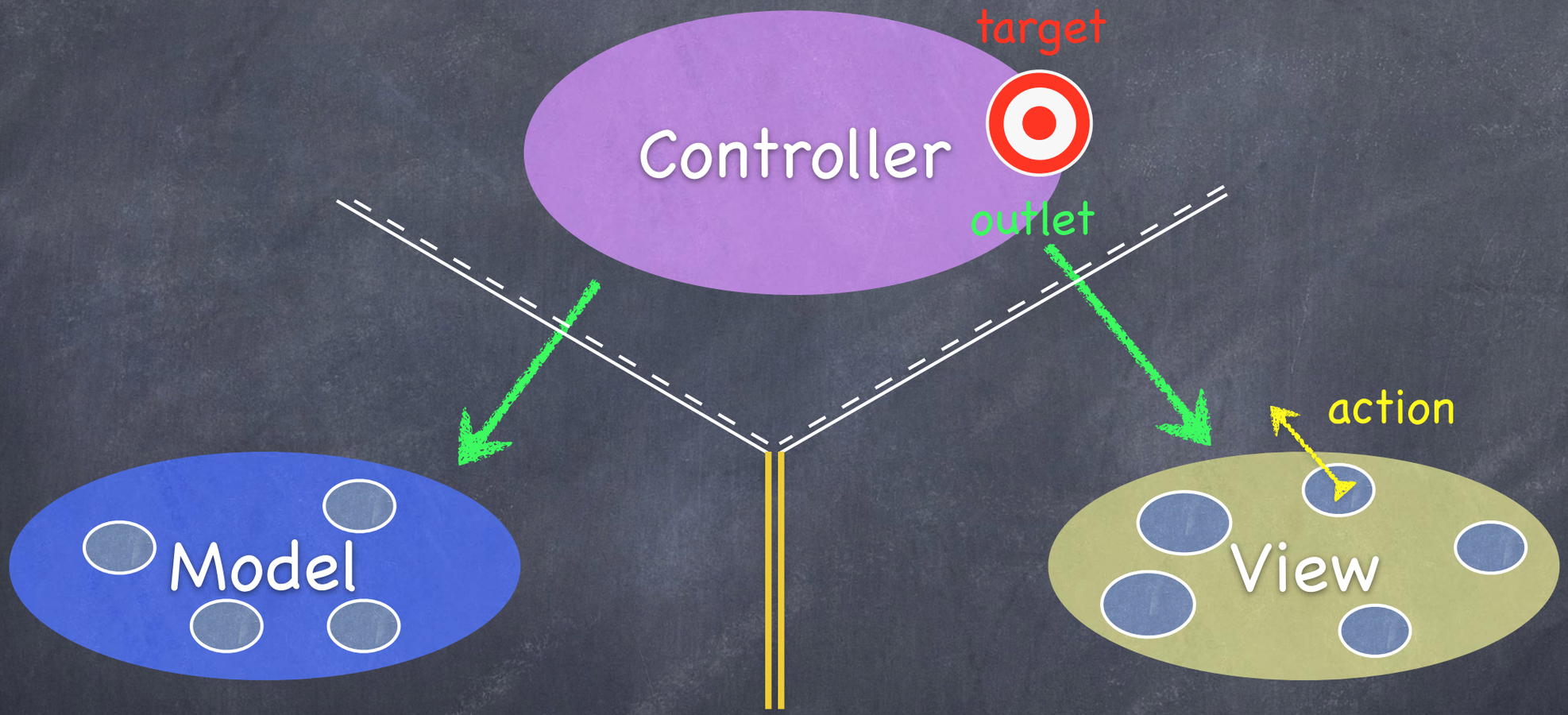

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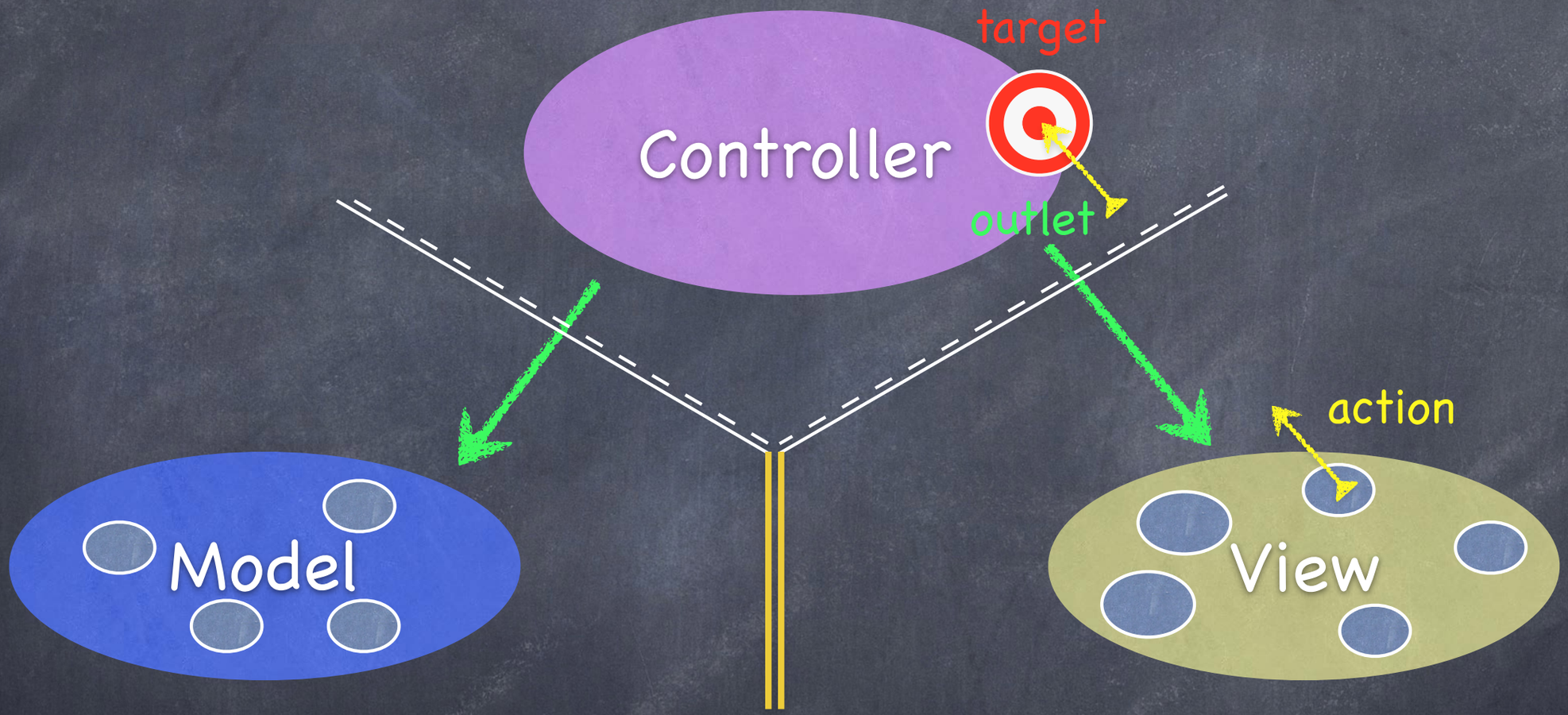
MVC



The View sends the action when things happen in the UI.

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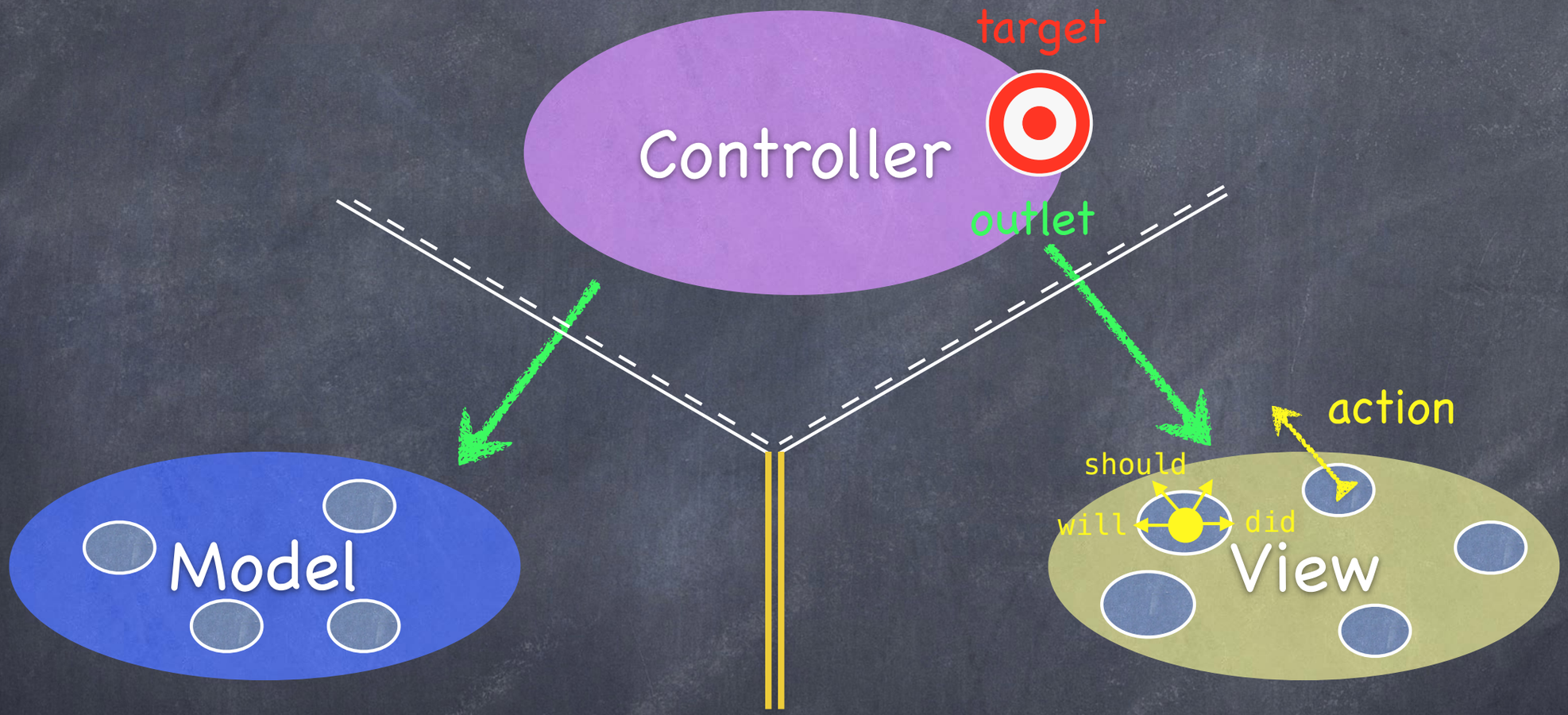

Sometimes the View needs to synchronize with the Controller.

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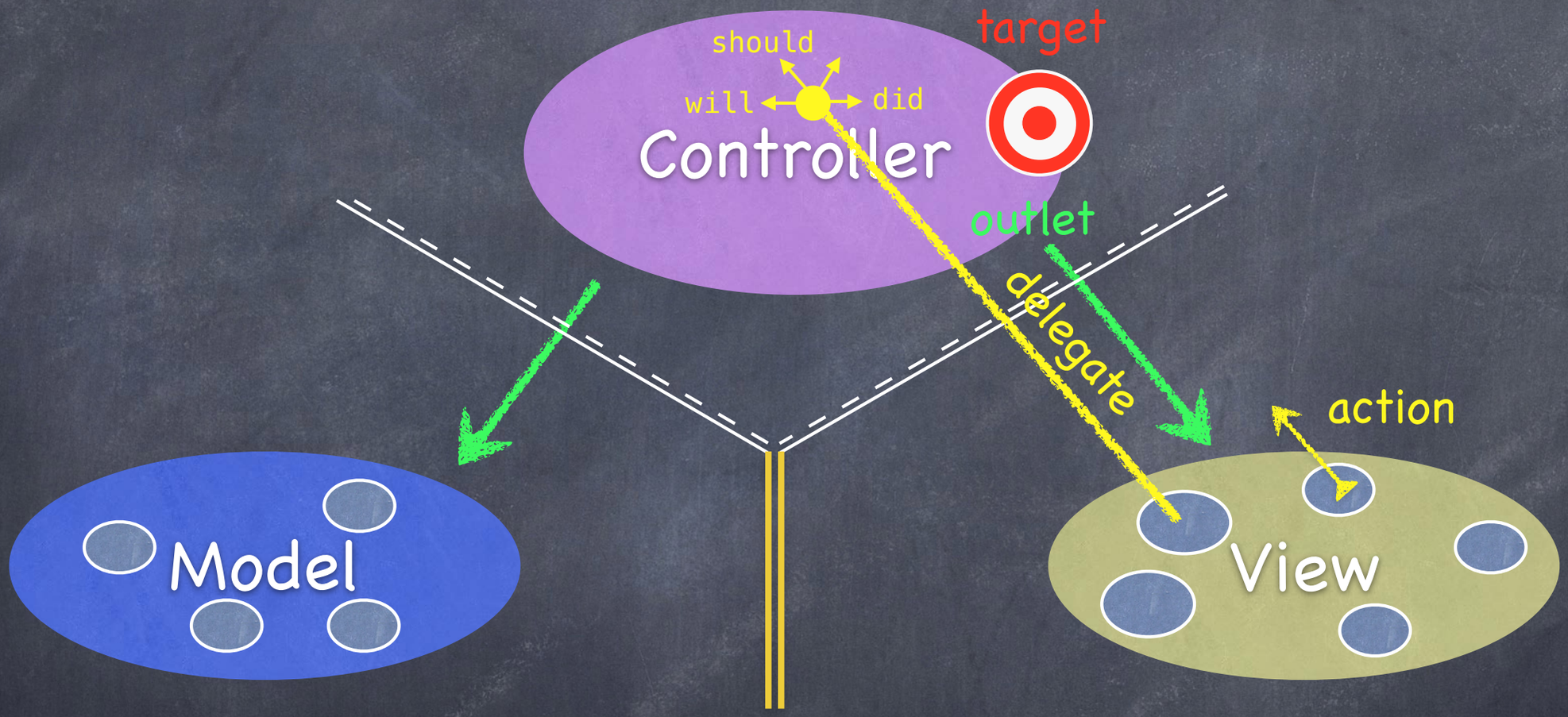

The Controller sets itself as the View's delegate.

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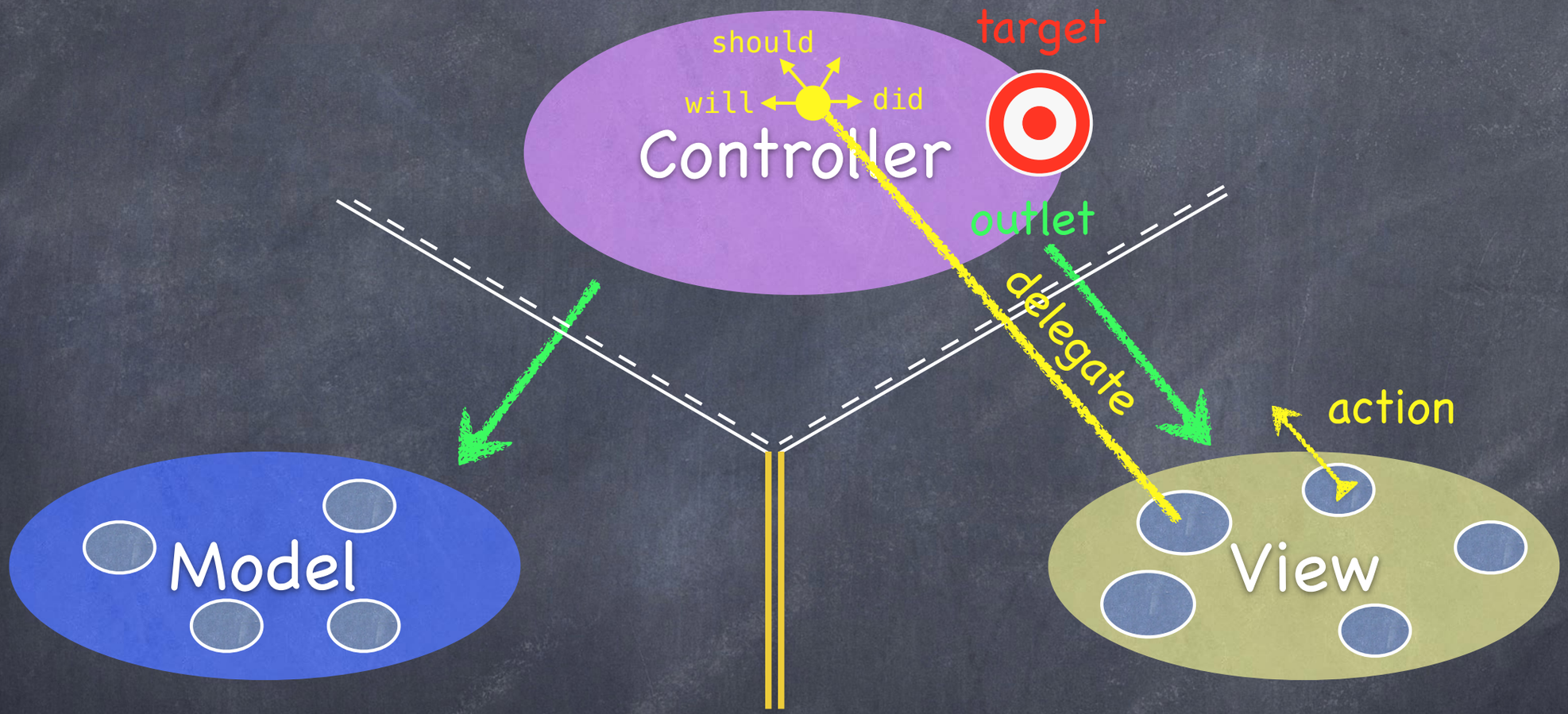

The delegate is set via a protocol (i.e. it's "blind" to class).

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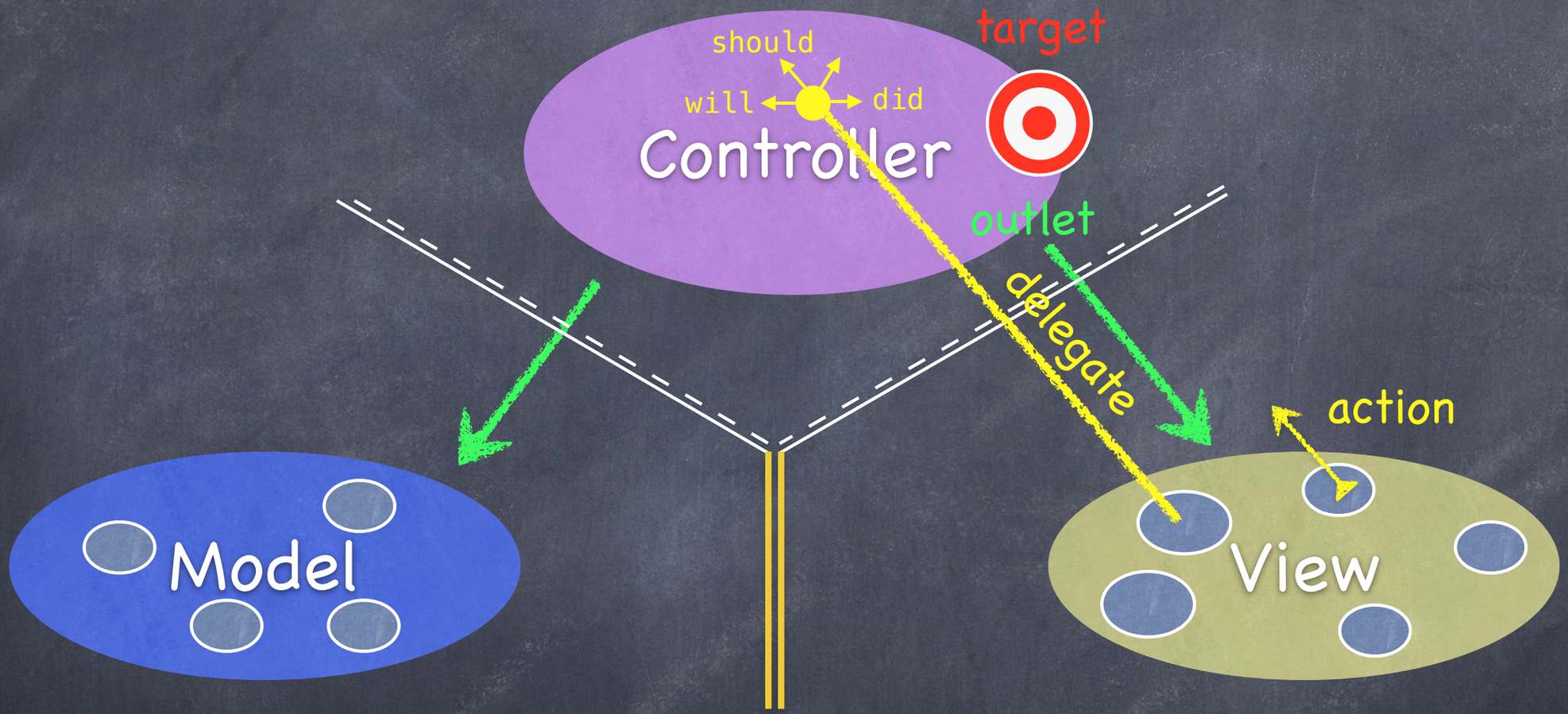

Views do not own the data they display.

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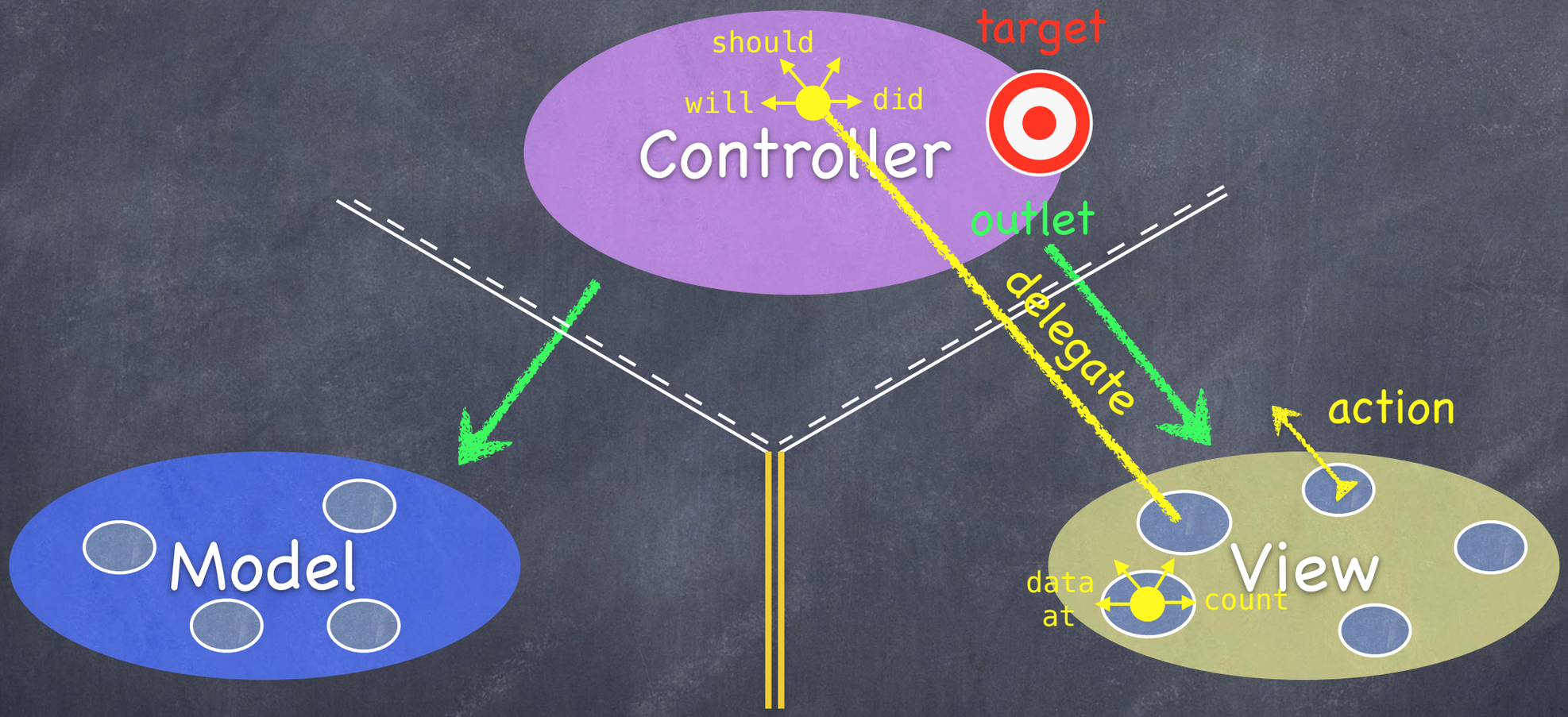

So, if needed, they have a protocol to acquire it.

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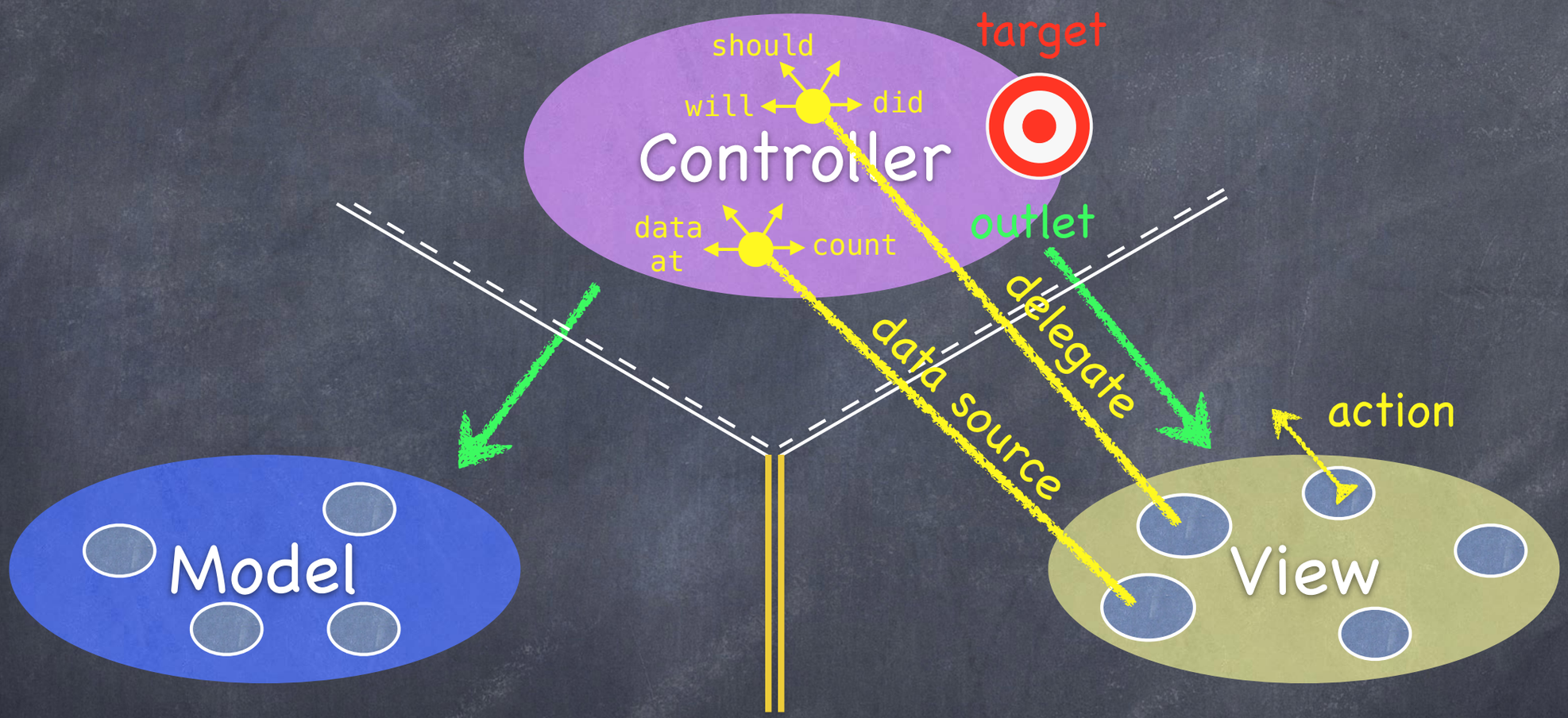
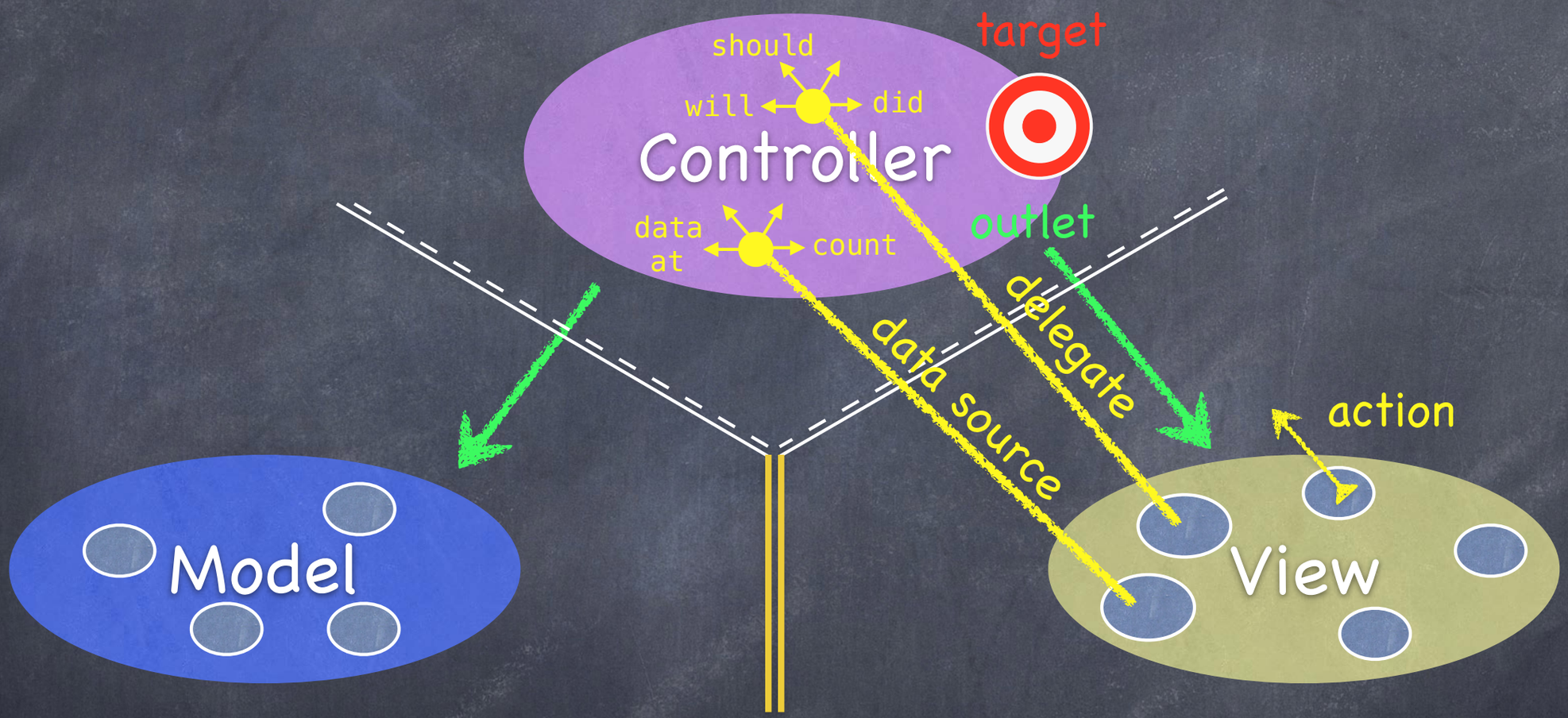


Controllers are almost always that data source (not Model!).

MVC



Controllers interpret/format Model information for the View.

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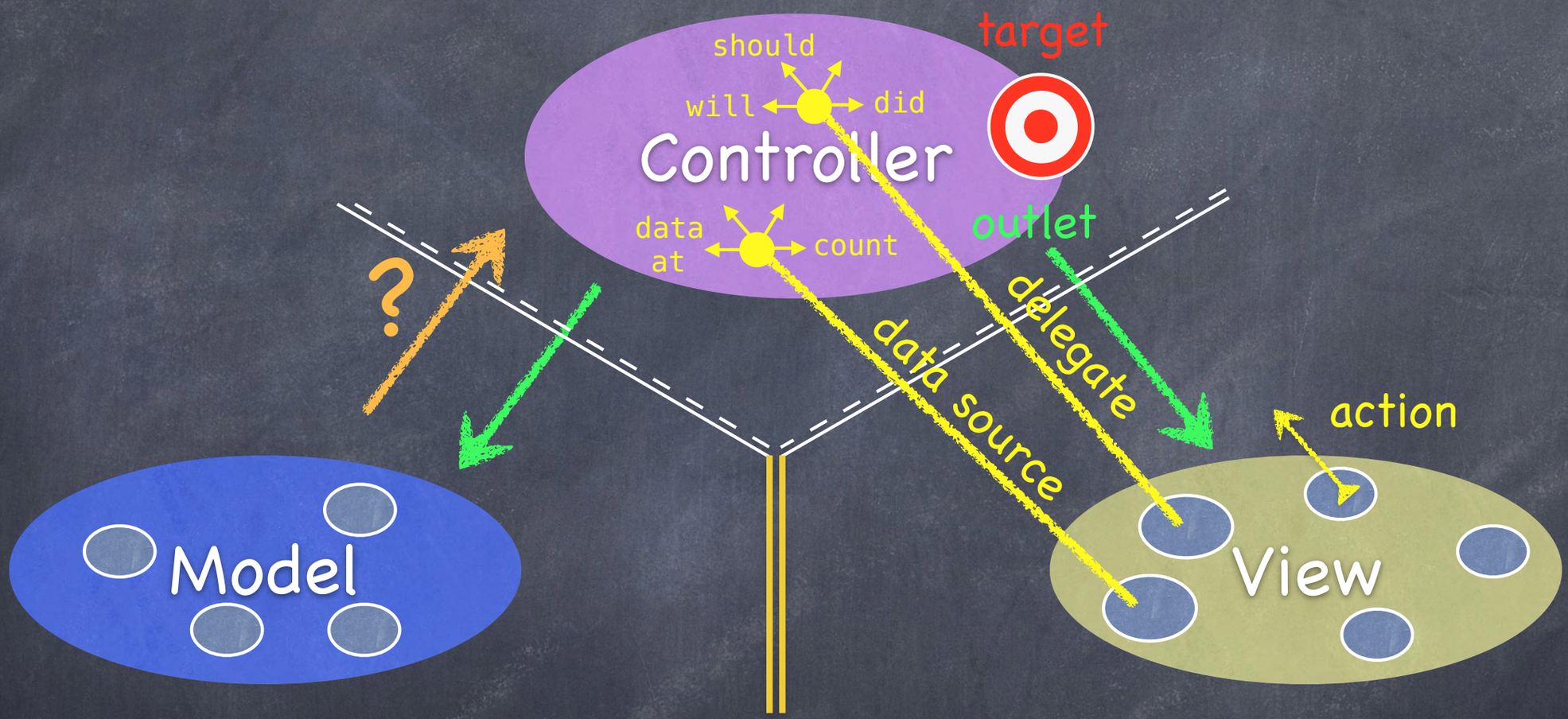
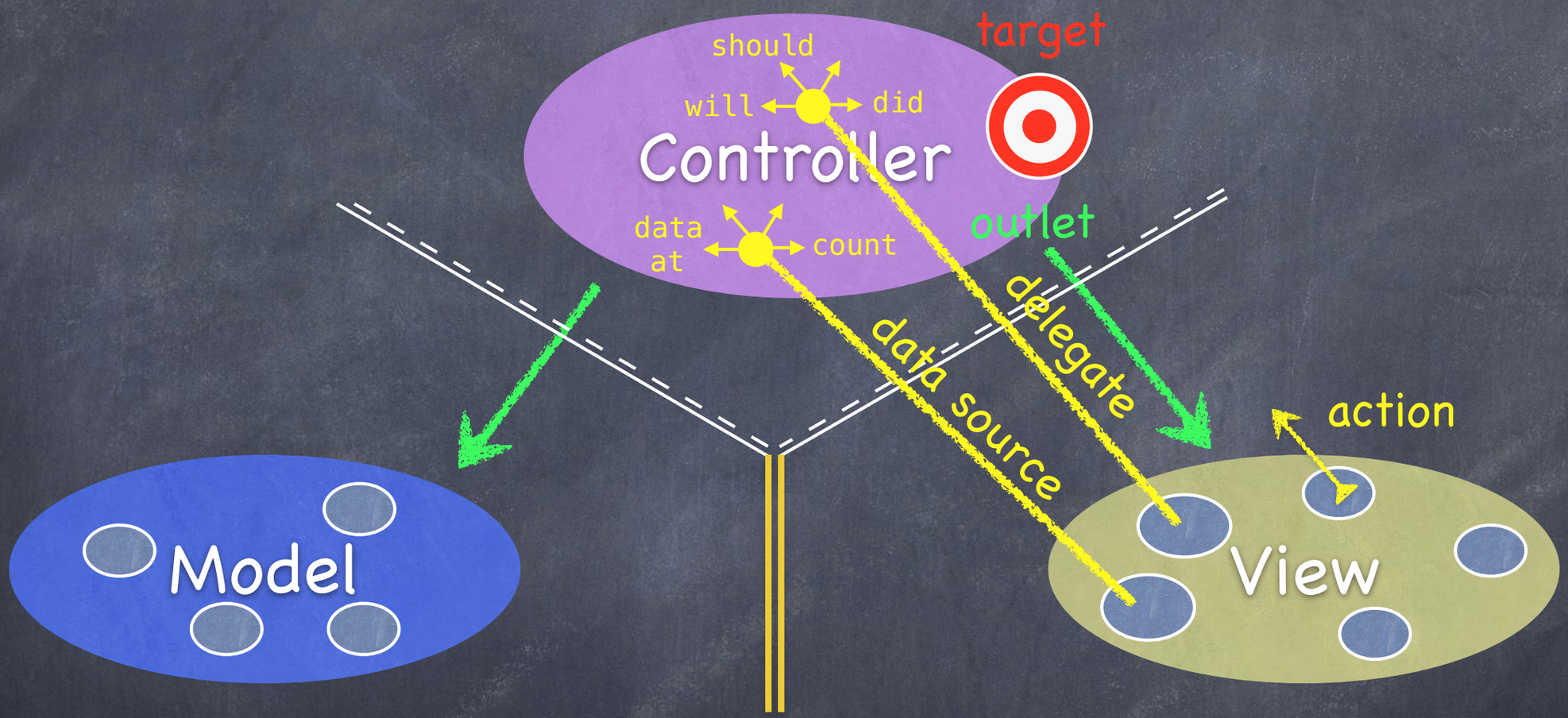
MVC



Can the Model talk directly to the Controller?

MVC



No. The Model is (should be) UI independent.

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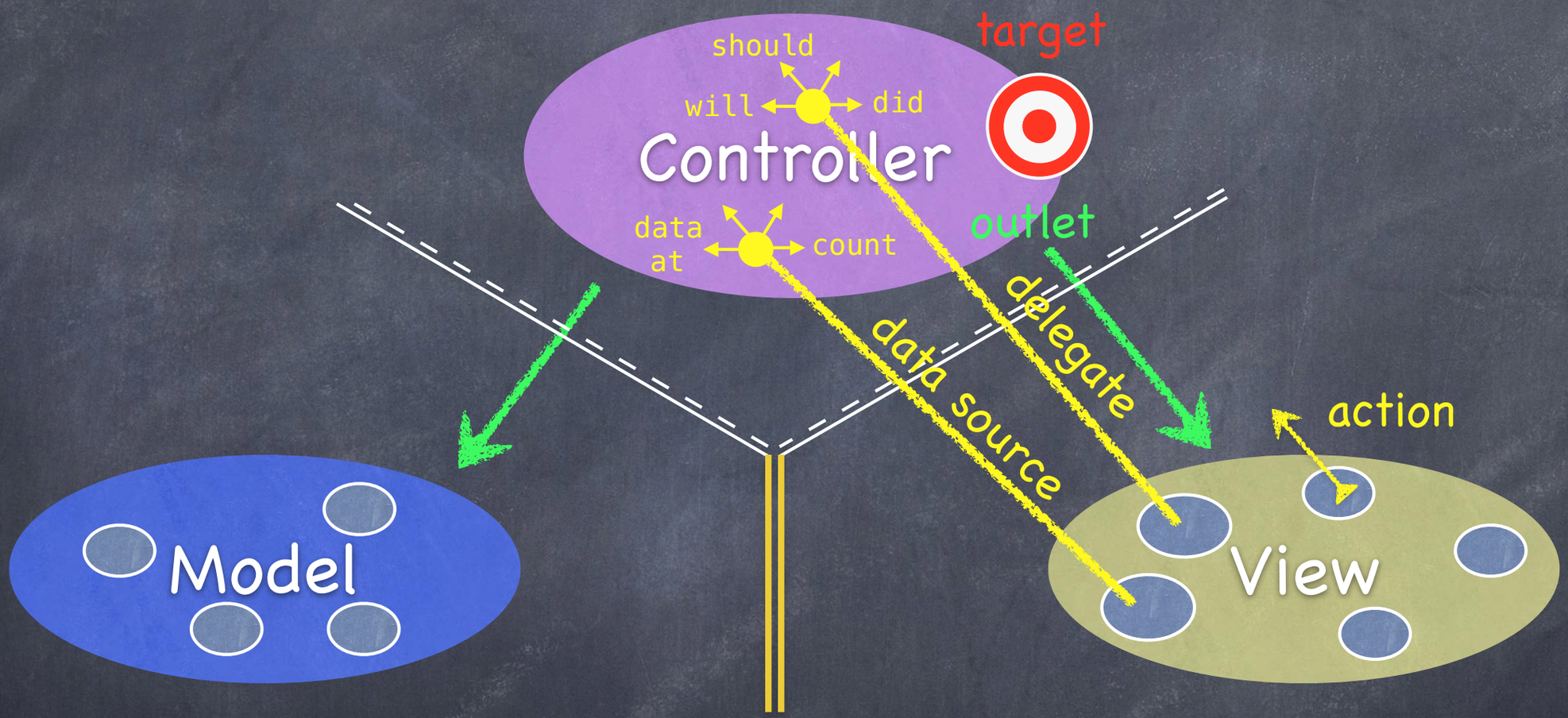
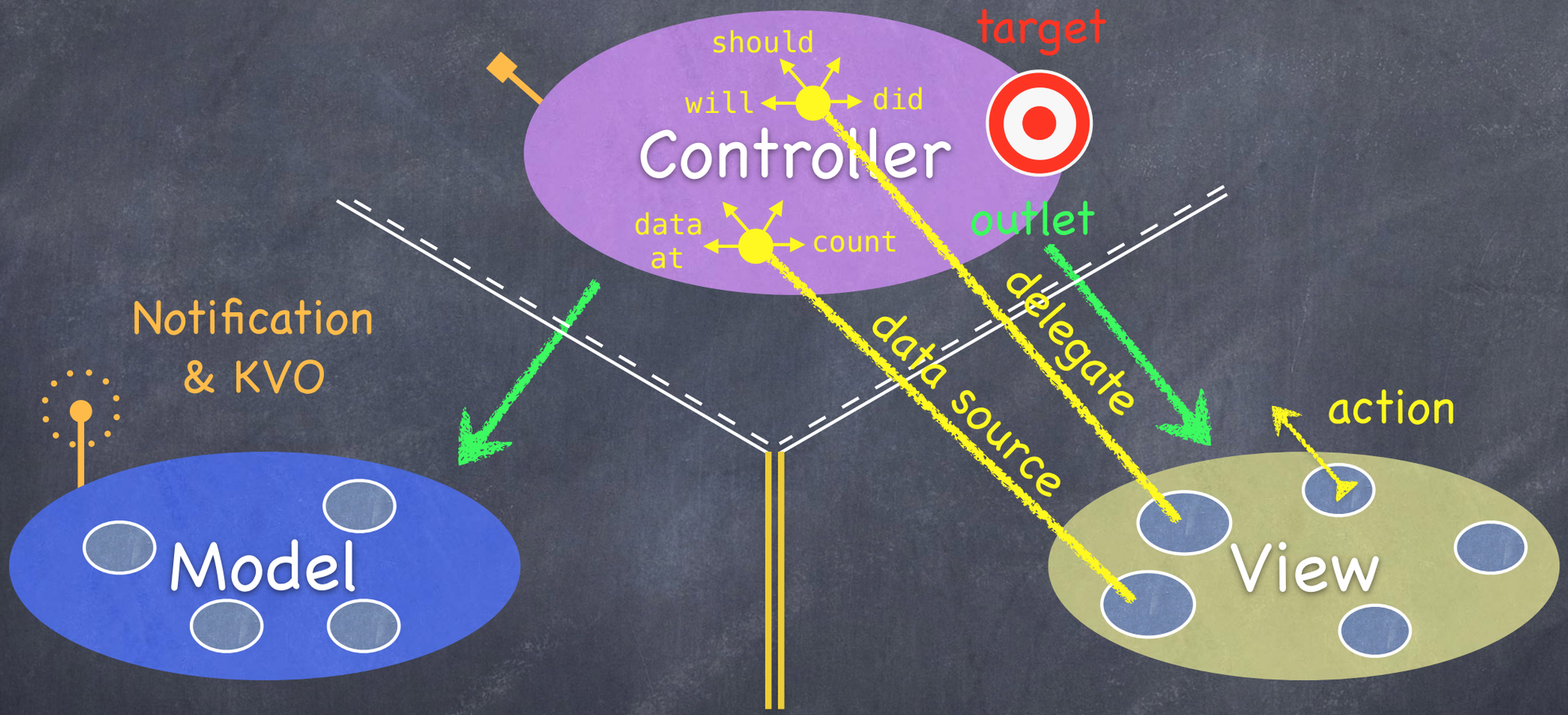


So what if the Model has information to update or something?

MVC



It uses a "radio station"-like broadcast mechanism.

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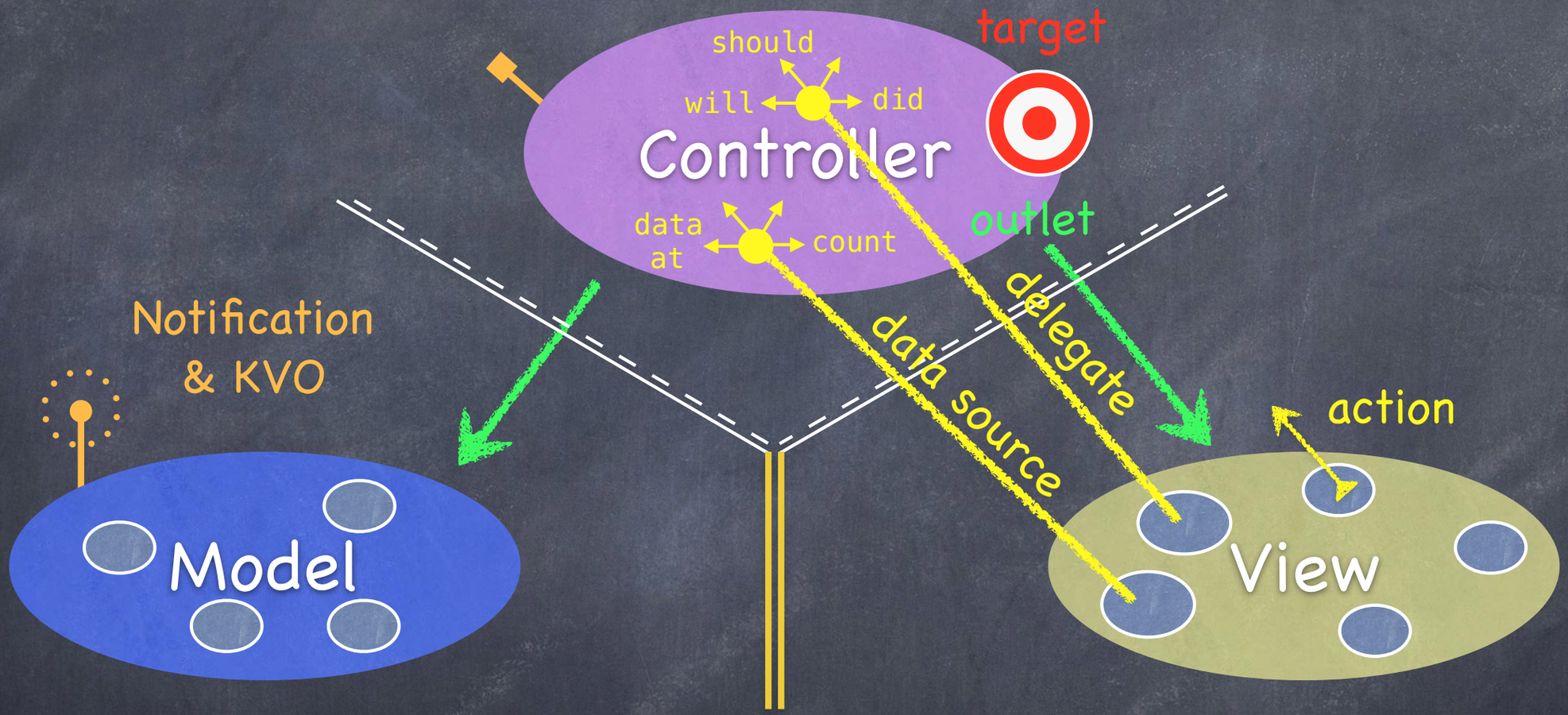
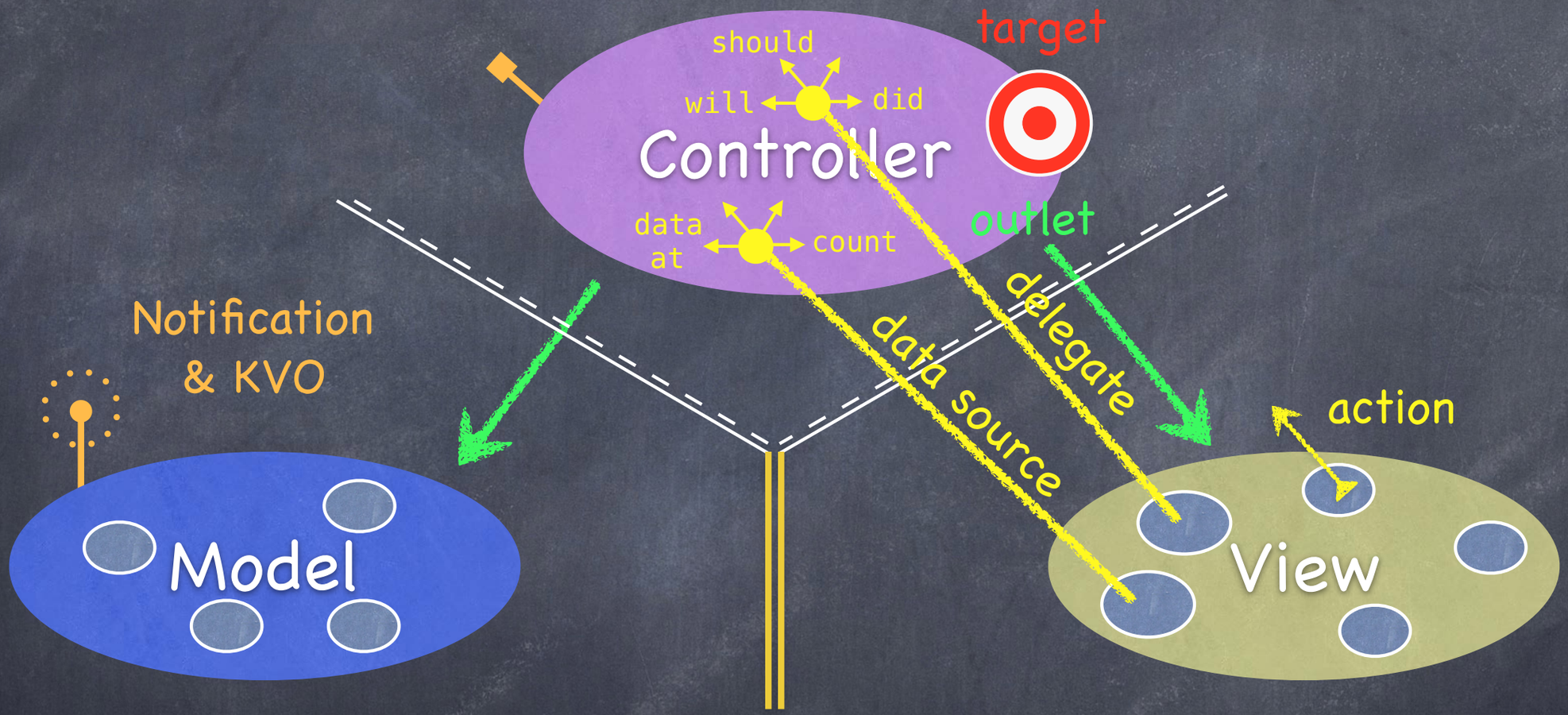


Controllers (or other Model) "tune in" to interesting stuff.

MVC



A View might "tune in," but probably not to a Model's "station."

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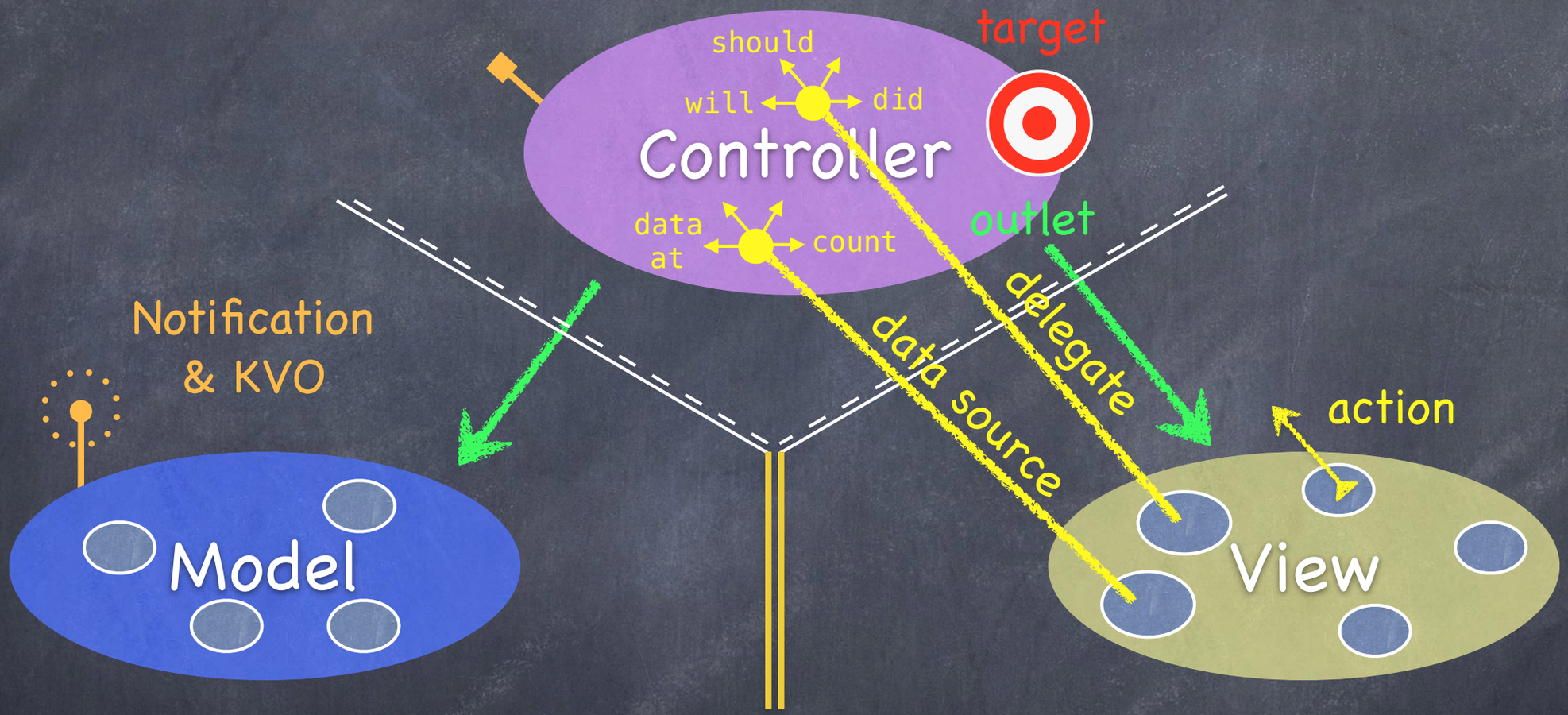

Now combine MVC groups to make complicated programs ...

{ Coding Session }

UITextView & Delegation

UITextField

- Delegate
  - Determining whether the user should be allowed to edit the text field’s contents.
  - Validating the text entered by the user.
  - Responding to taps in the keyboard’s return button.
  - Forwarding the user-entered text to other parts of your app.

Views & Drawing

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()
}
```

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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
```

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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)

(0,0)

increasing x

View Coordinate System

(500, 35)

- Origin is upper left
- Units are points, not pixels

A point is a standard length equivalent to 1x1 pixels on a non-retina device, and 2x2 pixels on a retina device

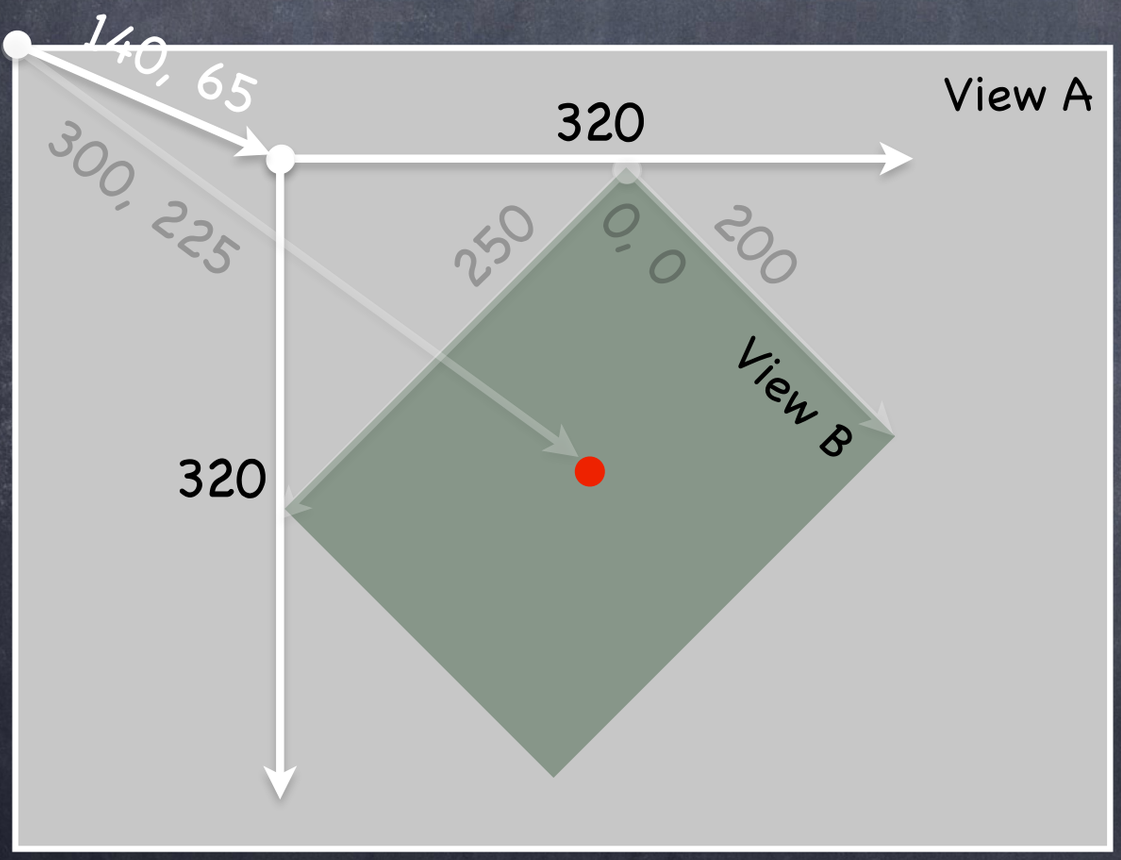
  - Pixels are the minimum-sized unit of drawing your device is capable of
  - Points are the units in the coordinate system
  - Most of the time there are 2 pixels per point, but it could be only 1 or something else
  - How many pixels per point are there? `UIView`'s `var contentScaleFactor: CGFloat`

- 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

increasing y

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)`

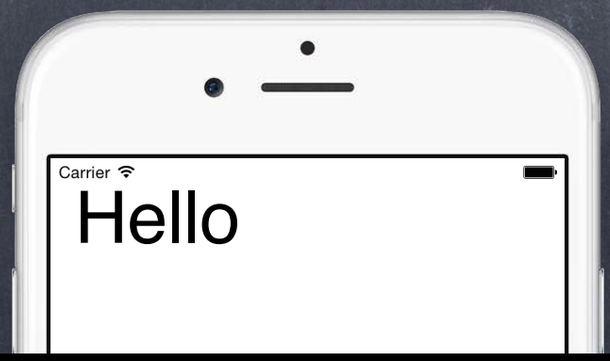
View B's middle in its own coordinates is …
`(bounds.midX, bounds.midY) = (100, 125)`

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

- So how do I implement my `drawRect`?
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- Core Graphics Concepts
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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`

{ Coding Session }

Custom UIView

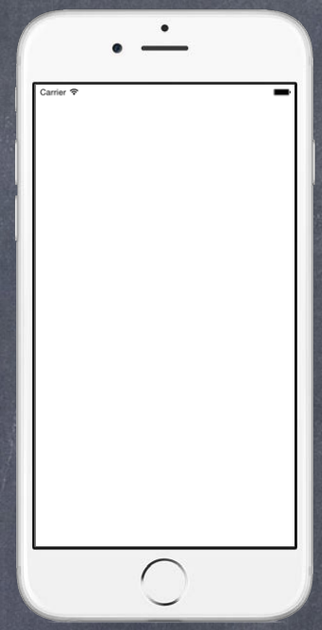
Defining a Path

- Create a UIBezierPath

```
let path = UIBezierPath()
```

- Move around, add lines or arcs to the path

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



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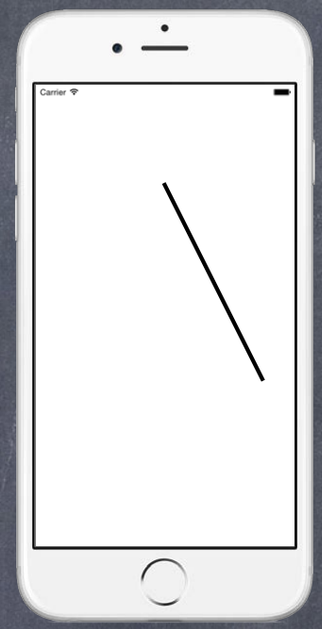

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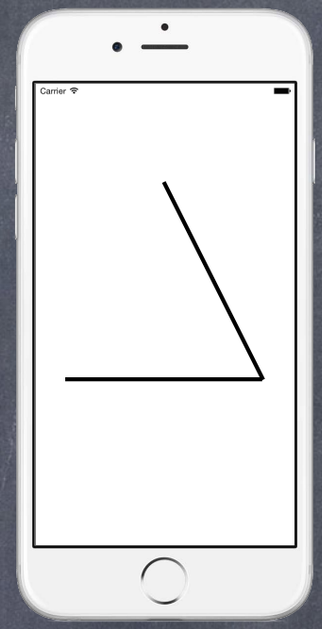

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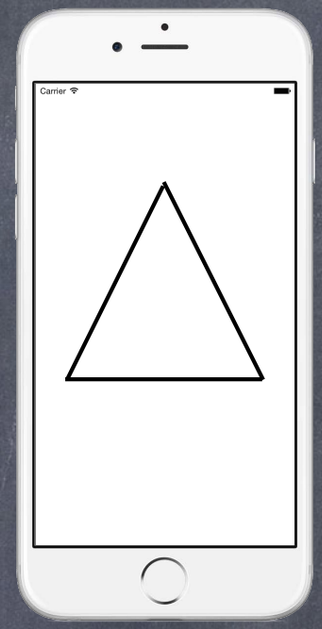
- Close the path (if you want)

```
path.closePath()
```



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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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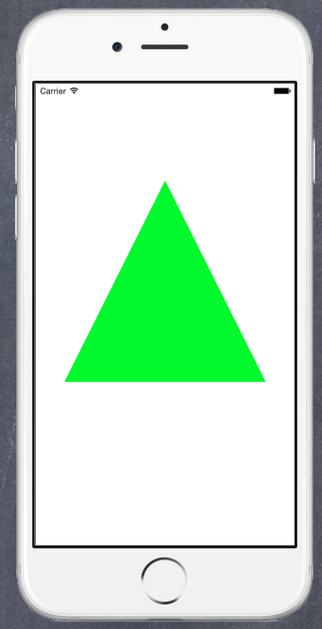

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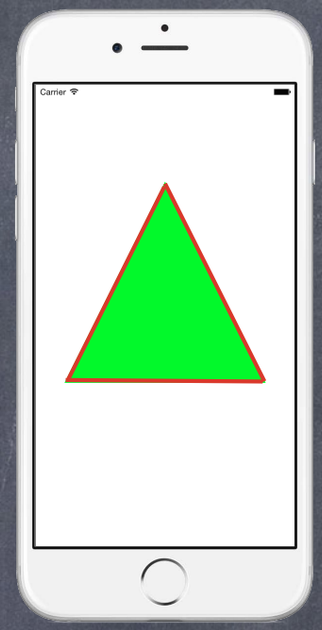
path.fill()                    // method in UIBezierPath
path.stroke()                  // method in UIBezierPath
```



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

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Gestures

- We've seen how to draw in a `UIView`, how do we get touches?
  - We can get notified of the raw touch events (touch down, moved, up, etc.)
  - Or we can react to certain, predefined "gestures." The latter is the way to go!
- Gestures are recognized by instances of `UIGestureRecognizer`
  - The base class is "abstract." We only actually use concrete subclasses to recognize.
- There are two sides to using a gesture recognizer
  1. Adding a gesture recognizer to a `UIView` (asking the `UIView` to "recognize" that gesture)
  2. Providing a method to "handle" that gesture (not necessarily handled by the `UIView`)
- Usually the first is done by a Controller
  - Though occasionally a `UIView` will do this itself if the gesture is integral to its existence
- The second is provided either by the `UIView` or a `Controller`
  - Depending on the situation. We'll see an example of both in our demo.

Gestures

- A handler for a gesture needs gesture-specific information
  So each concrete subclass provides special methods for handling that type of gesture
- For example, `UIPanGestureRecognizer` provides 3 methods
  ```
  func translationInView(UIView) -> CGPoint // cumulative since start of recognition
  func velocityInView(UIView) -> CGPoint // how fast the finger is moving (points/s)
  func setTranslation(CGPoint, inView: UIView)
  ```
  This last one is interesting because it allows you to reset the translation so far
  By resetting the translation to zero all the time, you end up getting "incremental" translation
- The abstract superclass also provides state information
  ```
  var state: UIGestureRecognizerState { get }
  ```
  This sits around in `.Possible` until recognition starts
  For a discrete gesture (e.g. a `Swipe`), it changes to `.Recognized` (`Tap` is not a normal discrete)
  For a continues gesture (e.g. a `Pan`), it moves from `.Began` thru repeated `.Changed` to `.Ended`
  It can go to `.Failed` or `.Cancelled` too, so watch out for those!

Gestures

- So, given this information, what would the pan handler look like?

```
func pan(gesture: UIPanGestureRecognizer) {
    switch gesture.state {
        case .Changed: fallthrough
        case .Ended:
            let translation = gesture.translationInView(pannableView)
            // update anything that depends on the pan gesture using translation.x and .y
            gesture.setTranslation(CGPointZero, inView: pannableView)
        default: break
    }
}
```

Remember that the action was `pan(_:)` (if no `_:`, then no gesture argument)

Gestures

- UIPinchGestureRecognizer

```
var scale: CGFloat            // not read-only (can reset)
var velocity: CGFloat { get } // scale factor per second
```

- UIRotationGestureRecognizer

```
var rotation: CGFloat         // not read-only (can reset); in radians
var velocity: CGFloat { get } // radians per second
```

- UISwipeGestureRecognizer

Set up the direction and number of fingers you want, then look for `.Recognized`

```
var direction: UISwipeGestureRecoginzerDirection // which swipes you want
var numberOfTouchesRequired: Int                 // finger count
```

- UITapGestureRecognizer

Set up the number of taps and fingers you want, then look for `.Ended`

```
var numberOfTapsRequired: Int    // single tap, double tap, etc.
var numberOfTouchesRequired: Int // finger count
```