Stanford CS193p

Developing Applications for iOS
Fall 2013-14

Today

- What is this class all about?
  Description
  Prerequisites
  Homework / Final Project
- iOS Overview
  What's in iOS?
- MVC
  Object-Oriented Design Concept
- Objective C
  (Time Permitting)
  New language!
  Basic concepts only for today.

What will I learn in this course?

- How to build cool apps
  - Easy to build even very complex applications
  - Result lives in your pocket or backpack!
  - Very easy to distribute your application through the AppStore
  - Vibrant development community
- Real-life Object-Oriented Programming
  - The heart of Cocoa Touch is 100% object-oriented
  - Application of MVC design model
  - Many computer science concepts applied in a commercial development platform:
    - Databases, Graphics, Multimedia, Multithreading, Animation, Networking, and much, much more!
  - Numerous students have gone on to sell products on the AppStore

Prerequisites

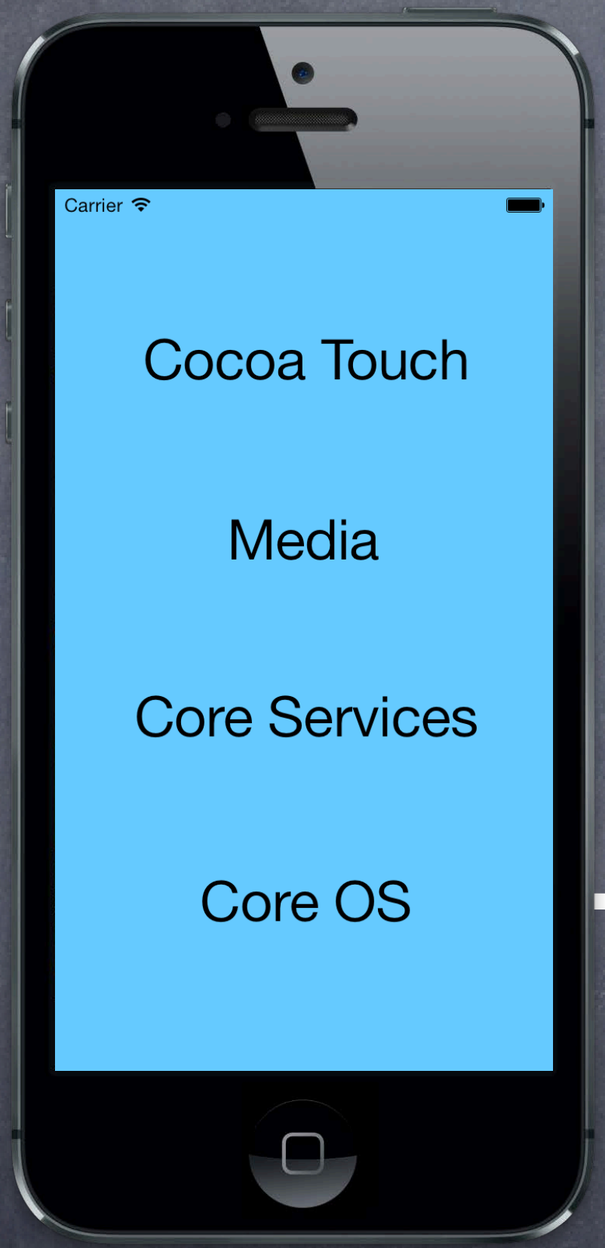
- **Most Important Prereq!**
  Object-Oriented Programming
  CS106A&B (or X) required
  CS107 or CS108 or CS110 required
  (or equivalent for non-Stanford undergrad)
- **Object-Oriented Terms**
  Class (description/template for an object)
  Instance (manifestation of a class)
  Message (sent to object to make it act)
  Method (code invoked by a Message)
  Instance Variable (object-specific storage)
  Superclass/Subclass (Inheritance)
- **You should know these terms!**
  If you are not very comfortable with all of these, this might not be the class for you!
- **Programming Experience**
  This is an upper-level CS course.

  If you have never written a program where you had to design and implement more than a handful of classes, this will be a big step up in difficulty for you.

Assignments

- Weekly Homework
  - 6 weekly (approximately) assignments
  - Individual work only
  - Required Tasks and Evaluation criteria
- Final Project
  - 3 weeks to work on it
  - Individual work only
  - Keynote presentation required (2 mins or so)

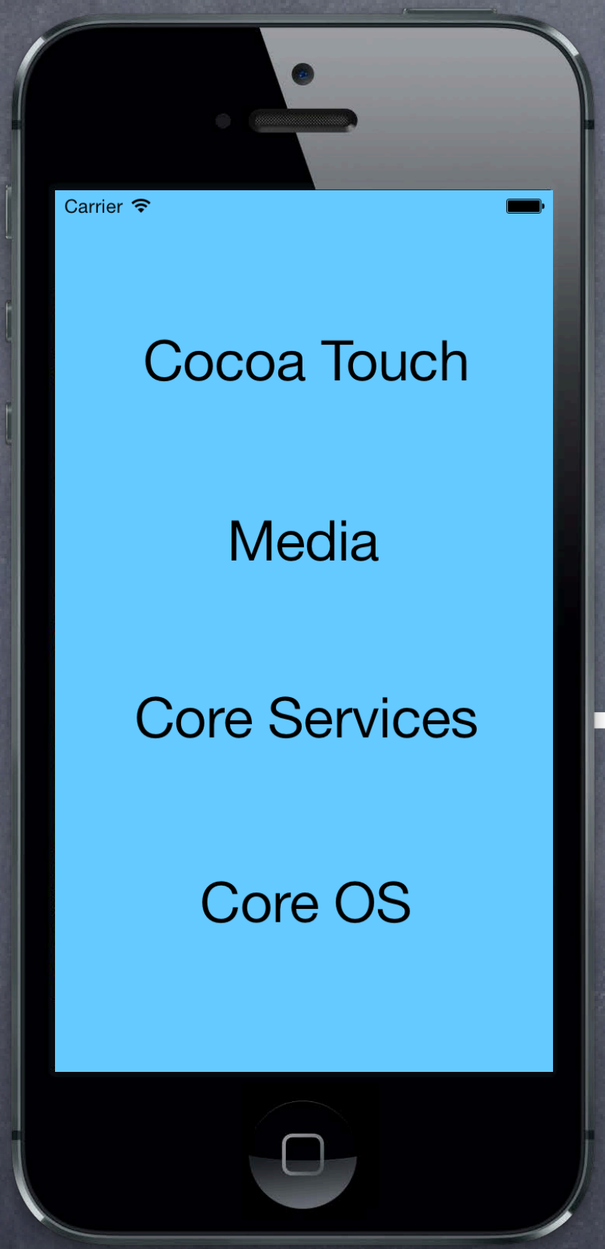
What's in iOS?



Core OS

OSX Kernel	Power Management
Mach 3.0	Keychain Access
BSD	Certificates
Sockets	File System
Security	Bonjour

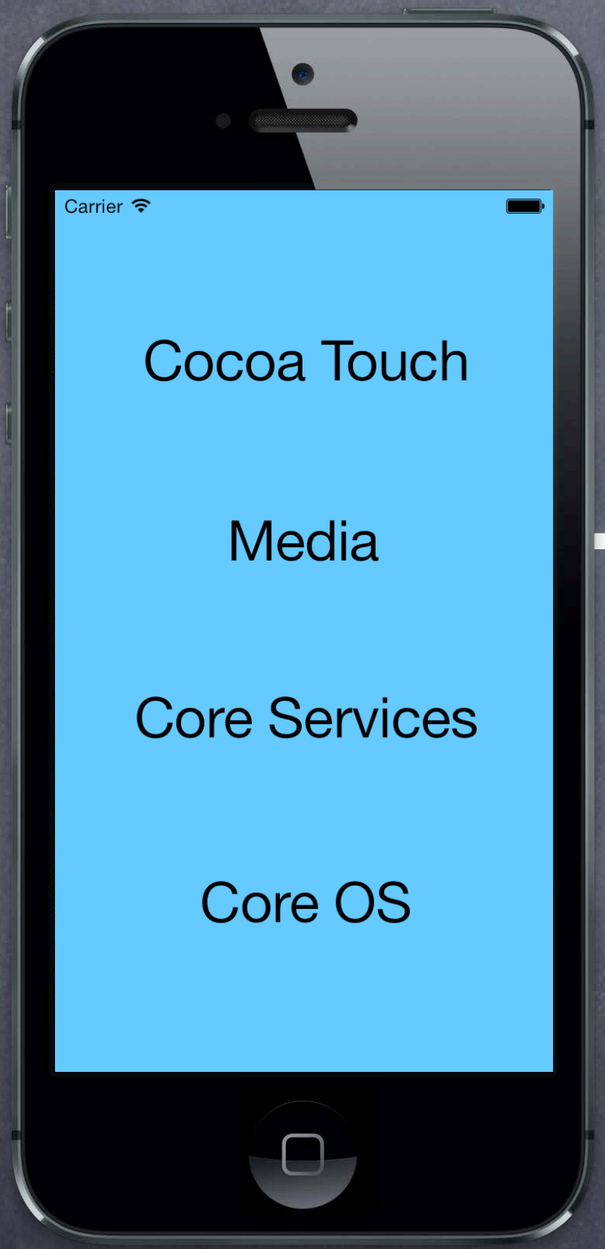
What's in iOS?



Core Services

Collections	Core Location
Address Book	Net Services
Networking	Threading
File Access	Preferences
SQLite	URL Utilities

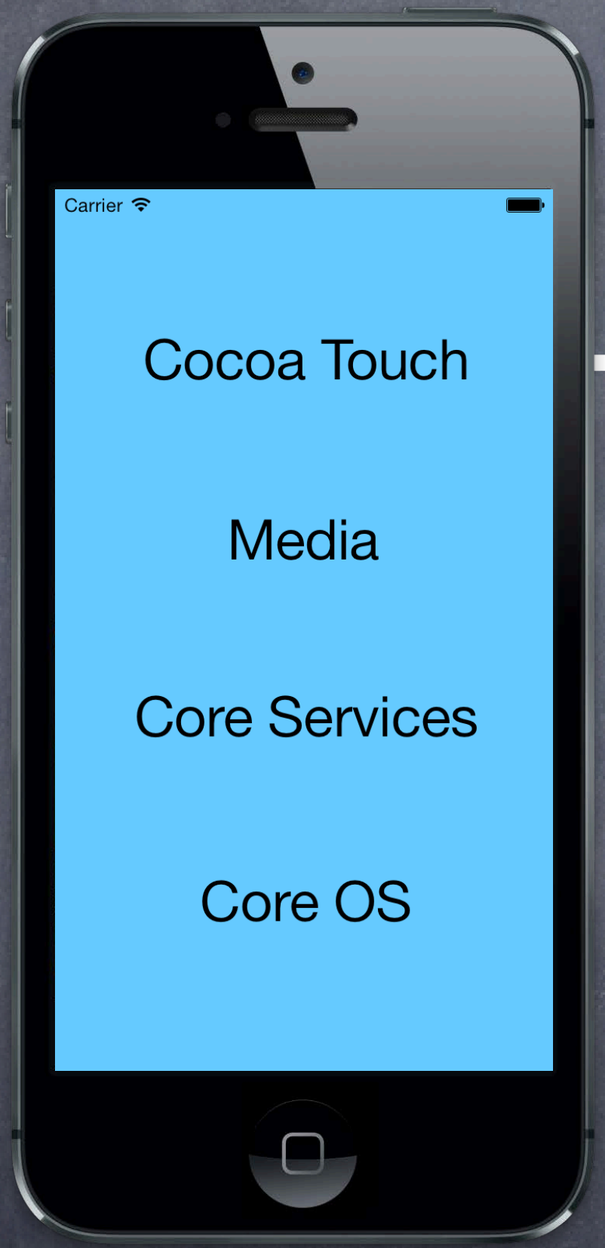
What's in iOS?



Media

Core Audio	JPEG, PNG, TIFF
OpenAL	PDF
Audio Mixing	Quartz (2D)
Audio Recording	Core Animation
Video Playback	OpenGL ES

What's in iOS?



Cocoa Touch

- Multi-Touch
- Core Motion
- View Hierarchy
- Localization
- Controls
- Alerts
- Web View
- Map Kit
- Image Picker
- Camera

Platform Components

- Tools

Xcode 5

Instruments

- Language

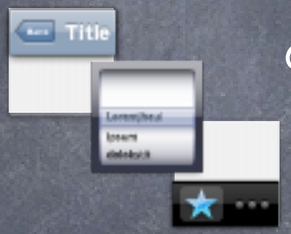
```
[display setTextColor:[UIColor blackColor]];
```

- Frameworks

Foundation

Core Data

Map Kit



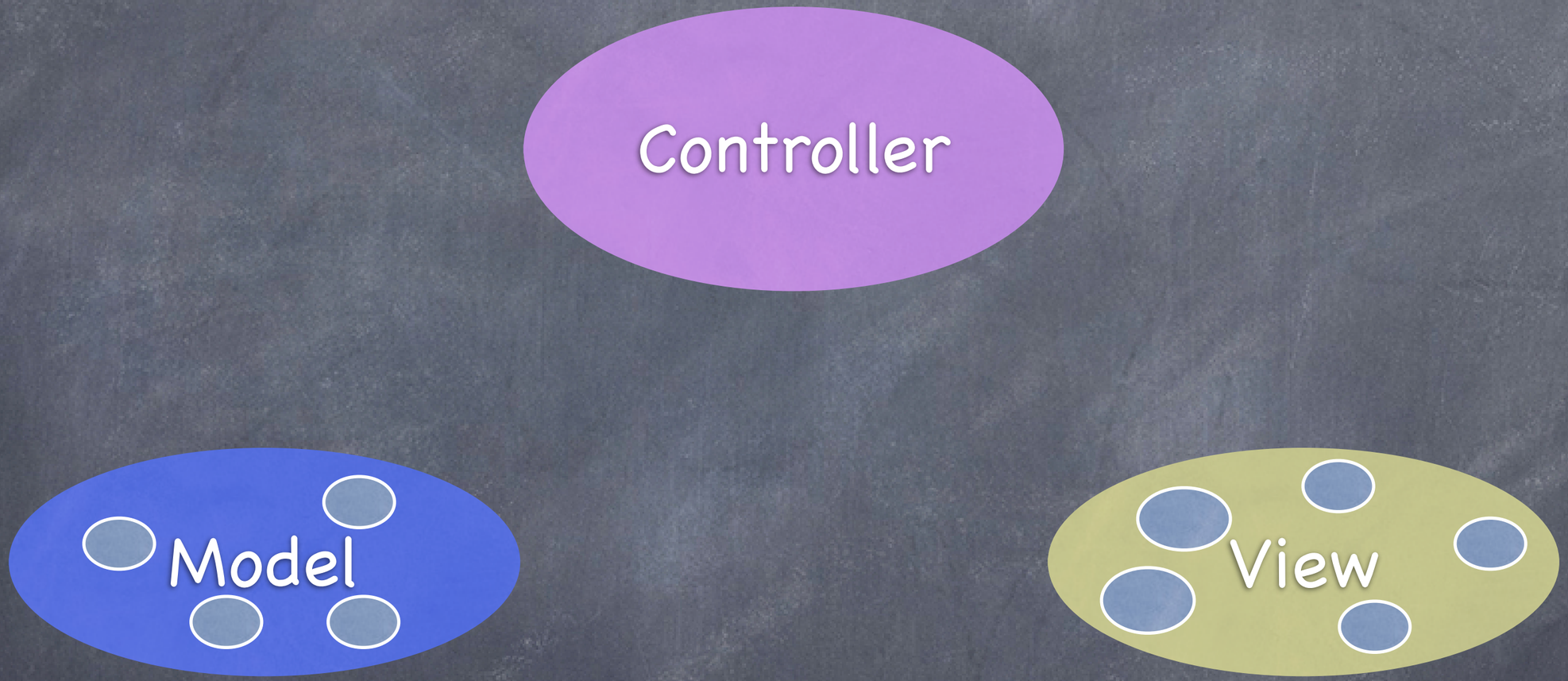
UIKit

Core Motion

- Design Strategies

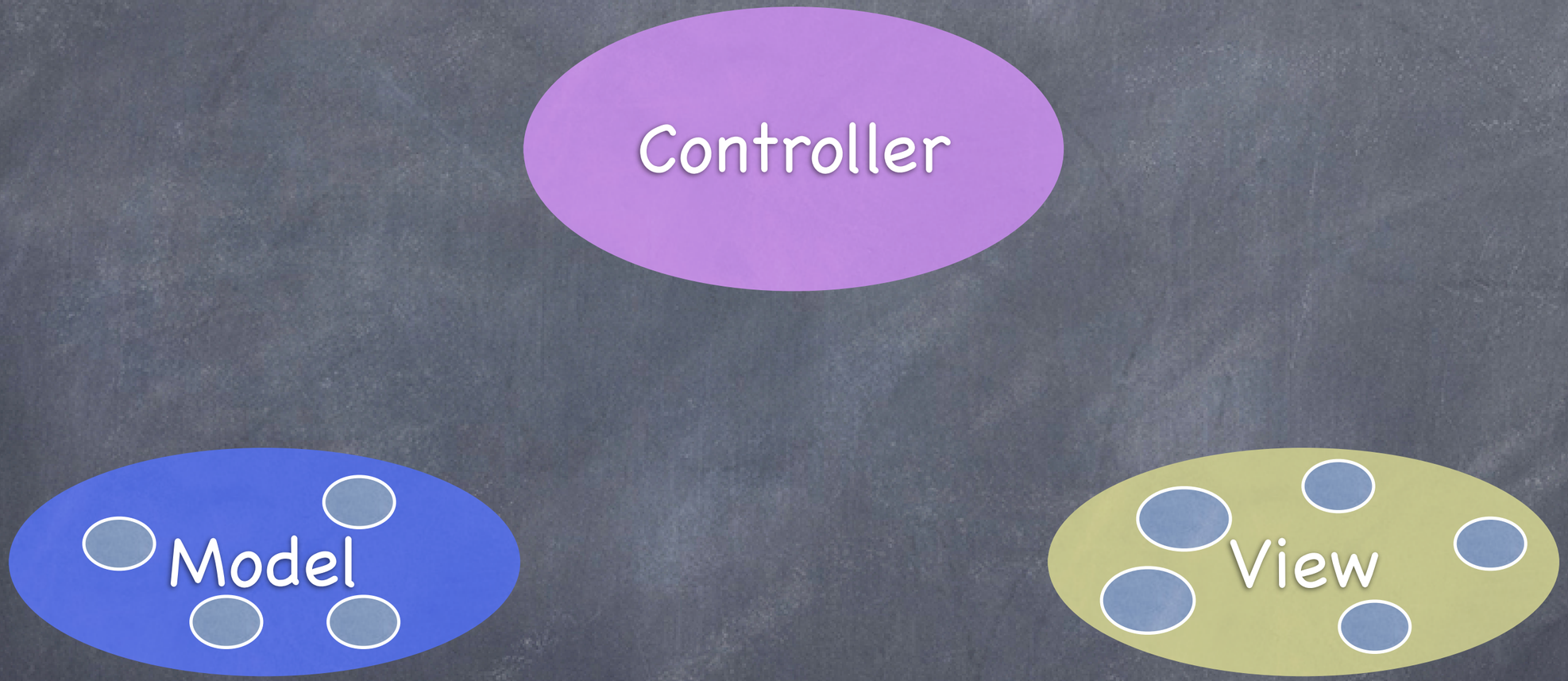
MVC

MVC



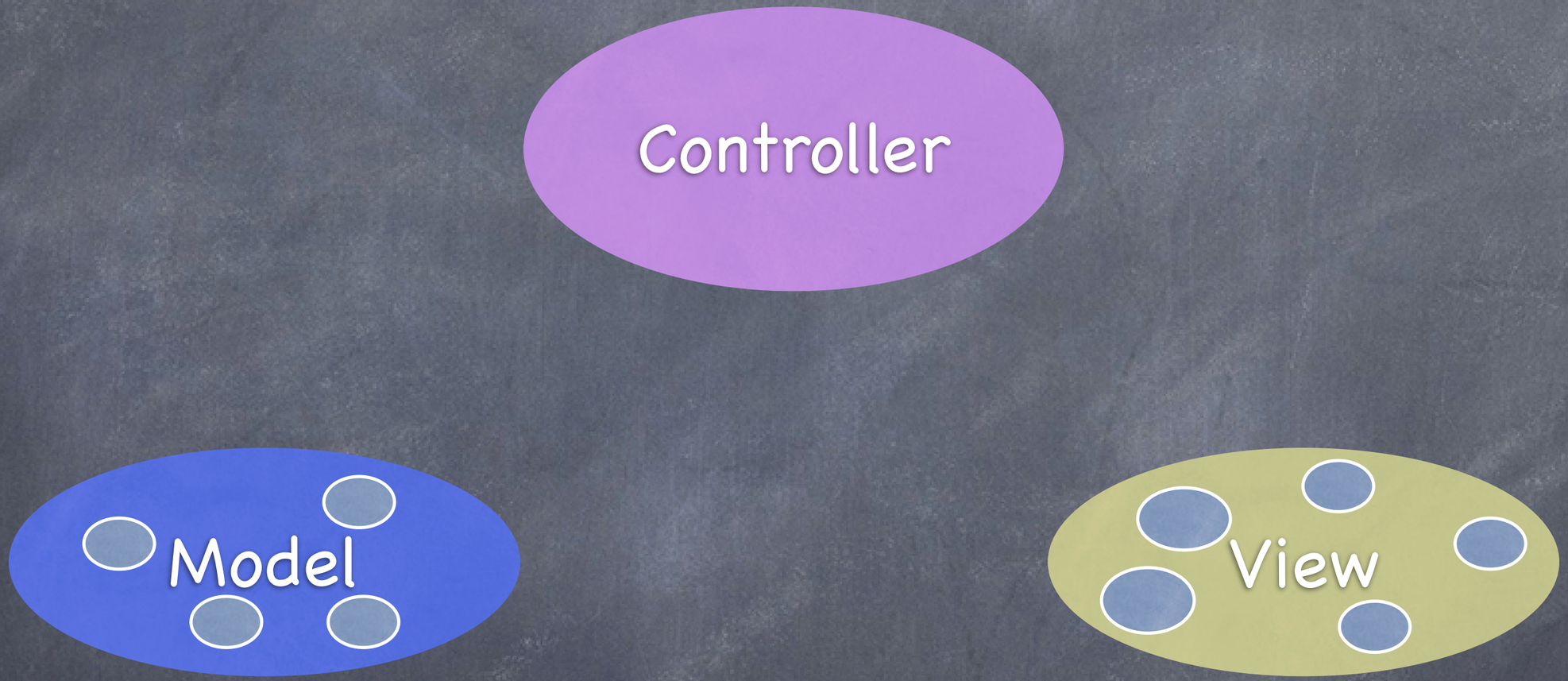
Divide objects in your program into 3 "camps."

MVC



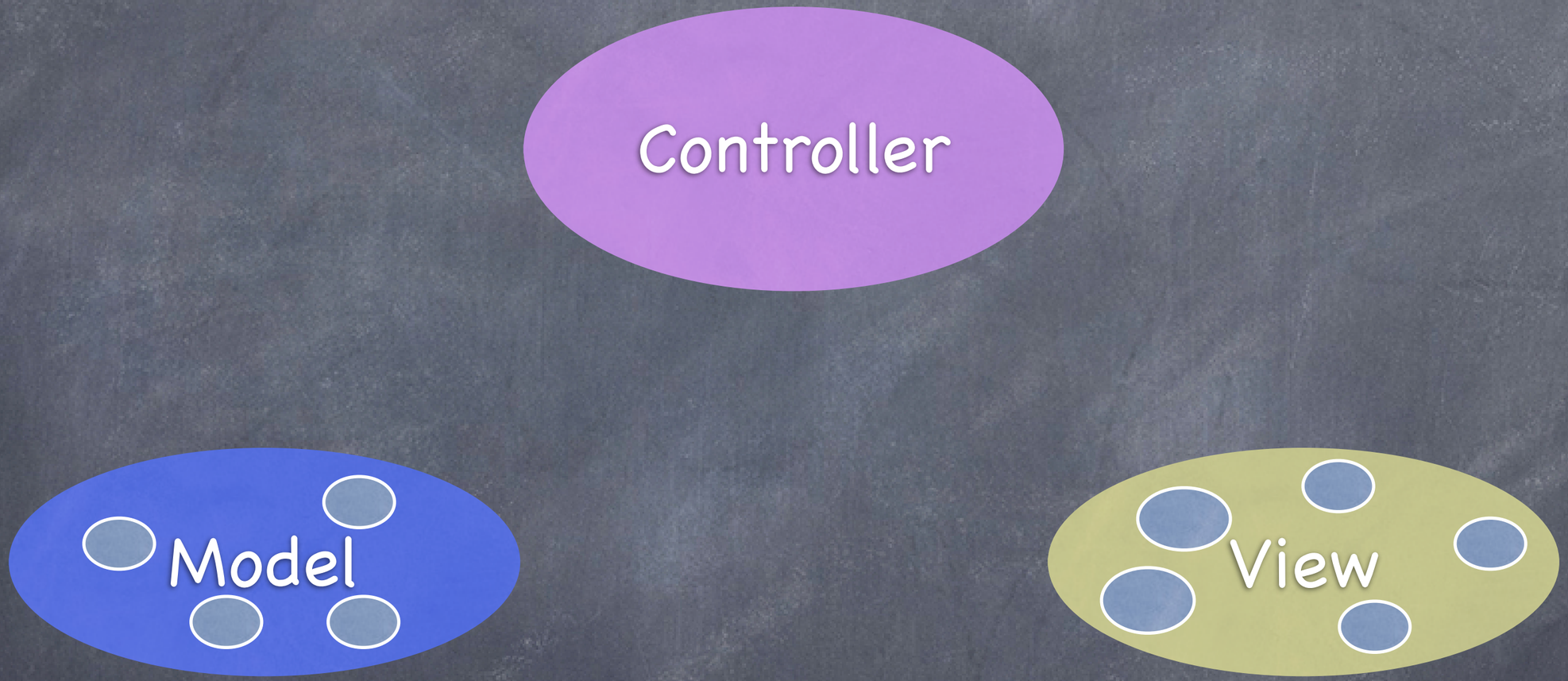
Model = What your application is (but not how it is displayed)

MVC



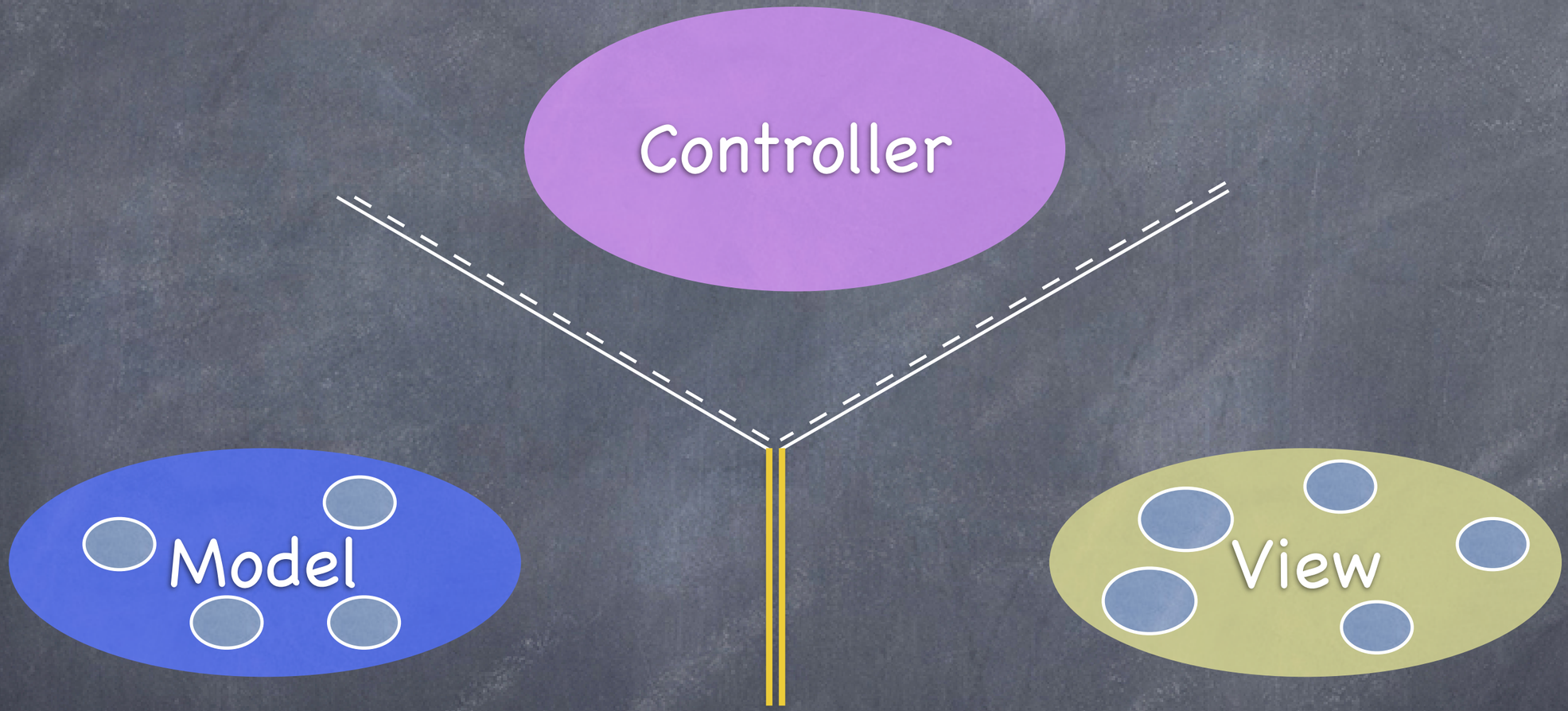
Controller = How your Model is presented to the user (UI logic)

MVC



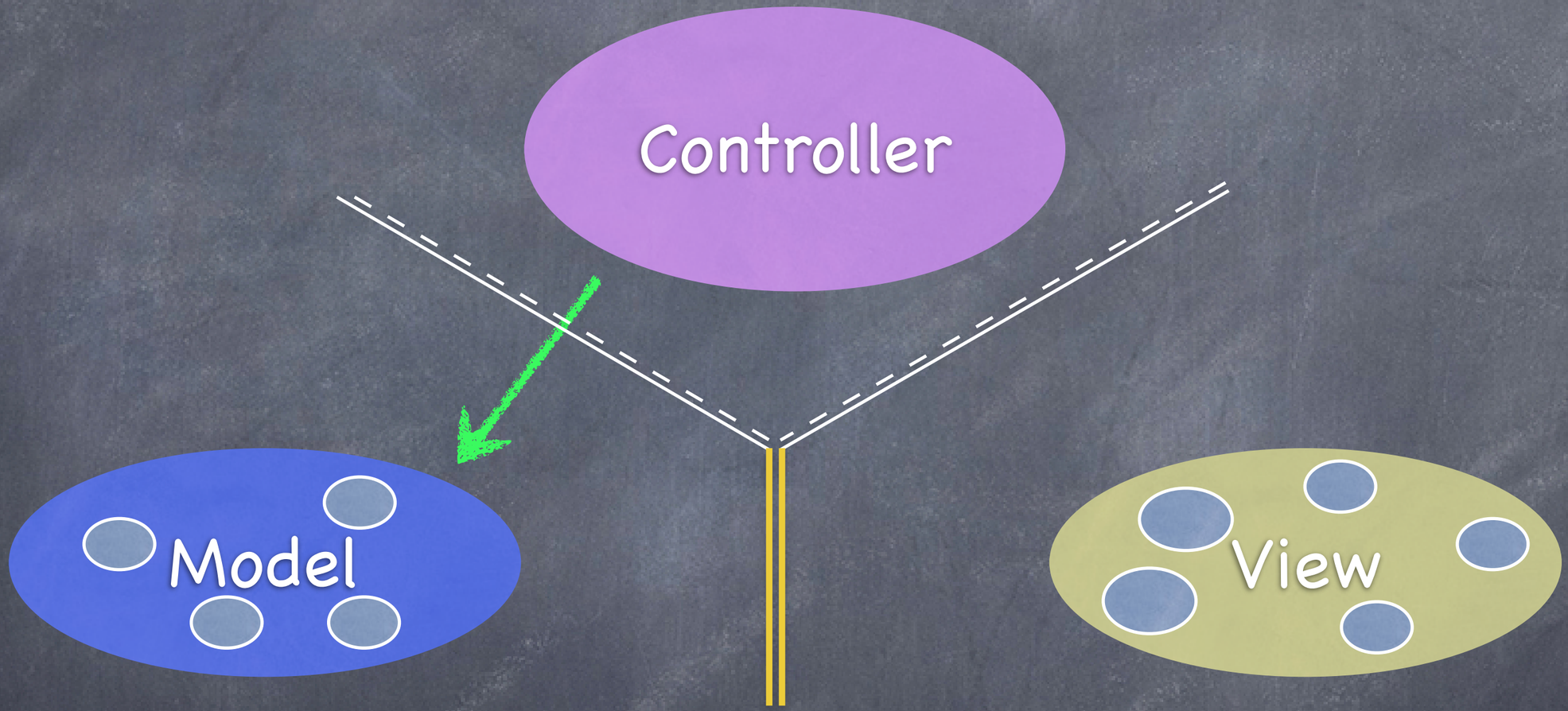
View = Your Controller's minions

MVC



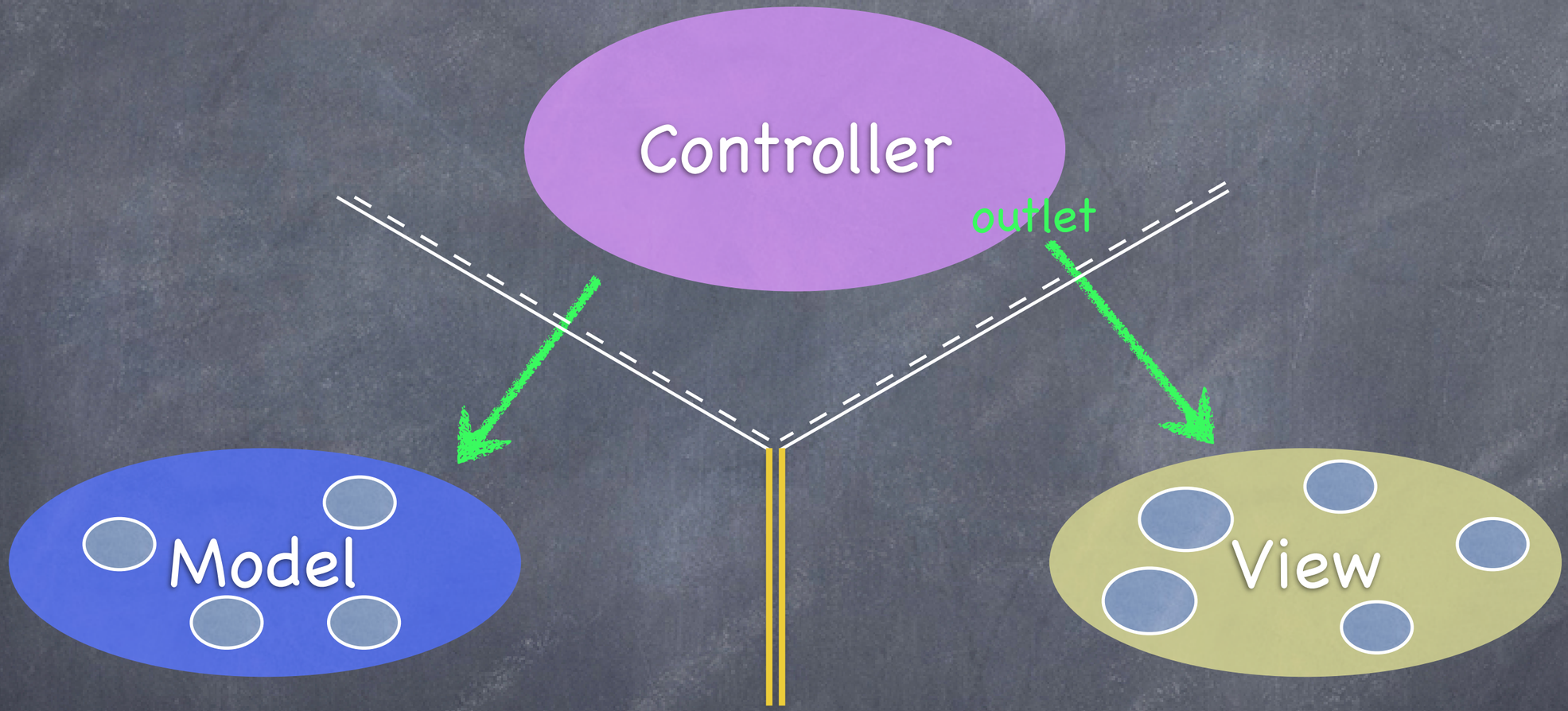
It's all about managing communication between camps

MVC



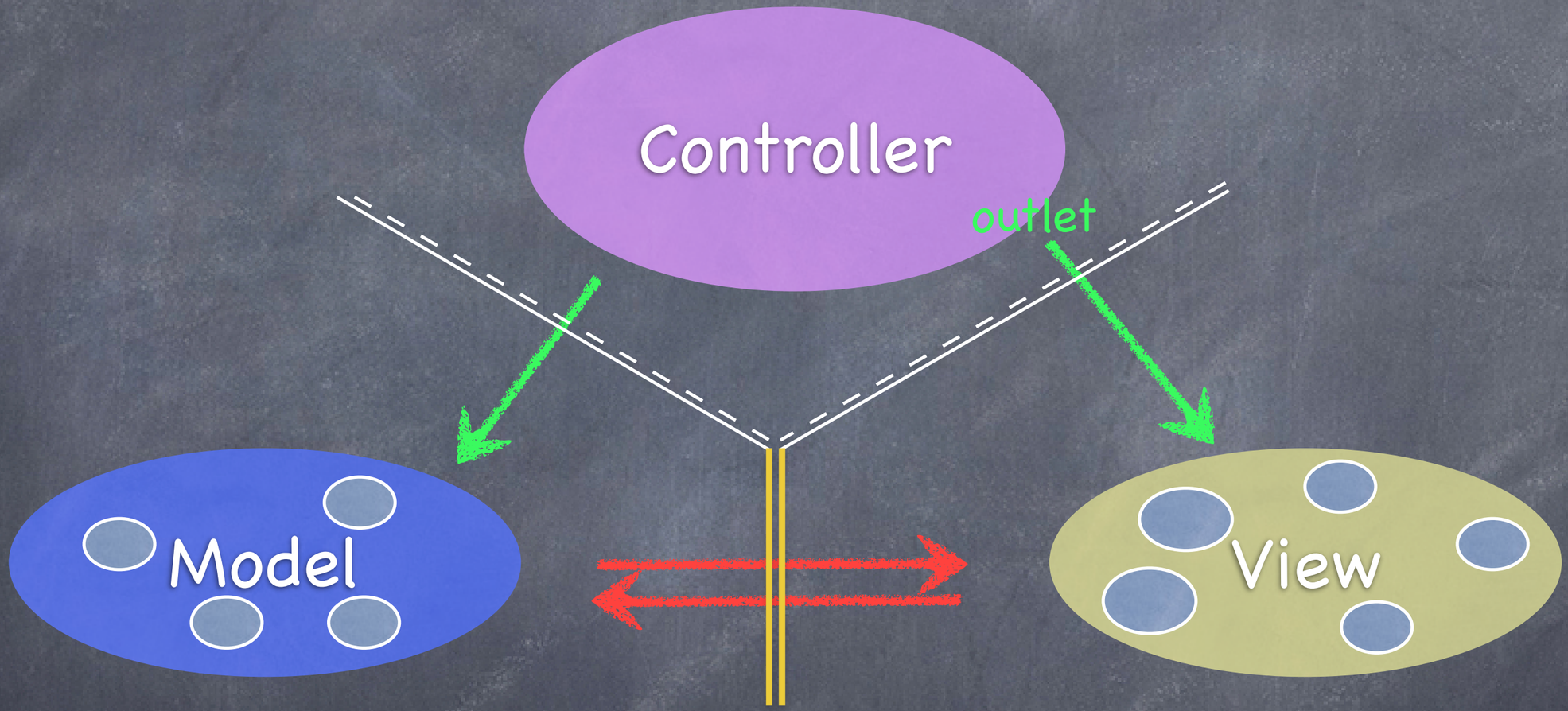
Controllers can always talk directly to their Model.

MVC



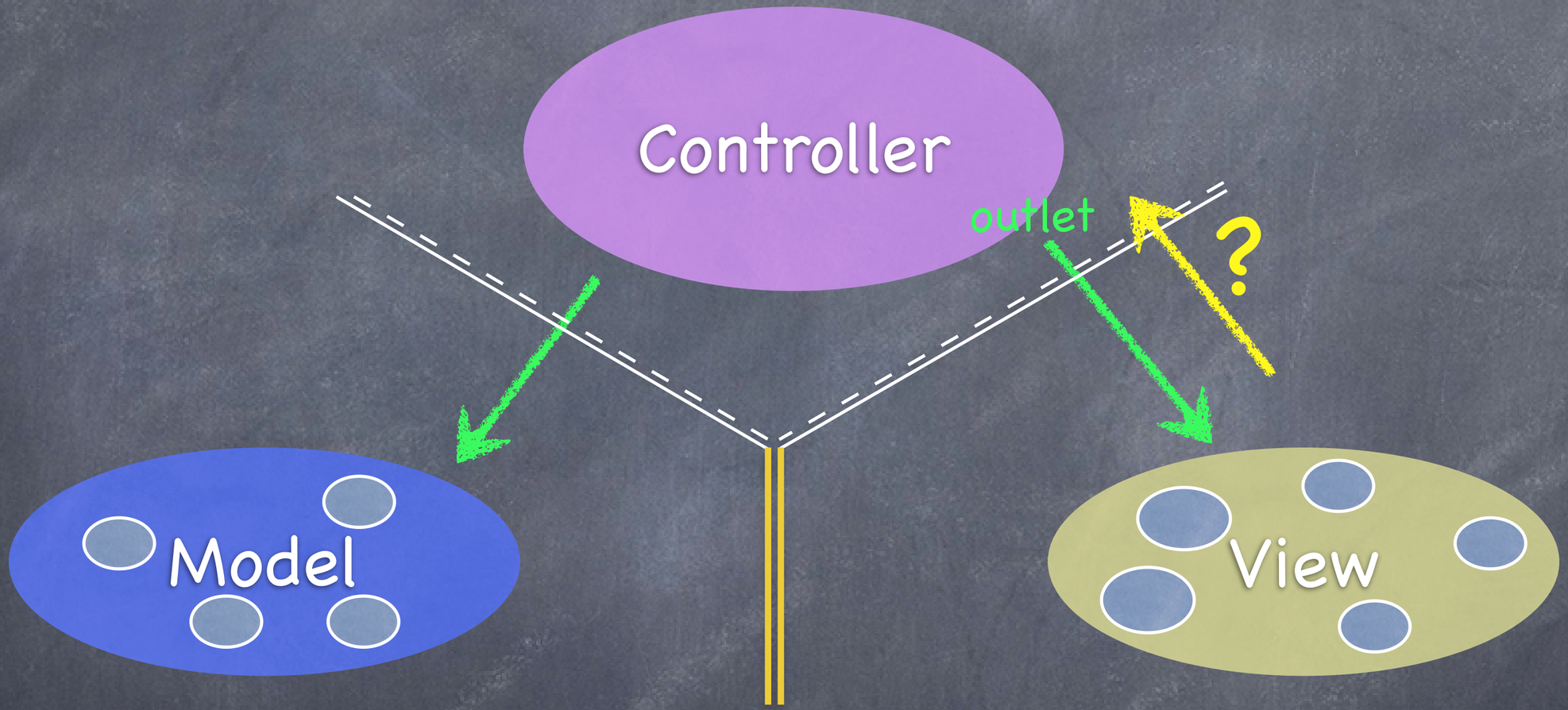
Controllers can also talk directly to their View.

MVC



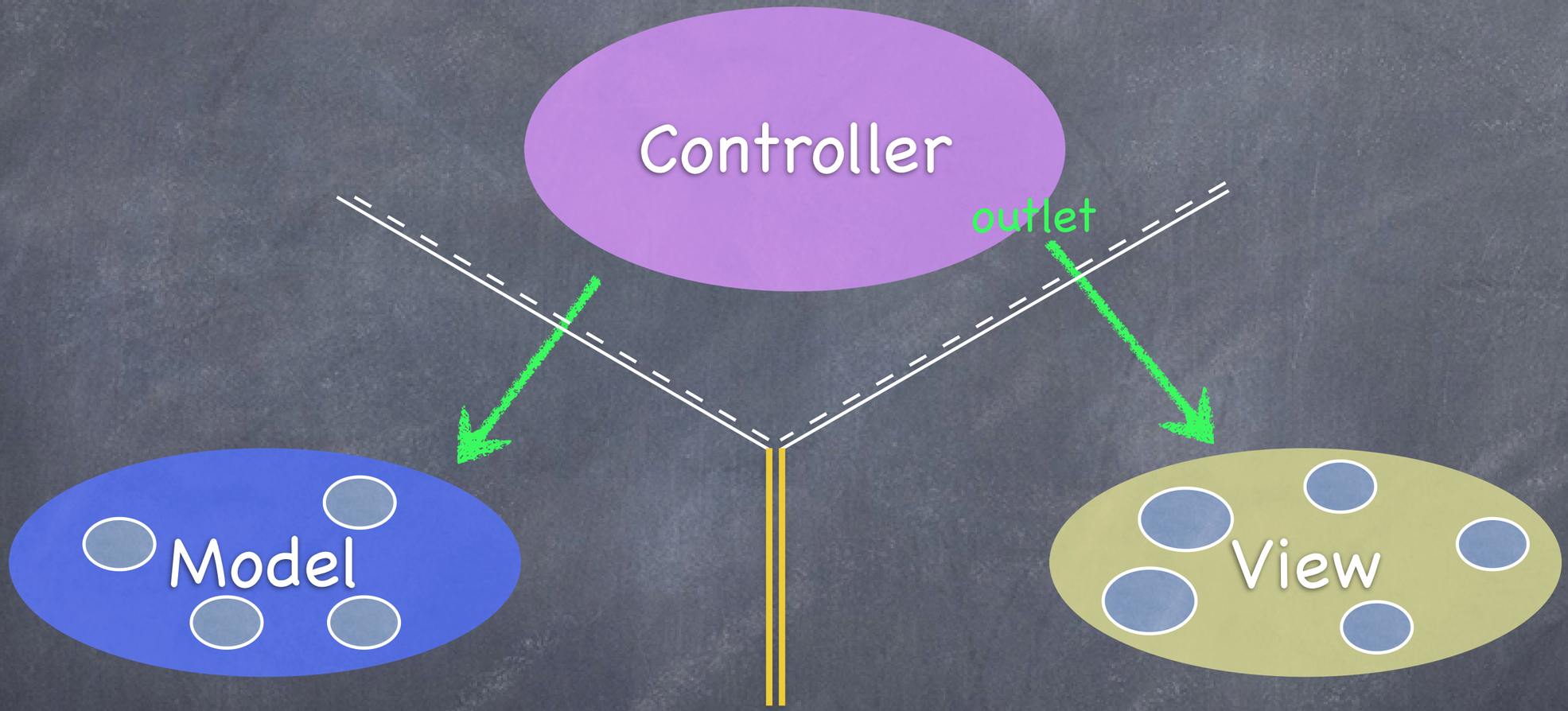
The Model and View should never speak to each other.

MVC



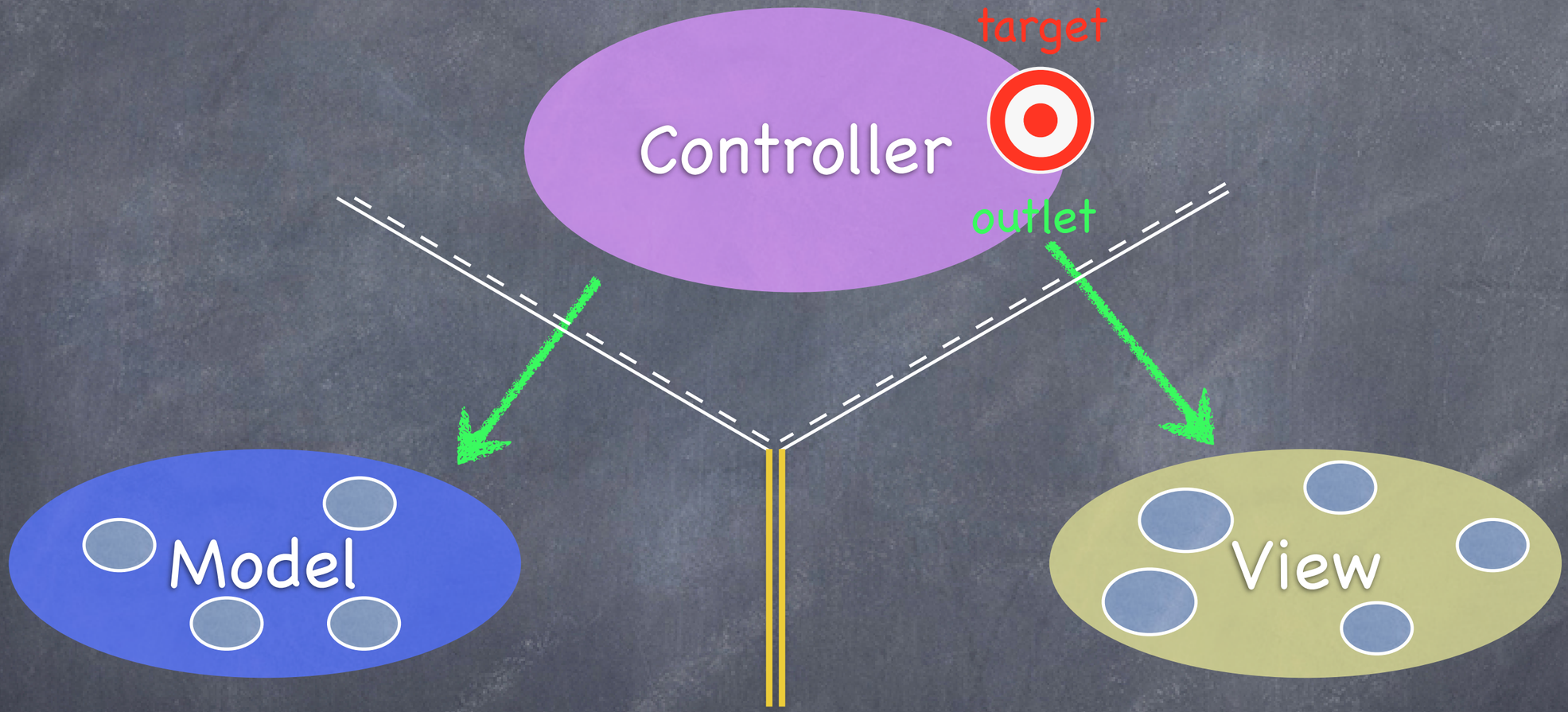
Can the View speak to its Controller?

MVC



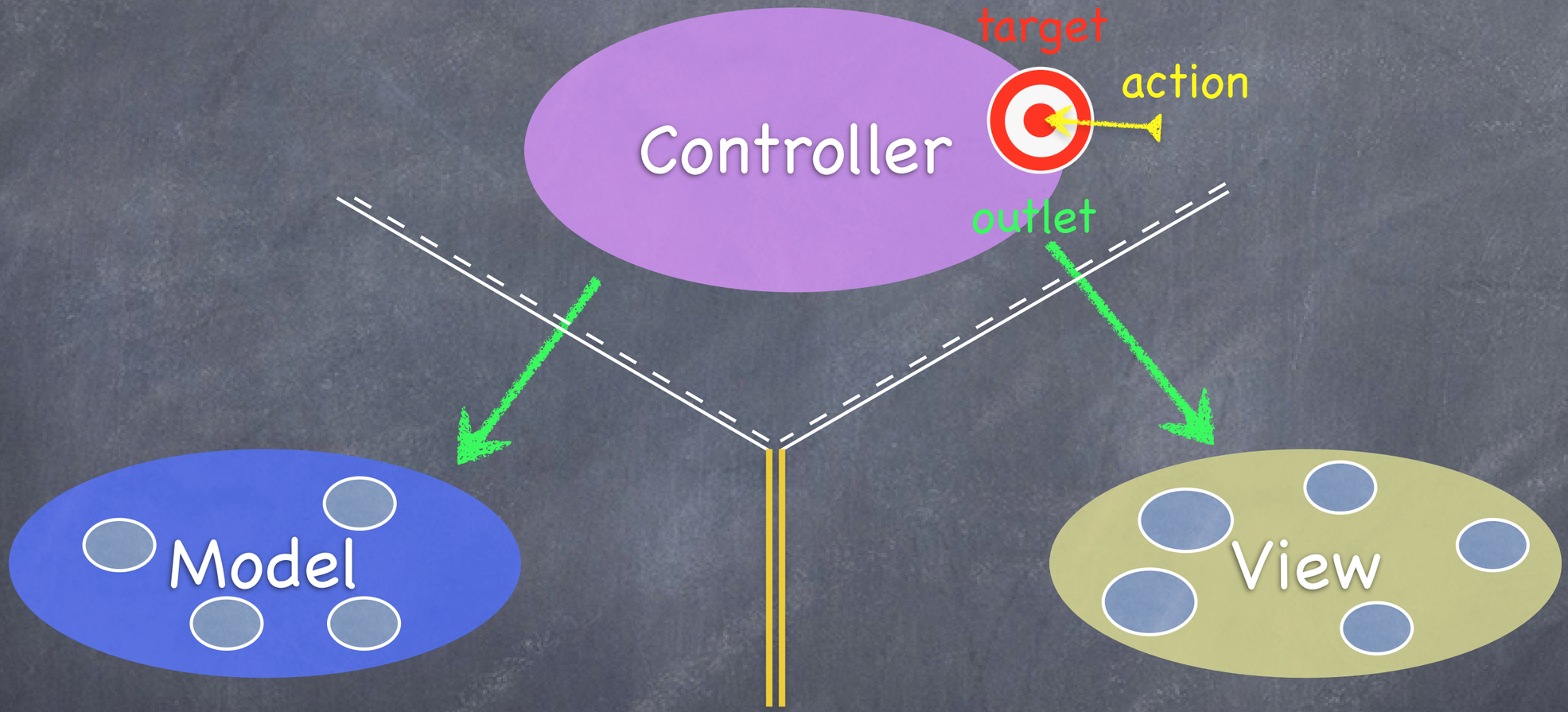
Sort of. Communication is "blind" and structured.

MVC



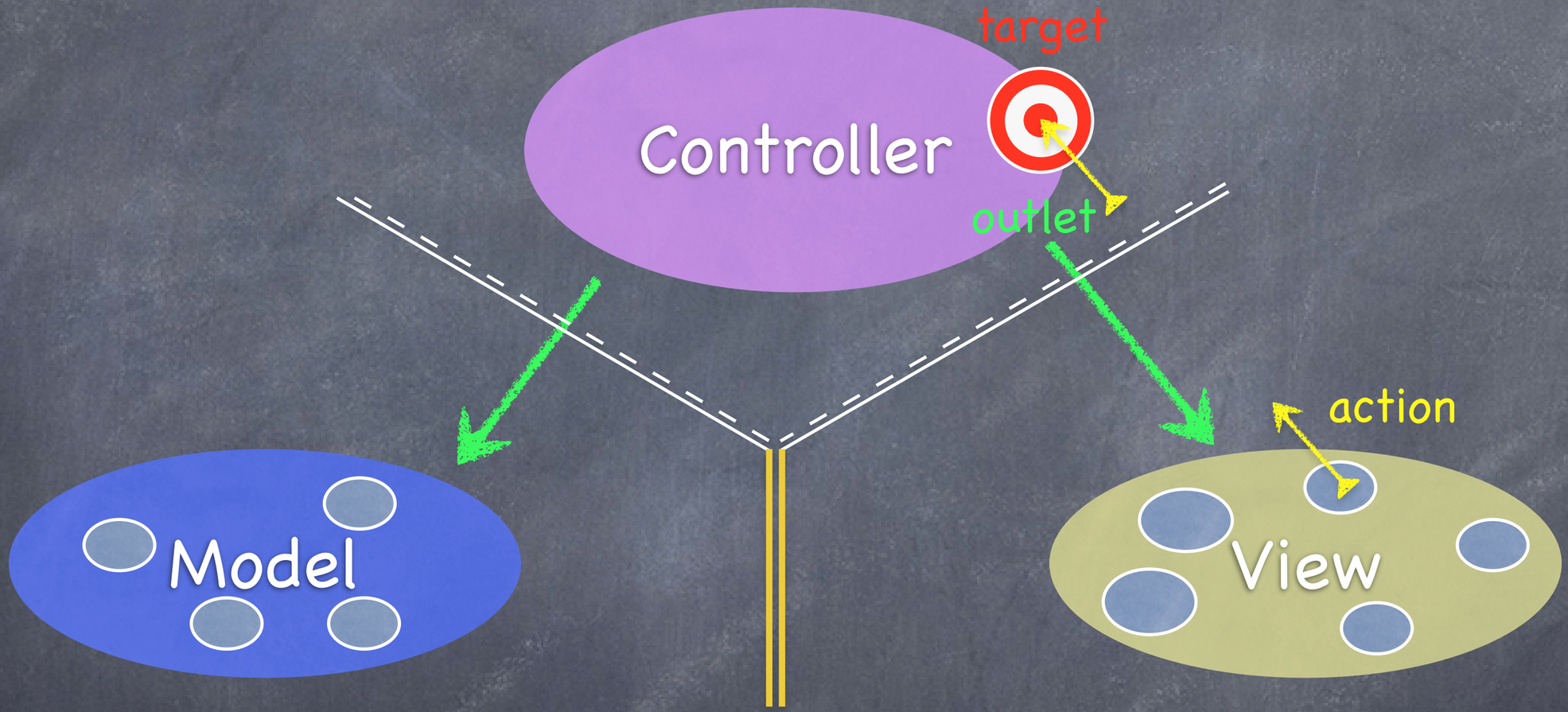
The Controller can drop a target on itself.

MVC



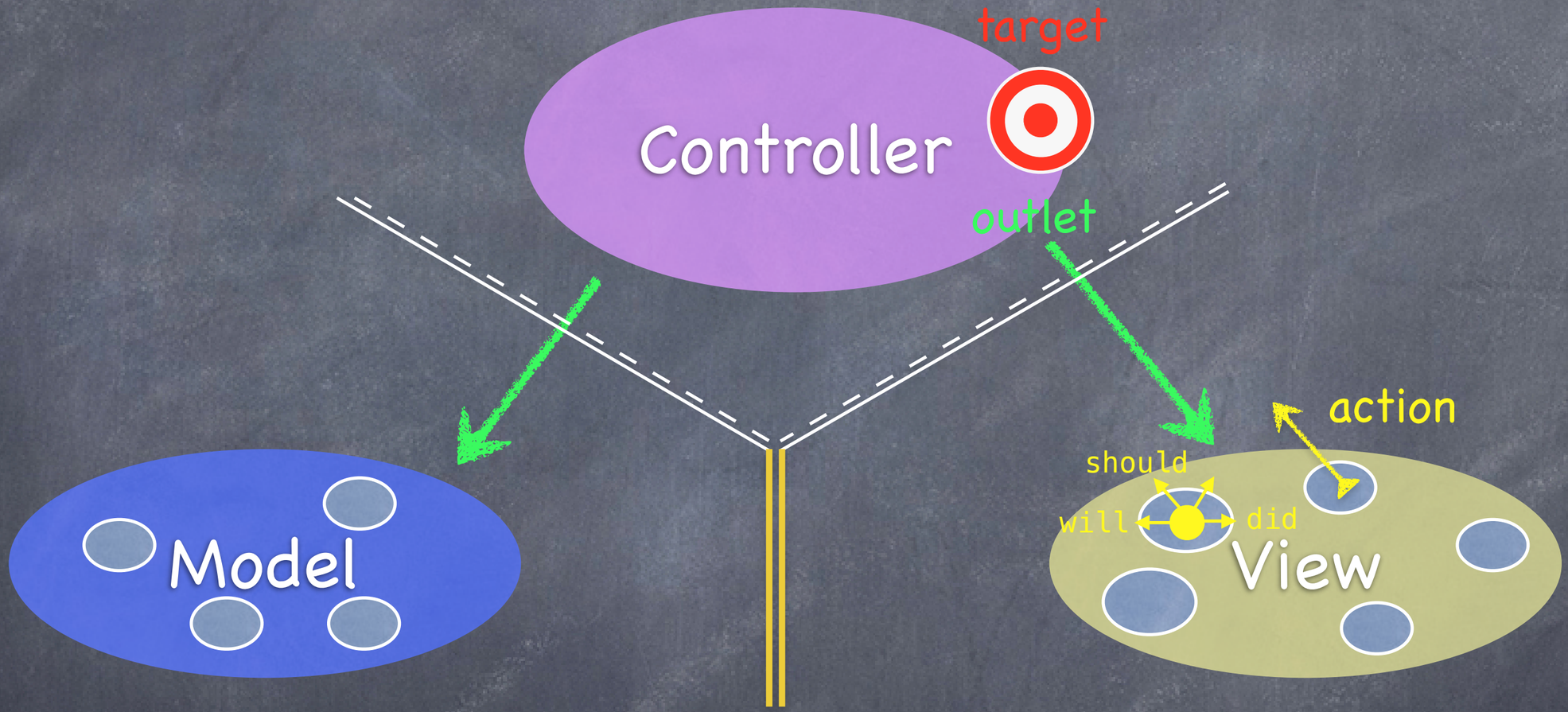
Then hand out an action to the View.

MVC



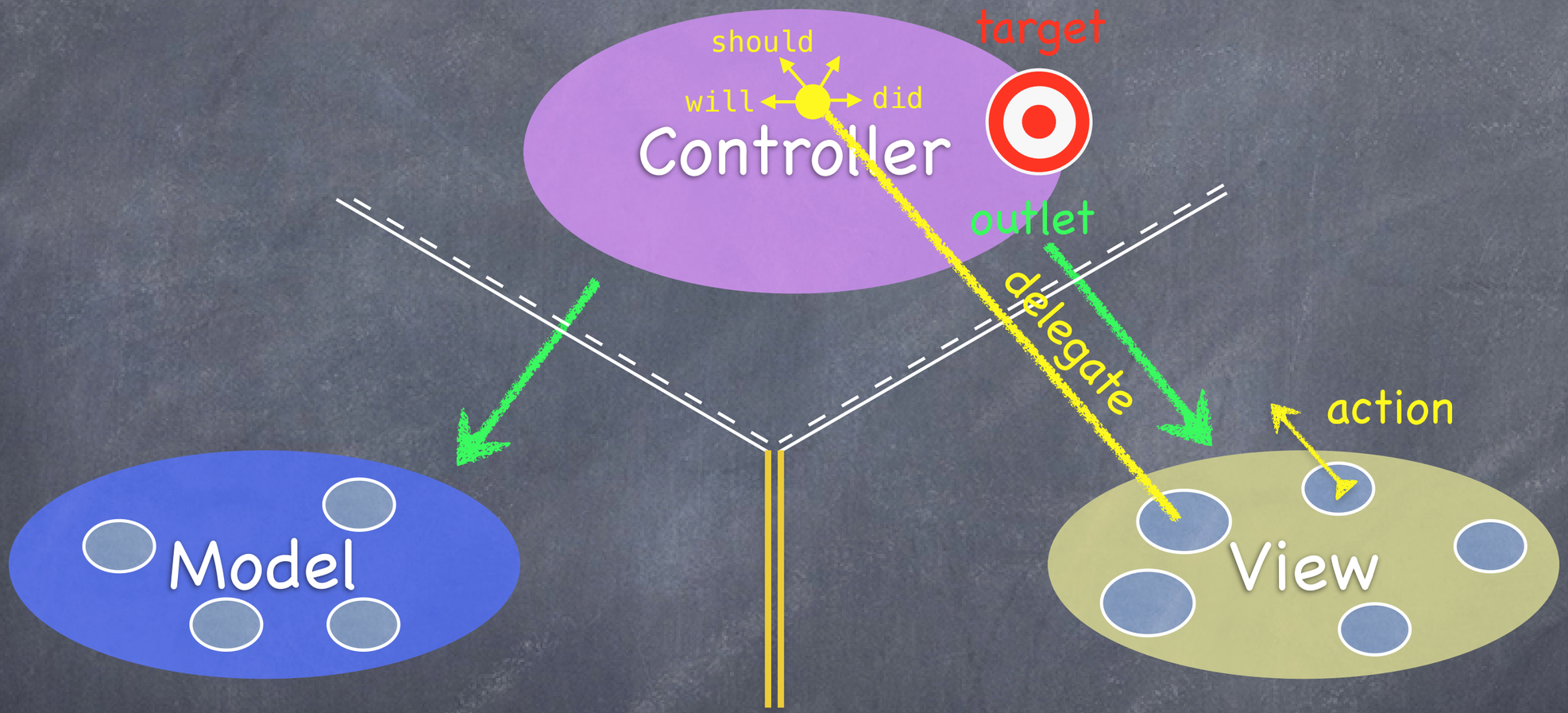
The View sends the action when things happen in the UI.

MVC



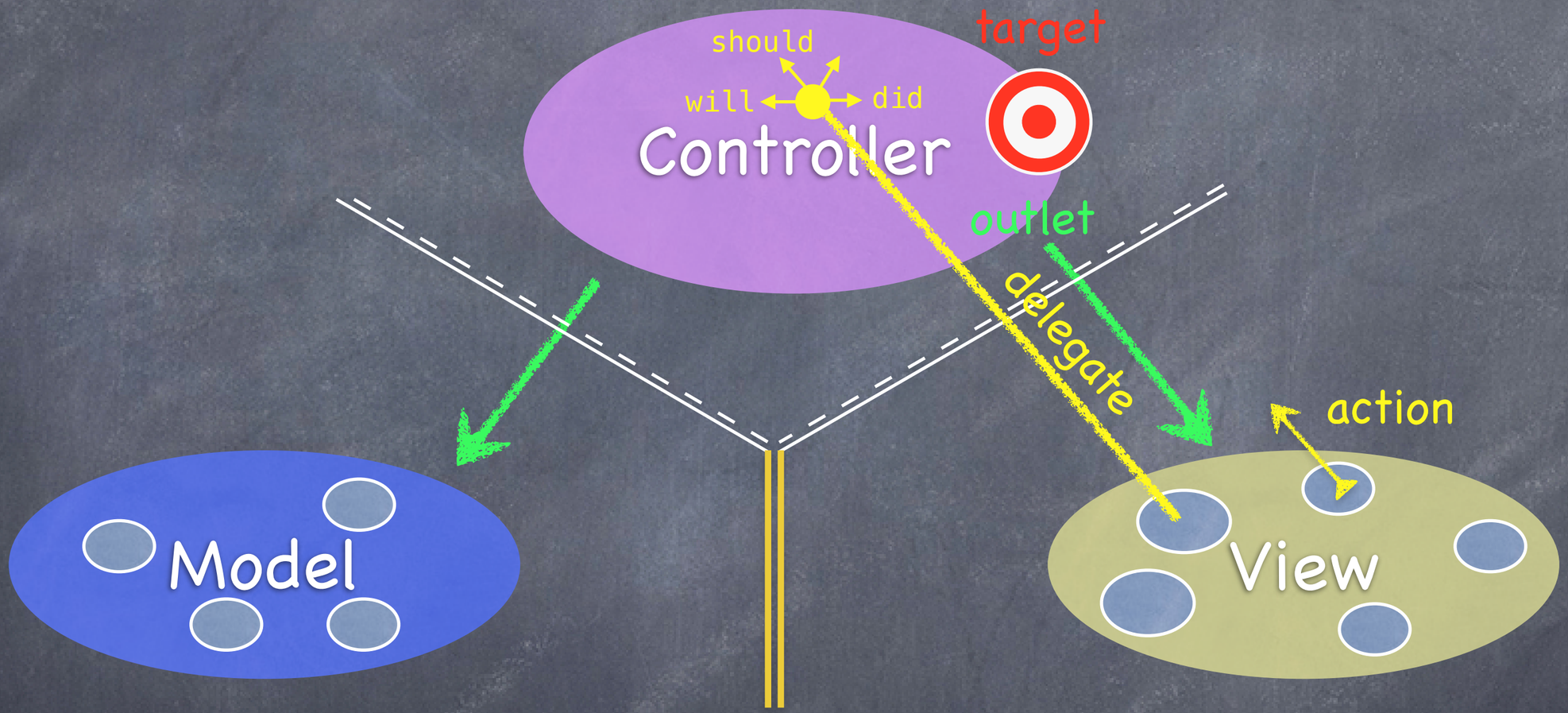
Sometimes the View needs to synchronize with the Controller.

MVC



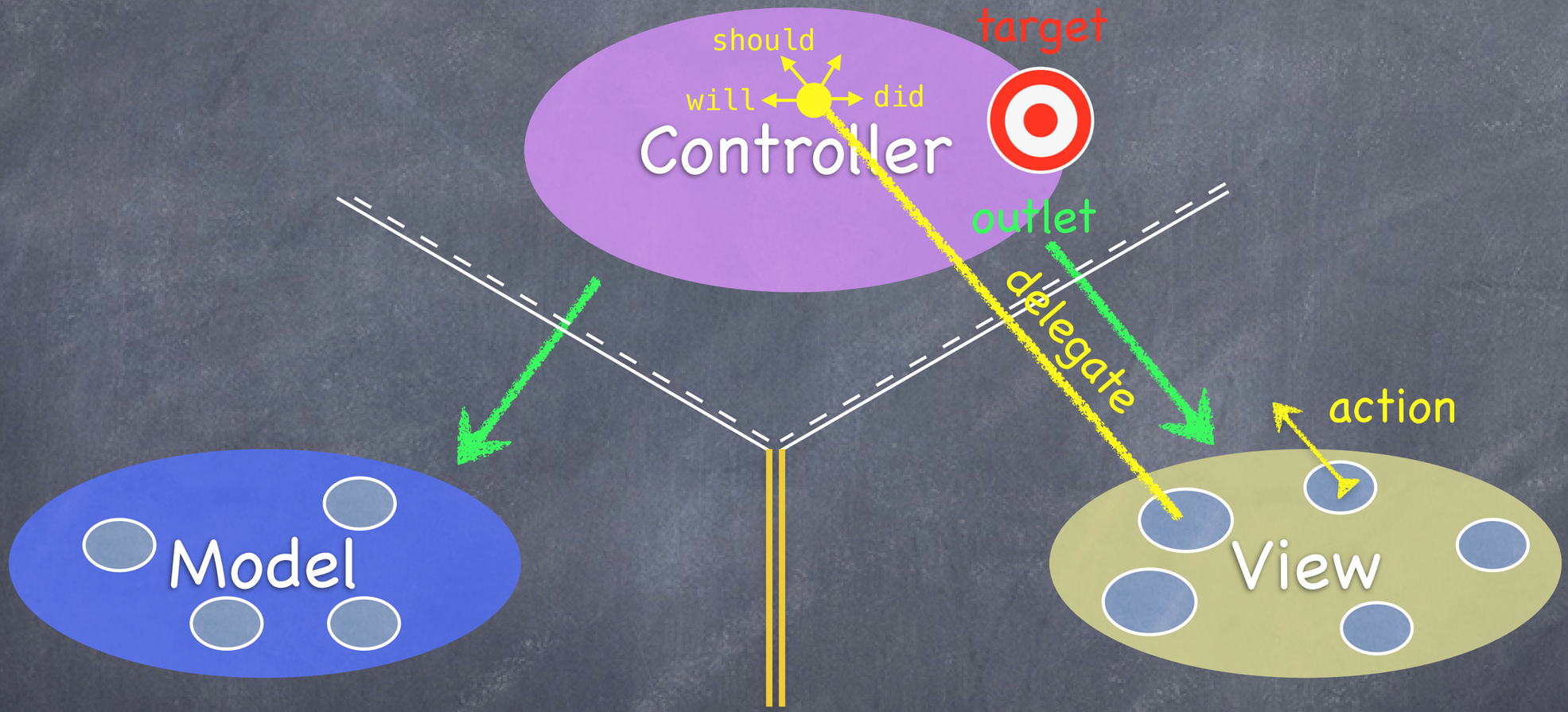
The Controller sets itself as the View's delegate.

MVC



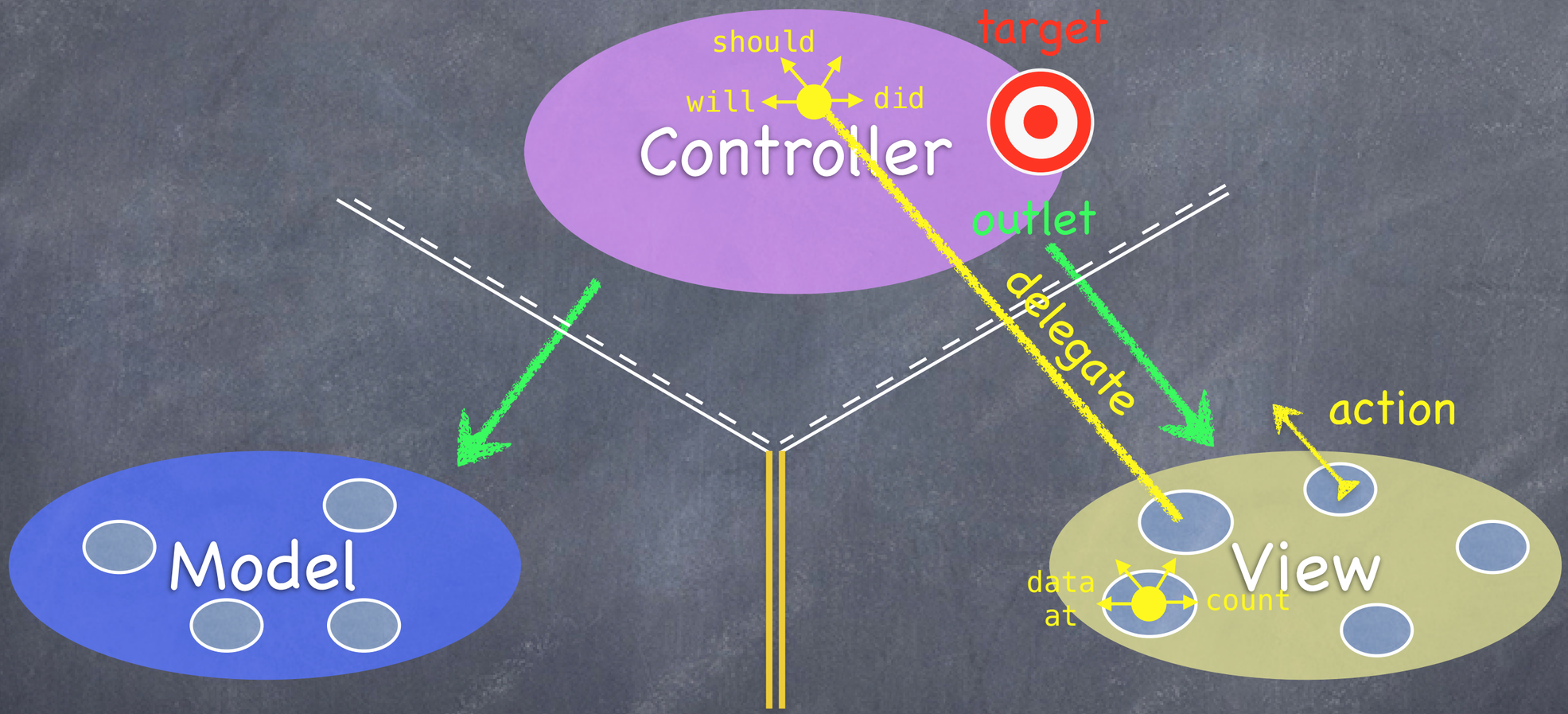
The delegate is set via a protocol (i.e. it's "blind" to class).

MVC



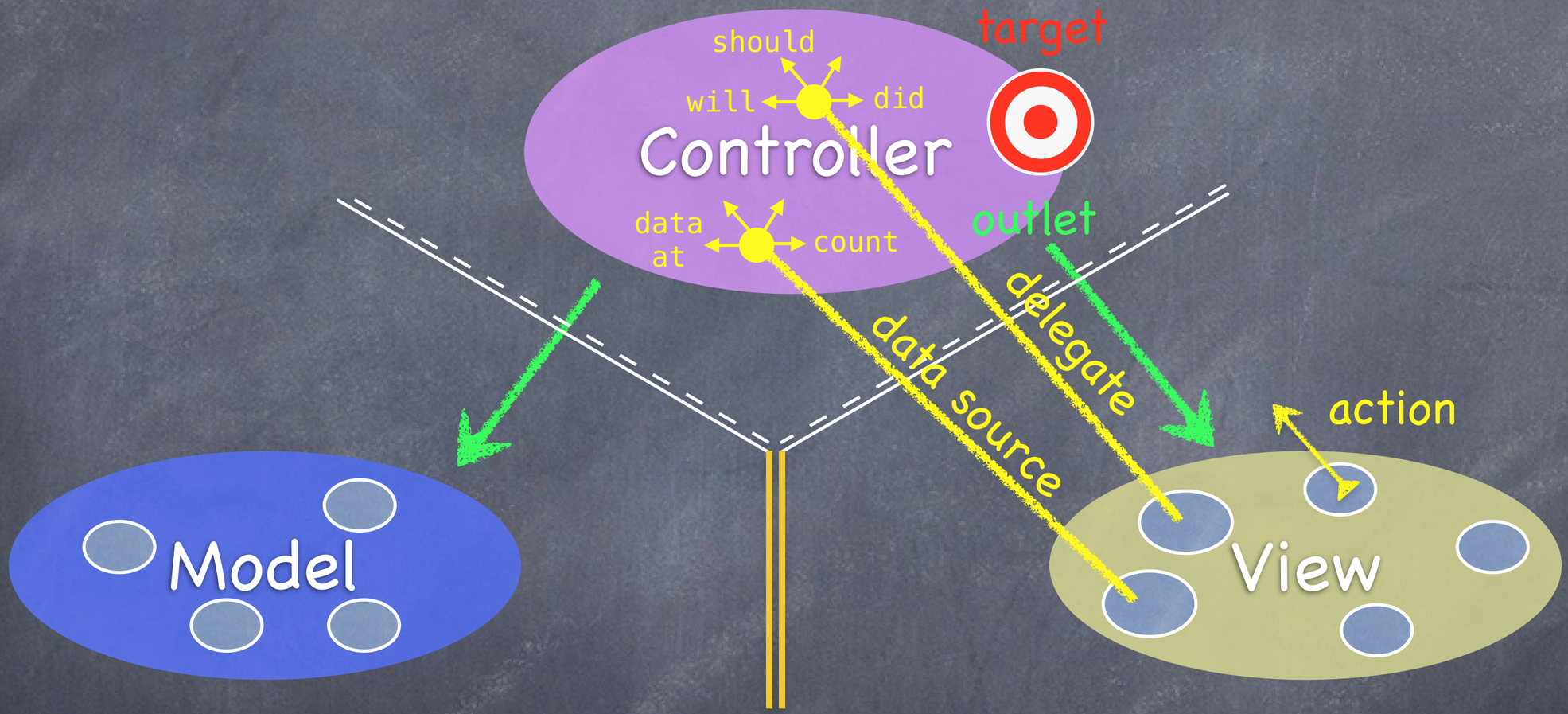
Views do not own the data they display.

MVC



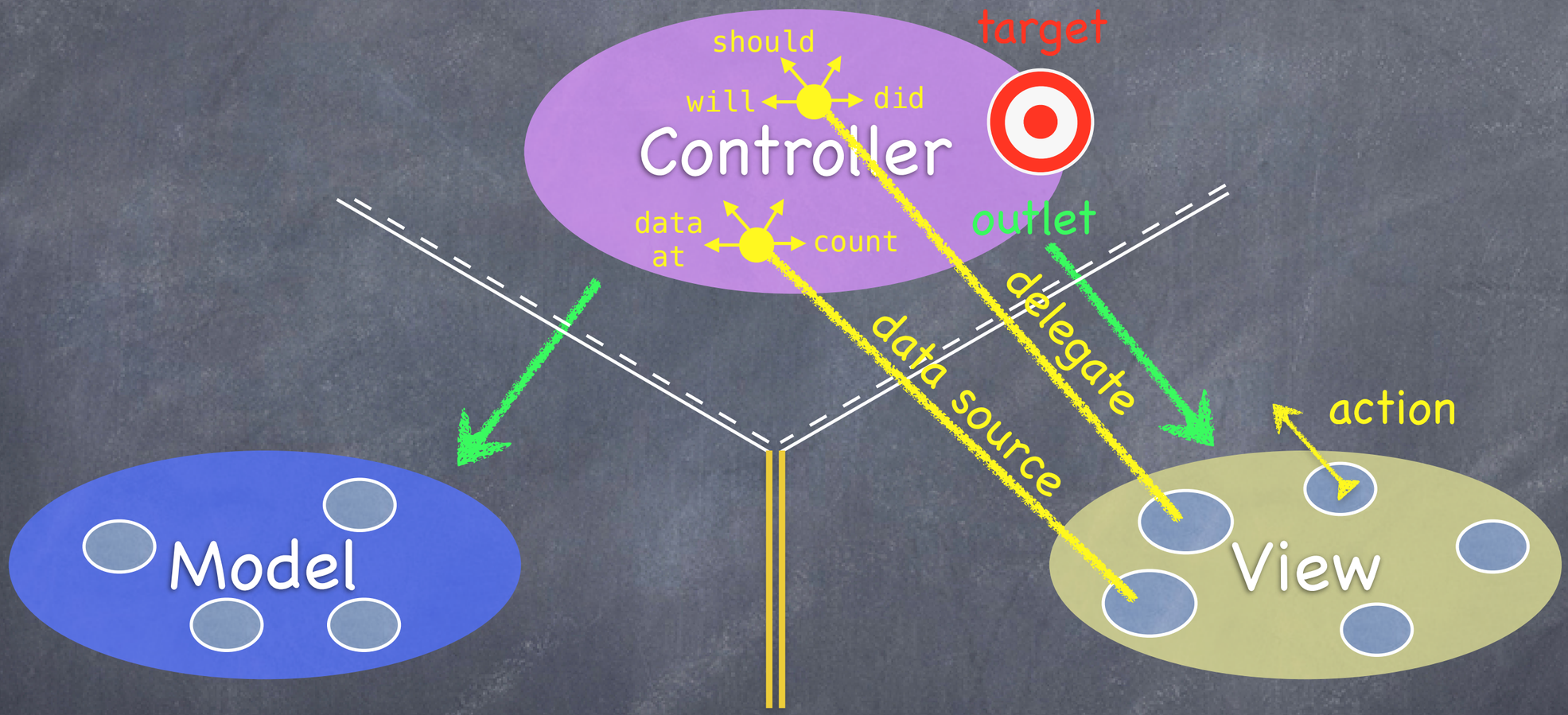
So, if needed, they have a protocol to acquire it.

MVC



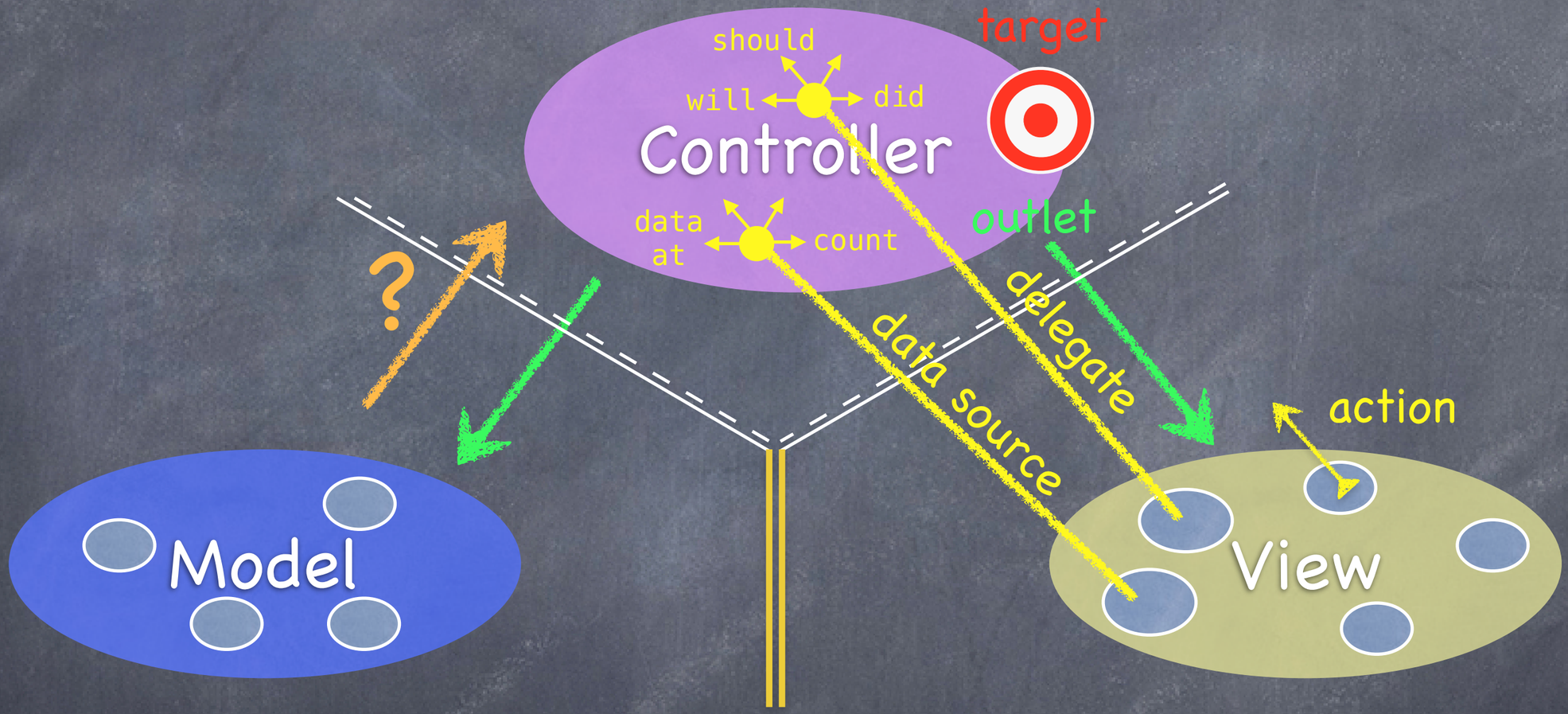
Controllers are almost always that data source (not Model!).

MVC



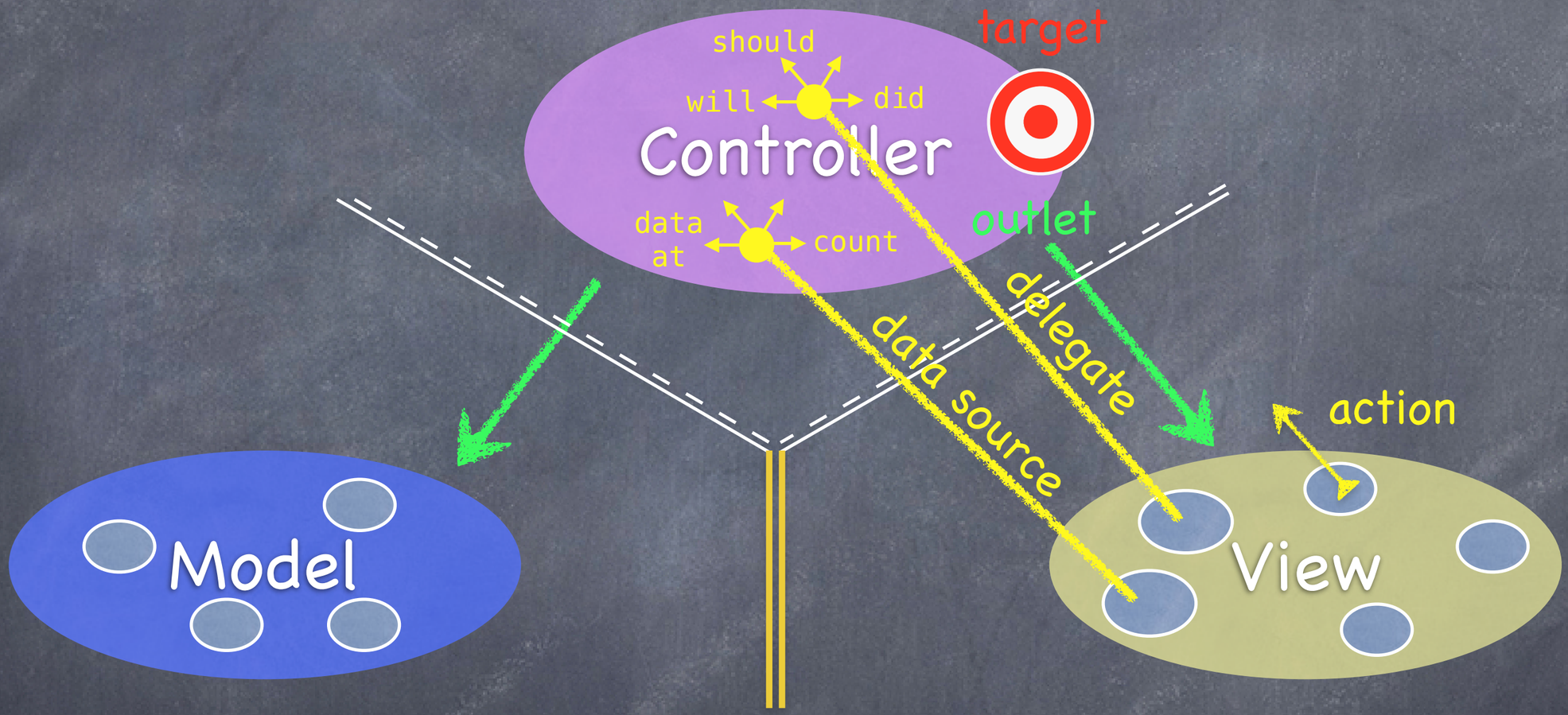
Controllers interpret/format Model information for the View.

MVC



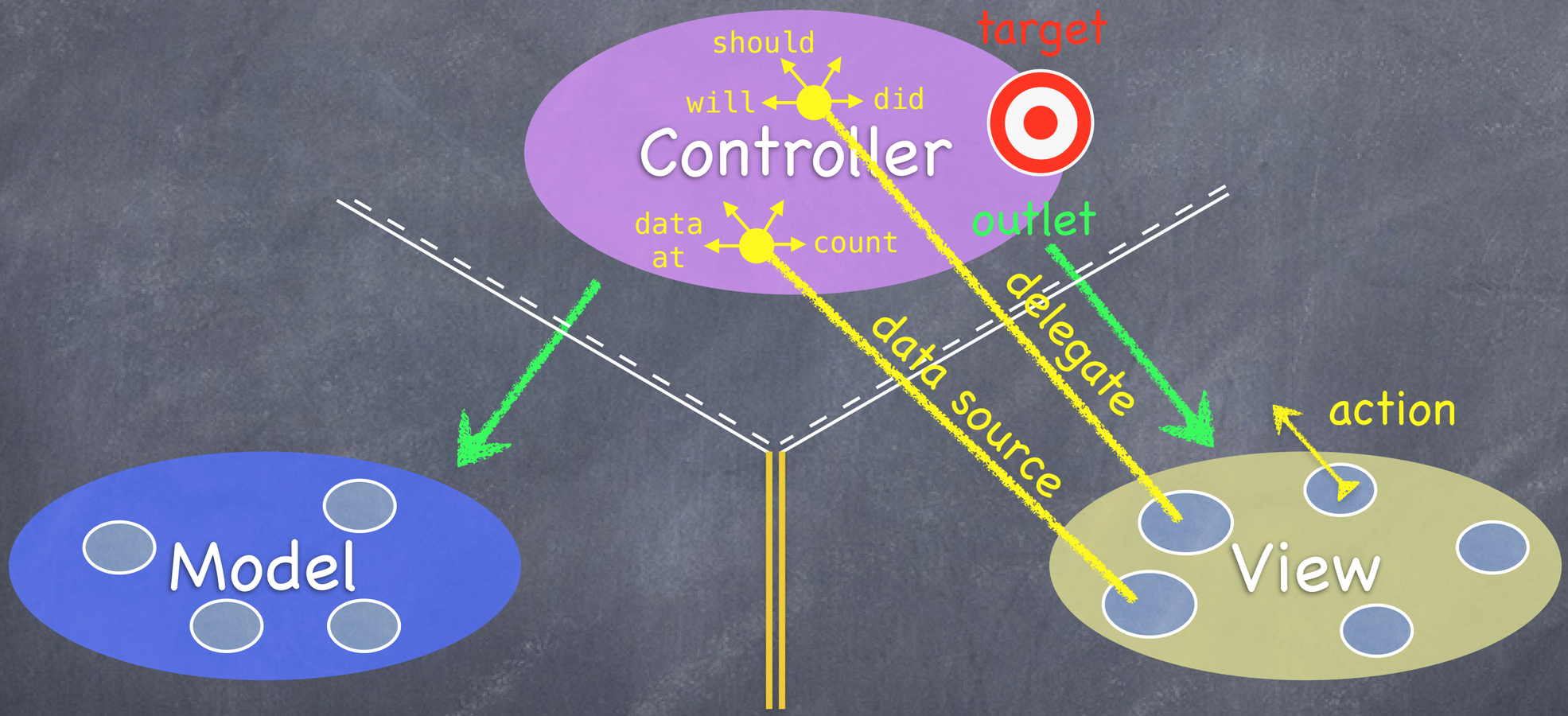
Can the Model talk directly to the Controller?

MVC



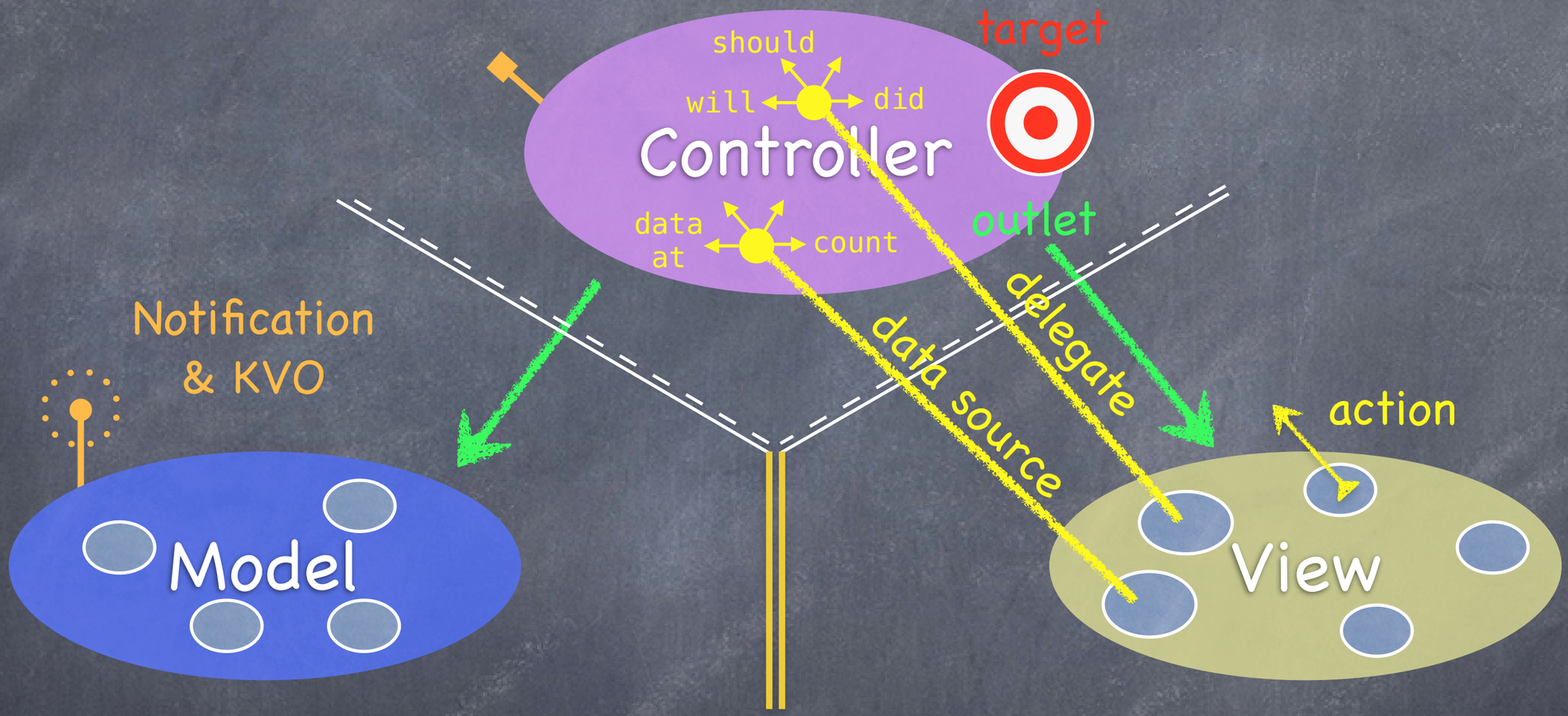
No. The Model is (should be) UI independent.

MVC



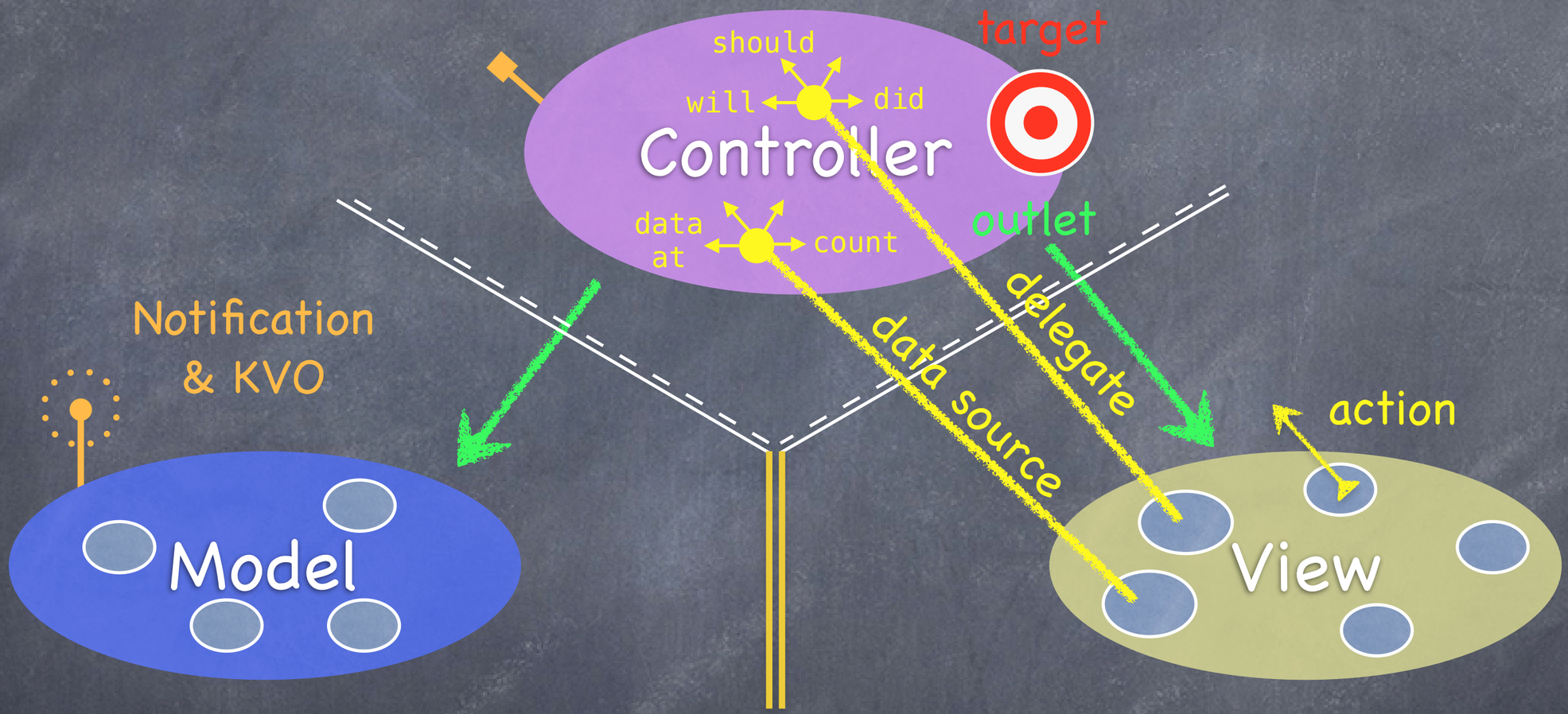
So what if the Model has information to update or something?

MVC



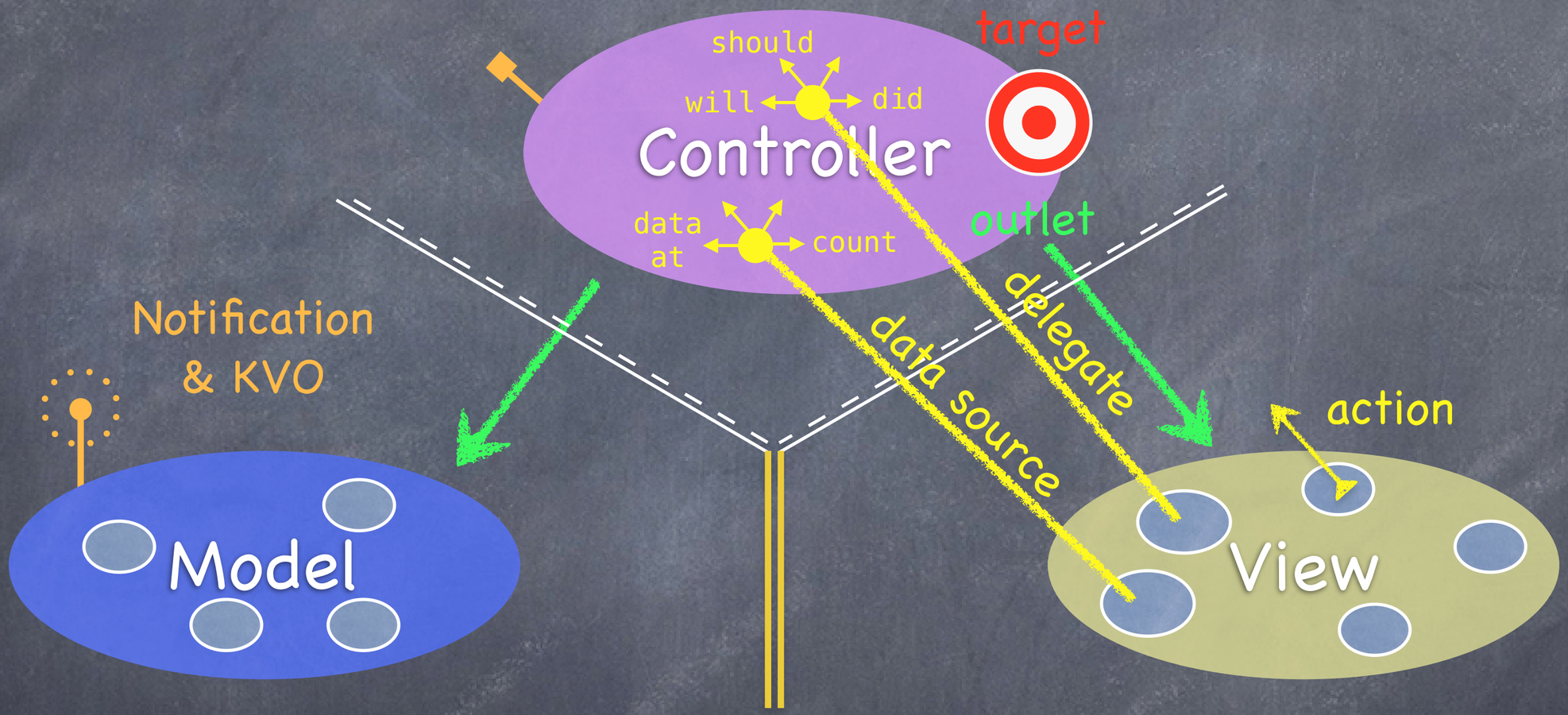
It uses a "radio station"-like broadcast mechanism.

MVC



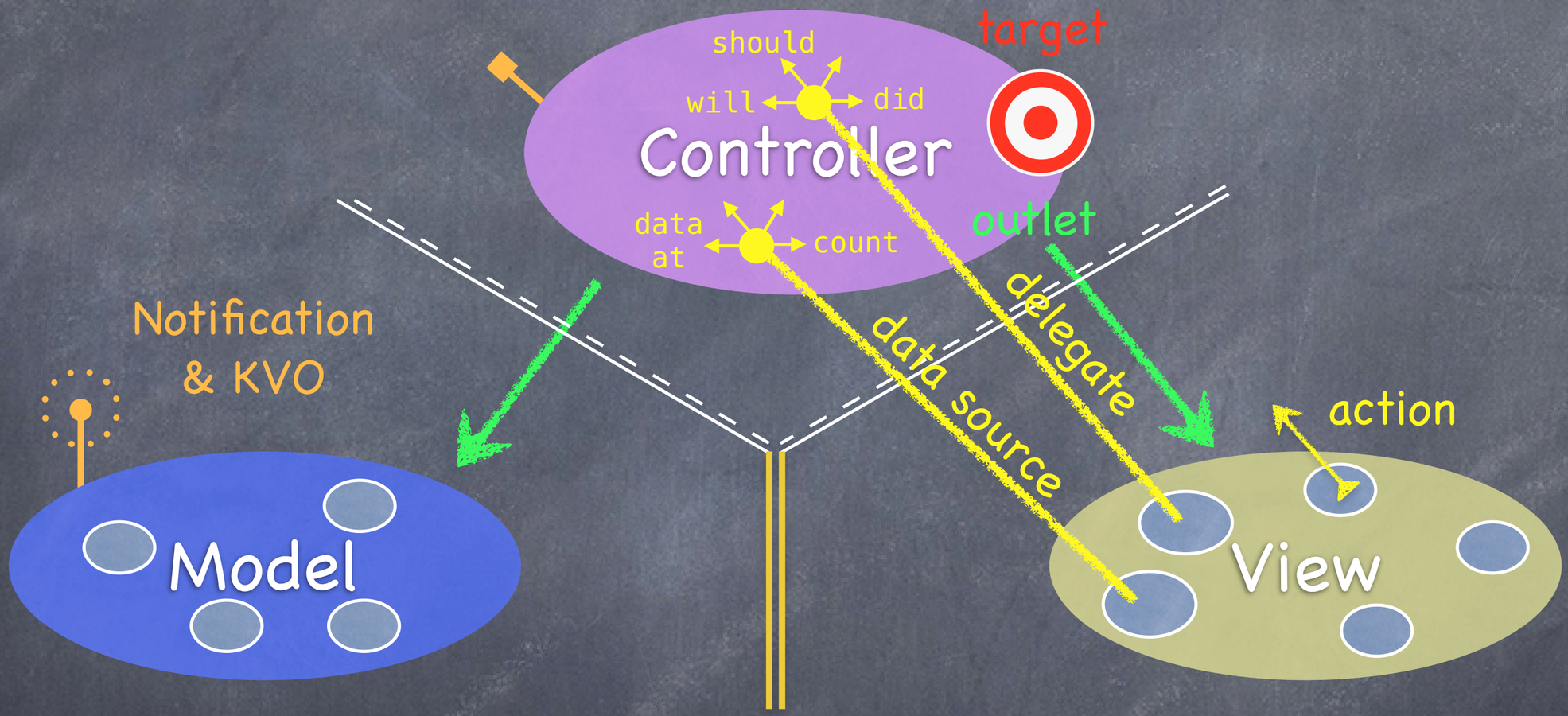
Controllers (or other Model) "tune in" to interesting stuff.

MVC



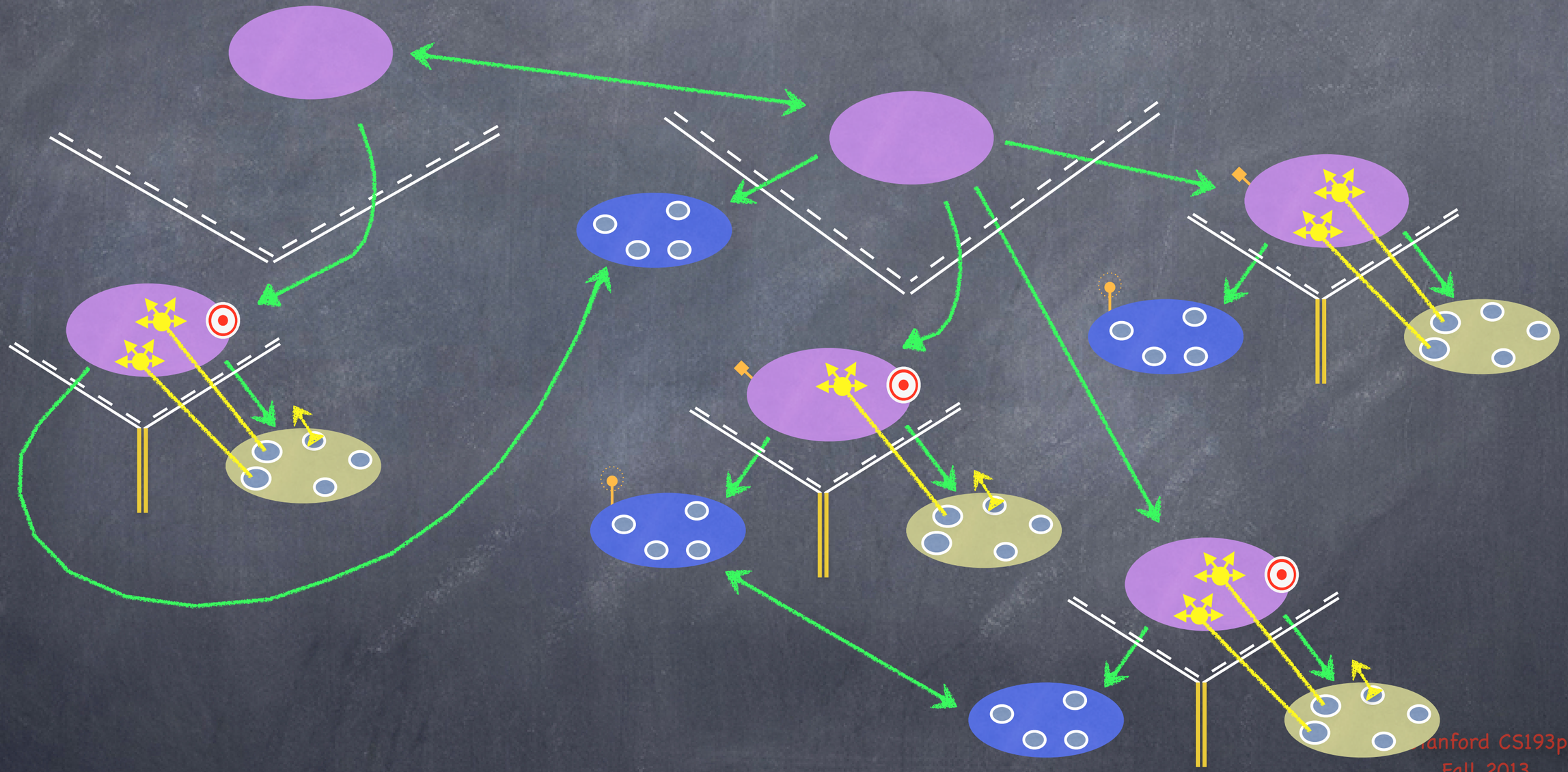
A View might "tune in," but probably not to a Model's "station."

MVC

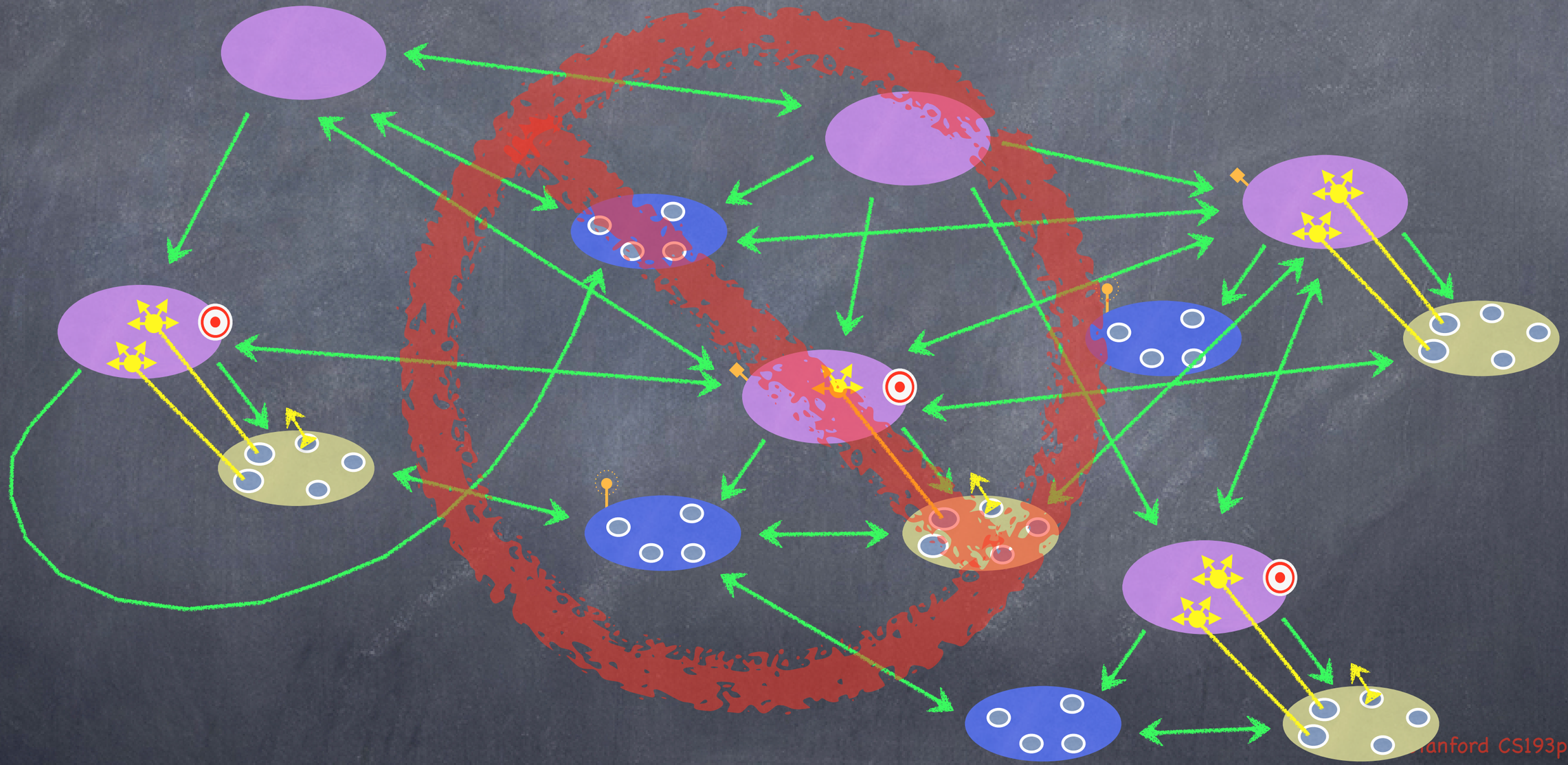


Now combine MVC groups to make complicated programs ...

MVCs working together



MVCs not working together



Objective-C

- New language to learn!
  - Strict superset of C
  - Adds syntax for classes, methods, etc.
  - A few things to "think differently" about (e.g. properties, dynamic binding)
- Most important concept to understand today: Properties
  - Usually we do not access instance variables directly in Objective-C.
  - Instead, we use "properties."
  - A "property" is just the combination of a getter method and a setter method in a class.
  - The getter (usually) has the name of the property (e.g. "myValue")
  - The setter's name is "set" plus capitalized property name (e.g. "setMyValue:")
  - (To make this look nice, we always use a lowercase letter as the first letter of a property name.)
  - We just call the setter to store the value we want and the getter to get it. Simple.
- This is just your first glimpse of this language!
  - We'll go much more into the details next week.
  - Don't get too freaked out by the syntax at this point.

Objective-C

Card.h

Public Declarations

Card.m

Private Implementation

Objective-C

Card.h

Card.m

Its superclass.

```
@interface Card : NSObject
```

The name of this class.

NSObject is the root class from which pretty much all iOS classes inherit (including the classes you author yourself).

Don't forget this!

```
@end
```

Objective-C

Card.h

```
@interface Card : NSObject

@end
```

Card.m

```
@implementation Card

@end
```

Note, superclass is not specified here.

Objective-C

Card.h

```
#import <Foundation/NSObject.h>



@interface Card : NSObject



@end
```

Superclass's header file.

Card.m

```
@implementation Card



@end
```

Objective-C

Card.h

```
#import <Foundation/Foundation.h>



@interface Card : NSObject



@end
```

Card.m

```
@implementation Card

@end
```

If the superclass is in iOS itself, we import the entire "framework" that includes the superclass.
In this case, Foundation, which contains basic non-UI objects like NSObject.

Objective-C

Card.h

```
@import Foundation;

@interface Card : NSObject

@end
```

In fact, in iOS 7 (only), there is special syntax for importing an entire framework called `@import`.

Card.m

```
@implementation Card

@end
```

Objective-C

Card.h

```
#import <Foundation/Foundation.h>



@interface Card : NSObject



@end
```

However, the old framework importing syntax is backwards-compatible in iOS 7.

Card.m

```
@implementation Card



@end
```

Objective-C

Card.h

```
#import <Foundation/Foundation.h>



@interface Card : NSObject



@end
```

Card.m

```
#import "Card.h"



@implementation Card



@end
```

Our own header file must be imported into our implementation file.

Objective-C

Card.h

```
#import <Foundation/Foundation.h>



@interface Card : NSObject



@end
```

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card



@end
```

Private declarations can go here.

Objective-C

Card.h

```
#import <Foundation/Foundation.h>



@interface Card : NSObject

@property (strong) NSString *contents;

@end
```

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card

@end
```

In iOS, we don't access instance variables directly.
Instead, we use an `@property` which declares two methods: a "setter" and a "getter".
It is with those two methods that the `@property`'s instance variable is accessed
(both publicly and privately).

This particular `@property` is a pointer.
Specifically, a pointer to an object whose class is (or inherits from) `NSString`.

ALL objects live in the heap (i.e. are pointed to) in Objective-C!
Thus you would never have a property of type "`NSString`" (rather, "`NSString *`").

Because this `@property` is in this class's header file, it is public.
Its setter and getter can be called from outside this class's `@implementation` block.

Objective-C

Card.h

```
#import <Foundation/Foundation.h>



@interface Card : NSObject

@property (strong) NSString *contents;


@end
```

`strong` means:
"keep the object that this property points to
in memory until I set this property to `nil` (zero)
(and it will stay in memory until everyone who has a `strong`
pointer to it sets their property to `nil` too)"

`weak` would mean:
"if no one else has a `strong` pointer to this object,
then you can throw it out of memory
and set this property to `nil`
(this can happen at any time)"

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card



@end
```

Objective-C

Card.h

```
#import <Foundation/Foundation.h>



@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;



@end
```

nonatomic means:
"access to this property is not thread-safe".
We will always specify this for object pointers in this course.
If you do not, then the compiler will generate locking code that will complicate your code elsewhere.

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card



@end
```

Objective-C

Card.h

```
#import <Foundation/Foundation.h>




@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;

@end
```

This is the @property implementation that the compiler generates automatically for you (behind the scenes).
You are welcome to write the setter or getter yourself, but this would only be necessary if you needed to do something in addition to simply setting or getting the value of the property.

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card

@synthesize contents = _contents;

- (NSString *)contents
{
    return _contents;
}

- (void)setContents:(NSString *)contents
{
    _contents = contents;
}

@end
```

This @synthesize is the line of code that actually creates the backing instance variable that is set and gotten.
Notice that by default the backing variable's name is the same as the property's name but with an underbar in front.

Objective-C

Card.h

```
#import <Foundation/Foundation.h>



@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;









@end
```

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card
```

Because the compiler takes care of everything you need to implement a property, it's usually only one line of code (the `@property` declaration) to add one to your class.

```
@end
```

Objective-C

Card.h

```
#import <Foundation/Foundation.h>


@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;

@property (nonatomic) BOOL chosen;
@property (nonatomic) BOOL matched;


@end
```

Notice no strong or weak here.
Primitive types are not stored in the heap, so there's no need to specify how the storage for them in the heap is treated.

Let's look at some more properties.
These are not pointers.
They are simple BOOLs.

Properties can be any C type.
That includes int, float, etc., even C structs.

C does not define a "boolean" type.
This BOOL is an Objective-C typedef.
It's values are YES or NO.

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card


@end
```

Objective-C

Card.h

```
#import <Foundation/Foundation.h>




@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;

@property (nonatomic) BOOL chosen;
@property (nonatomic) BOOL matched;









@end
```

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card

@synthesize chosen = _chosen;
@synthesize matched = _matched;

- (BOOL)chosen
{
    return _chosen;
}
- (void)setChosen:(BOOL)chosen
{
    _chosen = chosen;
}

- (BOOL)matched
{
    return _matched;
}
- (void)setMatched:(BOOL)matched
{
    _matched = matched;
}

@end
```

Here's what the compiler is doing behind the scenes for these two properties.

Objective-C

Card.h

```
#import <Foundation/Foundation.h>



@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;

@property (nonatomic, getter=isChosen) BOOL chosen;
@property (nonatomic, getter=isMatched) BOOL matched;



@end
```

It is actually possible to change the name of the getter that is generated. The only time you'll ever see that done in this class (or anywhere probably) is boolean getters.

This is done simply to make the code "read" a little bit nicer. You'll see this in action later.

Card.m

```
#import "Card.h"

@interface Card()
@end

@implementation Card

@synthesize chosen = _chosen;
@synthesize matched = _matched;

- (BOOL)isChosen
{
    return _chosen;
}
- (void)setChosen:(BOOL)chosen
{
    _chosen = chosen;
}

- (BOOL)isMatched
{
    return _matched;
}
- (void)setMatched:(BOOL)matched
{
    _matched = matched;
}

@end
```

Note change in getter method.

Note change in getter method.

Objective-C

Card.h

```
#import <Foundation/Foundation.h>




@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;

@property (nonatomic, getter=isChosen) BOOL chosen;
@property (nonatomic, getter=isMatched) BOOL matched;









@end
```

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card
```

Remember, unless you need to do something besides setting or getting when a property is being set or gotten, the implementation side of this will all happen automatically for you.

```
@end
```

Objective-C

Card.h

```
#import <Foundation/Foundation.h>




@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;

@property (nonatomic, getter=isChosen) BOOL chosen;
@property (nonatomic, getter=isMatched) BOOL matched;

- (int)match:(Card *)card;




@end
```

Enough properties for now.
Let's take a look at defining methods.

Here's the declaration of a public method called `match:` which takes one argument (a pointer to a `Card`) and returns an `integer`.

What makes this method public?
Because we've declared it in the header file.

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card




@end
```

Objective-C

Card.h

```
#import <Foundation/Foundation.h>




@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;

@property (nonatomic, getter=isChosen) BOOL chosen;
@property (nonatomic, getter=isMatched) BOOL matched;

- (int)match:(Card *)card;

@end
```

Here's the declaration of a public method called `match:` which takes one argument (a pointer to a `Card`) and returns an `integer`.

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card




- (int)match:(Card *)card
{
    int score = 0;

    return score;
}

@end
```

`match:` is going to return a "score" which says how good a match the passed `card` is to the `Card` that is receiving this message. 0 means "no match", higher numbers mean a better match.

Objective-C

Card.h

```
#import <Foundation/Foundation.h>




@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;

@property (nonatomic, getter=isChosen) BOOL chosen;
@property (nonatomic, getter=isMatched) BOOL matched;

- (int)match:(Card *)card;









@end
```

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card









- (int)match:(Card *)card
{
    int score = 0;


    if ([card.contents isEqualToString:self.contents]) {
        score = 1;
    }


    return score;
}




@end
```

There's a lot going on here!
For the first time, we are seeing the "calling" side of properties (and methods).

For this example, we'll return `1` if the passed `card` has the same `contents` as we do or `0` otherwise (you could imagine more complex scoring).

Objective-C

Card.h

```
#import <Foundation/Foundation.h>




@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;

@property (nonatomic, getter=isChosen) BOOL chosen;
@property (nonatomic, getter=isMatched) BOOL matched;

- (int)match:(Card *)card;









@end
```

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card









- (int)match:(Card *)card
{
    int score = 0;


    if ([card.contents isEqualToString:self.contents]) {
        score = 1;
    }


    return score;
}




@end
```

Notice that we are calling the "getter" for the contents `@property` (both on our `self` and on the passed `card`). This calling syntax is called "dot notation." It's only for setters and getters.

Objective-C

Card.h

```
#import <Foundation/Foundation.h>



@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;

@property (nonatomic, getter=isChosen) BOOL chosen;
@property (nonatomic, getter=isMatched) BOOL matched;

- (int)match:(Card *)card;









@end
```

Recall that the contents property is an NSString.

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card









- (int)match:(Card *)card
{
    int score = 0;


    if ([card.contents isEqualToString:self.contents]) {
        score = 1;
    }


    return score;
}


@end
```

isEqualToString: is an NSString method which takes another NSString as an argument and returns a BOOL (YES if the 2 strings are the same).

Also, we see the "square bracket" notation we use to send a message to an object.
In this case, the message isEqualToString: is being sent to the NSString returned by the contents getter.

Objective-C

Card.h

```
#import <Foundation/Foundation.h>




@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;

@property (nonatomic, getter=isChosen) BOOL chosen;
@property (nonatomic, getter=isMatched) BOOL matched;

- (int)match:(NSArray *)otherCards;









@end
```

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card




- (int)match:(NSArray *)otherCards
{
    int score = 0;


    if ([card.contents isEqualToString:self.contents]) {
        score = 1;
    }


    return score;
}




@end
```

We could make `match:` even more powerful by allowing it to match against multiple cards by passing an array of cards using the `NSArray` class in Foundation.

Objective-C

Card.h

```
#import <Foundation/Foundation.h>




@interface Card : NSObject

@property (strong, nonatomic) NSString *contents;

@property (nonatomic, getter=isChosen) BOOL chosen;
@property (nonatomic, getter=isMatched) BOOL matched;

- (int)match:(NSArray *)otherCards;









@end
```

Card.m

```
#import "Card.h"

@interface Card()

@end

@implementation Card

- (int)match:(NSArray *)otherCards
{
    int score = 0;

    for (Card *card in otherCards) {
        if ([card.contents isEqualToString:self.contents]) {
            score = 1;
        }
    }

    return score;
}









@end
```

We'll implement a very simple match scoring system here which is to score 1 point if ANY of the passed `otherCards`' `contents` match the receiving `Card`'s `contents`.
(You could imagine giving more points if multiple cards match.)

Note the `for-in` looping syntax here.
This is called "fast enumeration."
It works on arrays, dictionaries, etc.

Coming Up

- Next Lecture
  More of our Card Game Model
  Xcode 5 Demonstration (start building our Card Game application)

- Next Week
  Finish off our Card Game application
  Objective-C in more detail
  Foundation (array, dictionary, etc.)
  And much much more!