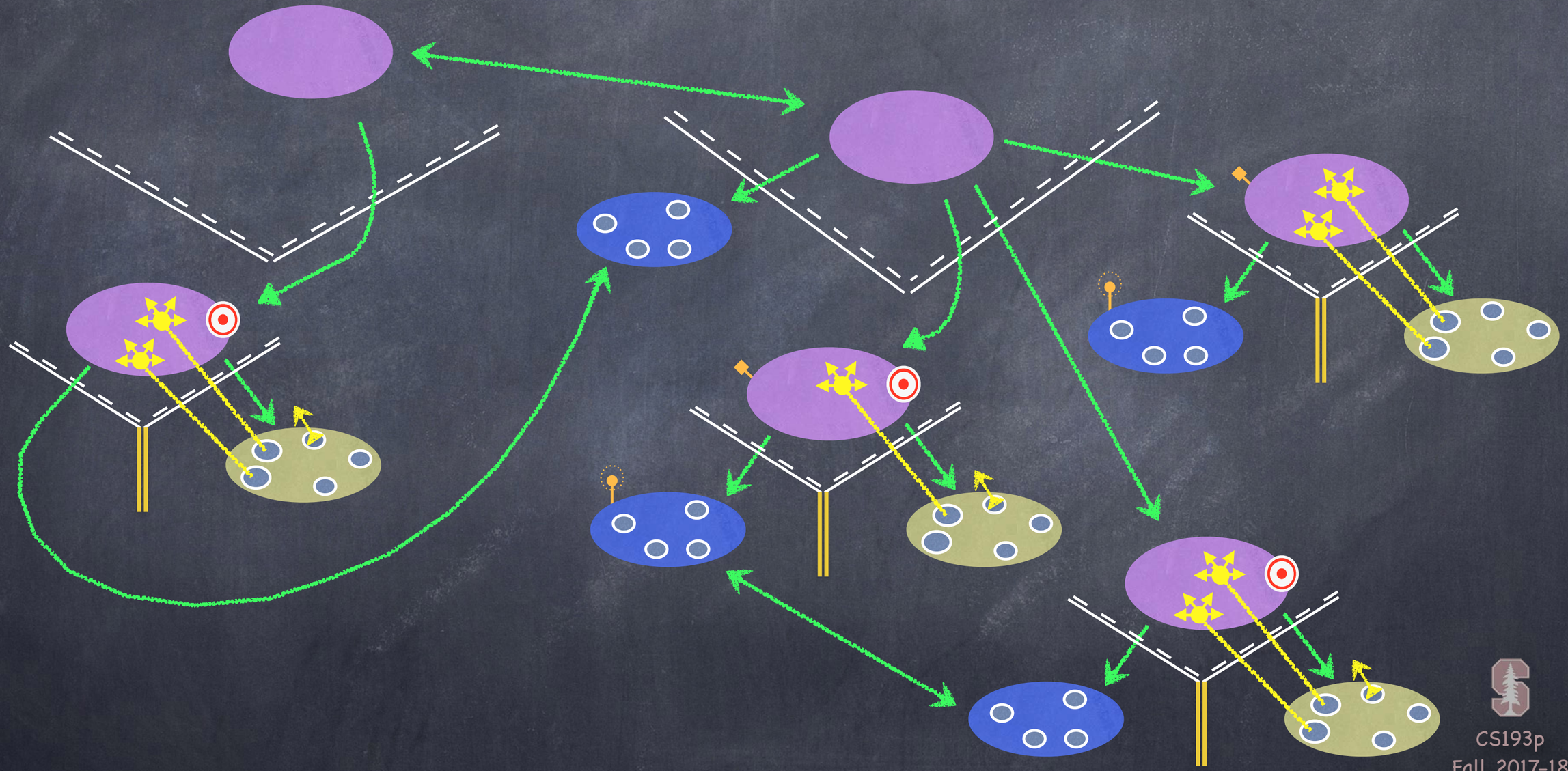
Stanford CS193p

Developing Applications for iOS
Fall 2017-18

Today

- Multiple MVCs
  - Tab Bar, Navigation and Split View Controllers
  - Demo: Theme Chooser in Concentration
- Timer
- Animation
  - `UIViewPropertyAnimator`
  - Transitions

MVCs working together

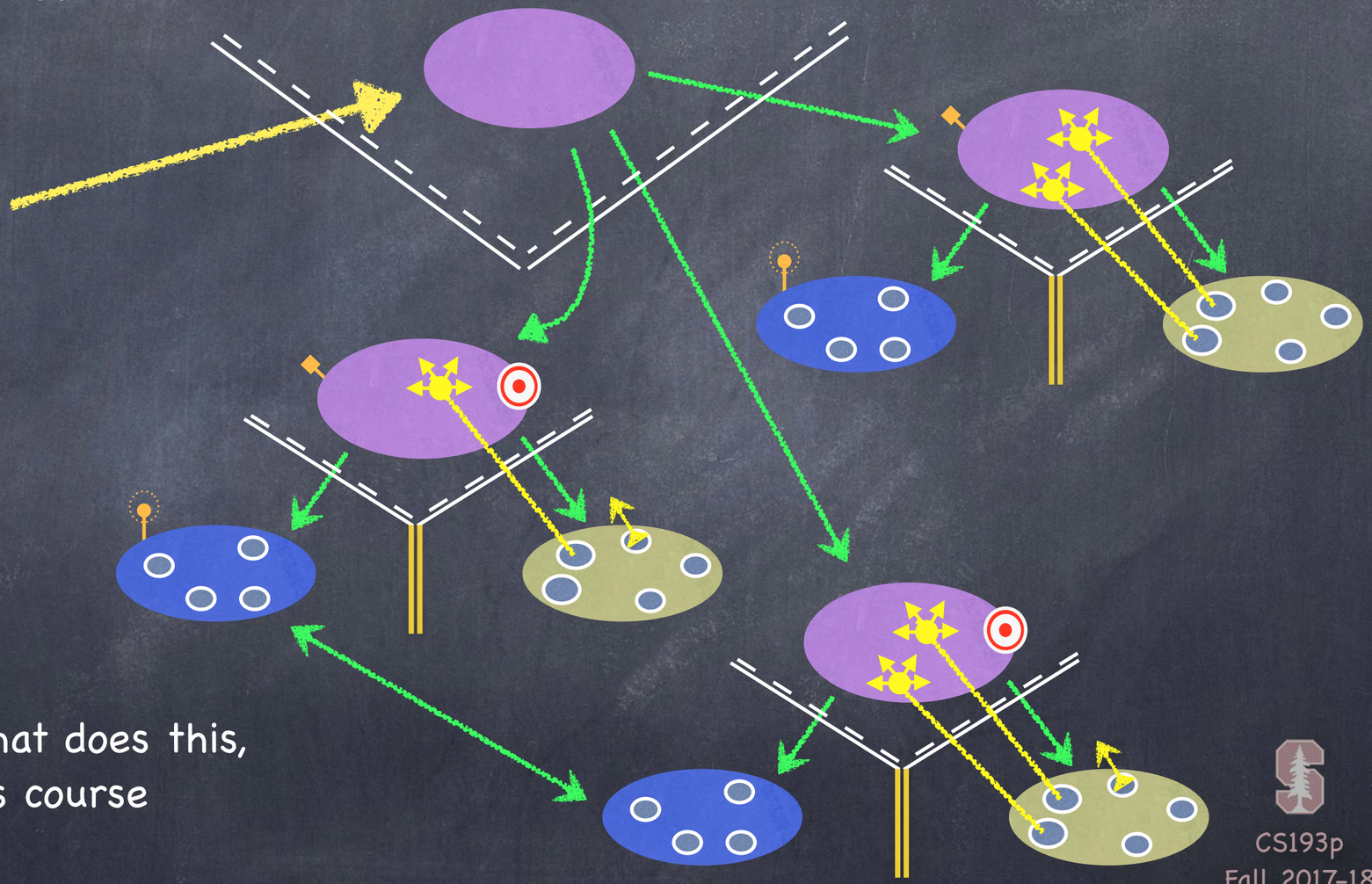


Multiple MVCs

- Time to build more powerful applications

  To do this, we must combine MVCs …

iOS provides some Controllers whose View is "other MVCs" *



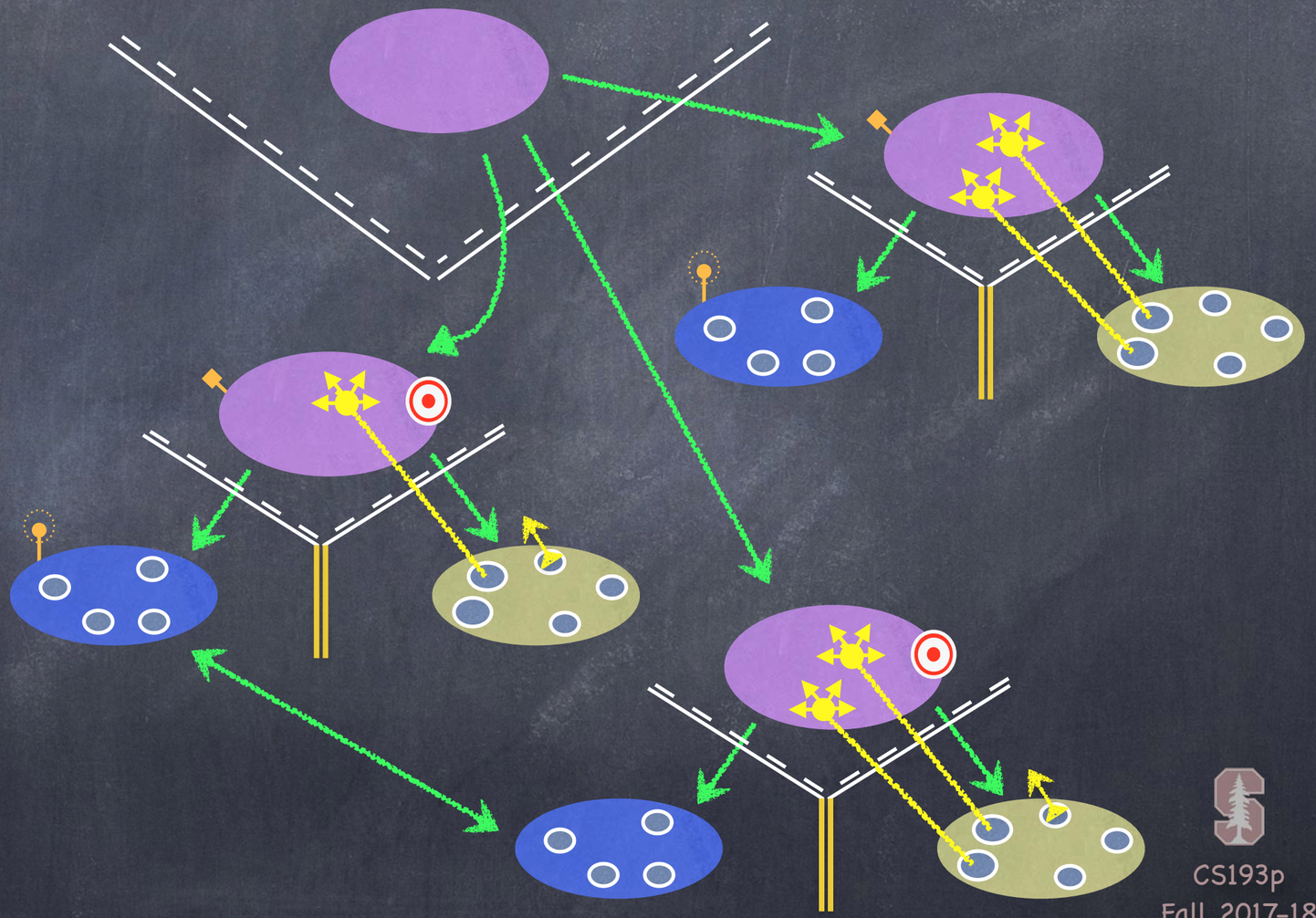
* you could build your own Controller that does this, but we're not going to cover that in this course

Multiple MVCs

- Time to build more powerful applications

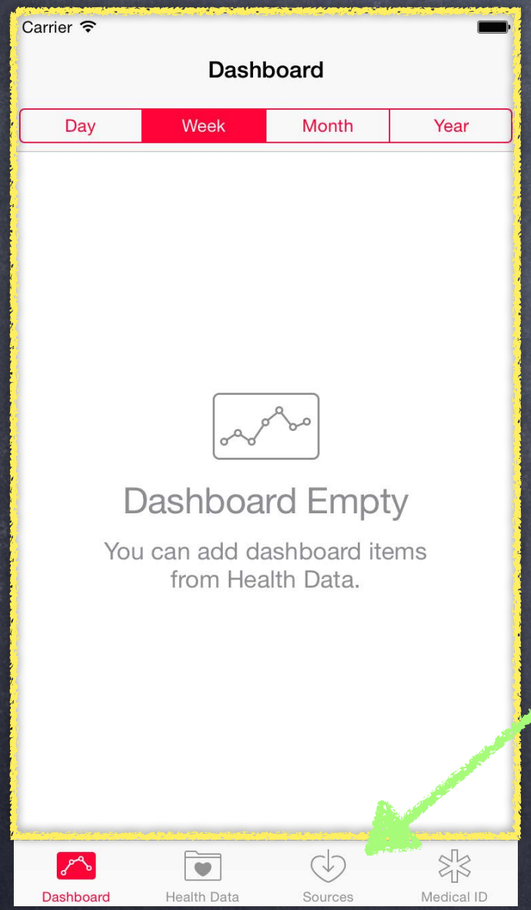
  To do this, we must combine MVCs …

iOS provides some Controllers whose View is "other MVCs"
Examples:
`UITabBarController`
`UISplitViewController`
`UINavigationController`



UITabBarController

- It lets the user choose between different MVCs …



A "Dashboard" MVC

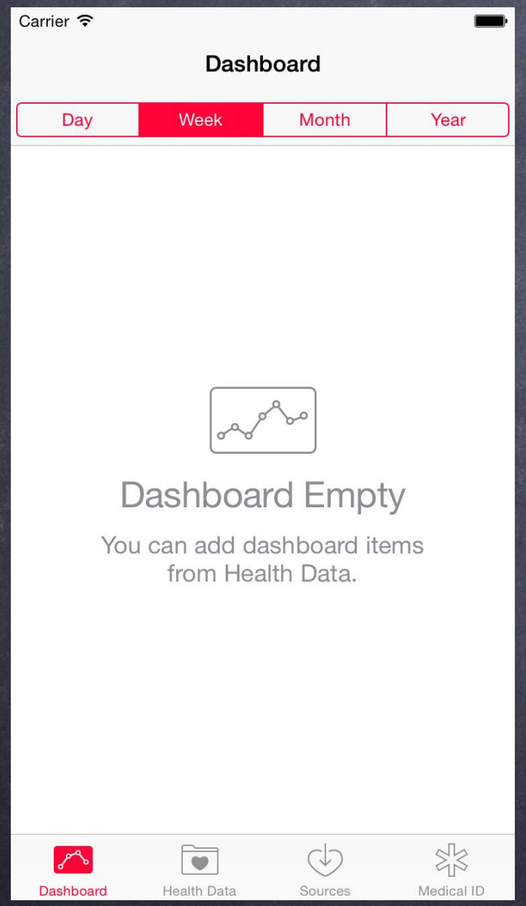
The icon, title and even a "badge value" on these is determined by the MVCs themselves via their property:

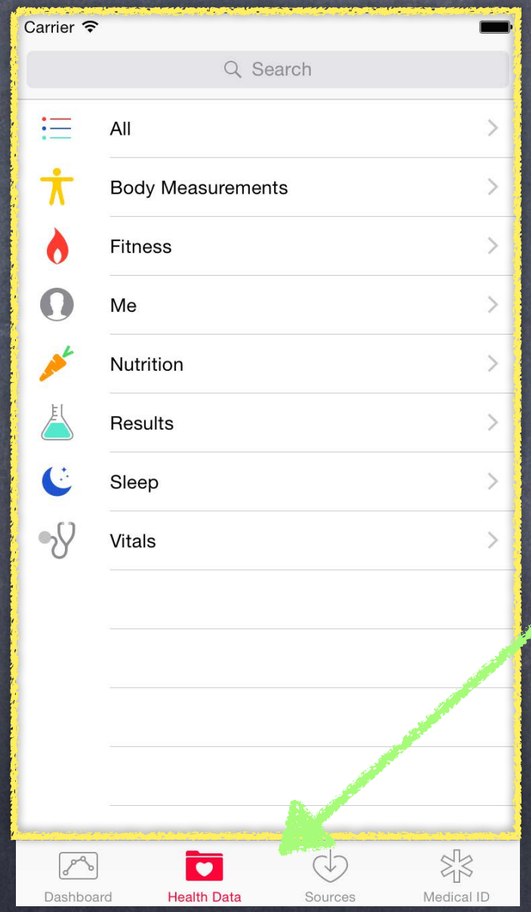
```
var tabBarItem: UITabBarItem!
```

But usually you just set them in your storyboard.

UITabBarController

- It lets the user choose between different MVCs …



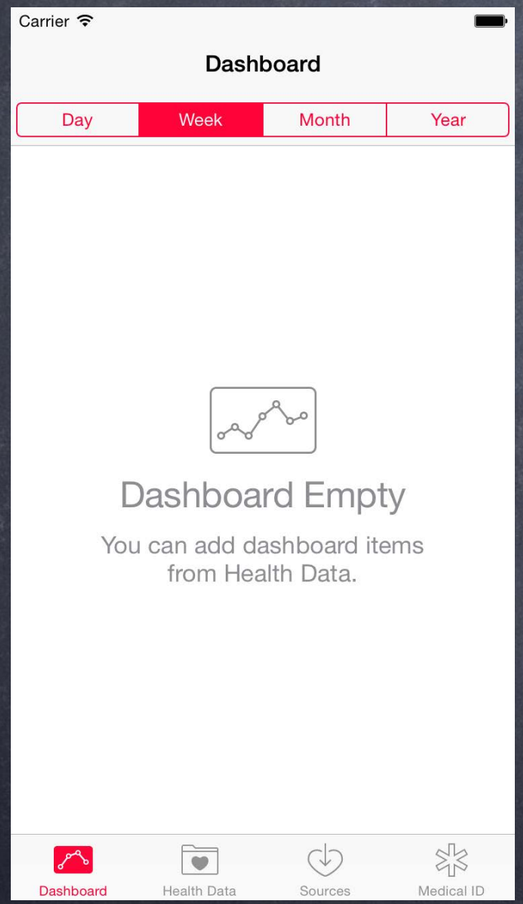


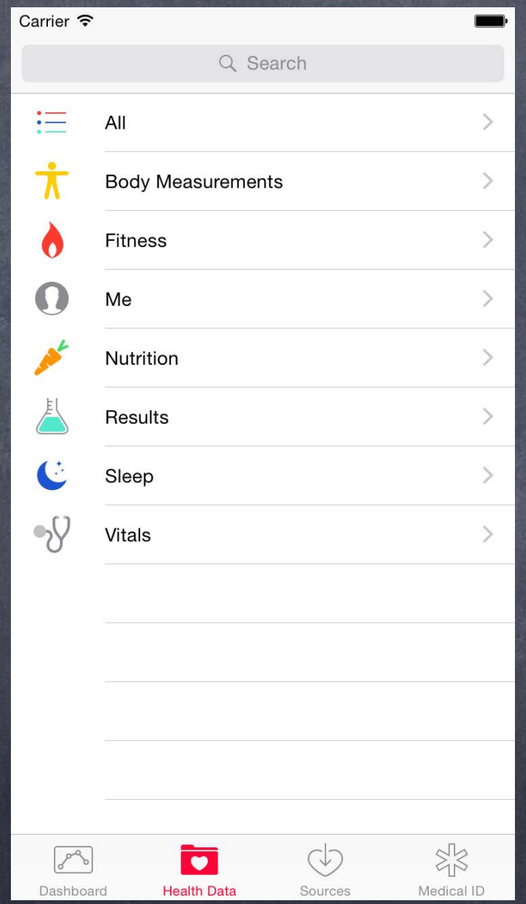
A "Health Data" MVC

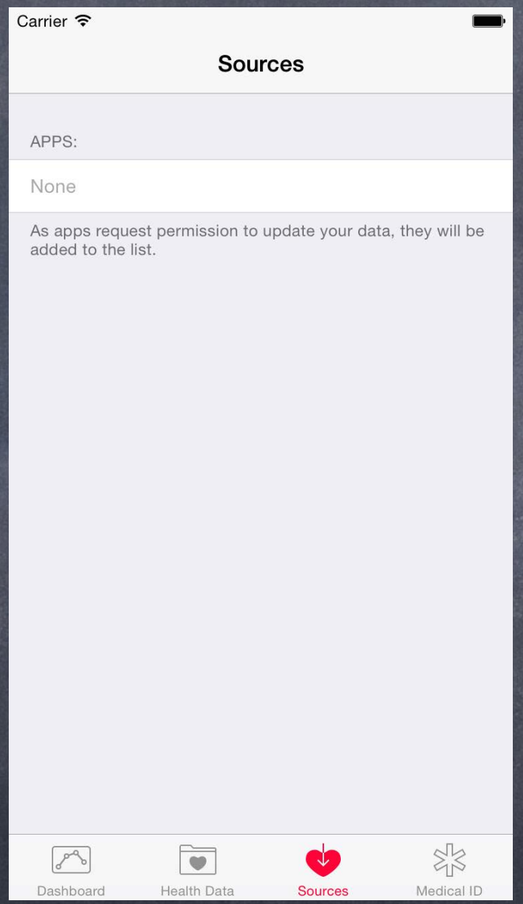
If there are too many tabs to fit here, the `UITabBarController` will automatically present a UI for the user to manage the overflow!

UITabBarController

- It lets the user choose between different MVCs …







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Fall 2017-18

UITabBarController

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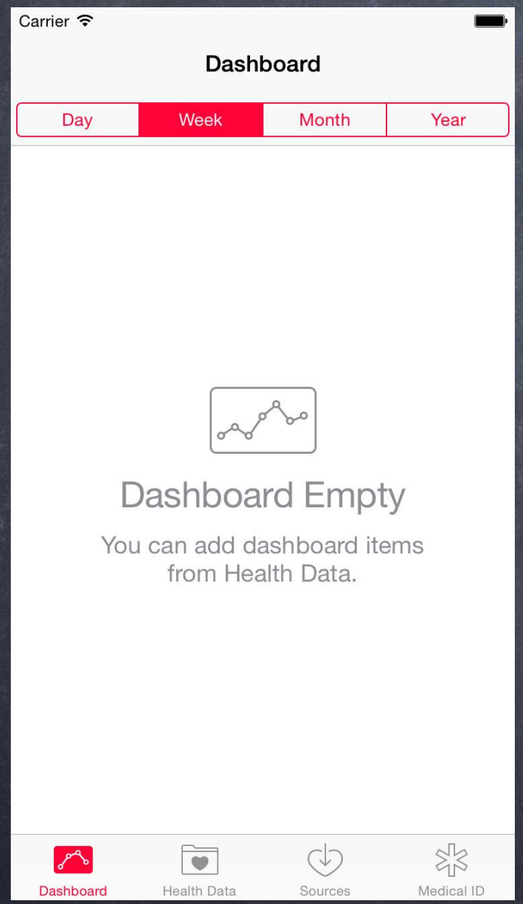
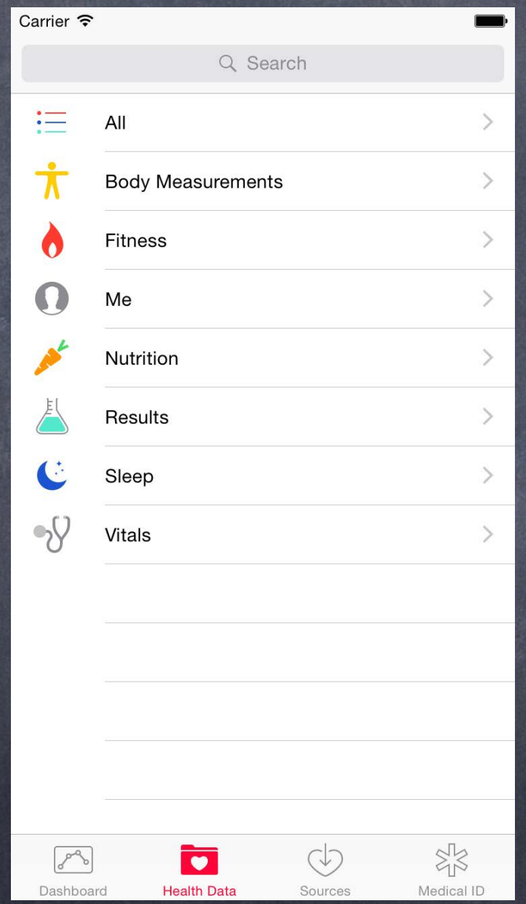
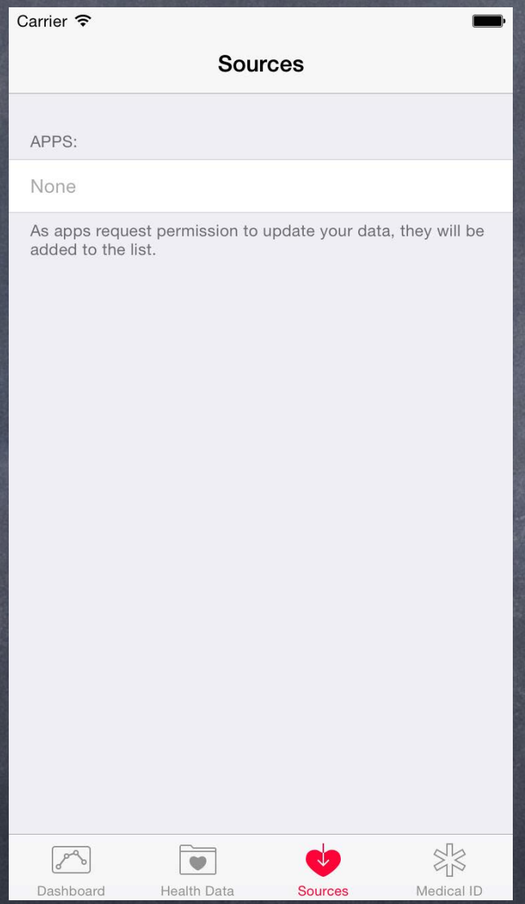
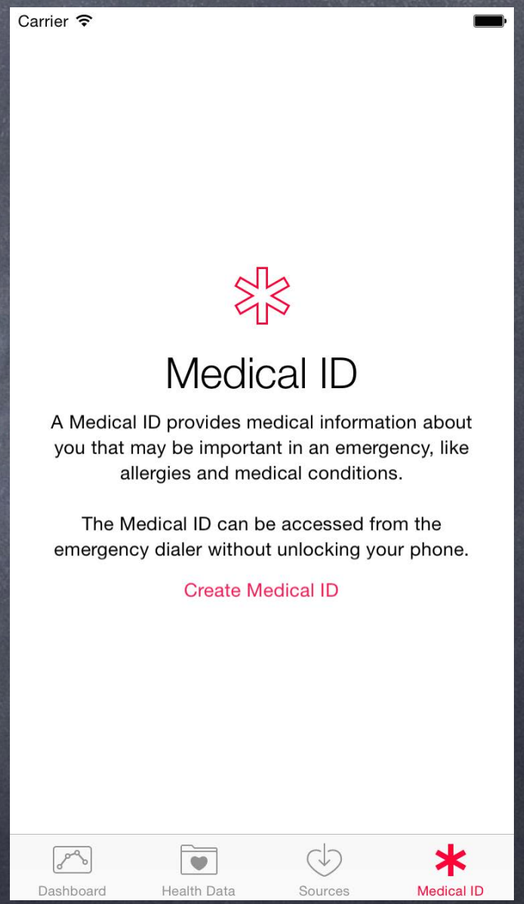






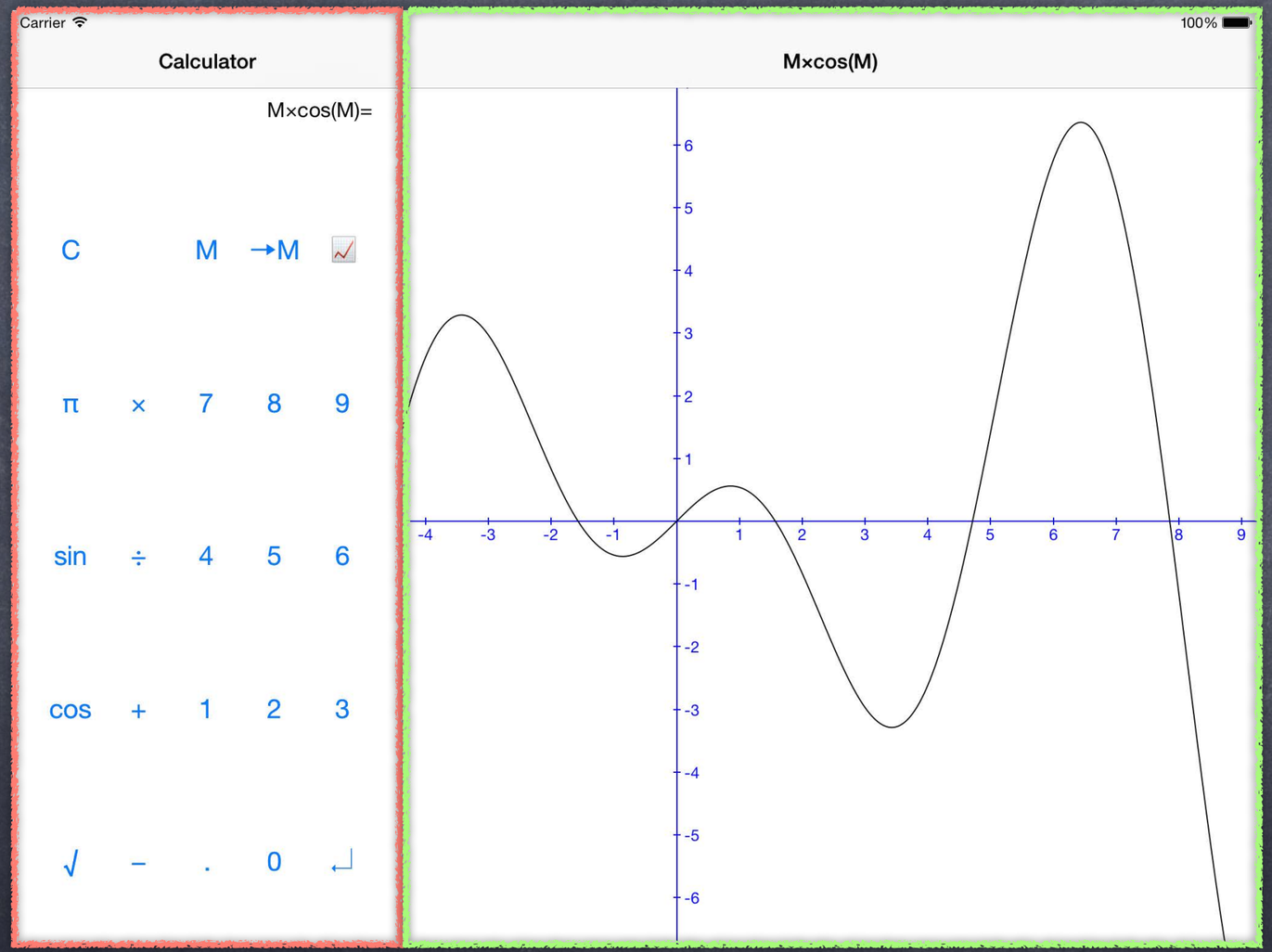


UISplitViewController

- Puts two MVCs side-by-side …

A Calculator MVC

Master



A Calculator Graph MVC

Detail

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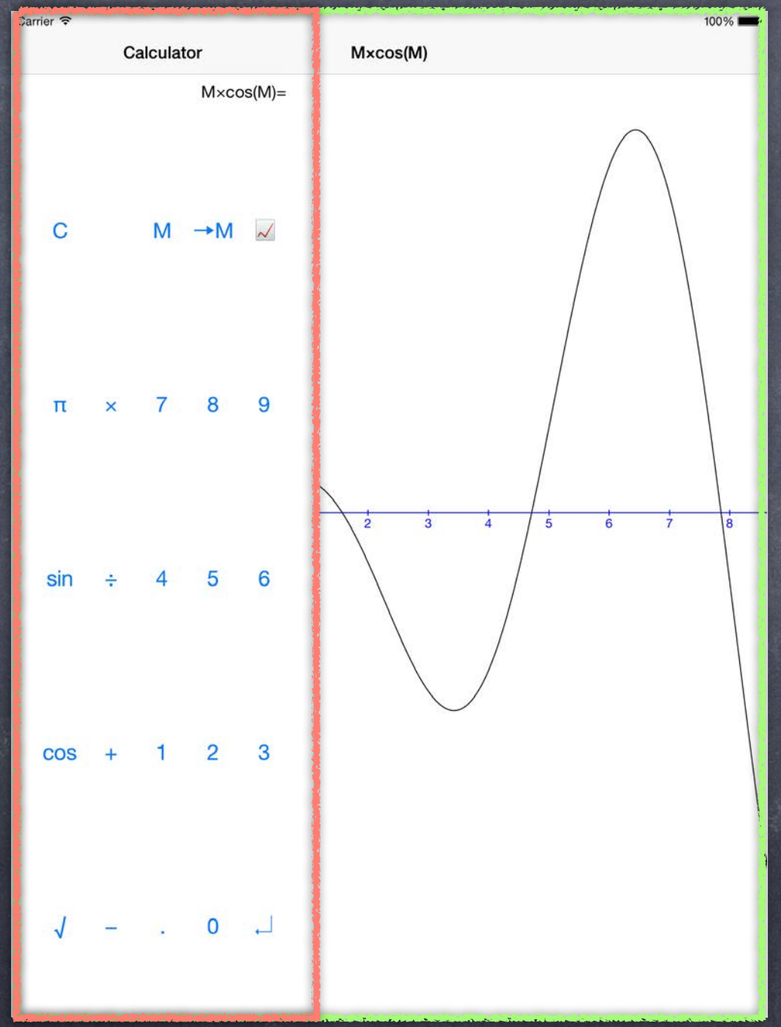
UISplitViewController

- Puts two MVCs side-by-side …

A
Calculator
MVC

Master



A
Calculator Graph
MVC

Detail

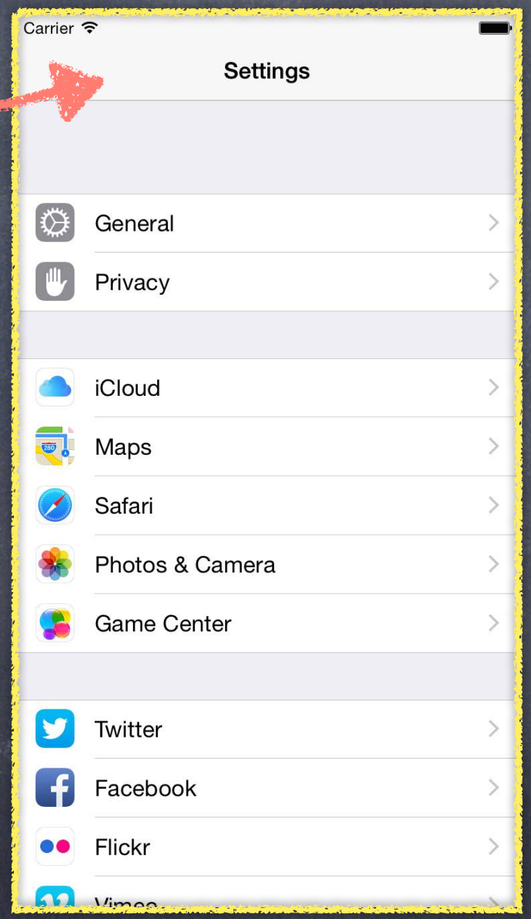
UINavigationController

- Pushes and pops MVCs off of a stack (like a stack of cards) …

This top area is drawn by the `UINavigationController`

But the contents of the top area (like the title or any buttons on the right) are determined by the MVC currently showing (in this case, the "All Settings" MVC)

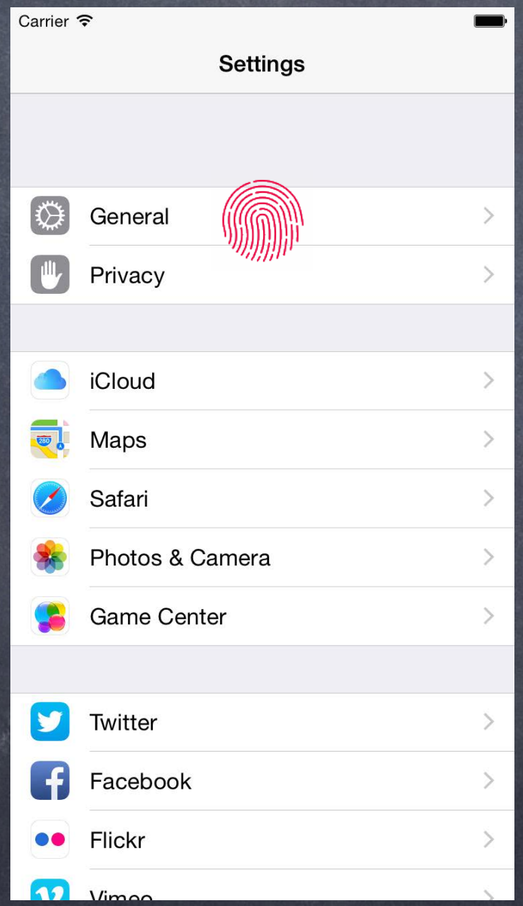
Each MVC communicates these contents via its `UIViewController`'s `navigationItem` property



An "All Settings" MVC

UINavigationController

- Pushes and pops MVCs off of a stack (like a stack of cards) …



UINavigationController

- Pushes and pops MVCs off of a stack (like a stack of cards) …

A "General Settings" MVC

It's possible to add MVC-specific buttons here too via the `UIViewController`'s `toolbarItems` property

UINavigationController

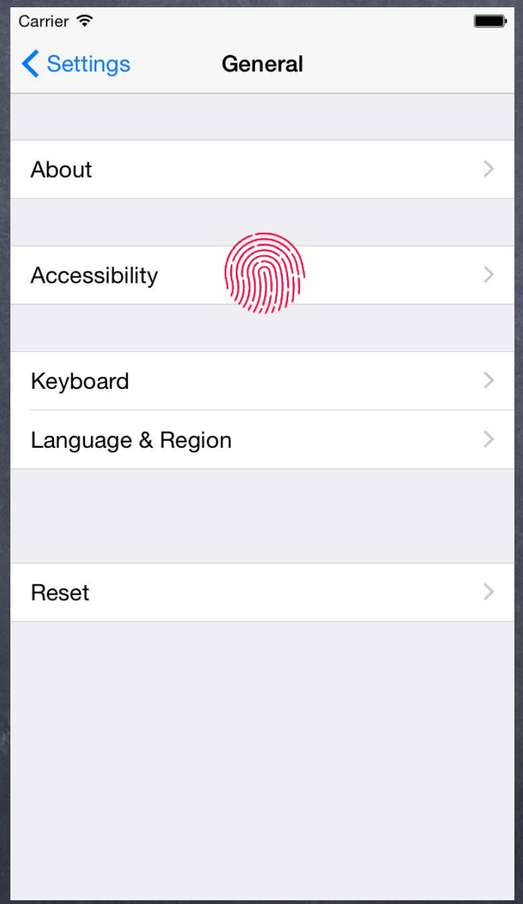
- Pushes and pops MVCs off of a stack (like a stack of cards) …

Notice this "back" button has appeared. This is placed here automatically by the UINavigationController.

A "General Settings" MVC

UINavigationController

- Pushes and pops MVCs off of a stack (like a stack of cards) …



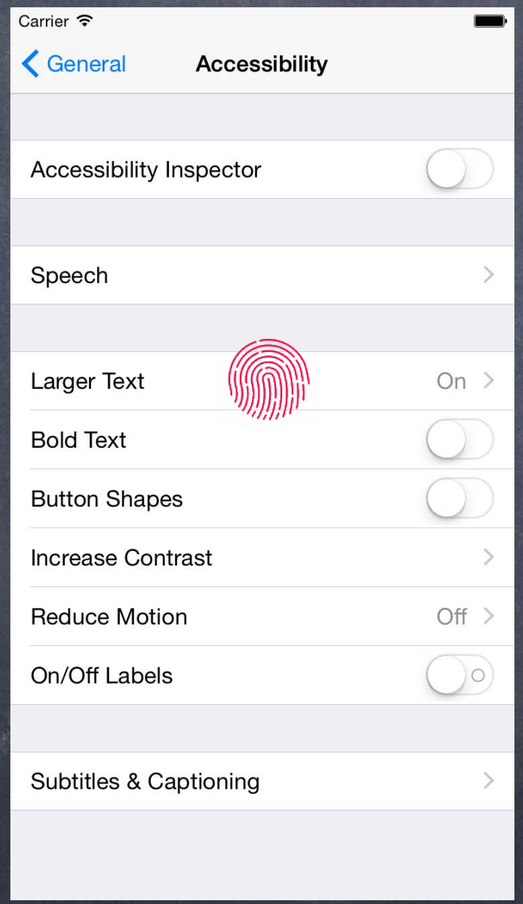
UINavigationController

- Pushes and pops MVCs off of a stack (like a stack of cards) …

An "Accessibility" MVC

UINavigationController

- Pushes and pops MVCs off of a stack (like a stack of cards) …



UINavigationController

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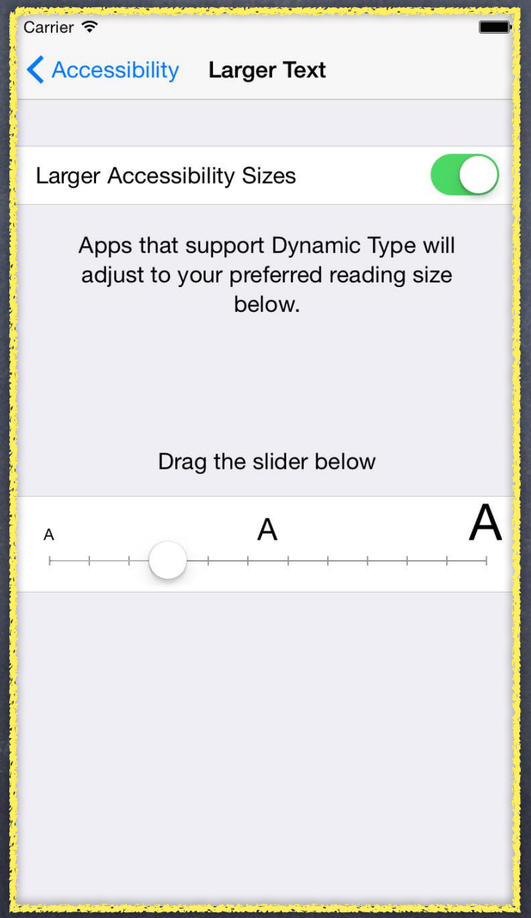
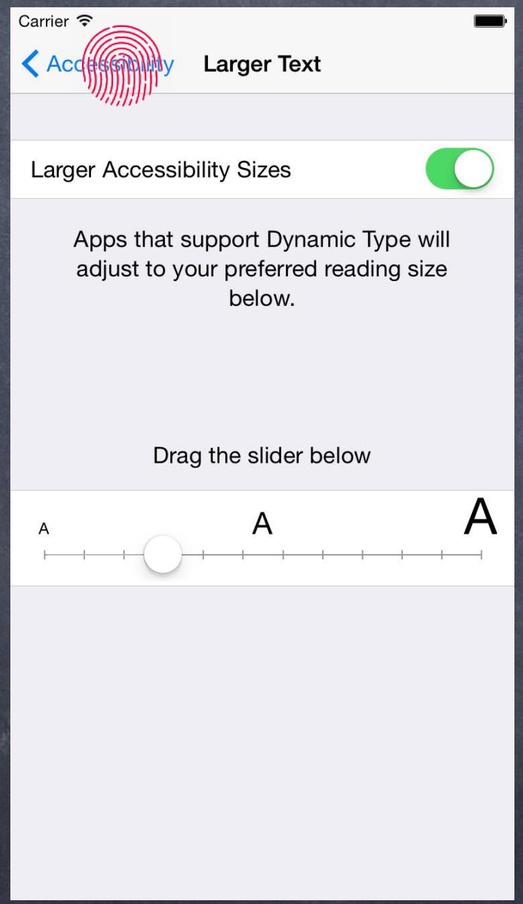


A "Larger Text" MVC

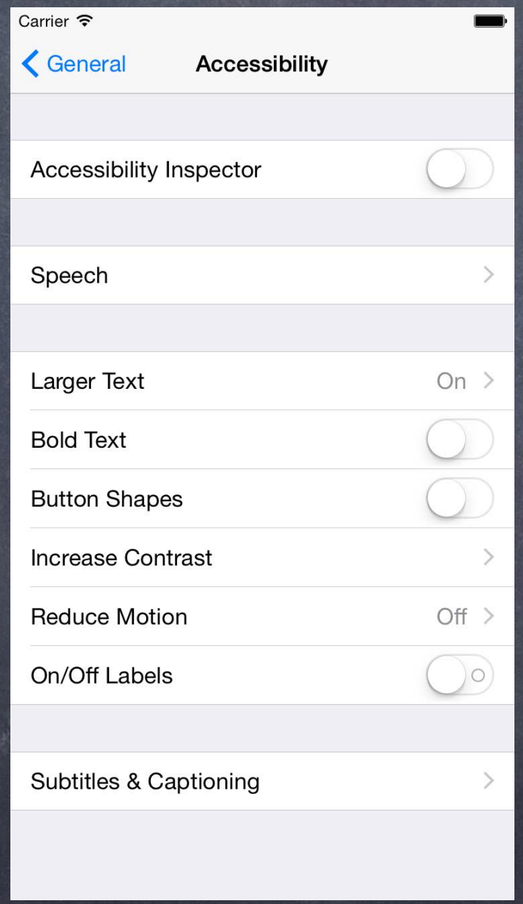
UINavigationController

- Pushes and pops MVCs off of a stack (like a stack of cards) …



UINavigationController

- Pushes and pops MVCs off of a stack (like a stack of cards) …



UINavigationController

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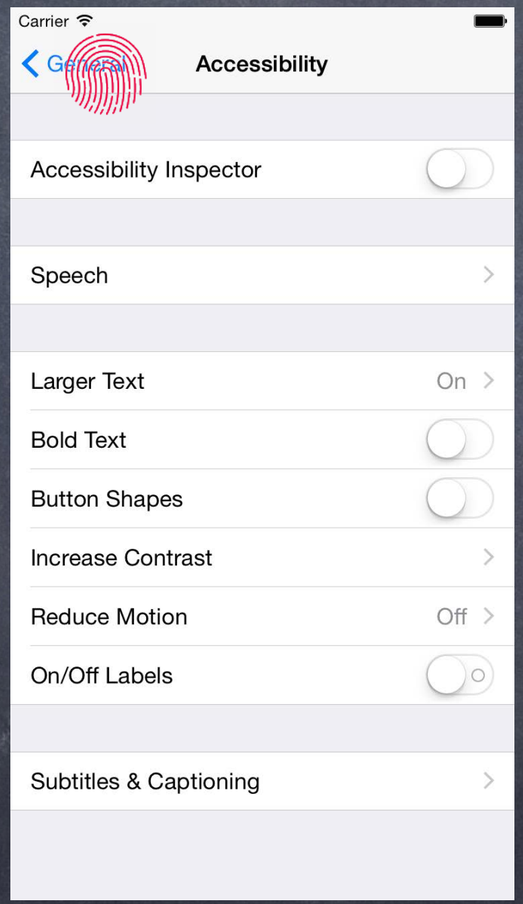

UINavigationController

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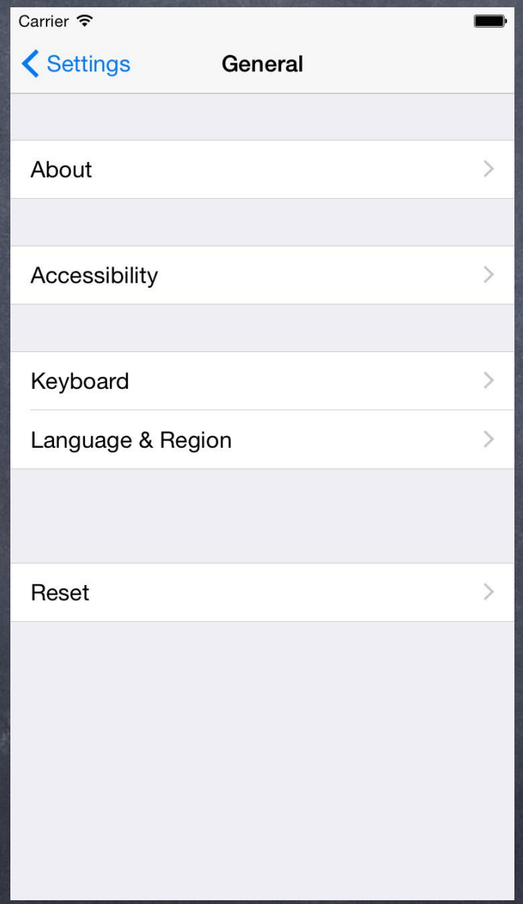

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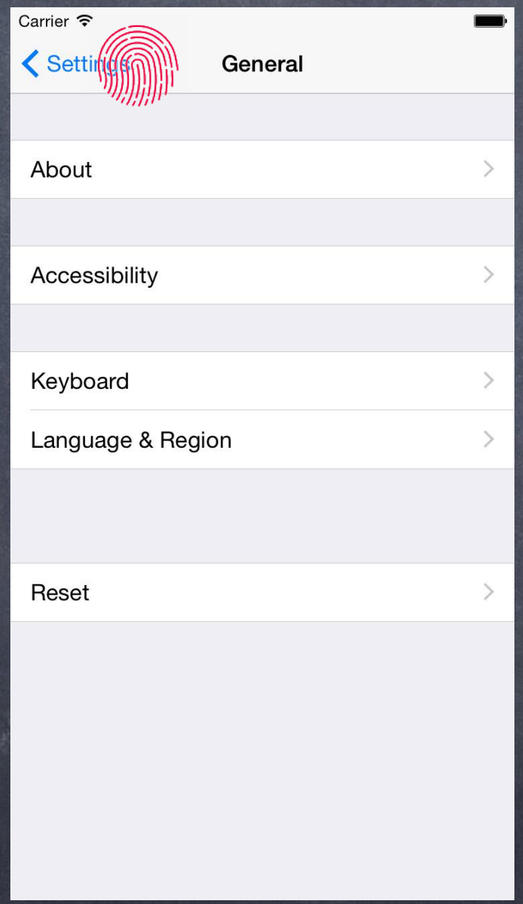
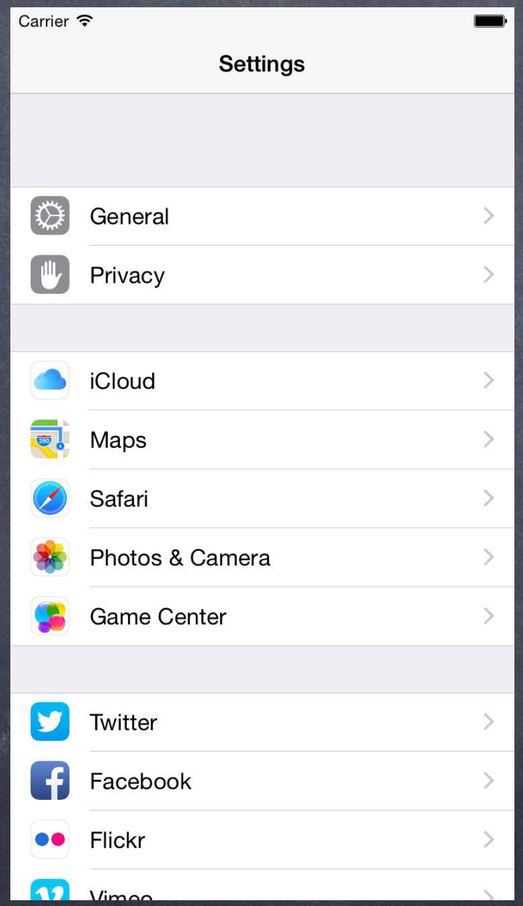
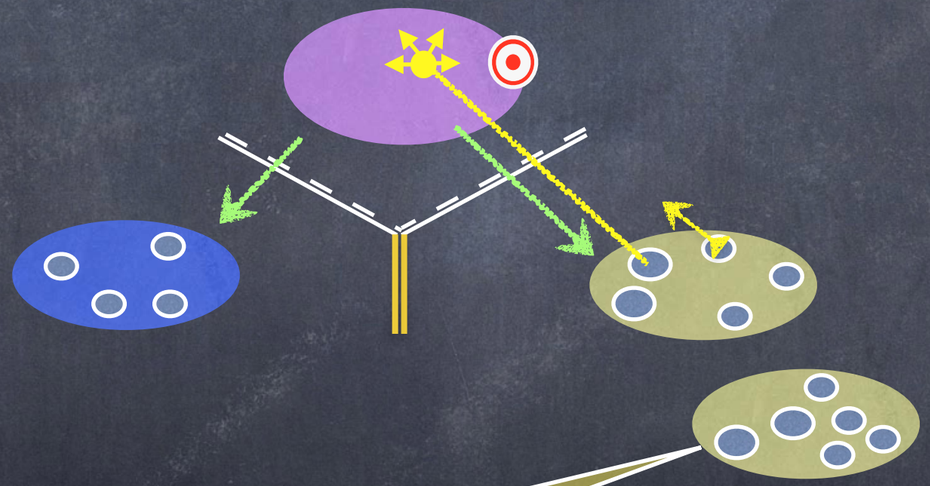


UINavigationController

- Pushes and pops MVCs off of a stack (like a stack of cards) …

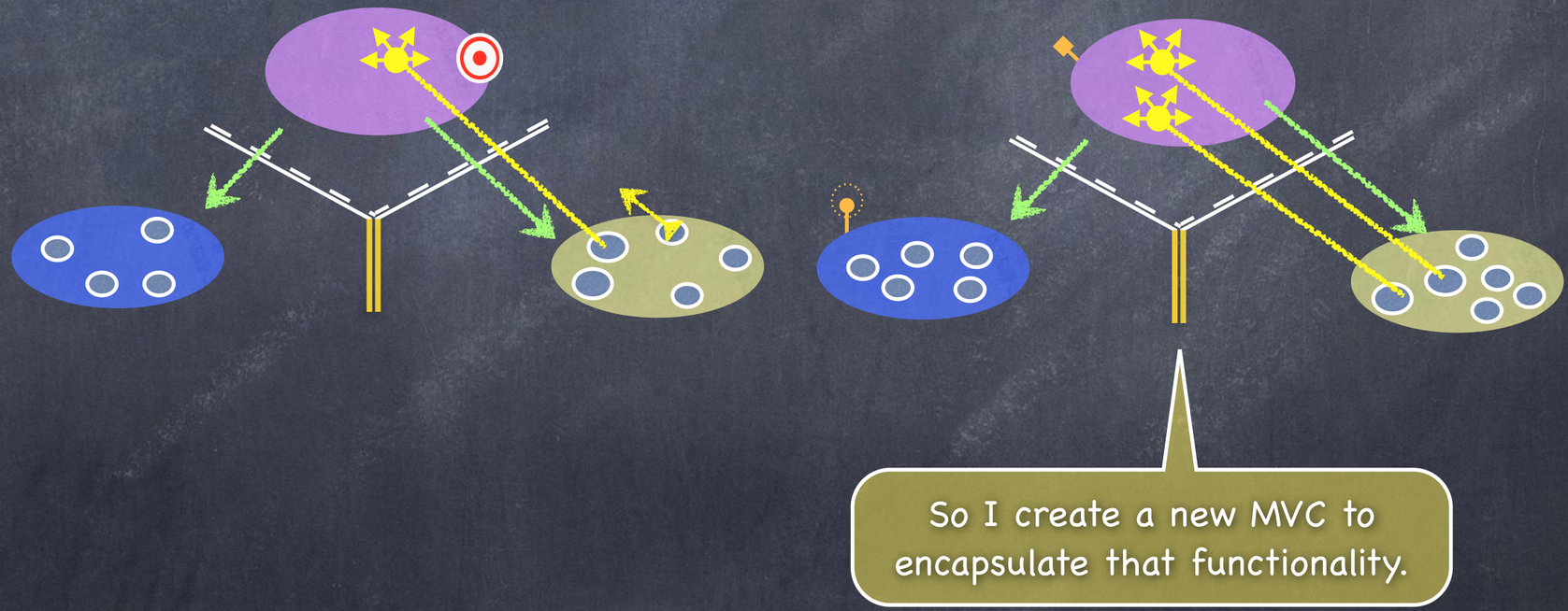


UINavigationController



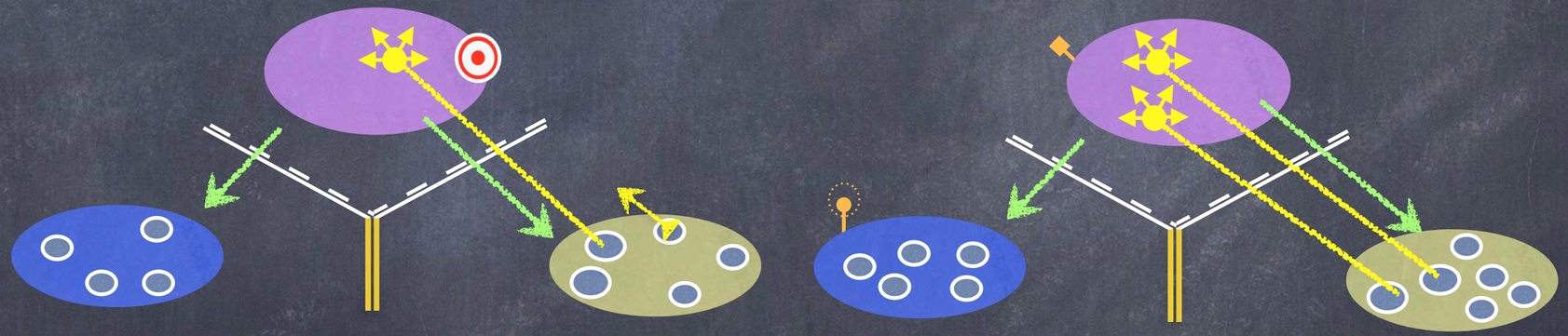
I want more features, but it doesn't make sense to put them all in one MVC!

UINavigationController

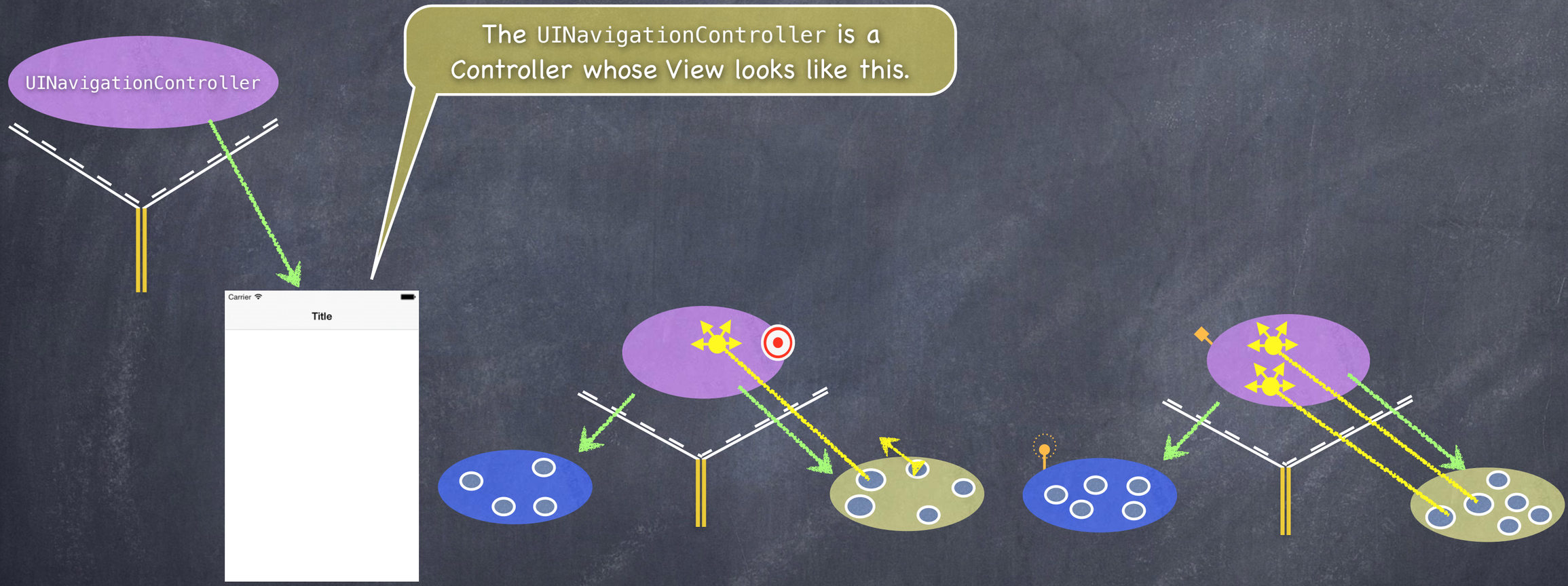


UINavigationController

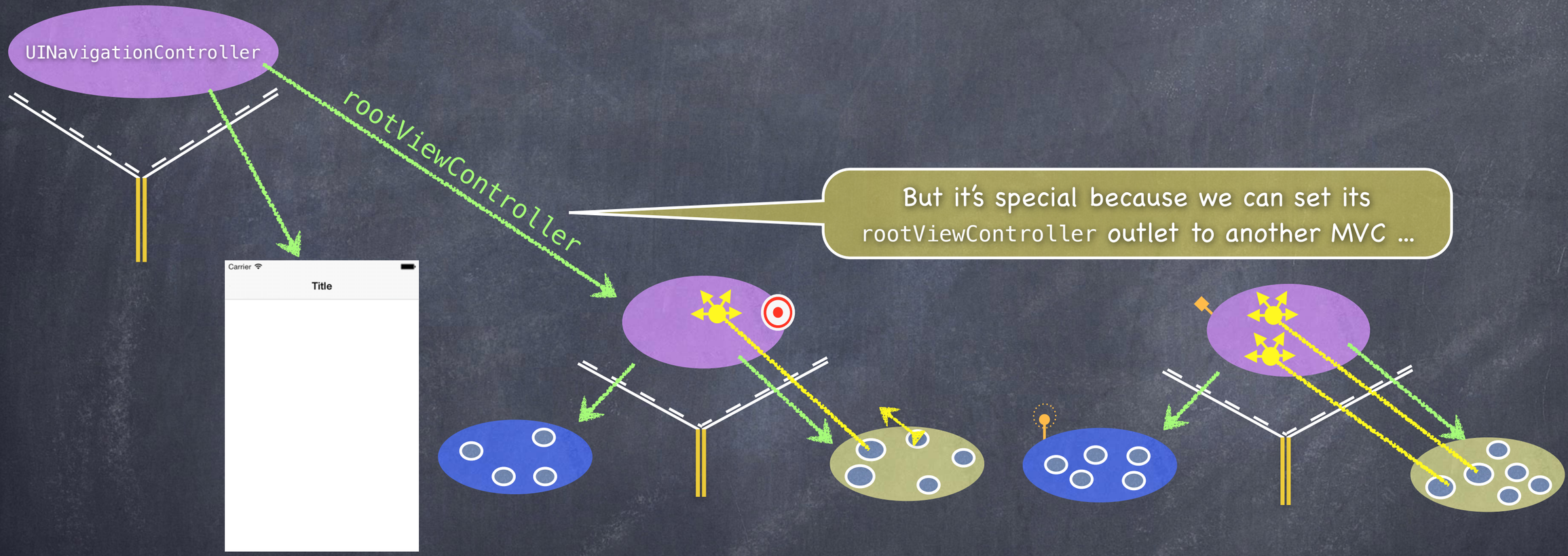
We can use a UINavigationController to let them share the screen.



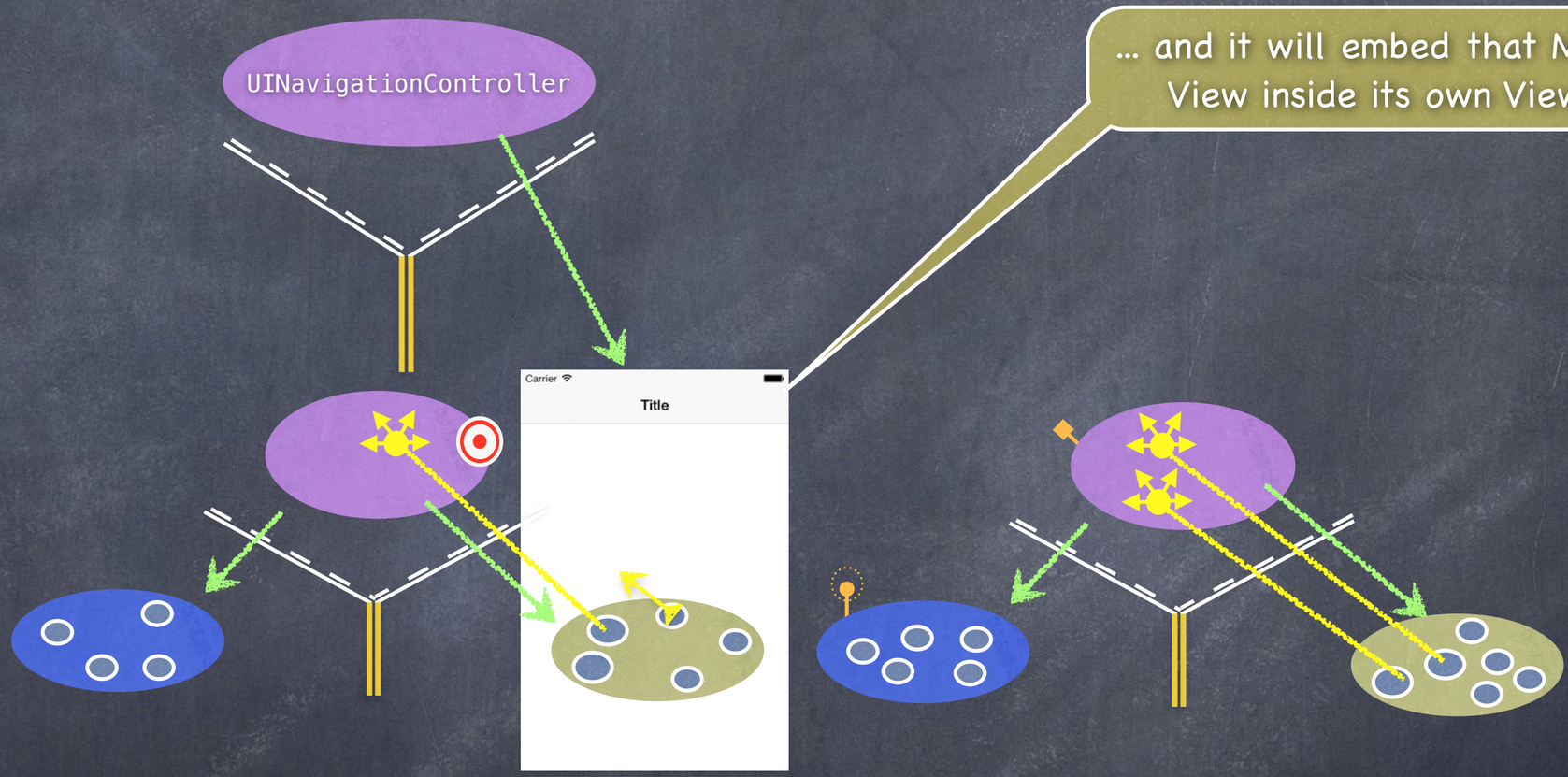
UINavigationController



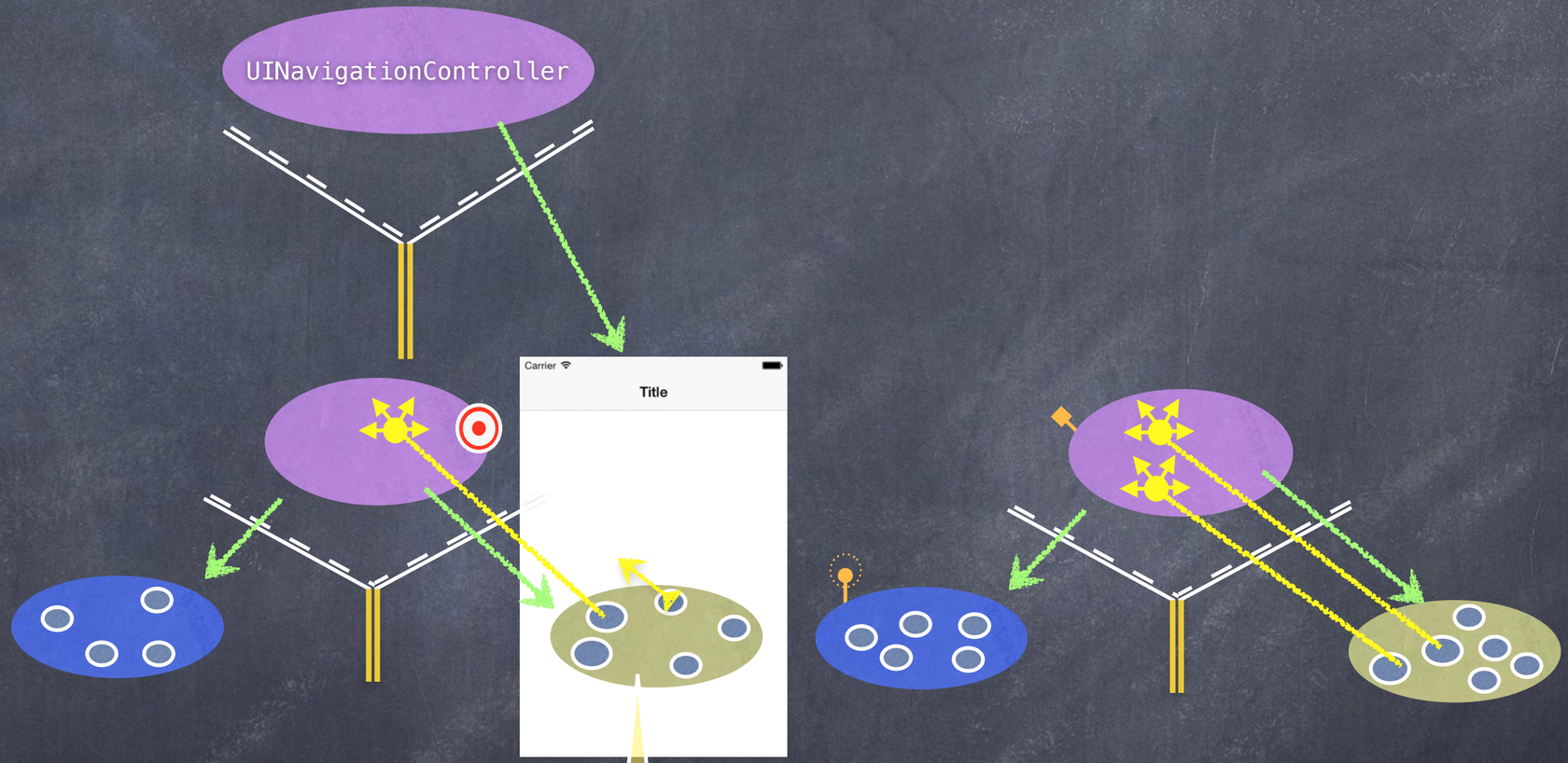
UINavigationController



UINavigationController

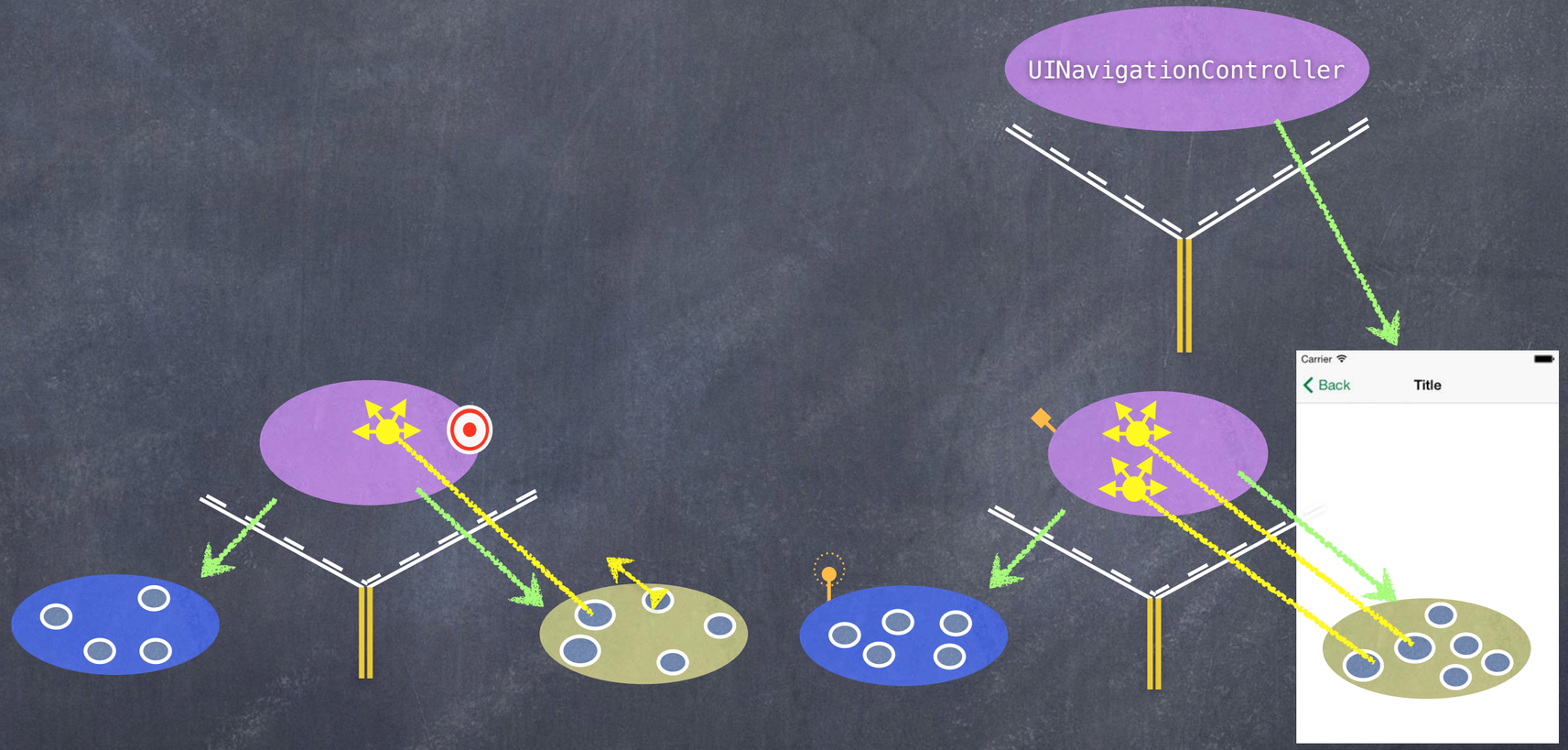


UINavigationController



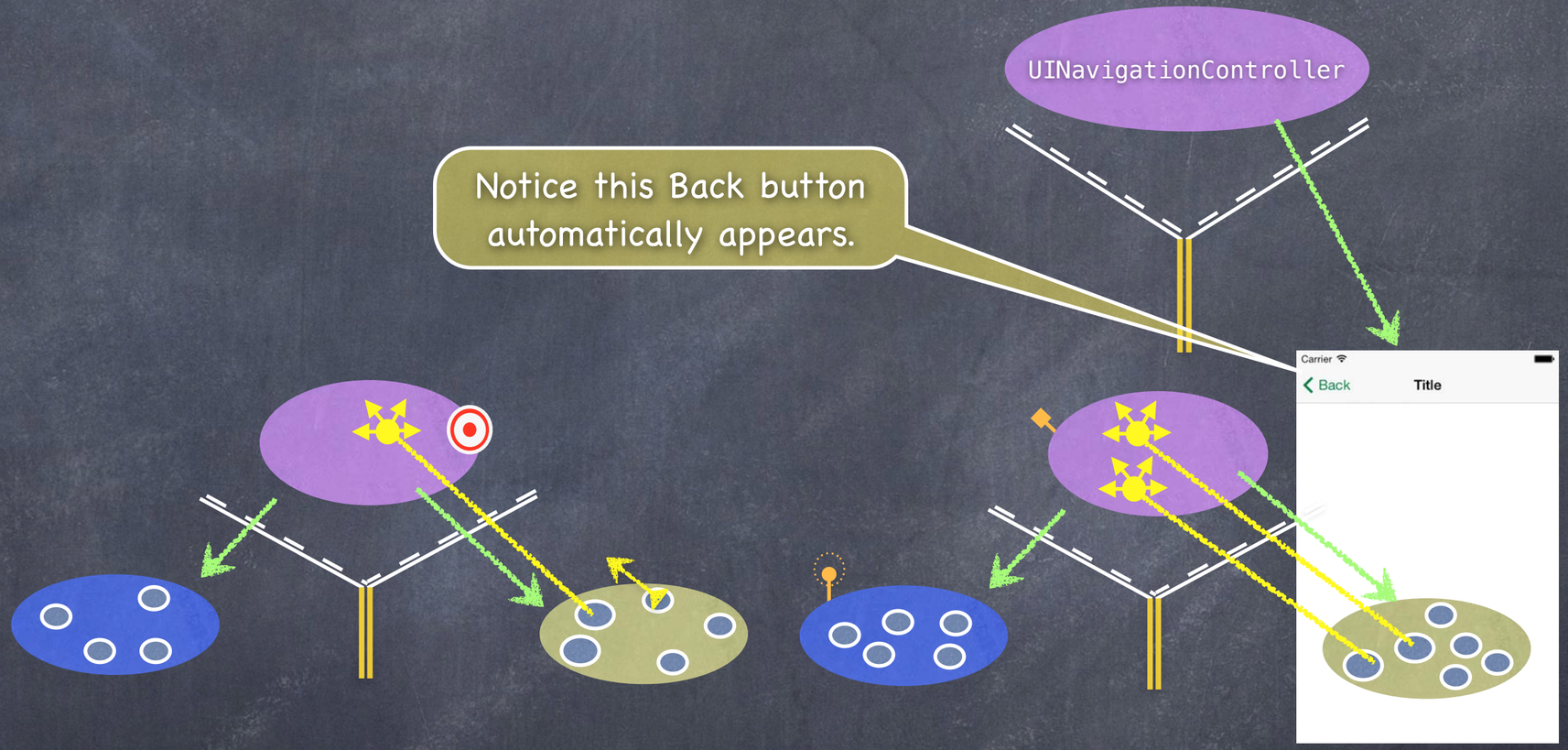
Then a UI element in this View (e.g. a `UIButton`) can segue to the other MVC and its View will now appear in the `UINavigationController` instead.

UINavigationController



We call this kind of segue a "Show (push) segue".

UINavigationController



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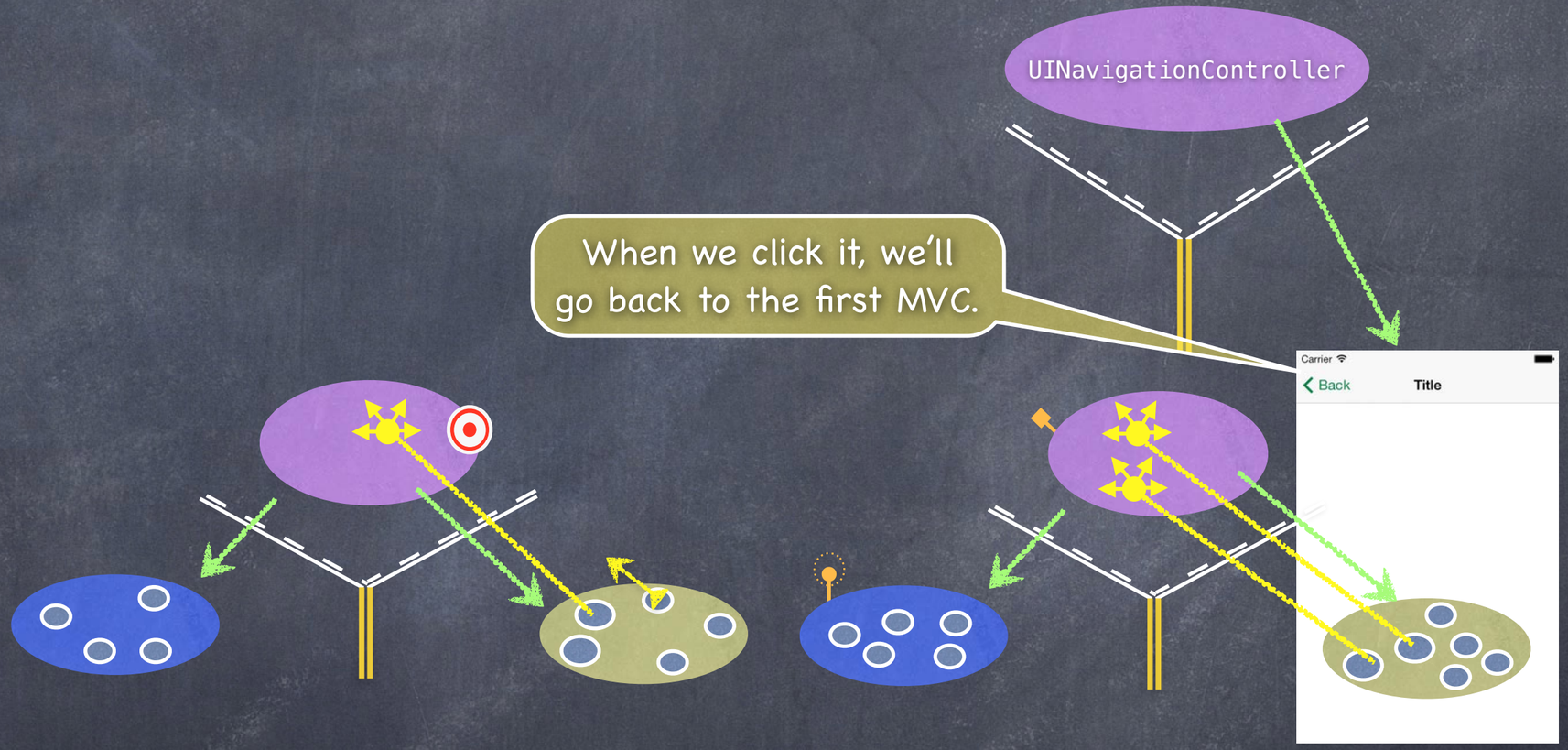
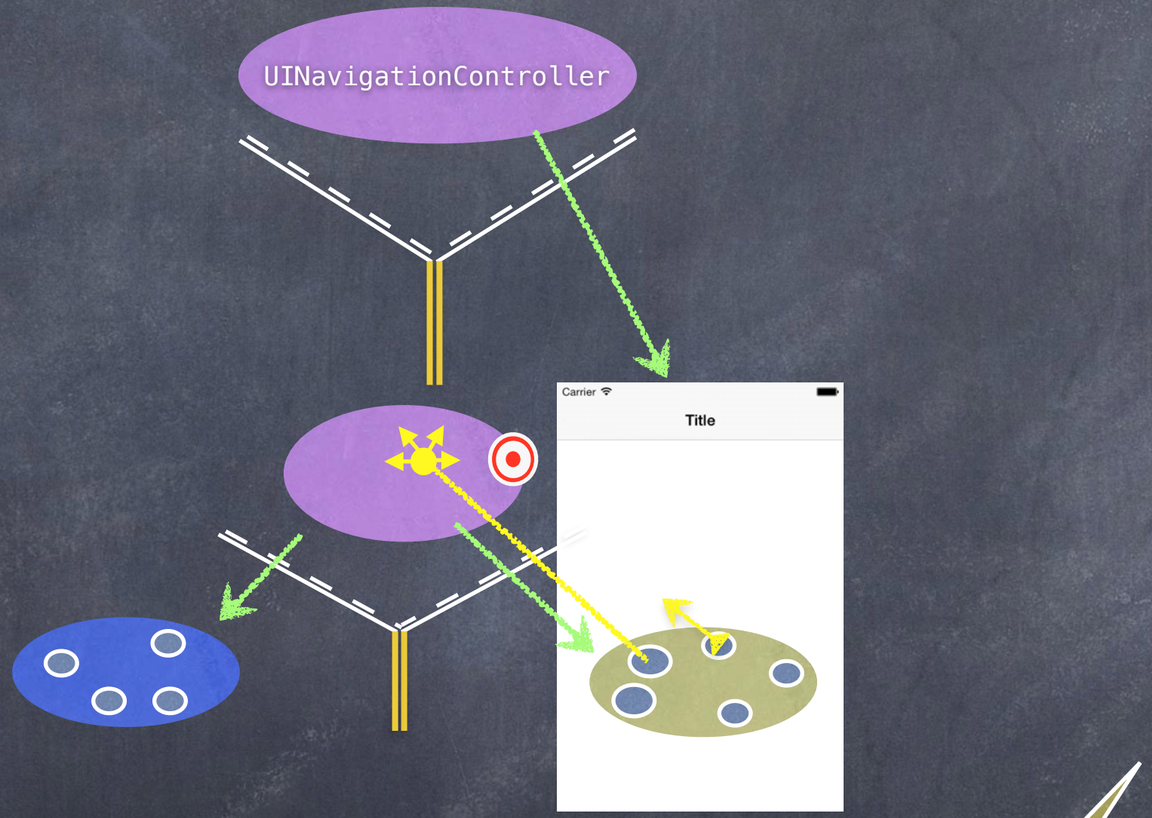
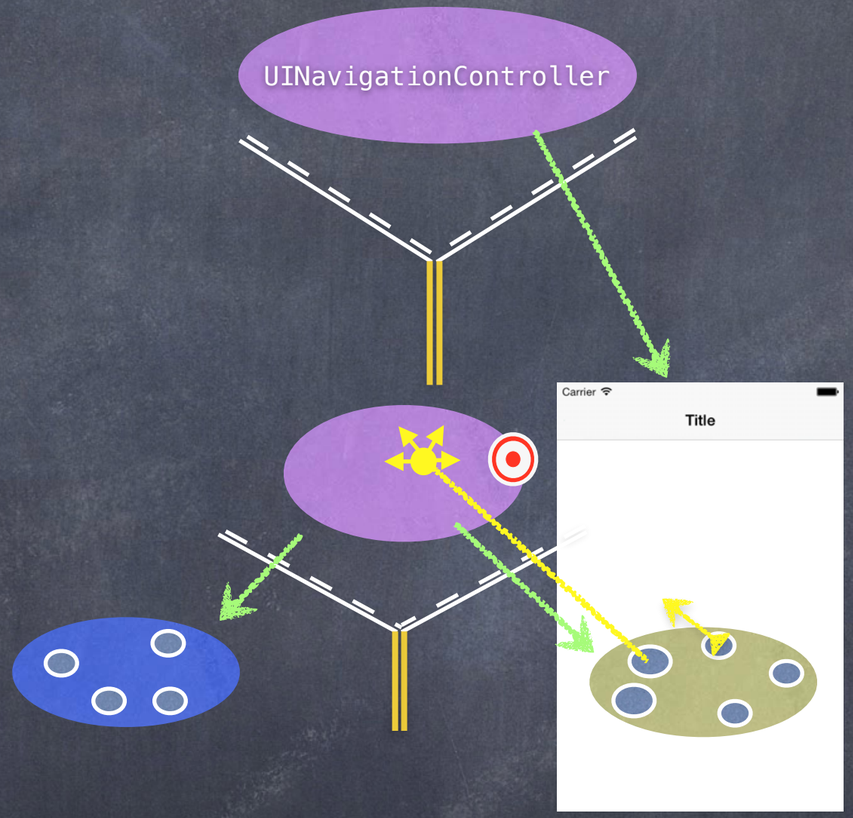


UINavigationController



Notice that after we back out of an MVC,
it disappears (it is deallocated from the heap, in fact).

UINavigationController



Accessing the sub-MVCs

- You can get the sub-MVCs via the `viewControllers` property

```
var viewControllers: [UIViewController]? { get set } // can be optional (e.g. for tab bar)
// for a tab bar, they are in order, left to right, in the array
// for a split view, [0] is the master and [1] is the detail
// for a navigation controller, [0] is the root and the rest are in order on the stack
// even though this is settable, usually setting happens via storyboard, segues, or other
// for example, navigation controller's push and pop methods
```

- But how do you get ahold of the SVC, TBC or NC itself?

Every `UIViewController` knows the Split View, Tab Bar or Navigation Controller it is currently in

These are `UIViewController` properties …

```
var tabBarController: UITabBarController? { get }
var splitViewController: UISplitViewController? { get }
var navigationController: UINavigationController? { get }
```

So, for example, to get the detail (right side) of the split view controller you are in …

```
if let detail: UIViewController? = splitViewController?.viewControllers[1] { … }
```

Pushing/Popping

- Adding (or removing) MVCs from a UINavigationController

```
func pushViewController(_ vc: UIViewController, animated: Bool)
func popViewController(animated: Bool)
```

But we usually don't do this. Instead we use Segues. More on this in a moment.

Wiring up MVCs

- How do we wire all this stuff up?

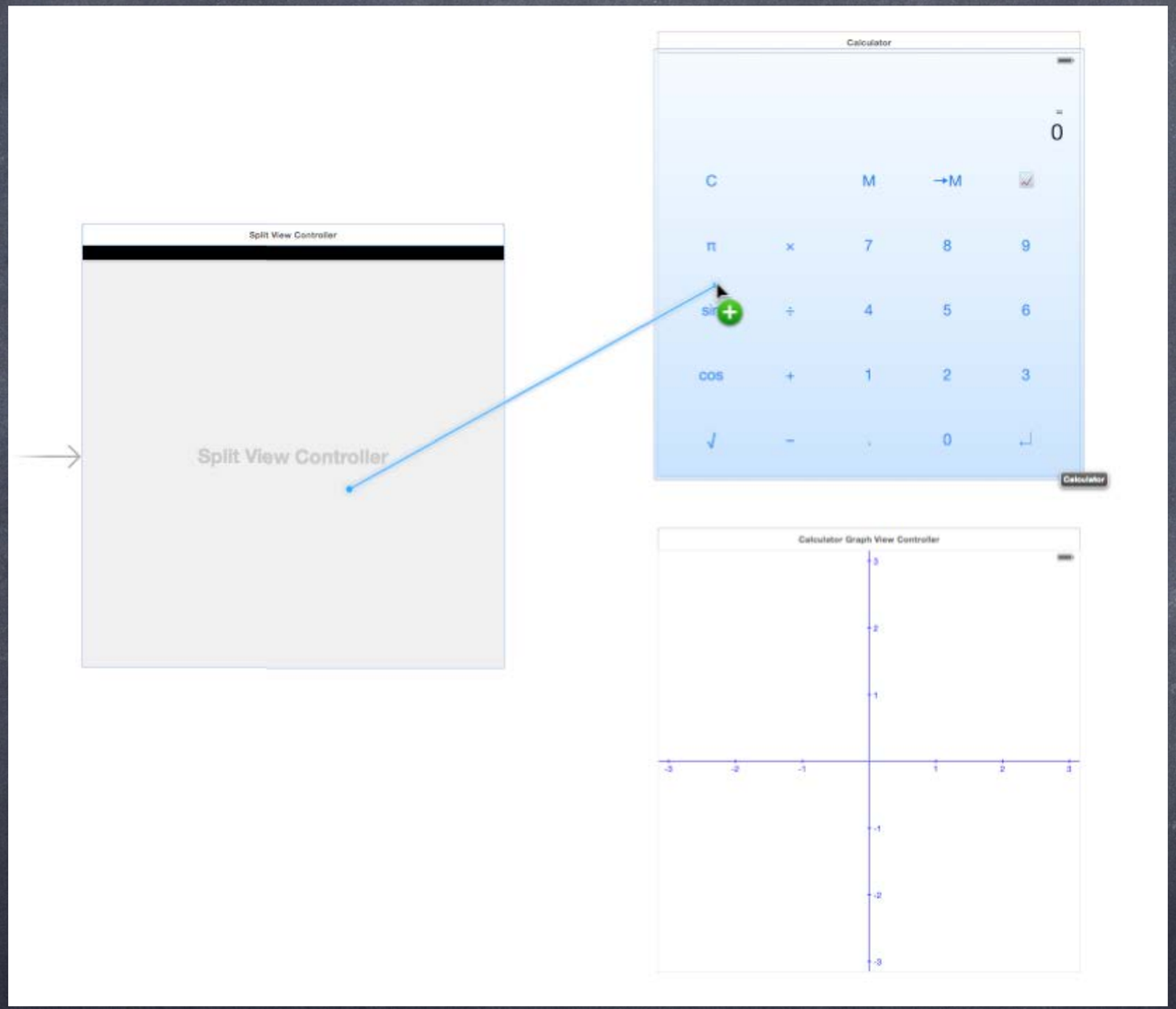
  Let's say we have a Calculator MVC and a Calculator Graphing MVC
  How do we hook them up to be the two sides of a Split View?

  Just drag out a 

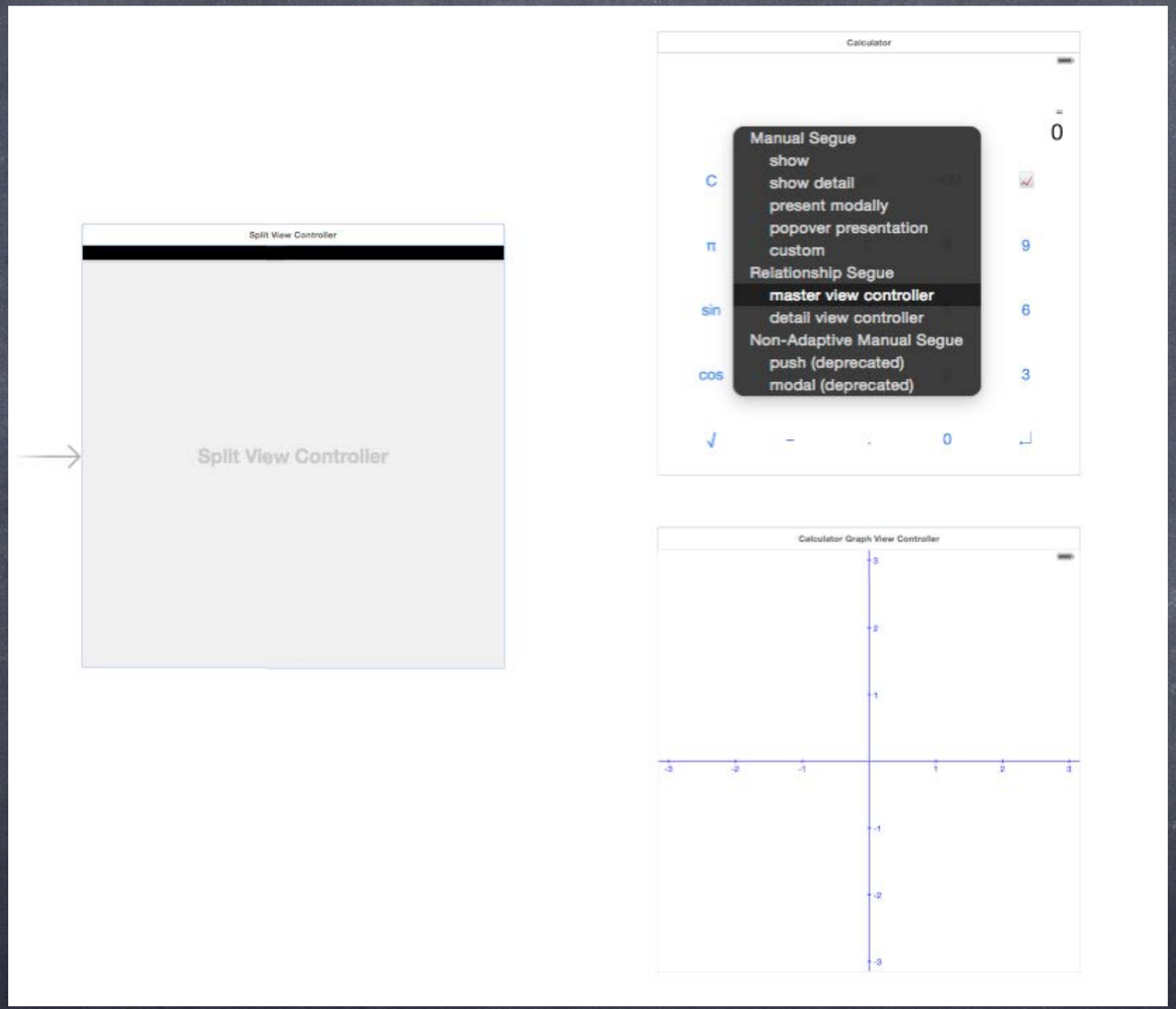
  (and delete all the extra VCs it brings with it)

  Then ctrl-drag from the `UISplitViewController` to the master and detail MVCs ...

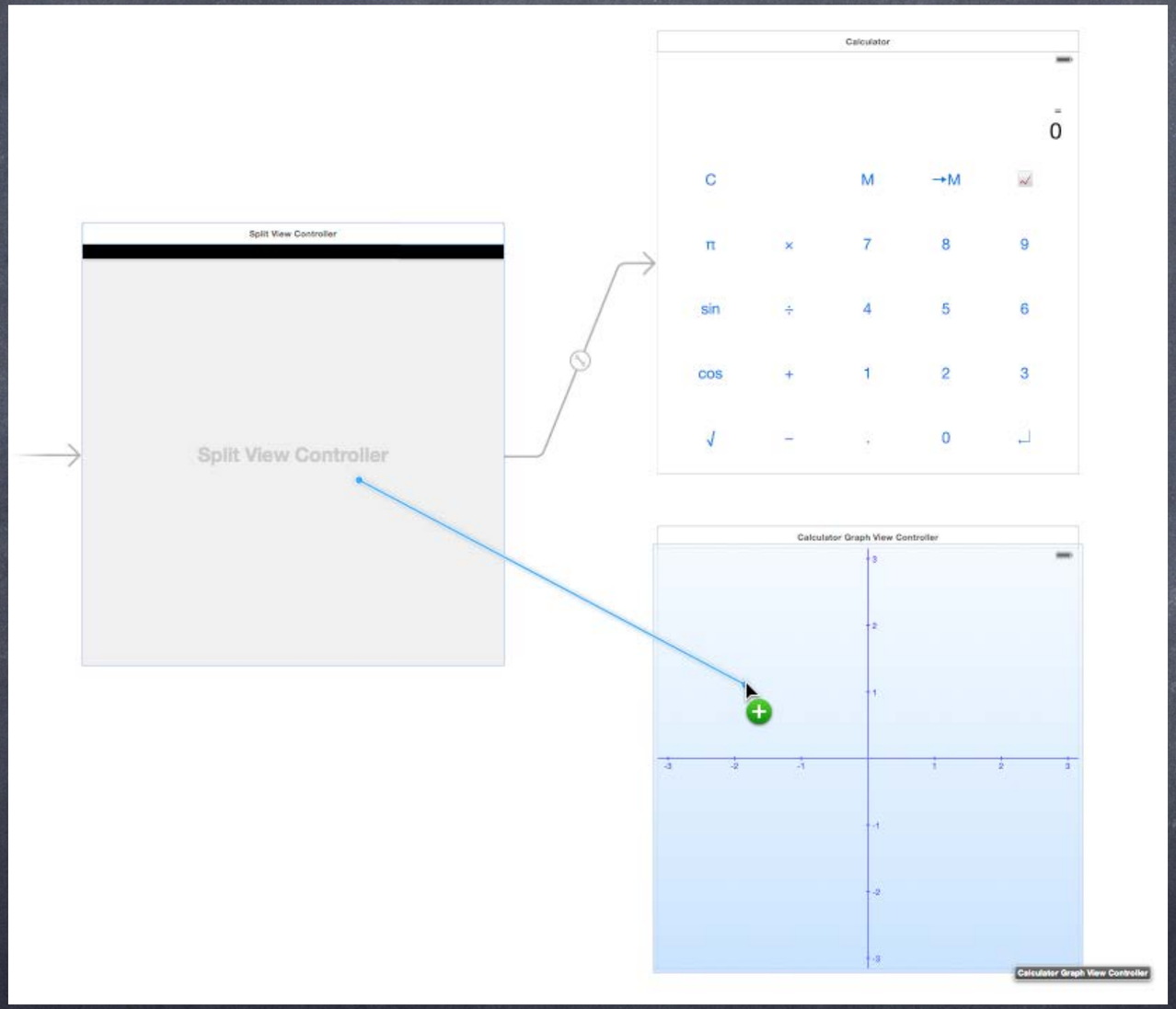
Wiring up MVCs



Wiring up MVCs



Wiring up MVCs



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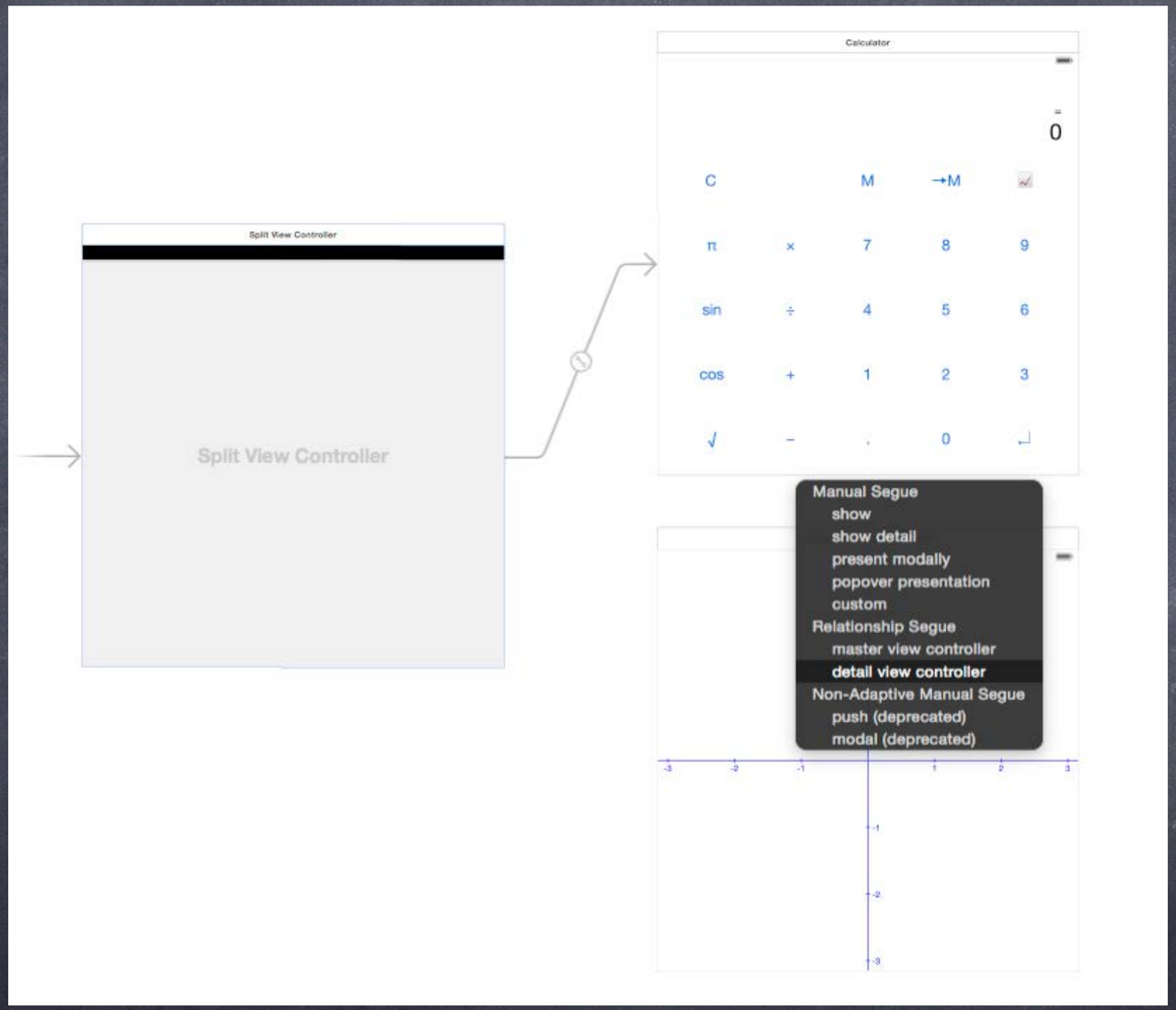
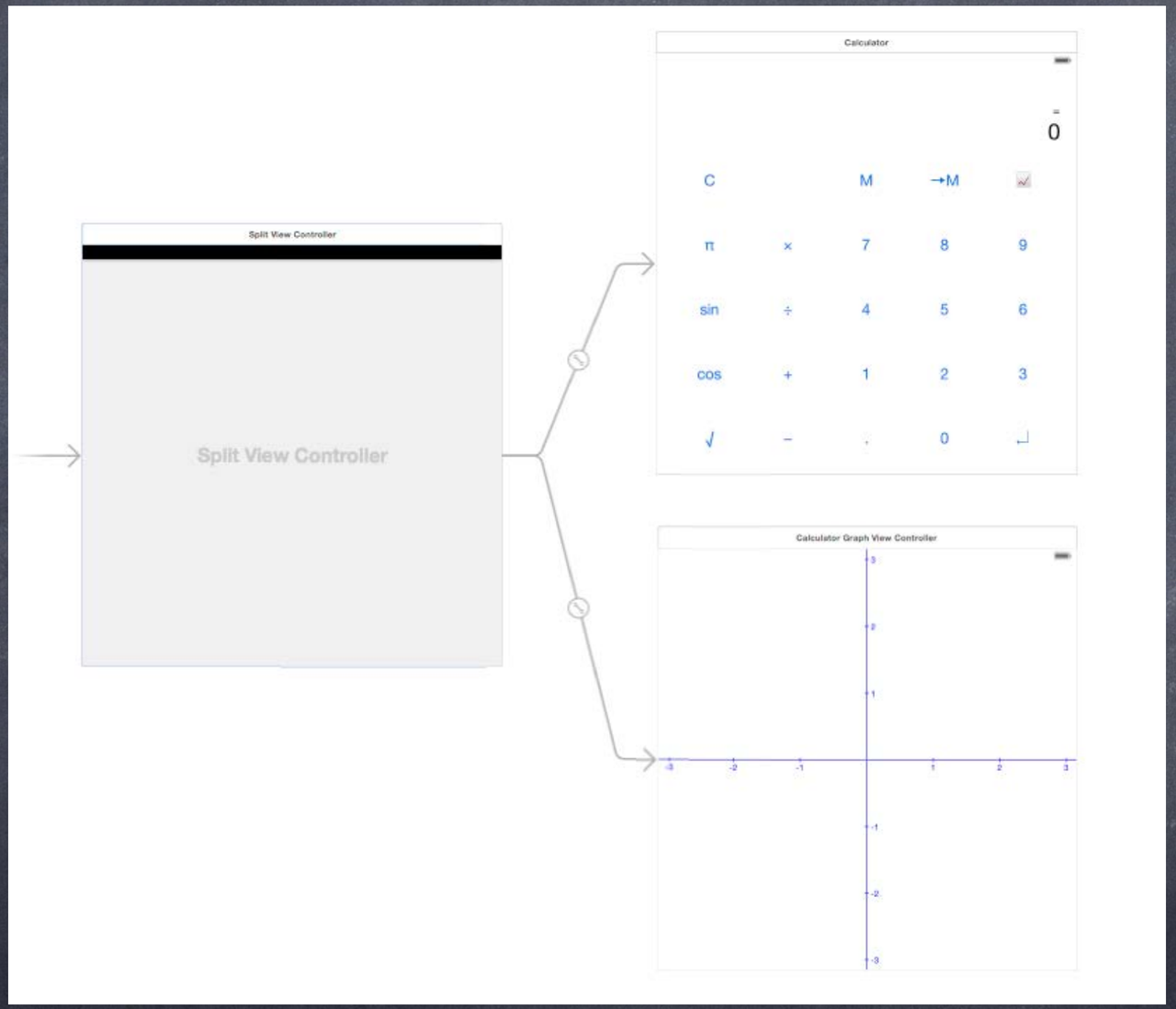
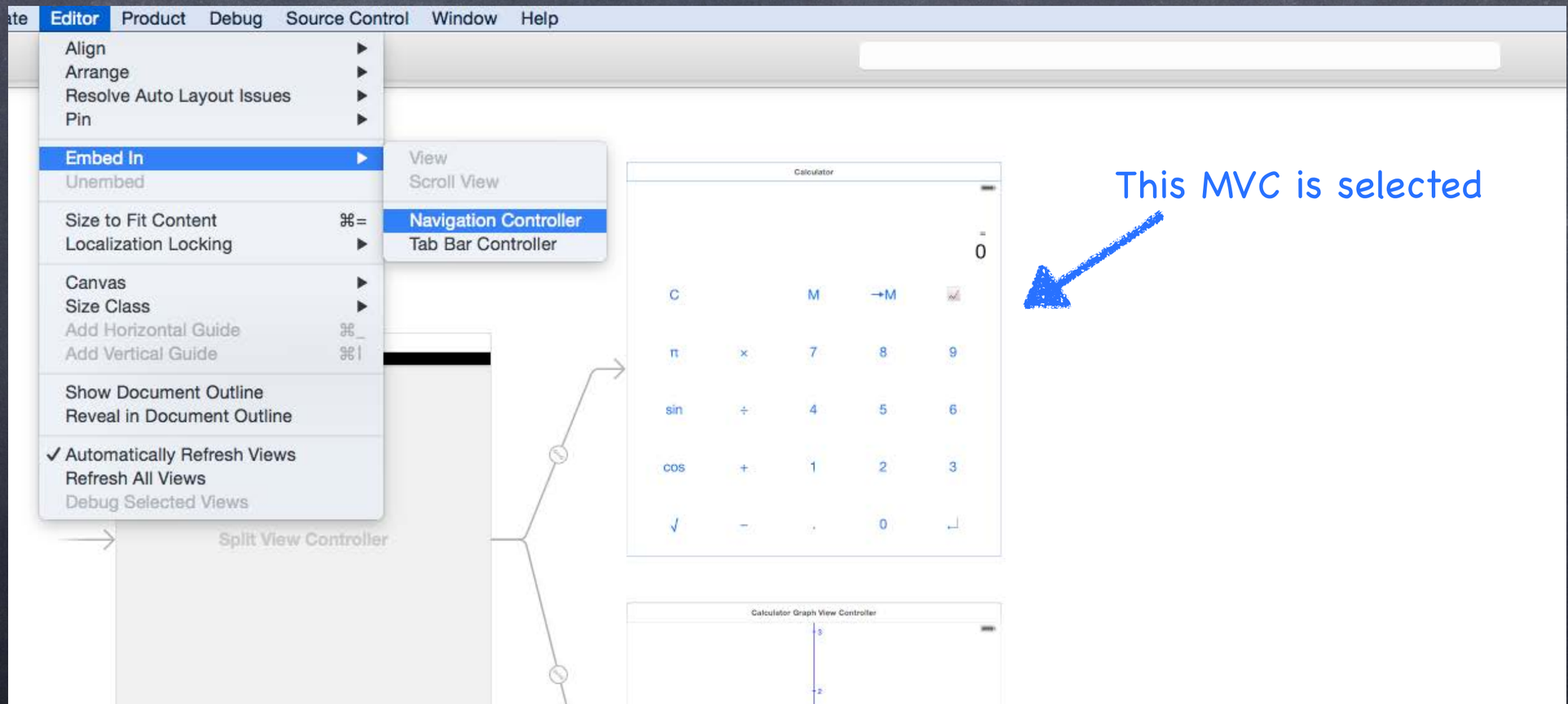


Wiring up MVCs



Wiring up MVCs

- But split view can only do its thing properly on iPad/iPhone+
  - So we need to put some Navigation Controllers in there so it will work on iPhone
  - The Navigation Controllers will be good for iPad too because the MVCs will get titles
  - The simplest way to wrap a Navigation Controller around an MVC is with Editor->Embed In



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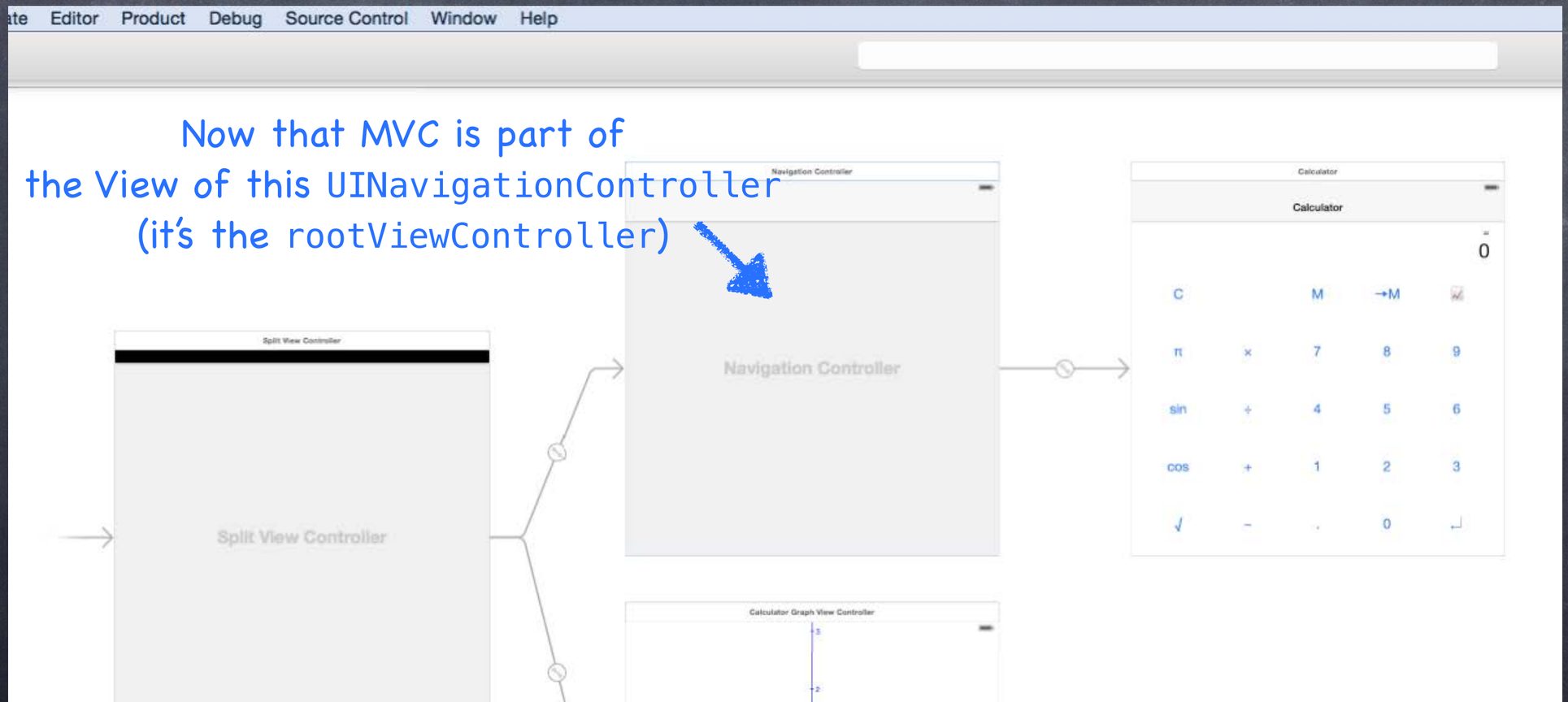

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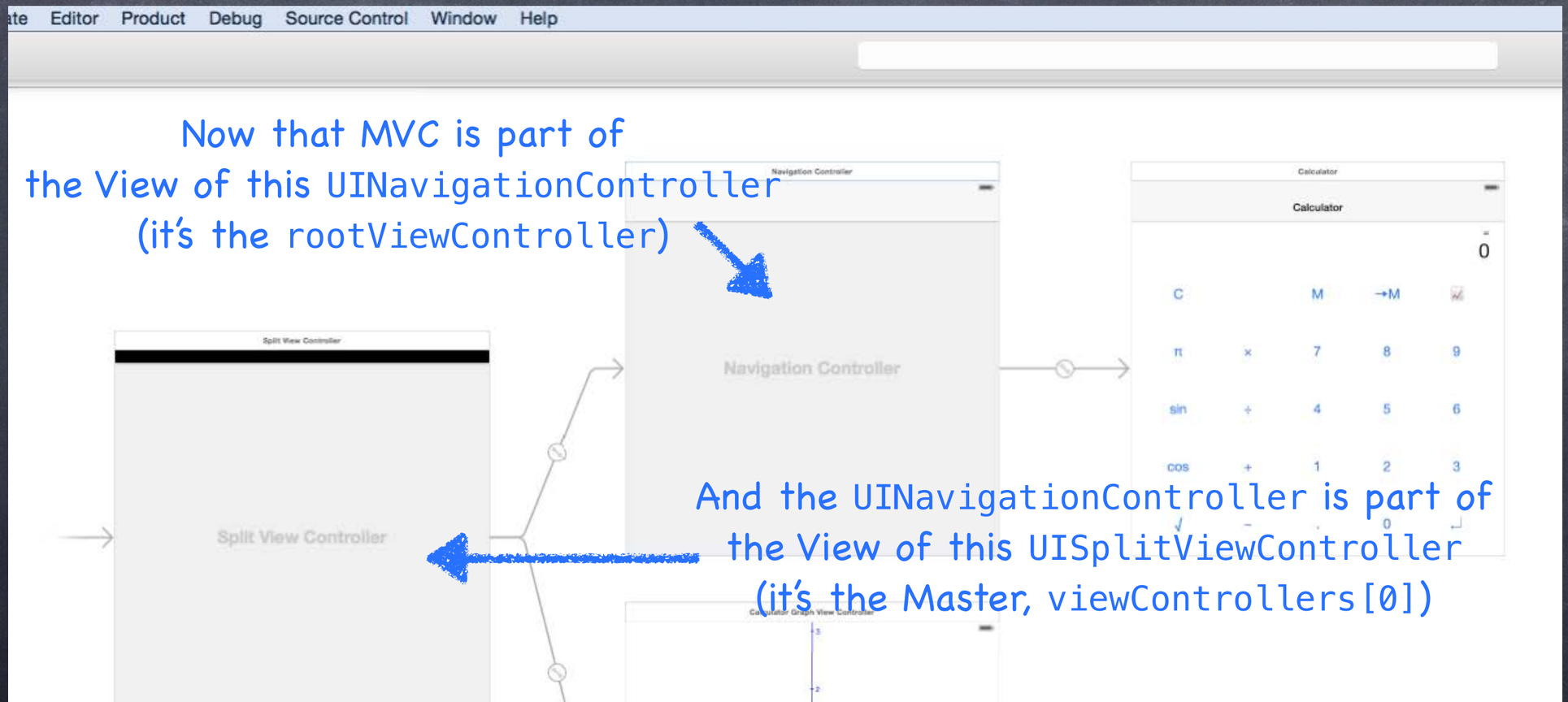

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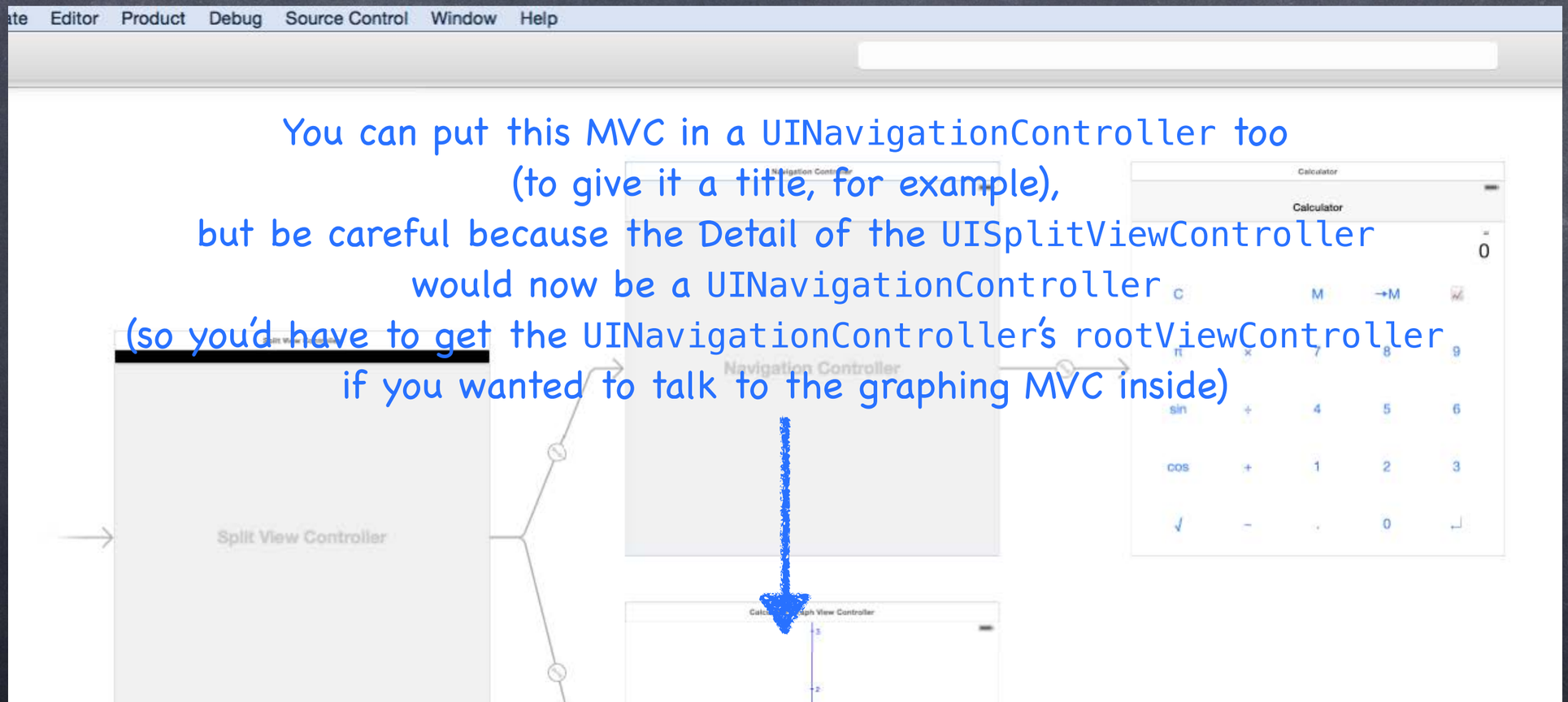
  - The Navigation Controllers will be good for iPad too because the MVCs will get titles
  - The simplest way to wrap a Navigation Controller around an MVC is with Editor->Embed In



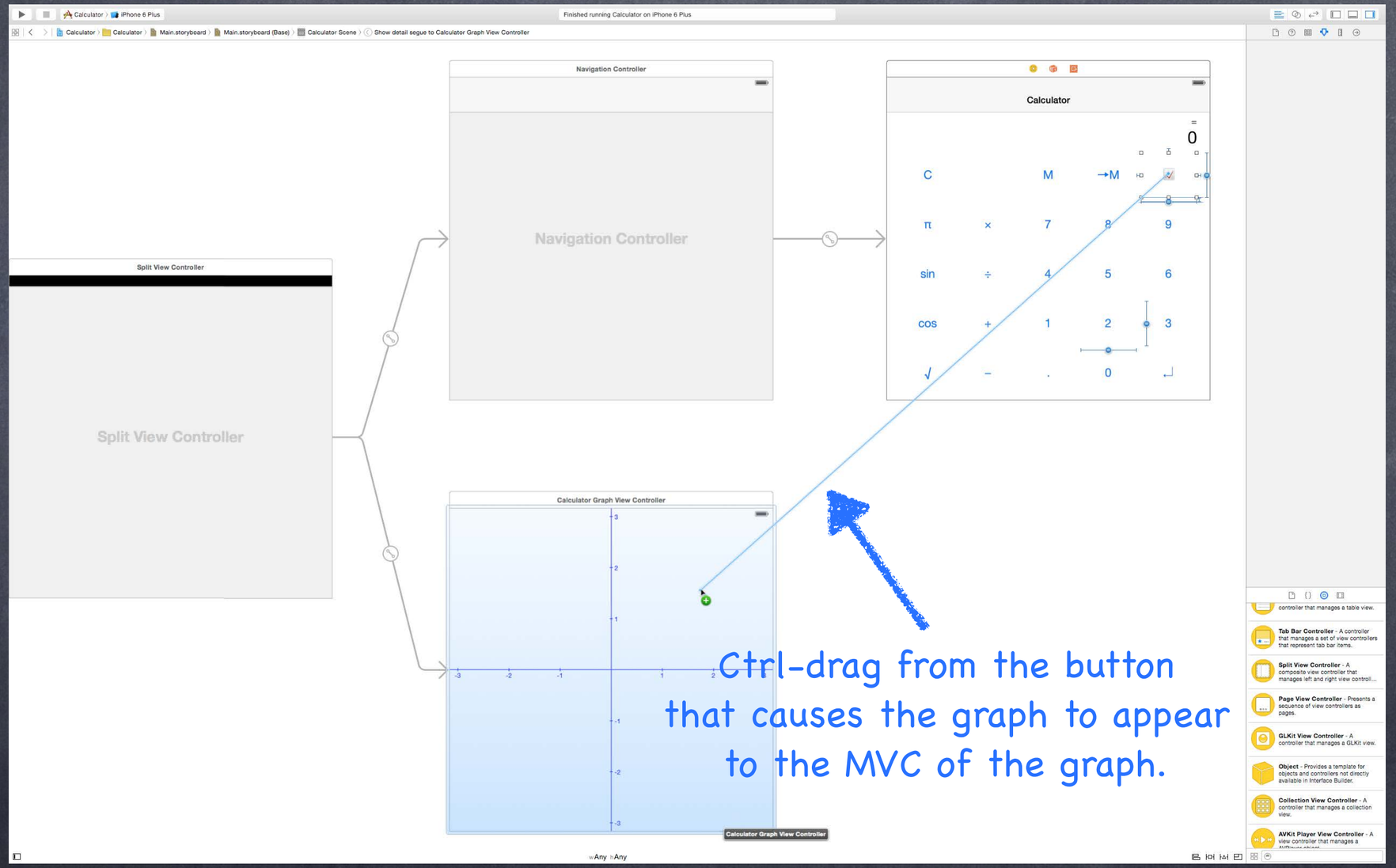
Segues

- We've built up our Controllers of Controllers, now what?
  - Now we need to make it so that one MVC can cause another to appear
  - We call that a "segue"
- Kinds of segues (they will adapt to their environment)
  - Show Segue (will push in a Navigation Controller, else Modal)
  - Show Detail Segue (will show in Detail of a Split View or will push in a Navigation Controller)
  - Modal Segue (take over the entire screen while the MVC is up)
  - Popover Segue (make the MVC appear in a little popover window)
- Segues always create a new instance of an MVC
  - This is important to understand
  - Even the Detail of a Split View will get replaced with a new instance of that MVC
  - When you segue in a Navigation Controller it will not segue to some old instance, it'll be new
  - Going "back" in a Navigation Controller is NOT a segue though (so no new instance there)

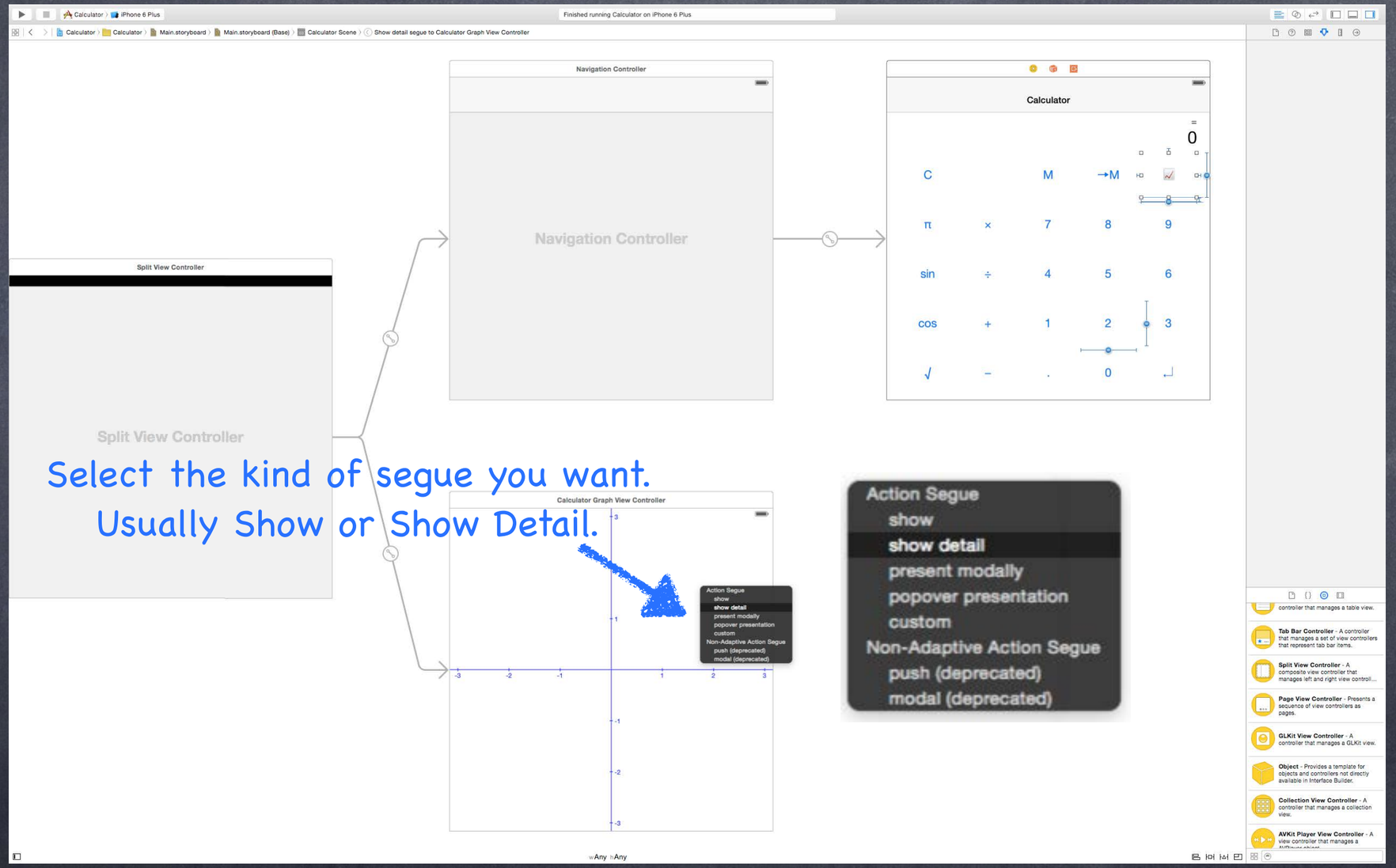
Segues

- How do we make these segues happen?
  - Ctrl-drag in a storyboard from an instigator (like a button) to the MVC to segue to
  - Can be done in code as well

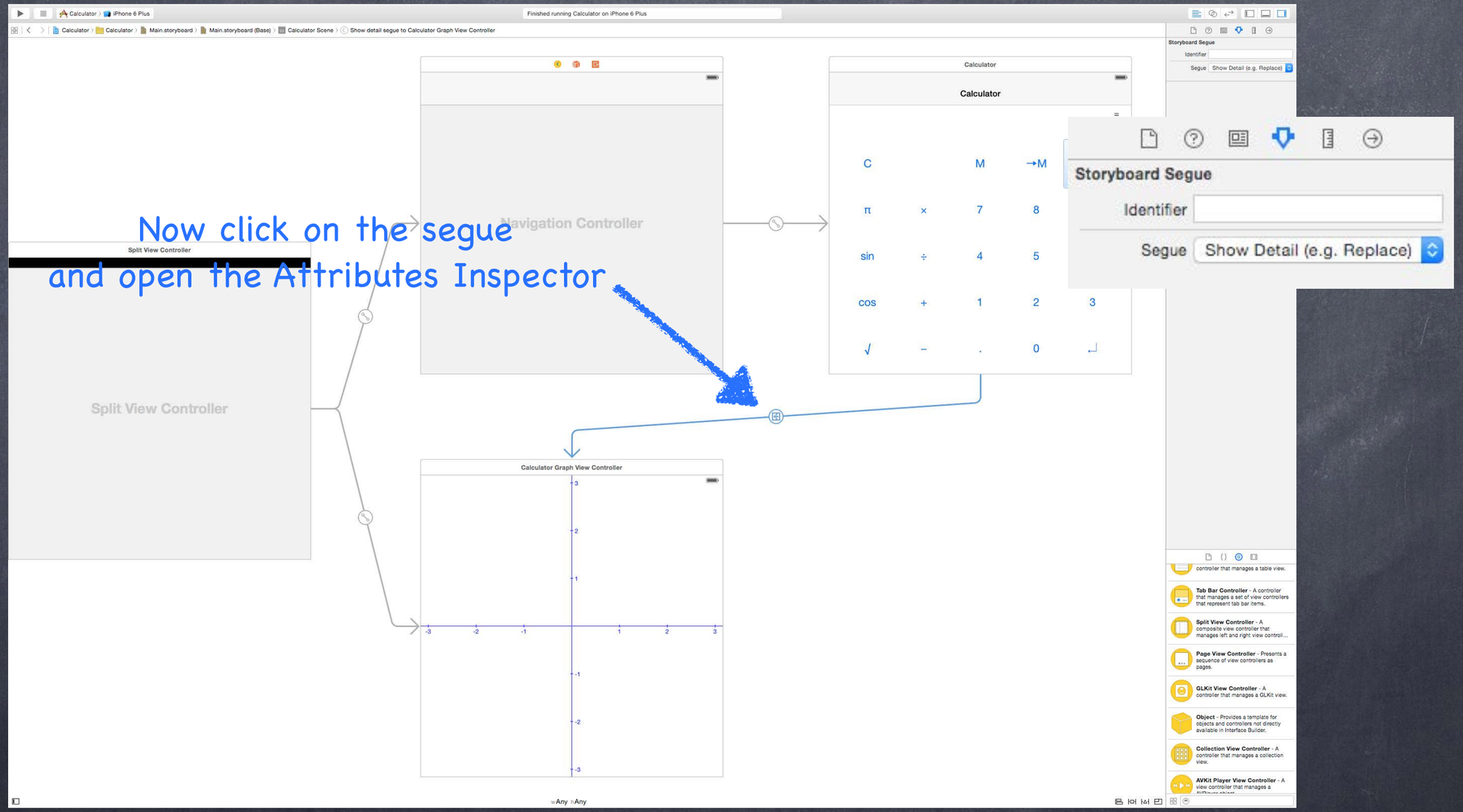
Segues


Navigation Controller
Calculator
Split View Controller
Navigation Controller
Split View Controller
Calculator Graph View Controller
Ctrl-drag from the button that causes the graph to appear to the MVC of the graph.

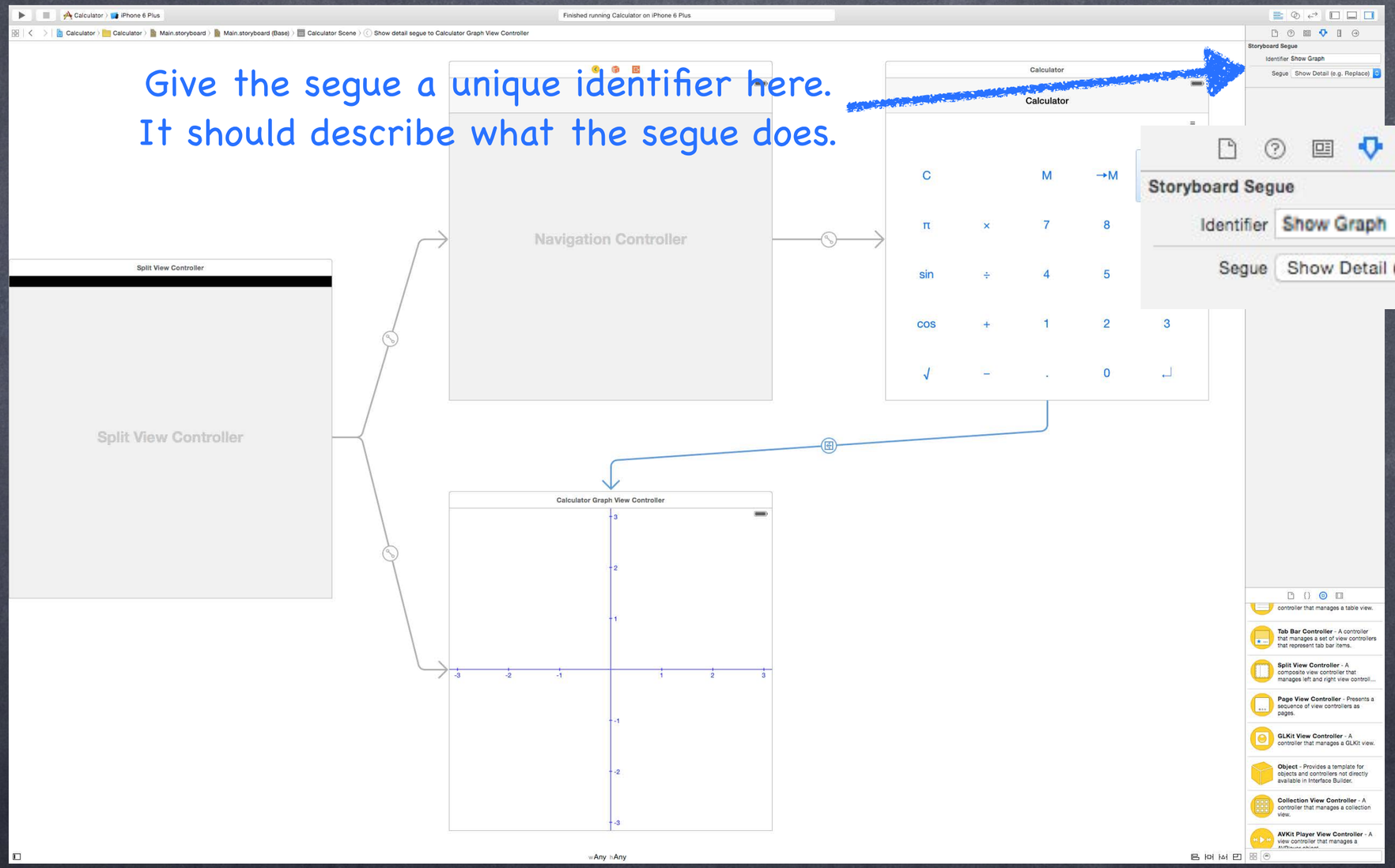
Segues


Navigation Controller
Navigation Controller
Calculator
Split View Controller
Split View Controller
Select the kind of segue you want.
Usually Show or Show Detail.
Calculator Graph View Controller
Action Segue
show
show detail
present modally
popover presentation
custom
Non-Adaptive Action Segue
push (deprecated)
modal (deprecated)

Segues


Now click on the segue
and open the Attributes Inspector
Split View Controller
Navigation Controller
Calculator
Calculator Graph View Controller
Storyboard Segue
Identifier
Segue
Show Detail (e.g. Replace)

Segues


Give the segue a unique identifier here.
It should describe what the segue does.
Split View Controller
Navigation Controller
Calculator
Calculator Graph View Controller
Storyboard Segue
Identifier Show Graph
Segue Show Detail (e.g. Replace)

Segues

- What's that identifier all about?
  - You would need it to invoke this segue from code using this `UIViewController` method
  - `func performSegue(withIdentifier: String, sender: Any?)`
  - (but we almost never do this because we set usually ctrl-drag from the instigator)
  - The `sender` can be whatever you want (you'll see where it shows up in a moment)
  - You can ctrl-drag from the Controller itself to another Controller if you're segueing via code
  - (because in that case, you'll be specifying the `sender` above)
- More important use of the identifier: preparing for a segue
  - When a segue happens, the View Controller containing the instigator gets a chance to prepare the destination View Controller to be segued to
  - Usually this means setting up the segued-to MVC's Model and display characteristics
  - Remember that the MVC segued to is always a fresh instance (never a reused one)

Preparing for a Segue

- The method that is called in the instigator's Controller

```
func prepare(for segue: UIStoryboardSegue, sender: Any?) {
    if let identifier = segue.identifier {
        switch identifier {
            case “Show Graph”:
                if let vc = segue.destination as? GraphController {
                    vc.property1 = …
                    vc.callMethodToSetItUp(…)
                }
            default: break
        }
    }
}
```

Preparing for a Segue

- The method that is called in the instigator's Controller

```
func prepare(for segue: UIStoryboardSegue, sender: Any?) {
    if let identifier = segue.identifier {
        switch identifier {
            case “Show Graph”:
                if let vc = segue.destination as? GraphController {
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                    vc.callMethodToSetItUp(…)
                }
            default: break
        }
    }
}
```

The segue passed in contains important information about this segue:

1. the identifier from the storyboard
2. the Controller of the MVC you are segueing to (which was just created for you)

Preparing for a Segue

- The method that is called in the instigator's Controller

```
func prepare(for segue: UIStoryboardSegue, sender: Any?) {
    if let identifier = segue.identifier {
        switch identifier {
            case “Show Graph”:
                if let vc = segue.destination as? GraphController {
                    vc.property1 = …
                    vc.callMethodToSetItUp(…)
                }
            default: break
        }
    }
}
```

The sender is either the instigating object from a storyboard (e.g. a UIButton)
or the sender you provided (see last slide) if you invoked the segue manually in code

Preparing for a Segue

- The method that is called in the instigator's Controller

```
func prepare(for segue: UIStoryboardSegue, sender: Any?) {
    if let identifier = segue.identifier {
        switch identifier {
            case “Show Graph”:
                if let vc = segue.destination as? GraphController {
                    vc.property1 = …
                    vc.callMethodToSetItUp(…)
                }
            default: break
        }
    }
}
```

Here is the identifier from the storyboard (it can be `nil`, so be sure to check for that case)
Your Controller might support preparing for lots of different segues from different instigators
so this identifier is how you'll know which one you're preparing for

Preparing for a Segue

- The method that is called in the instigator's Controller

```
func prepare(for segue: UIStoryboardSegue, sender: Any?) {
    if let identifier = segue.identifier {
        switch identifier {
            case “Show Graph”:
                if let vc = segue.destination as? GraphController {
                    vc.property1 = …
                    vc.callMethodToSetItUp(…)
                }
            default: break
        }
    }
}
```

For this example, we'll assume we entered "Show Graph" in the Attributes Inspector when we had the segue selected in the storyboard

Preparing for a Segue

- The method that is called in the instigator's Controller

```
func prepare(for segue: UIStoryboardSegue, sender: Any?) {
    if let identifier = segue.identifier {
        switch identifier {
            case “Show Graph”:
                if let vc = segue.destination as? GraphController {
                    vc.property1 = …
                    vc.callMethodToSetItUp(…)
                }
            default: break
        }
    }
}
```

Here we are looking at the Controller of the MVC we're segueing to
It is Any so we must cast it to the Controller we (should) know it to be

Preparing for a Segue

- The method that is called in the instigator's Controller

```
func prepare(for segue: UIStoryboardSegue, sender: Any?) {
    if let identifier = segue.identifier {
        switch identifier {
            case “Show Graph”:
                if let vc = segue.destination as? GraphController {
                    vc.property1 = …
                    vc.callMethodToSetItUp(…)
                }
            default: break
        }
    }
}
```

This is where the actual preparation of the segued-to MVC occurs
Hopefully the MVC has a clear public API that it wants you to use to prepare it
Once the MVC is prepared, it should run on its own power (only using delegation to talk back)

Preparing for a Segue

- The method that is called in the instigator's Controller

```
func prepare(for segue: UIStoryboardSegue, sender: Any?) {
    if let identifier = segue.identifier {
        switch identifier {
            case “Show Graph”:
                if let vc = segue.destination as? GraphController {
                    vc.property1 = …
                    vc.callMethodToSetItUp(…)
                }
            default: break
        }
    }
}
```

It is crucial to understand that this preparation is happening BEFORE outlets get set!

It is a very common bug to prepare an MVC thinking its outlets are set.

Preventing Segues

- You can prevent a segue from happening too
  - Just return `false` from this method your `UIViewController` …
  - `func shouldPerformSegue(withIdentifier identifier: String?, sender: Any?) -> Bool`
  - The `identifier` is the one in the storyboard.
  - The `sender` is the instigating object (e.g. the button that is causing the segue).

Demo

- Concentration Theme Chooser
  - This is all best understood via demonstration
  - We'll put the MVCs into navigation controllers inside split view controllers
  - That way, it will work on both iPad and iPhone devices

Timer

- Used to execute code periodically
  - You can set it up to go off once at at some time in the future, or to repeatedly go off
  - If repeatedly, the system will not guarantee exactly when it goes off, so this is not "real-time"
  - But for most UI "order of magnitude" activities, it's perfectly fine
  - We don't generally use it for "animation" (more on that later)
  - It's more for larger-grained activities

Timer

- Fire one off with this method …

```
class func scheduledTimer(
    withTimeInterval: TimeInterval,
    repeats: Bool,
    block: (Timer) -> Void
) -> Timer
```

- Example

```
private weak var timer: Timer?
timer = Timer.scheduledTimer(withTimeInterval: 2.0, repeats: true) { timer in
    // your code here
}
```

Every 2 seconds (approximately), the closure will be executed.

Note that the `var` we stored the timer in is `weak`.

That's okay because the run loop will keep a `strong` pointer to this as long as it's scheduled.

Timer

- Stopping a repeating timer
  - We need to be a bit careful with repeating timers … you don't want them running forever.
  - You stop them by calling `invalidate()` on them …
  - `timer.invalidate()`
  - This tells the run loop to stop scheduling the timer.
  - The run loop will thus give up its `strong` pointer to this timer.
  - If your pointer to the timer is `weak`, it will be set to `nil` at this point.
  - This is nice because an invalidated timer like this is no longer of any use to you.
- Tolerance
  - It might help system performance to set a tolerance for "late firing".
  - For example, if you have timer that goes off once a minute, a tolerance of 10s might be fine.
  - `myOneMinuteTimer.tolerance = 10 // in seconds`
  - The firing time is relative to the start of the timer (not the last time it fired), i.e. no "drift".

Kinds of Animation

- Animating `UIView` properties
  Changing things like the frame or transparency.
- Animating Controller transitions (as in a `UINavigationController`)
  Beyond the scope of this course, but fundamental principles are the same.
- Core Animation
  Underlying powerful animation framework (also beyond the scope of this course).
- OpenGL and Metal
  3D
- SpriteKit
  "2.5D" animation (overlapping images moving around over each other, etc.)
- Dynamic Animation
  "Physics"-based animation.

UIView Animation

- Changes to certain `UIView` properties can be animated over time
  - `frame`/`center`
  - `bounds` (transient size, does not conflict with animating `center`)
  - `transform` (translation, rotation and scale)
  - `alpha` (opacity)
  - `backgroundColor`