iPhone Programming

CMSC 498i – Spring 2010

Model View Controller

Lecture #8 – Chuck Pisula

Today's Topics

- Architecting an Application
- Model View Controller Pattern
- Communication Strategies
  - Notifications
  - Data Source, Delegation
  - Key-Value Observing, Key-Value Coding

Architecture

- Design before coding
- Spend time understanding the problem
- A good design can save you time and improve quality
- Today
    - Application design patterns
    - Strategies for handling and communicating data
    - Examples of what to do and use

Architecture

- Break code into objects and units based on functionality
- Each module has a focused purpose

Architecture

- Break code into objects and units based on functionality
- Each module has a focused purpose
- Example: “iNeedToDo” ToDo Application
  - Data only objects
  - User Interface objects
  - Coordination
  - Application Logic

ToDo Application

- In Detail…

ToDo Application

Application Delegate

Manage application
lifecycle and events

ToDoListViewController

Provide cells for table
Manage array of events

ToDo Application

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ToDo Application

```
@implementation iNeedToDoAppDelegate

- (void)applicationDidFinishLaunching:(UIApplication *)app {
    [window addSubview:[navigationController view]];
    [window makeKeyAndVisible];
}
....
@end
```

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ToDo Application

```
    [window addSubview:[navigationController view]];
    [window makeKeyAndVisible];
}
....
@end
```

```
@implementation UINavigationController

- (UIView *)view {
    if (!_view) {
       [self loadView];
    }
    return _view;
}

- (void)loadView {
    // Create top level container view with nav bar
    rootController = // set to ToDoListViewController in NIB
    [topView addSubview:[rootController view]];
}

@end
```

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ToDo Application

```
    rootController = // set to ToDoListViewController in NIB
    [topView addSubview:[rootController view]];
}

@end
```

```
@implementation UIViewController

// ToDoListViewController is a UIViewController!
- (void)loadView {
    [NSBundle loadNibNamed: [self nibName]
                     owner: self
                   options:nil];
}

@end
```

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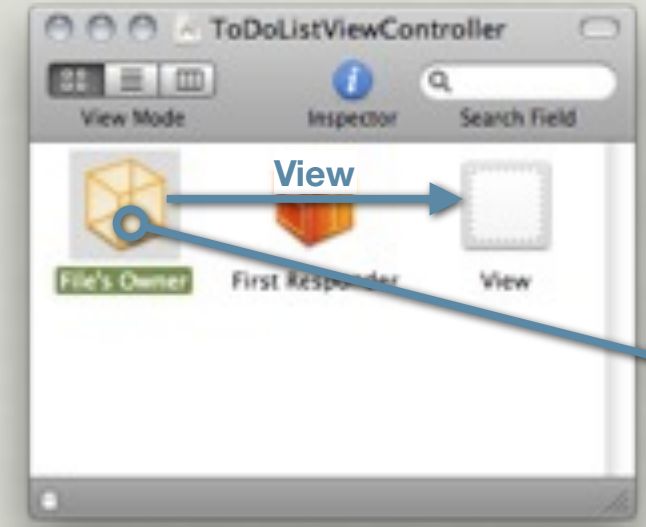

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NSDate (Additions)

date formatting strings in NSDate category

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UITableView

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Display a single event in a table

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Display a single event in a table

Focused Purpose

- **Example** – `UITableView`
- Handles presentation of table cells in a linear layout
- Provides options to control appearance
- Provides standard UI and behaviors
  - Customize by providing a **delegate** – `UITableViewDelegate`
- Has no knowledge of any specific data
  - Cells provided by **data source** - `UITableViewDataSource`
  - Edits are implemented by the **data source**

Focused Purpose

- **Example** – `ToDoEvent`
- Stores data specific to a todo event
- Provides access to stored data through setter / getter
- Typically provide ability to archive / unarchive the data
- Has no knowledge of how it will be displayed
    - Examples
        - Might display different date formats based on available width
        - We may use “past the due date” to mean display the title in red

Focused Purpose

- **Example** – `ToDoListViewController`
- Knows about the data, and display – Coordinates it all.
- Manages and filters array of events
- Provides cells to table view for display
- Updates events in response to edits
- Tells display about changes to the data

ToDo Application

Model	View	Controller
ToDoEvent Store and provide access event data	**UITableView** Display a list of cells provided by data source **ToDoEventCell** Display a single event in a table	**ToDoListViewController** Provide cells for table Manage array of events

Model View Controller

Model - View - Controller

- MVC

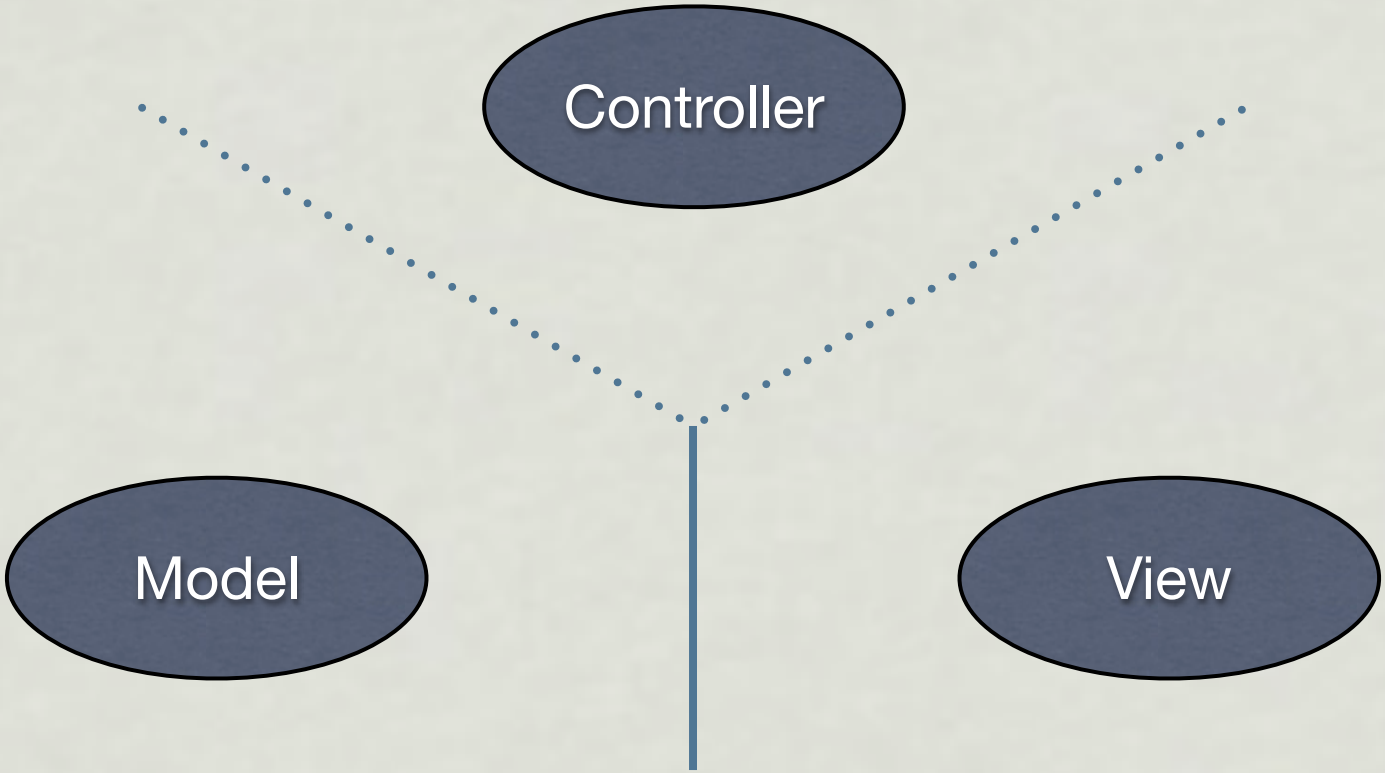
Model - View - Controller

- **MVC**
- A pattern concerned with application architecture
  - Isolate data from input and presentation
  - Each role has a specific purpose and line of communication

Model - View - Controller

- **MVC**
- A pattern concerned with application architecture
  - Isolate data from input and presentation
  - Each role has a specific purpose and line of communication
- Object roles
  - **Model** – data storage and domain specific logic
  - **View** – user interface, data presentation
  - **Controller** – respond to events, update data, implement application logic

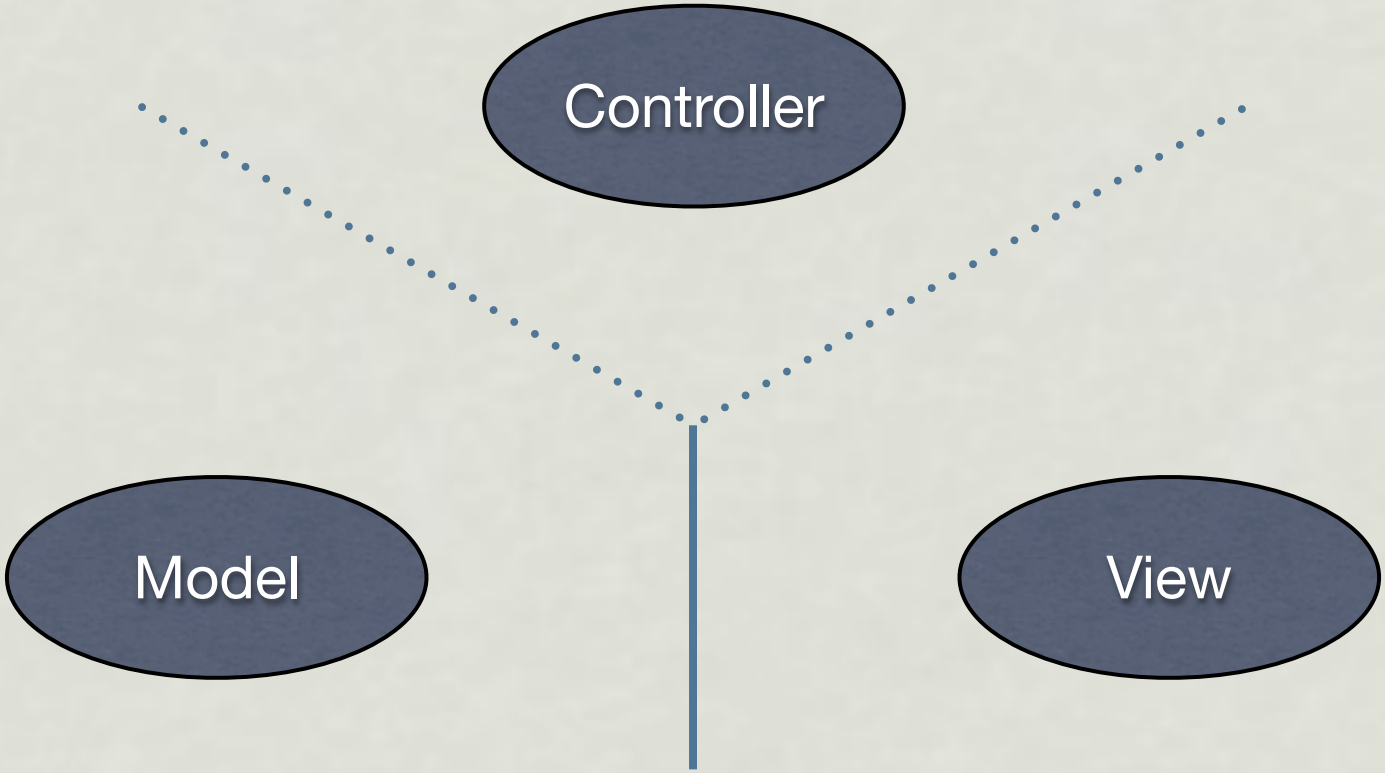
MVC



(or if you like… MCV)

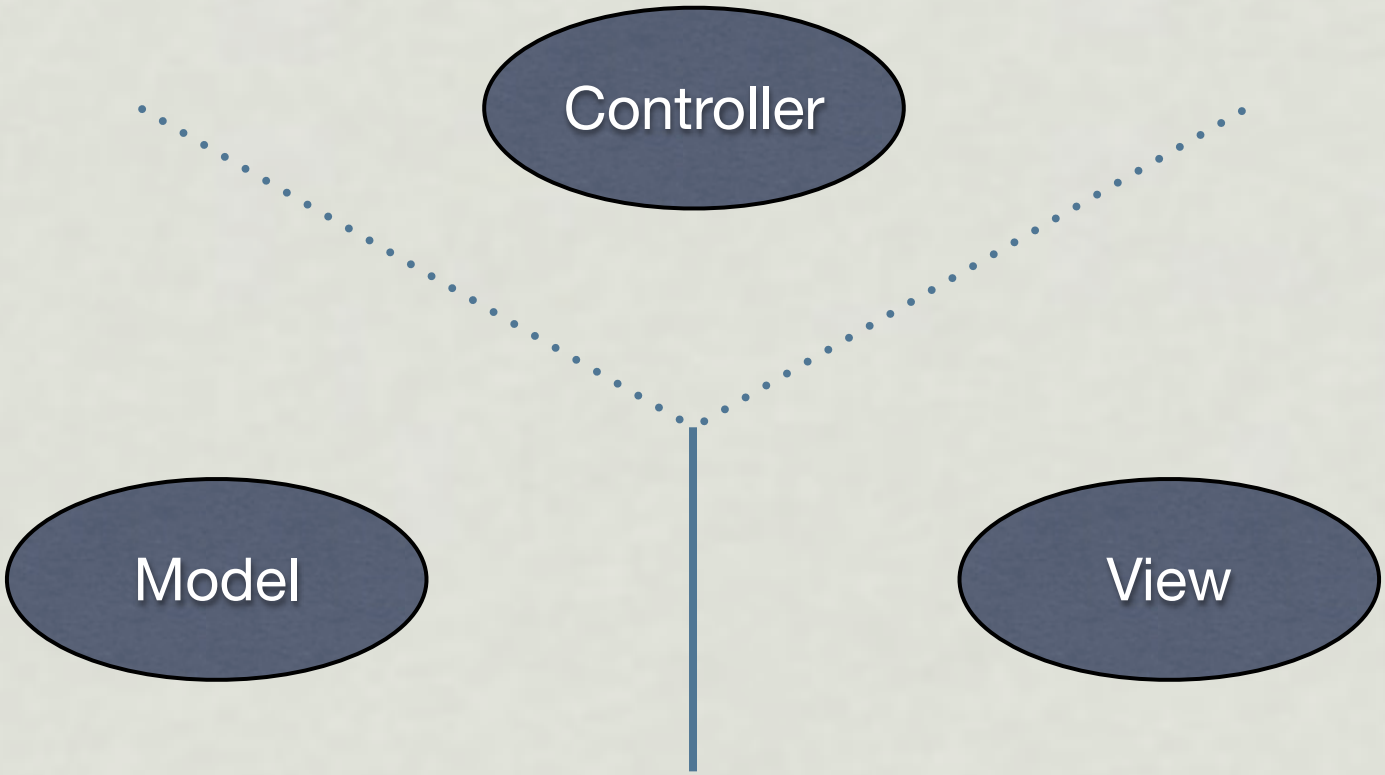
MVC

- Model and View do not communicate directly



Controller & Model

- Controller updates model and watches for changes



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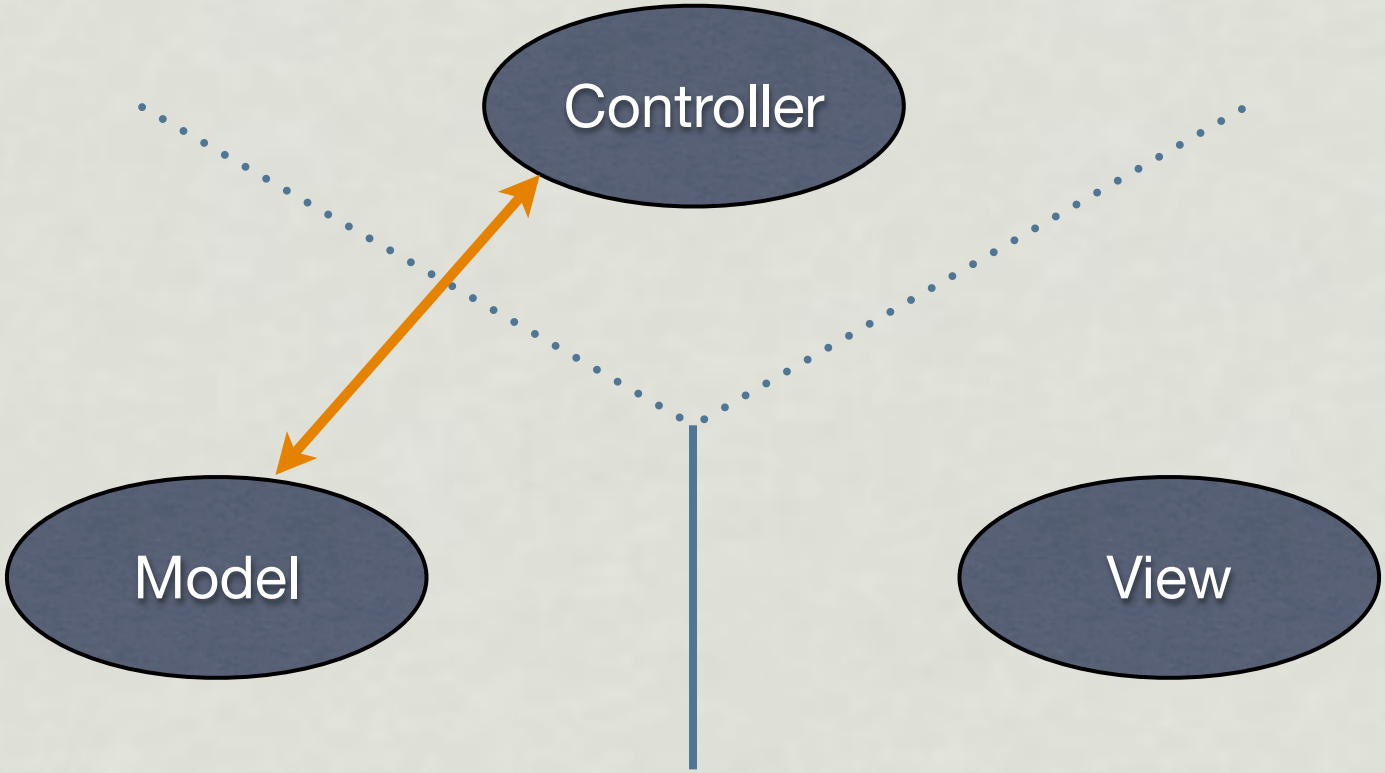
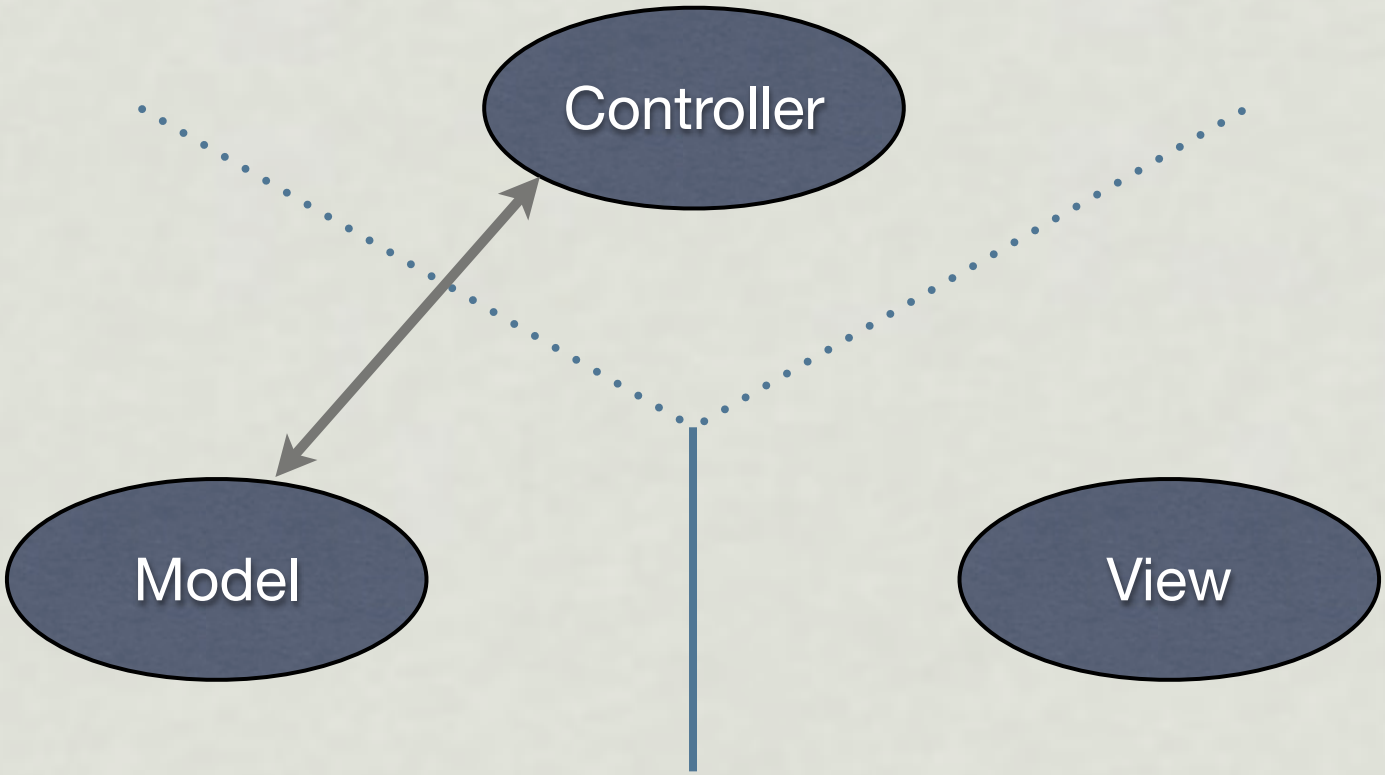


Controller & View

- Controller updates view, responds to view actions



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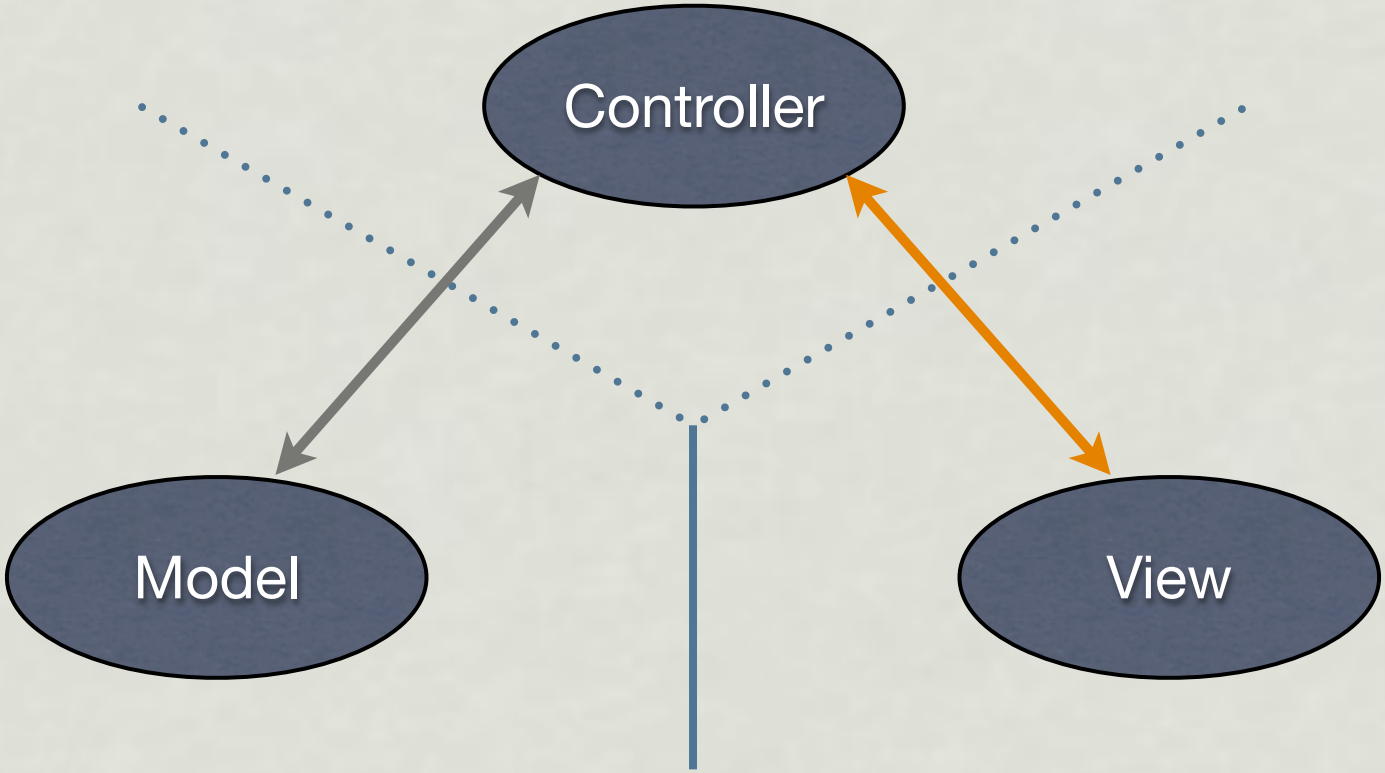
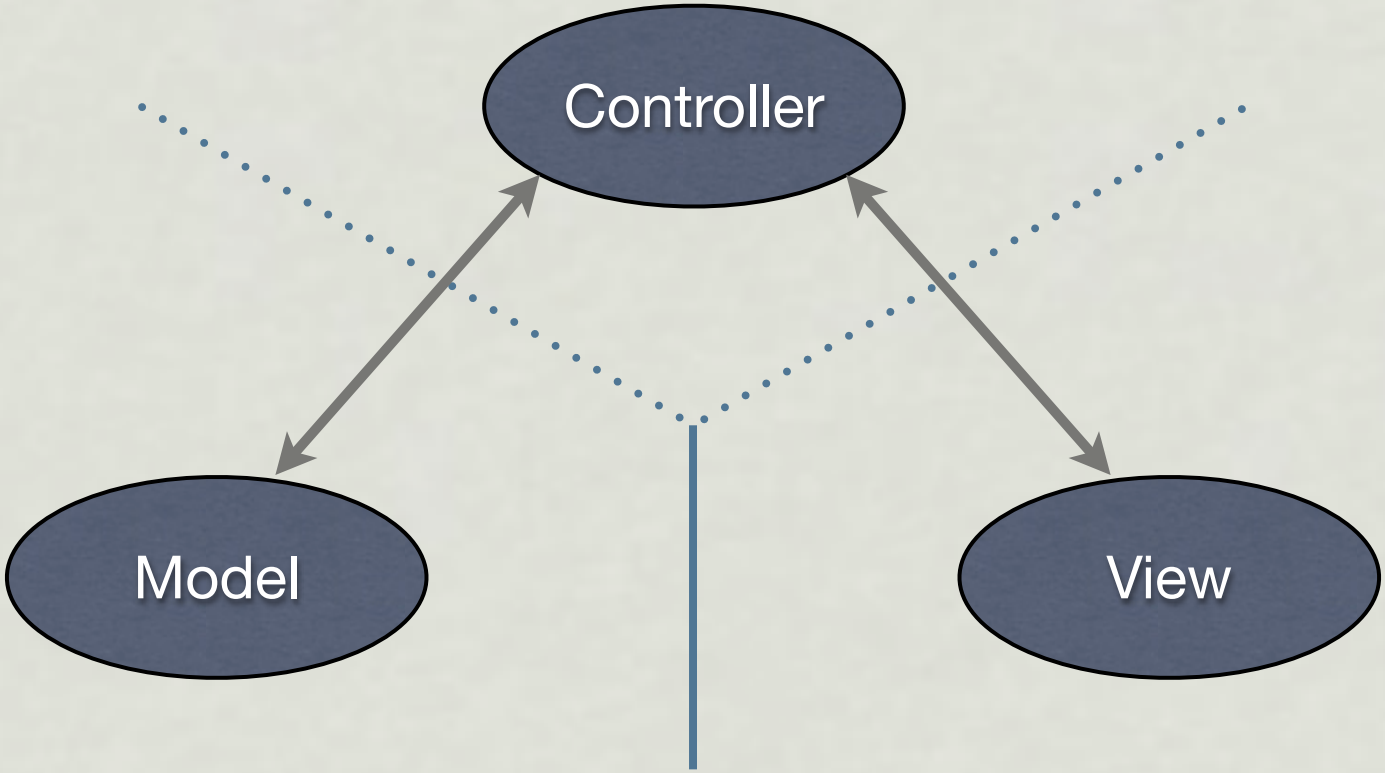


Controller & View

- Hybrid – Watch for changes without needing a controller



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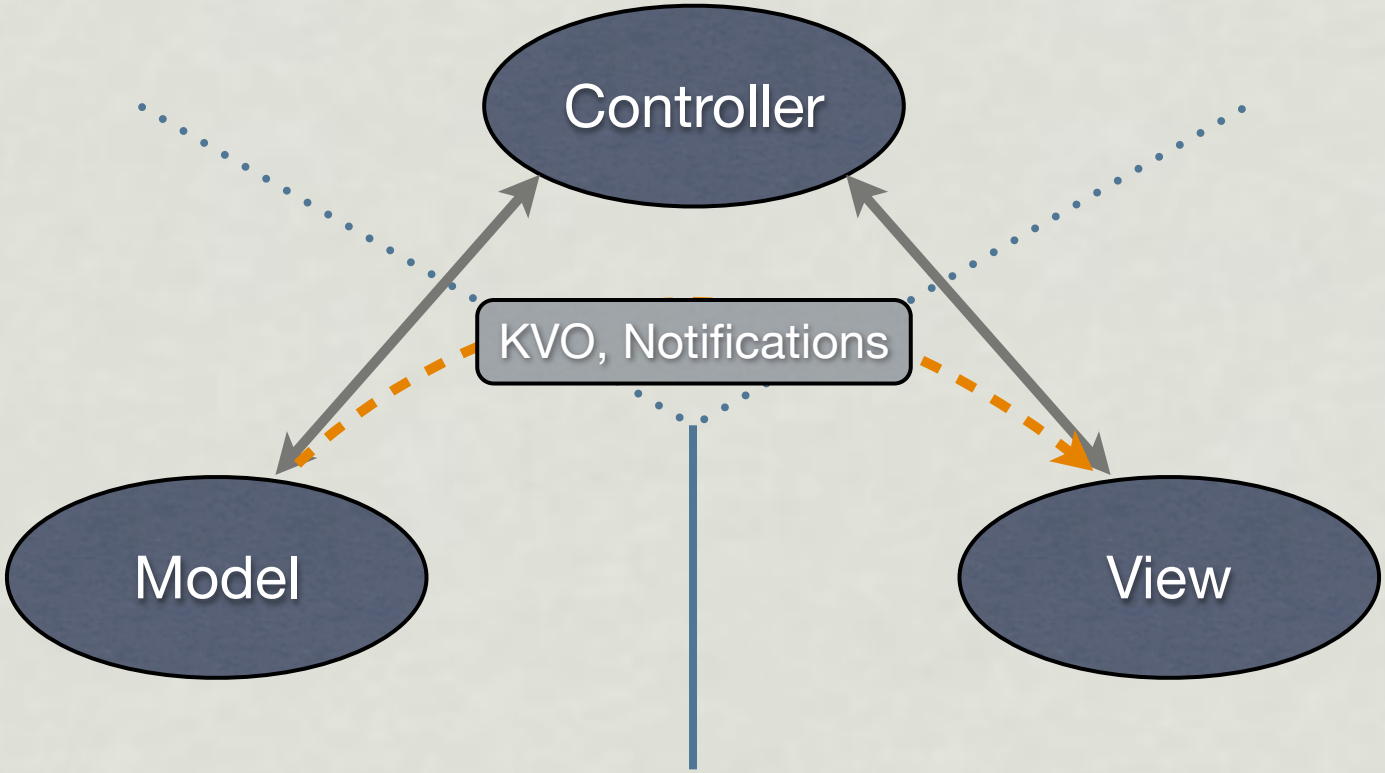
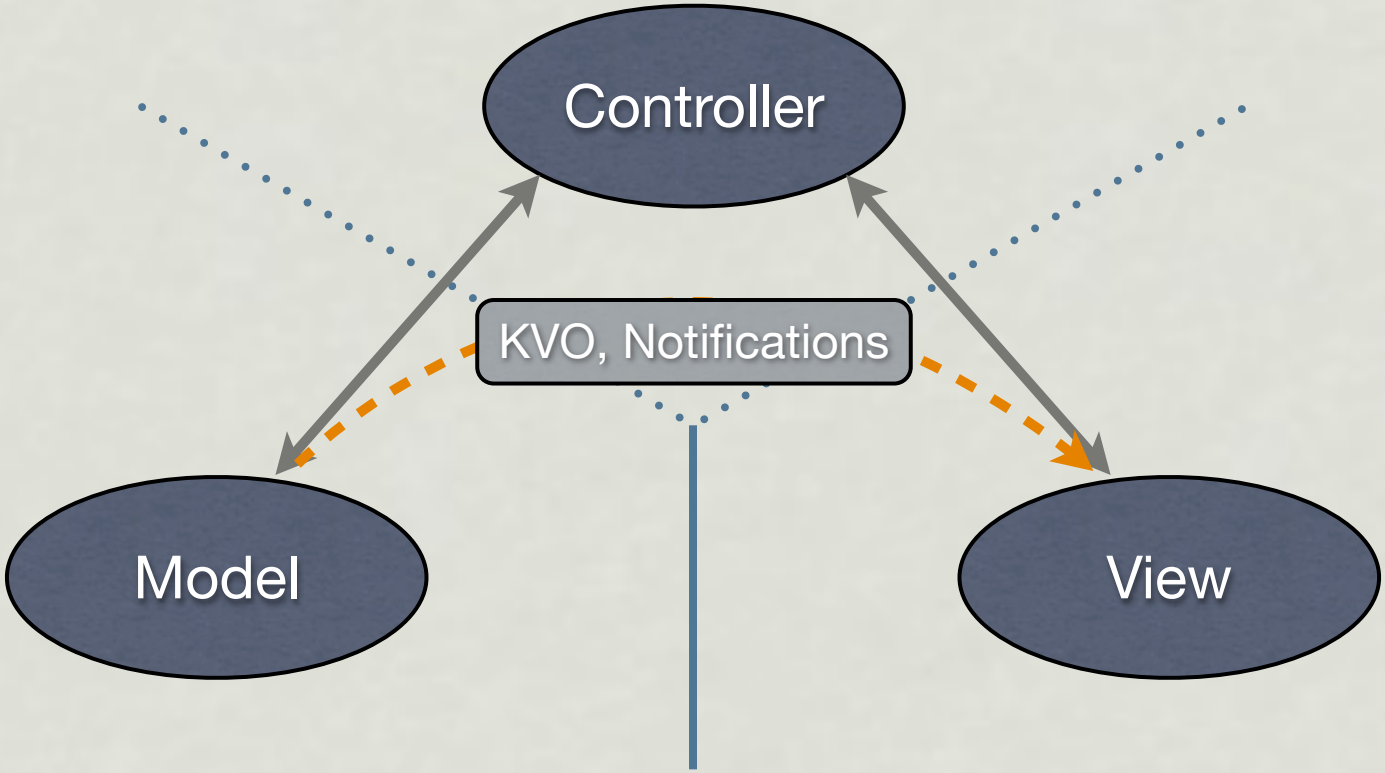
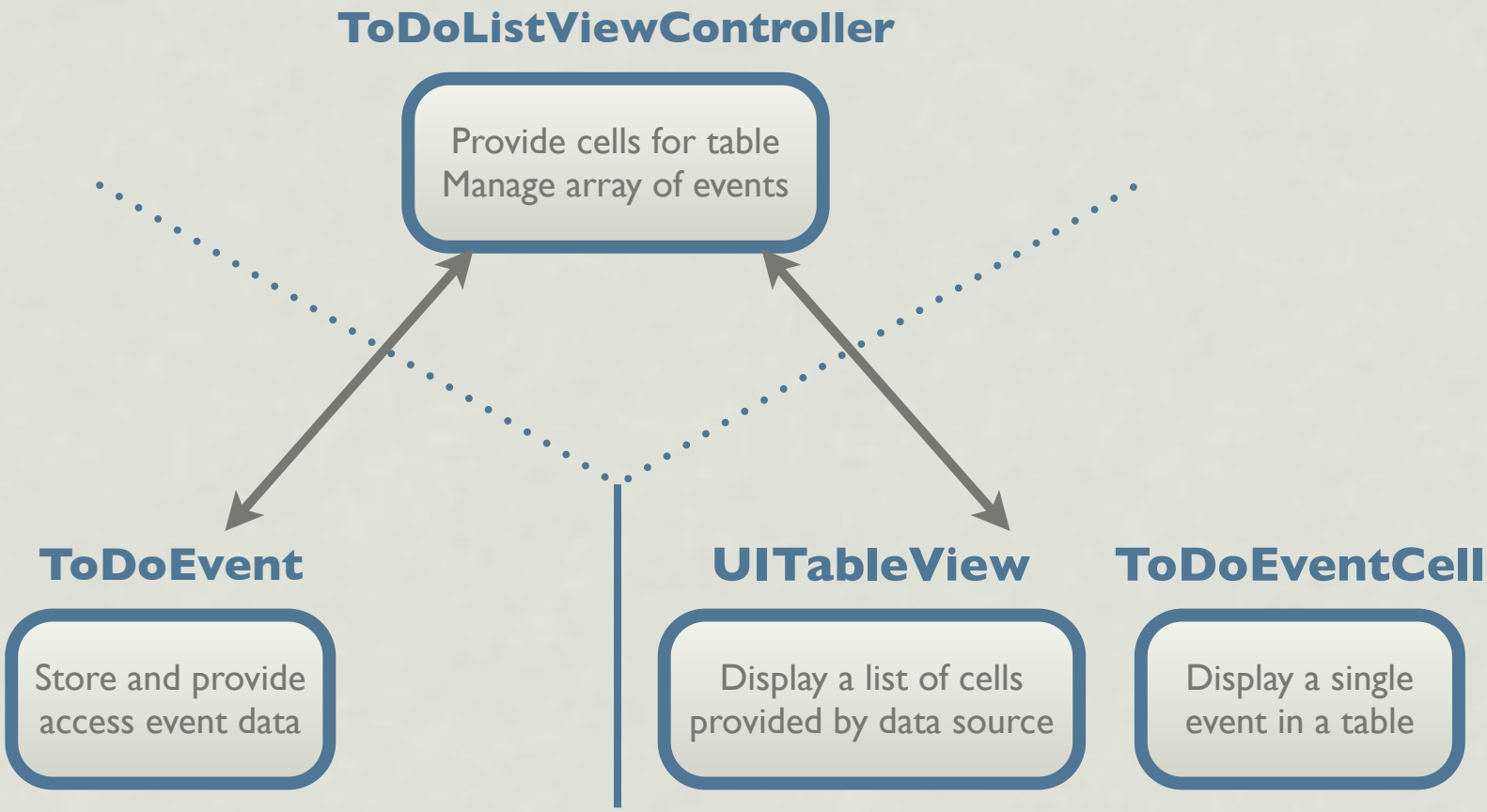


Controller & View



In Practice


ToDoListViewController
Provide cells for table
Manage array of events
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Store and provide
access event data
UITableView
Display a list of cells
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Display a single
event in a table

Model - View - Controller

- Why are we talking about it?
- Benefits of MVC
  - **Reusability** - model, and view code tend to be reusable
  - **Reduced Complexity** – clean separation
    - *Extensibility* - code more adaptable to change
    - *Maintainability* - produce more maintainable code
  - Clean division of labor allows better independent development
  - Model objects are easily unit testable

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  - Clean division of labor allows better independent development
  - Model objects are easily unit testable
- Understand MVC to effectively use iPhone APIs

Model

- Data – maintains, provides access, logic to manipulate
- Views and Controller may directly reference the Model, but not the other way around
- Models communicate with views and controllers anonymously using notifications

Model

- Data – maintains, provides access, logic to manipulate
- Views and Controller may directly reference the Model, but not the other way around
- Models communicate with views and controllers anonymously using notifications
- Reasons to keep model logic separate
  - Cleanly separated models are easily unit testable
  - Typically platform agnostic, reusable for other platforms
  - Avoids need to maintain and synchronize state when one object is responsible for storage

Model Parts

- **Instance Variables** - declare variables to hold your data
- **Accessors / Properties** - provide ways to get / set values
- **Initialization** - set instance variable to reasonable default values
- **Deallocation** - release referenced objects
- **Encoding** - provide ability to persist your object
- **Copying** - allow clients to get a snapshot of your object as a copy
- **Observation** - clients can observe object changes using built in KVO mechanism, you may want to post your own notifications

Model Example

- `ToDoEvent`
- Stores a `NSDate` instead of a formatted date string
  - Avoids making assumptions about display
  - Leaves formatting up to the view
- Observable Changes
  - Automatic through **Key-Value Observing** (*more on this later*)
  - Or coordinated by the controller

View

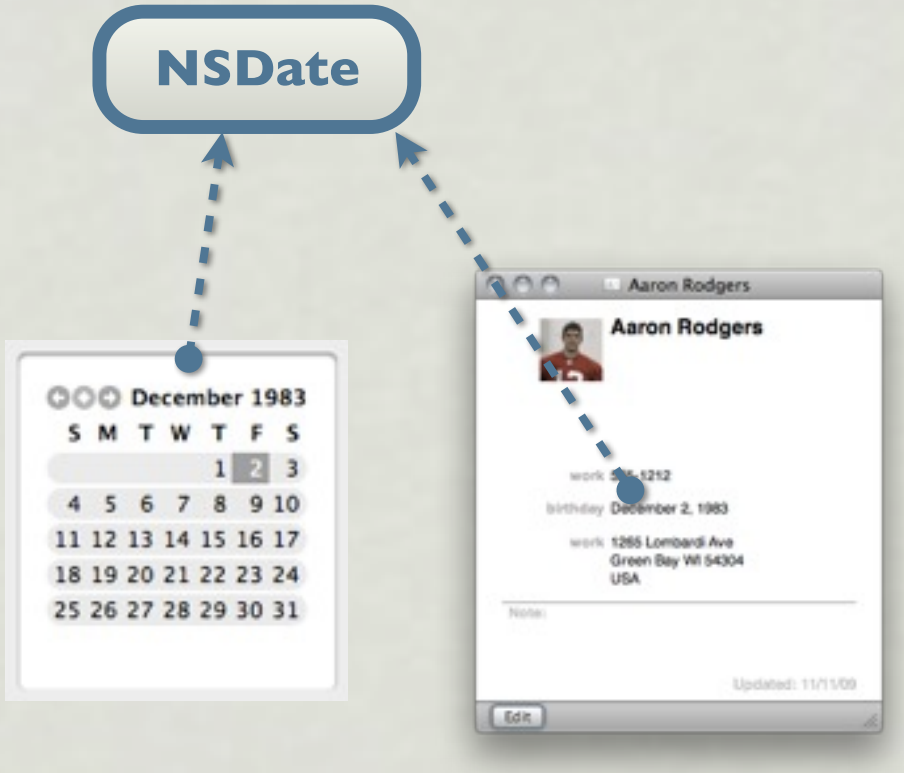
- Present information to users

View

- Present information to users
- Reasons to keep view logic separate
  - Views more reusable when generic and not specific to the data
  - Simultaneous display by different views of the same data
    - Present it in different ways
    - Present different parts of the same model

View Example

- **Model**: Date – in this case, taken from a `Person` object
- **Generic Display** – one view shows a formatted date, the other a calendar view. These could be reused by anywhere...



View Example

- **Model**: `CalcHistory` – stores calculator result history
- **Multiple Views** – one view shows the entire history, the other just the most recent item.

View Example

- **Model**: `ToDoEvent`
- **Multiple Views** – One cell displays title and time, the other shows title and full date. One displays past due in Red.

Controllers

- Coordinate data flow between Model and View
- Purpose
  - Respond to delegation messages from views
  - Respond to action messages from controls
  - Respond to notifications from models and other objects
  - Establish connections between managed objects

Controllers

- Coordinate data flow between Model and View
- Purpose
  - Respond to delegation messages from views
  - Respond to action messages from controls
  - Respond to notifications from models and other objects
  - Establish connections between managed objects
- The one object in MVC that knows a lot about the others
  - Typically (but not always) not very reusable

MVC Architecture

- **Example** – Address Book

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- **Example** – Address Book
- User edits a persons phone number in a text field
- Change communicated to controller by an action
- Controller may interpret the value
    - E.g. If not enough digits were entered, reject the change
- Controller updates model object
- View is told to redisplay
    - Controller could drive this
    - View could use some other observation mechanism

Data Flow

Data Flow

- If a view knows nothing about the model
  - How does it know what to display?
  - How does it know when to display?

Data Flow

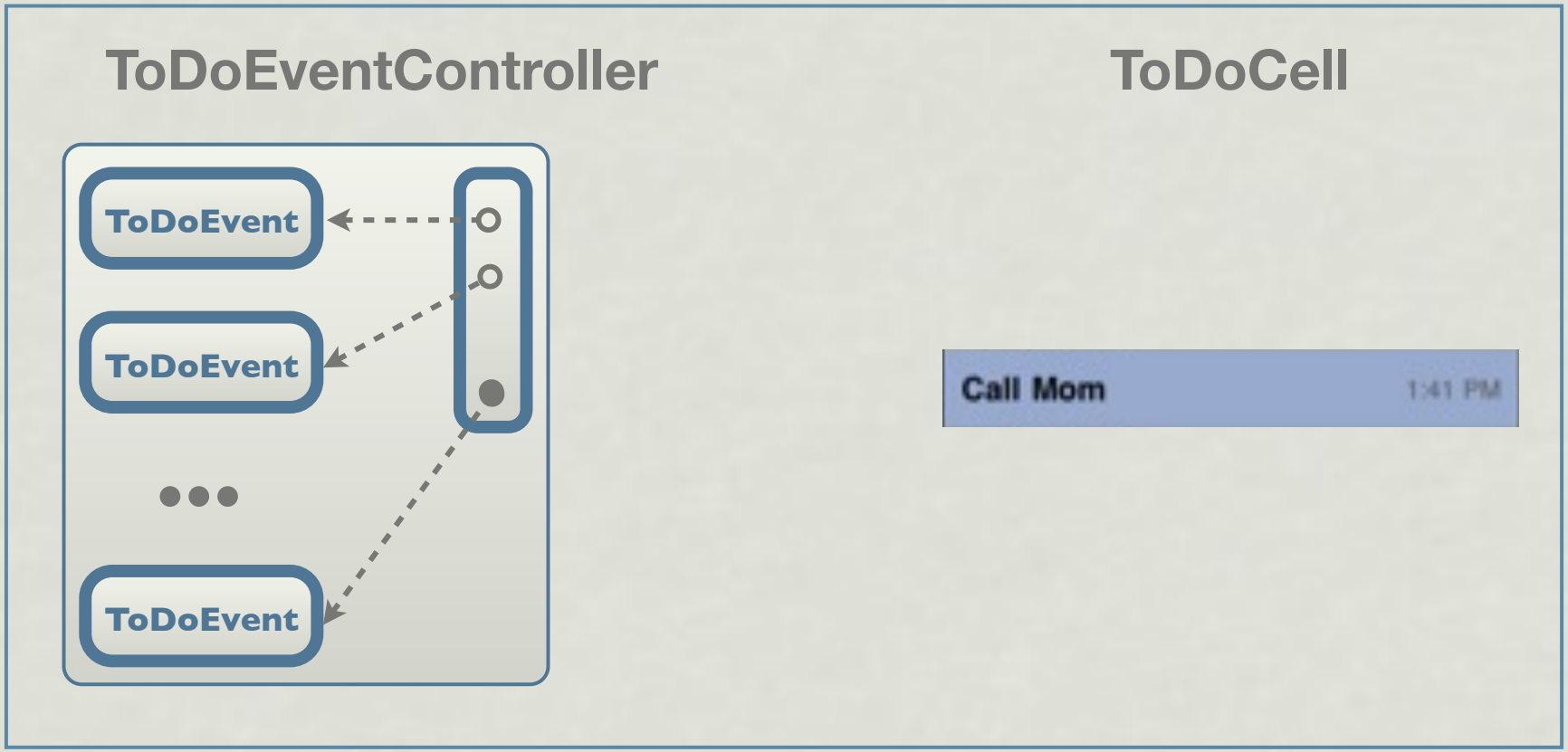
- Views really **do** know about the model
    - They don’t manage or manipulate them…

Data Flow

- Views really **do** know about the model
  - They don't manage or manipulate them…
- Getting the model
  - Push
    - Controller pushes data to the view using "setter" method
    - Changes communicated by calling setter methods again
  - Pull
    - View pulls data from controller using "data source" methods
    - Changes communicated by telling view to "reload"

Push An Object (reference)

- Controller passes a reference by calling `[cell setToDoEvent:]`



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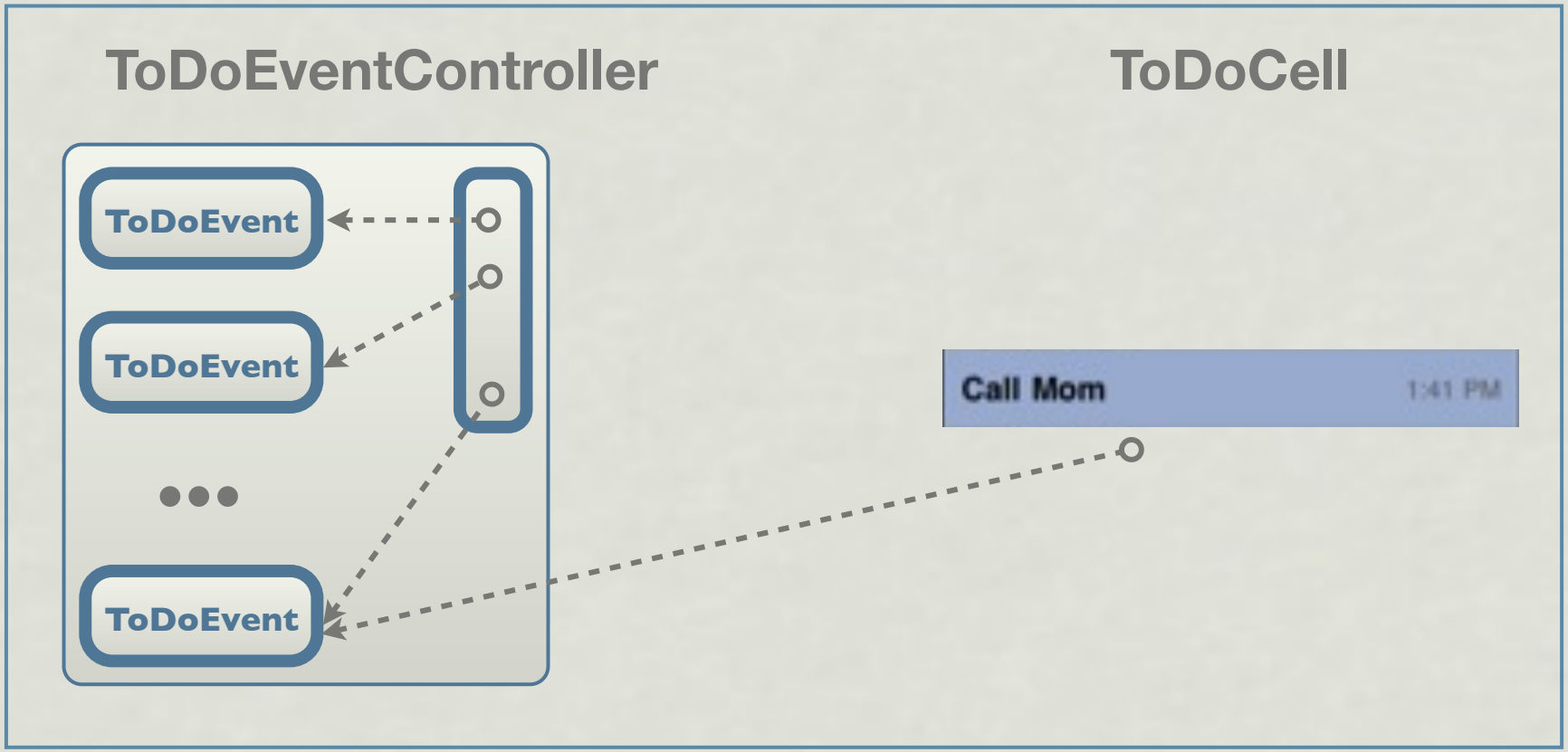
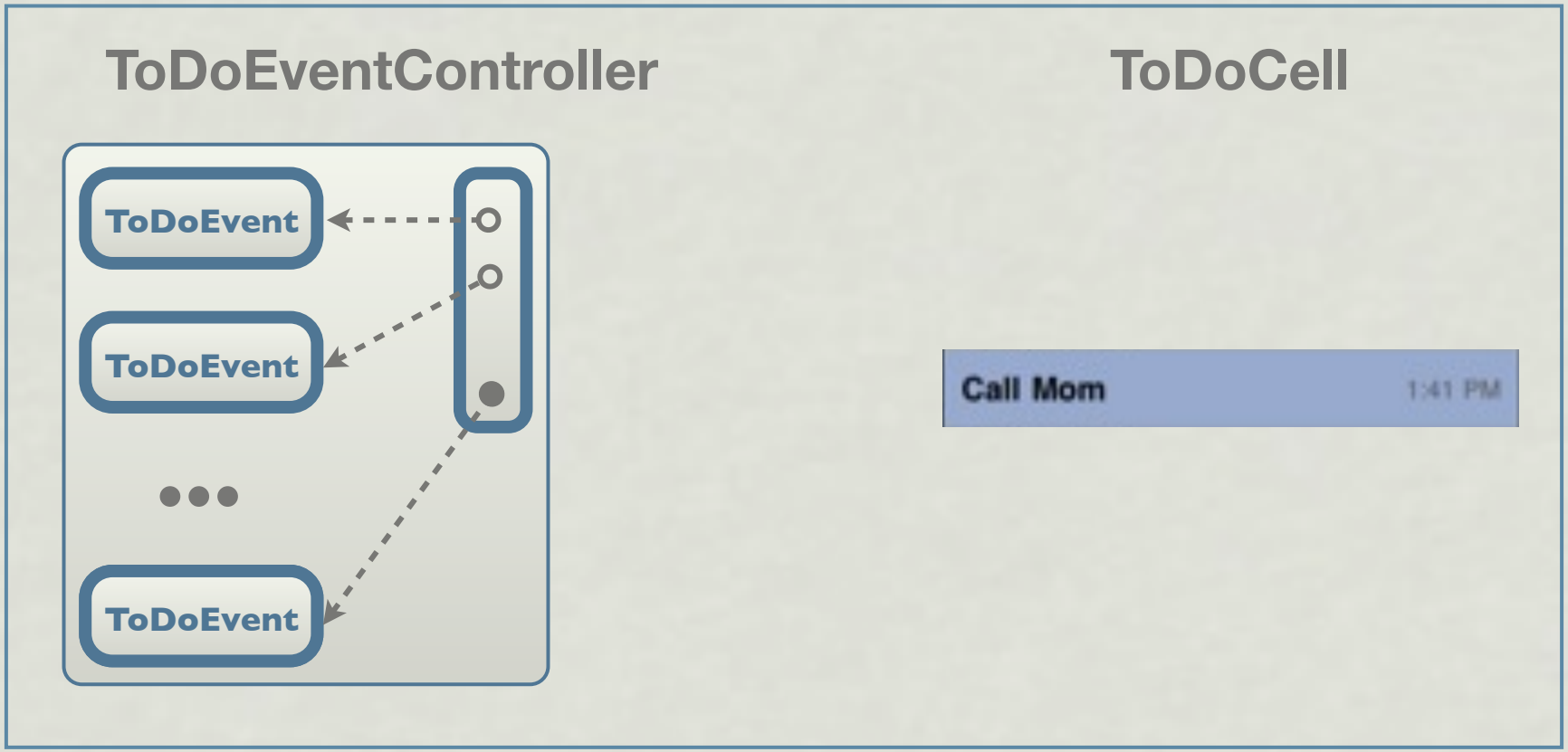


Push An Object (copy)

- Can also use a copy if the situation warrants it



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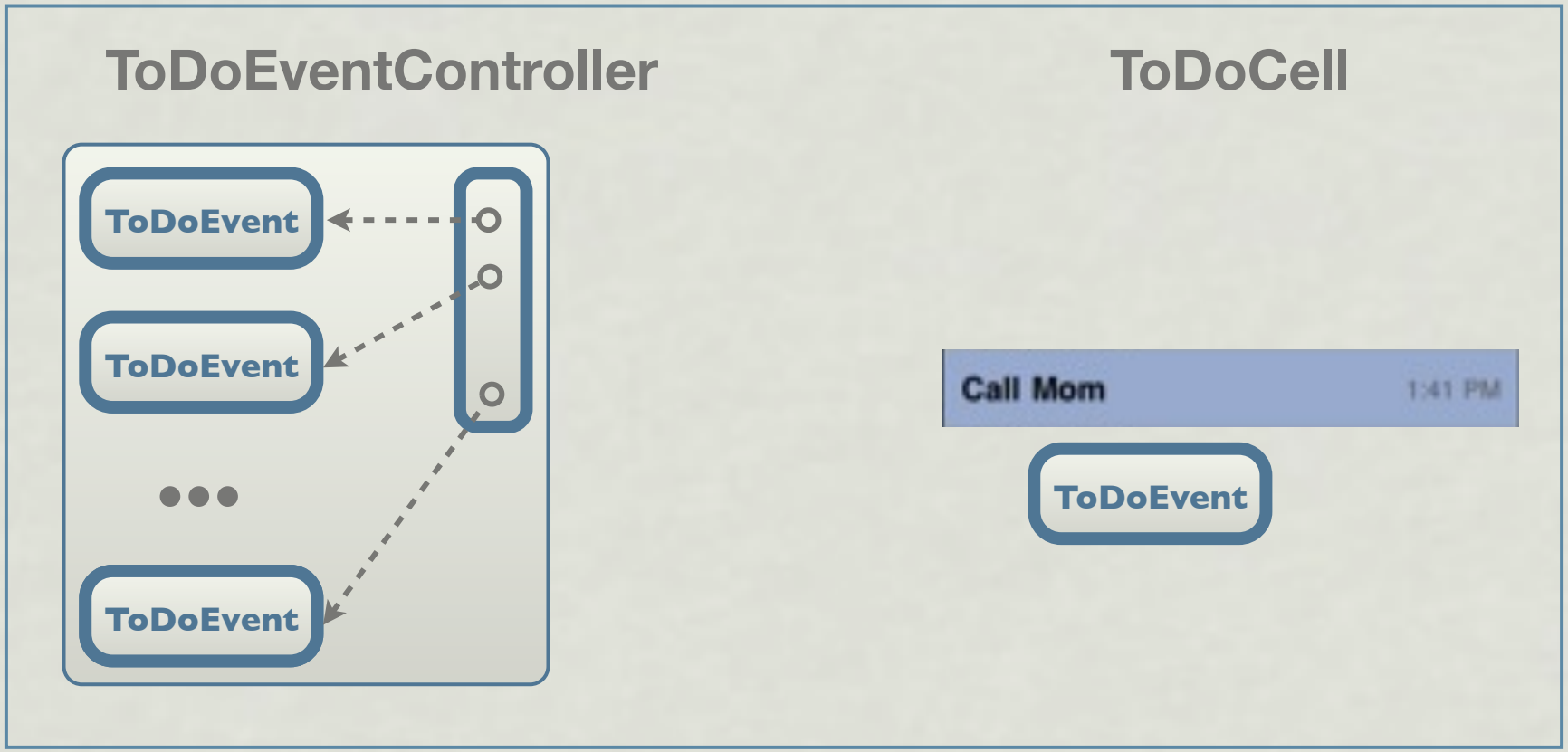

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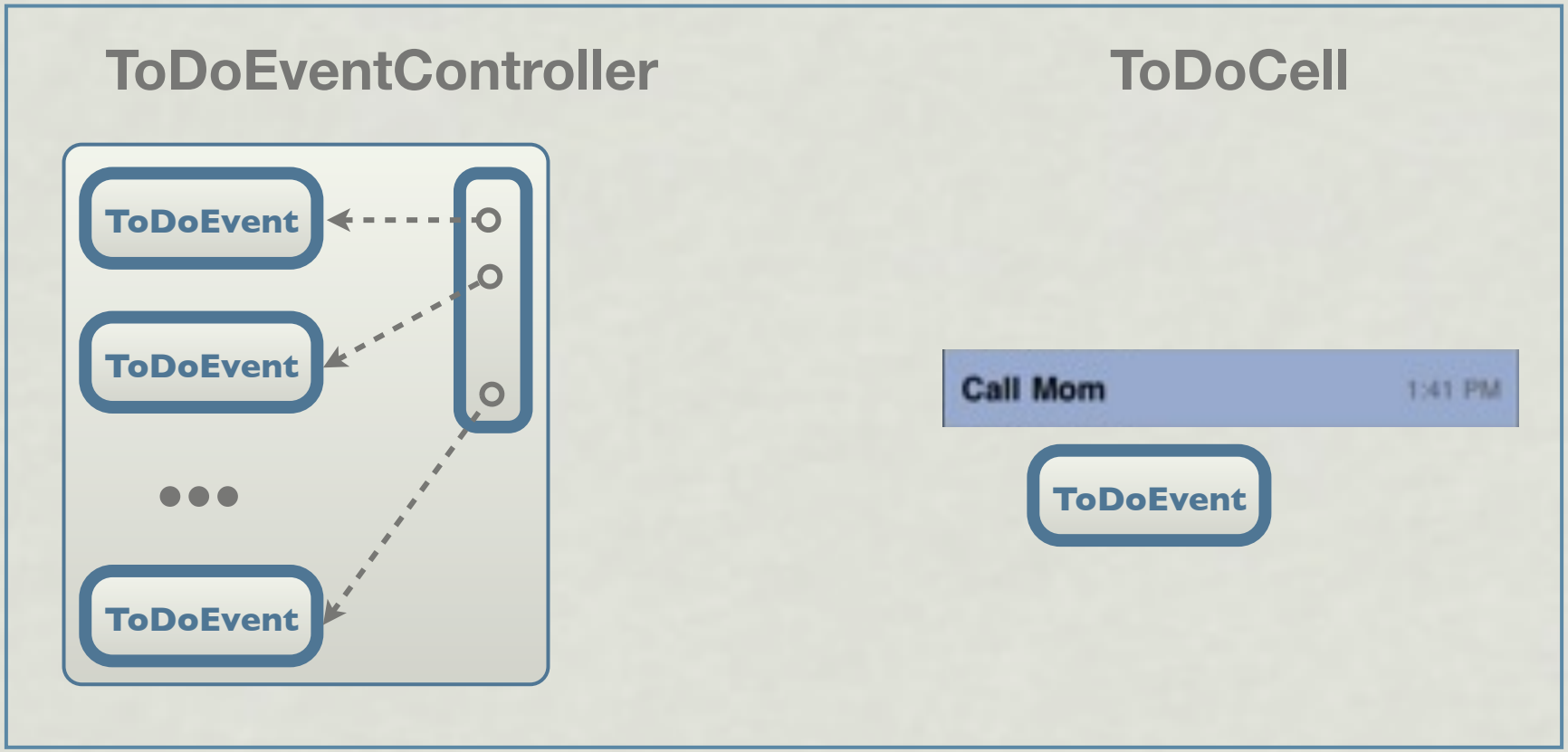

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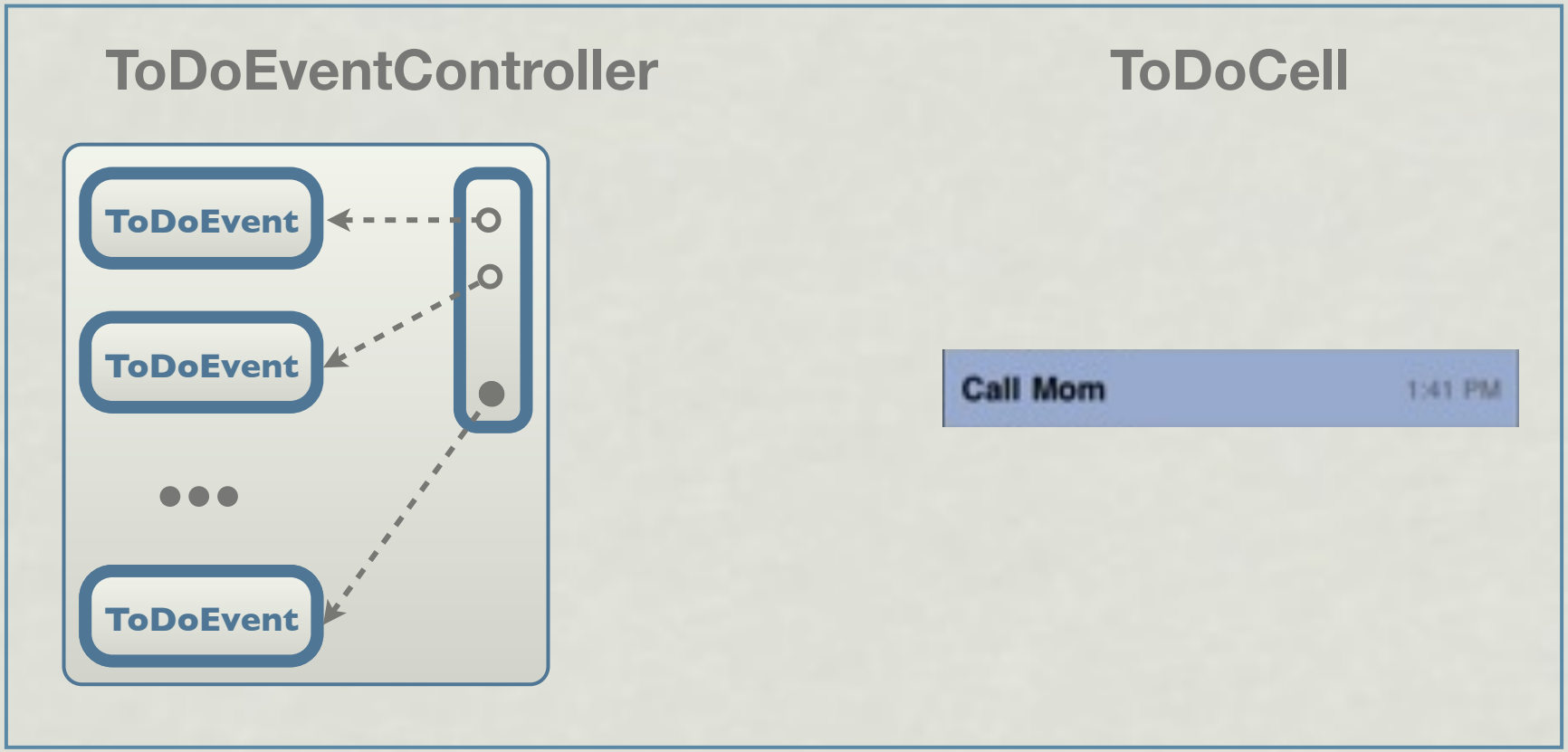

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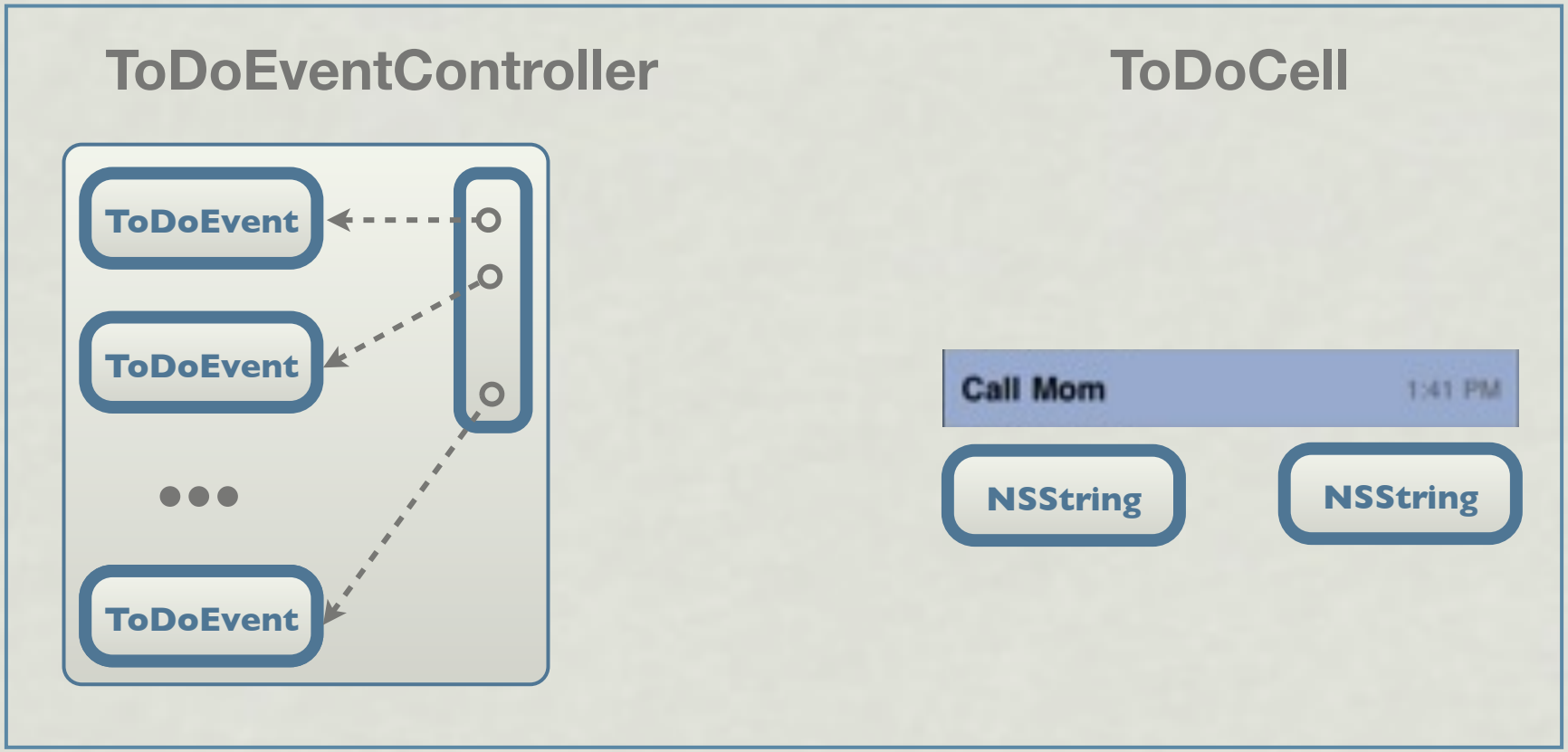
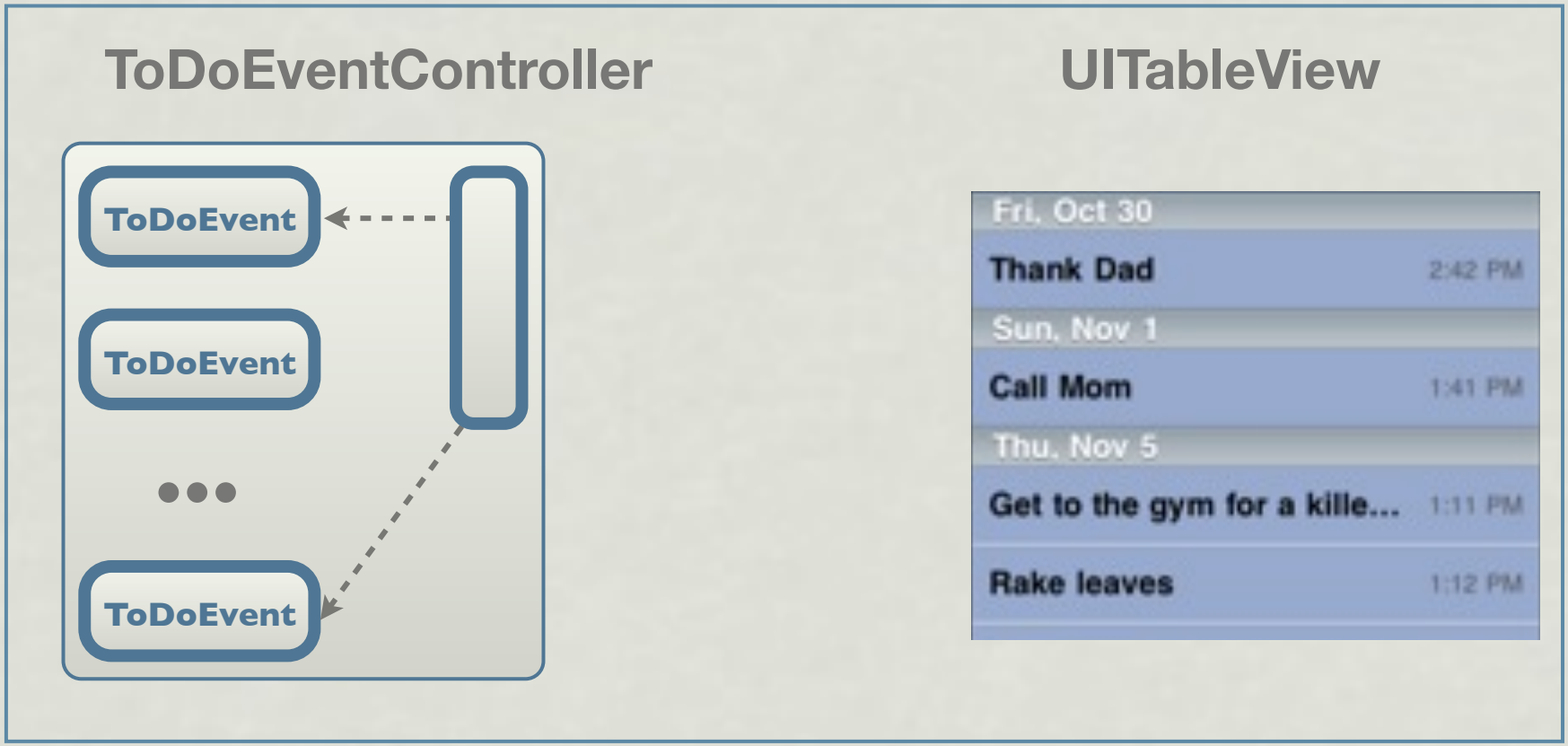


Pull – Example

- `UITableView` gets the number of sections from its data source
  - Some time after you call `[table reloadData]`



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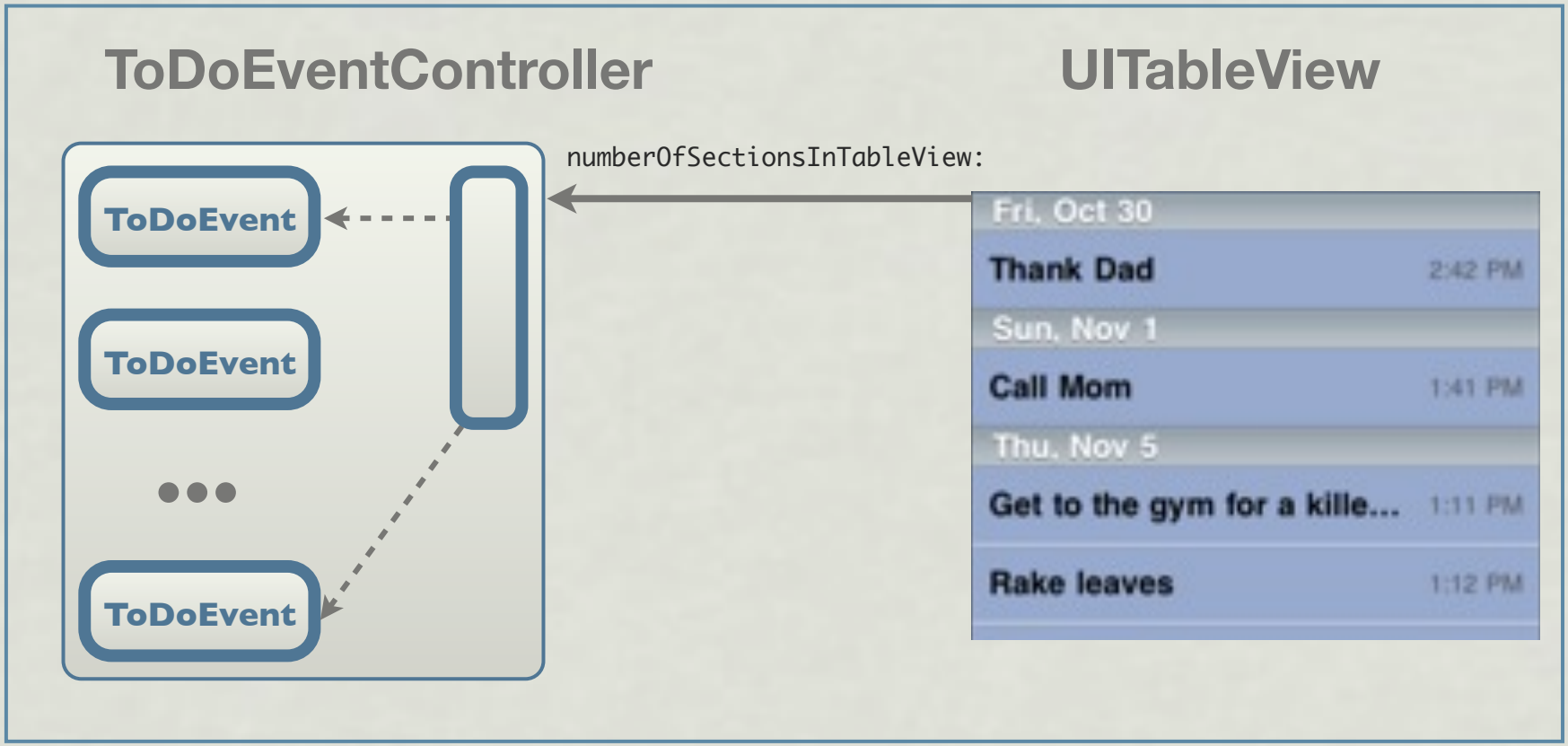

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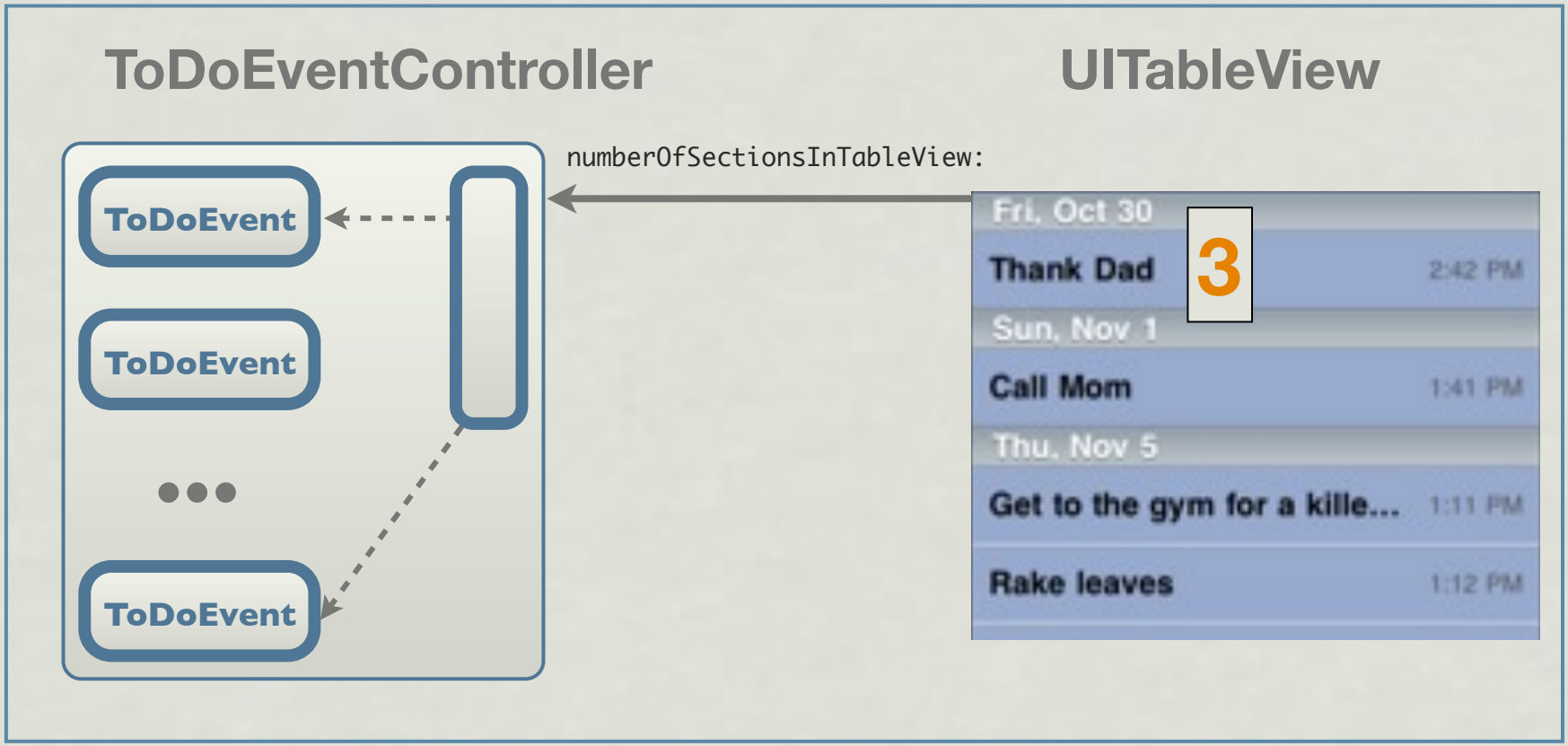

Data Changes

Updating View Data

- Controller Mediation
  - “setter” (push)
  - “reload” (pull)
- Views may also discover changes using observation
  - **NSNotification** - A model may define change notifications
  - **Key-Value Coding** – Cocoa mechanism that allows objects to be notified of changes to specific properties of other objects

Notifications

- Listen for `NSNotifications` signifying value changes

```
NSNotificationCenter *nc = [NSNotificationCenter defaultCenter];
[nc addObserver: self
       selector: @selector(eventDueDateChanged:)
           name: ToDoEventDueDateChangedNotification
         object: event_];
```

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- Register for a named notifications
- Provide a callback – target object, and method to be invoke
- Declare which object you are interested in observing

Notifications – Example

- Monitors for changes using `NSNotifications`

```
- (void)setToDoEvent:(ToDoEvent *)event {
    NSNotificationCenter *nc = [NSNotificationCenter defaultCenter];
    if (event != event_) {
      [nc removeObserver:self name:ToDoEventDueDateChangedNotification object:event_];
      [event_ release];
      event_ = [event retain];
      [nc addObserver:self selector:@selector(eventDueDateChanged:)
                 name:ToDoEventDueDateChangedNotification object: event_];
    }
}
```

Notifications – Example

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    }
}
```

- Notification callback

```
- (void)eventDueDateChanged:(NSNotification *)note {
    ToDoEvent *event = [notification object]; // should be == event_
    NSDictionary *userInfo = [notification userInfo];

    [label_ setText:[event_ dueDate]];

}
```

Notification Posting

- Posting your own notifications

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- Declare the notification name

```
// ToDoEvent.h
extern NSString *const ToDoEventDueDateChangedNotification;
```

```
// ToDoEvent.m
NSString *const ToDoEventDueDateChangedNotification = @"ToDoEventDueDateChangedNotification";
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Notification Posting

- Posting your own notifications
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```

- Posting

```
- (void)setDueDate:(NSDate *)date {
   ....
   NSNotificationCenter *nc = [NSNotificationCenter defaultCenter];
   NSDictionary *userInfo = ........;

   [nc postNotificationName:ToDoEventDueDateChangedNotification
                     object:self
                   userInfo:userInfo];
}
```

Key-Value Observing

- Directly observe an object property for changes

```
ToDoEvent *event_;
```

```
[event_ addObserver:self
         forKeyPath:@"dueDate"
            options:0
            context:NULL];
```

Key-Value Observing

- Directly observe an object property for changes

```
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[event_ addObserver:self
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- Observe a property by name, using a **key** (or **keypath**)

Key-Value Observing

- Directly observe an object property for changes

```
ToDoEventDetailController *detailController;
```

```
[detailController addObserver:self
                   forKeyPath:@"event.dueDate"
                      options:0
                      context:NULL];
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Key-Value Observing

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- Observe a property by name, using a **key** (or **keypath**)
- Specify observation options - See `NSKeyValueObserving.h`

Key-Value Observing

- Directly observe an object property for changes

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ToDoEvent *event_;
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[event_ addObserver:self
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- Observe a property by name, using a **key** (or **keypath**)
- Specify observation options - See `NSKeyValueObserving.h`
- Supplied **context pointer** is passed to you in KVO's callback

```
- (void)observeValueForKeyPath:(NSString *)keyPath
                      ofObject:(id)object
                        change:(NSDictionary *)change
                       context:(void *)context;
```

KVO – Example

- Monitor for changes using KVO

```
- (void)setToDoEvent:(ToDoEvent *)event {
    if (event_ != event) {
        [event_ removeObserver:self forKeyPath:@"dueDate"];
        [event_ release];
        event_ = [event retain];
        [event_ addObserver:self forKeyPath:@"dueDate" options:0 context:NULL];
    }
}
```

KVO – Example

- Monitor for changes using KVO

```
- (void)setToDoEvent:(ToDoEvent *)event {
    if (event_ != event) {
        [event_ removeObserver:self forKeyPath:@"dueDate"];
        [event_ release];
        event_ = [event retain];
        [event_ addObserver:self forKeyPath:@"dueDate" options:0 context:NULL];
    }
}
```

- KVO Callback

```
- (void)observeValueForKeyPath:(NSString *)keyPath ofObject:(id)object
                        change:(NSDictionary *)change context:(void *)context
{
    if (object == event_ && [keyPath isEqual:@"dueDate"]) {
        // update display
    }
}
```

Key-Value Observing

- KVO notifications posted automatically* by Cocoa
- Automatic when you use
  - Setters : `[event setDueDate: aDueDate];`
  - Dot notation : `event.dueDate = aDueDate;`
  - Key-Value Coding : `[event setValue: aDueDate forKey:@"dueDate"];`

Key-Value Observing

- KVO notifications posted automatically* by Cocoa
- Automatic when you use
  - Setters : `[event setDueDate: aDueDate];`
  - Dot notation : `event.dueDate = aDueDate;`
  - Key-Value Coding : `[event setValue: aDueDate forKey:@"dueDate"];`
- Not automatic for directly accessed outside of a “set” method

Notification / KVO Cleanup

- Stop observing in your dealloc!
- Stop observing when you no longer care to observe

Notification / KVO Cleanup

- Stop observing in your dealloc!
- Stop observing when you no longer care to observe
- Notifications

```
// NSNotificationCenter
- (void)removeObserver:(id)observer;
- (void)removeObserver:(id)observer name:(NSString *)name object:(id)obj;
```

Notification / KVO Cleanup

- Stop observing in your dealloc!
- Stop observing when you no longer care to observe
- Notifications

```
// NSNotificationCenter
- (void)removeObserver:(id)observer;
- (void)removeObserver:(id)observer name:(NSString *)name object:(id)obj;
```

- KVO

```
// NSObject ( NSKeyValueObserverRegistration )
- (void)removeObserver:(NSObject *)observer forKeyPath:(NSString *)kpath;
```

Key-Value *

KV*

- KVO – **Key-Value Observing**
  - Allows observing property changes of another object by name
- KVC – **Key-Value Coding**
  - Allows access to properties of another object by name

KVO

- Already discussed this…

Key-Value Coding

- Can work with a value by “name” instead
- Example

```
@property(retain, readwrite) NSString *title;
```

```
[object setTitle:@”a title”];
NSLog(@”the title is %@”, [object title]);
```

Key-Value Coding

- Can work with a value by “name” instead
- Example

```
@property(retain, readwrite) NSString *title;
```

```
[object setValue:@”a title” forKey:@”title”];
NSLog(@”the title is %@”, [object valueForKey:@”title”]);
```

Key-Value Coding

- Can work with a value by “name” instead
- Example

```
- (void)setPriority:(float)priority;
- (float)priority;
```

```
[object setValue:[NSNumber numberWithFloat:3.14] forKey:@”priority”]
NSLog(@”the priority is %@”, [object valueForKey:@”priority”];
```

Key-Value Coding

- Can work with a value by “name” instead
- Example

```
- (void)setPriority:(float)priority;
- (float)priority;
```

```
[object setValue:[NSNumber numberWithFloat:3.14] forKey:@”priority”]
NSLog(@”the priority is %@”, [object valueForKey:@”priority”];
```

- KVC uses your methods if provided
- KVC will “box” and “unbox” scalar types if necessary

KV*

- KVC
- KVO

KV*

- KVC
- KVO
- KVB – **Key-Value Binding**
  - Uses KVO/KVC to keeps view's display in sync with model!
  - Establishes mediated connection between model and view
  - *Mac OS X Only*

KV*

- More on KV* online : “Key-Value Coding Programming Guide”
  - KVC method naming compliance
  - KVC defines good naming patterns to use in your own code
    - Must follow to work with KV*
  - To-Many, To-One relationships

Final Notes

Next Week

- View Controllers – Manage “screenful” of displayed data

Reading Assignments

- CocoaFundamentals.pdf
  - The Model-View-Controller Pattern: p.158 - 166
    - Ignore NSObject/Array/TreeController, …
- Key-Value Programming Guide (KeyValueCoding.pdf)
  - If Interested*
  - Intro Chapters: p.9 - 22