HIT3329 / HIT8329
Creating Data Driven Mobile Applications

Lecture 5
Core Data

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Last Lecture Reviewed

1. Protocols
2. Delegates & Datasources
3. Interface Builder
4. Application Object
5. Collections
6. File IO

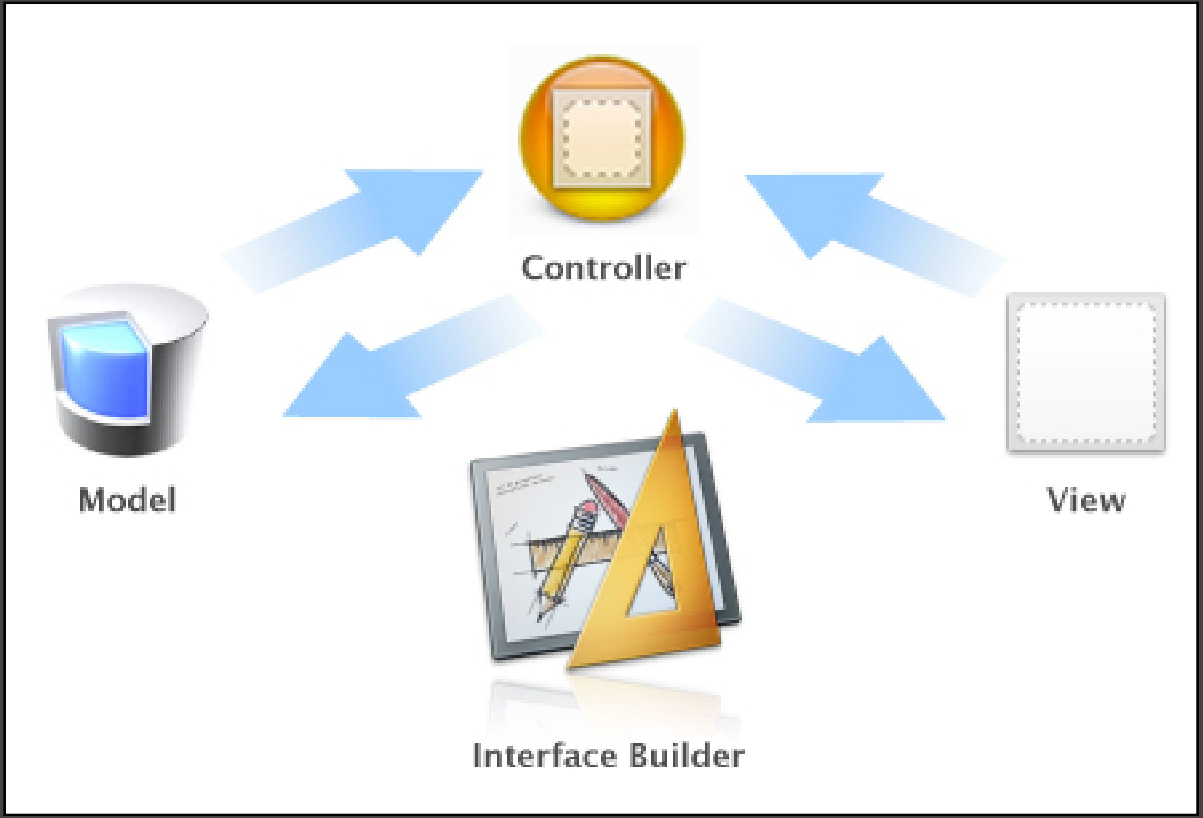
Questions?

What's On For Today?

1. Core Data Concepts
2. Creating a Managed Model
3. Retrieving Data
4. CRUD Operations
5. Notification Center

1.0 Core Data Concepts

In iOS the *Model* from Model-View-Controller (MVC) design pattern is often implemented with Core Data



1.1 What is Core Data?

- An "Object Graph Management Framework"
  - Not a database
  - Not an ORM
- APIs for storing/retrieving data objects
- Helps you make ***persistent data objects***

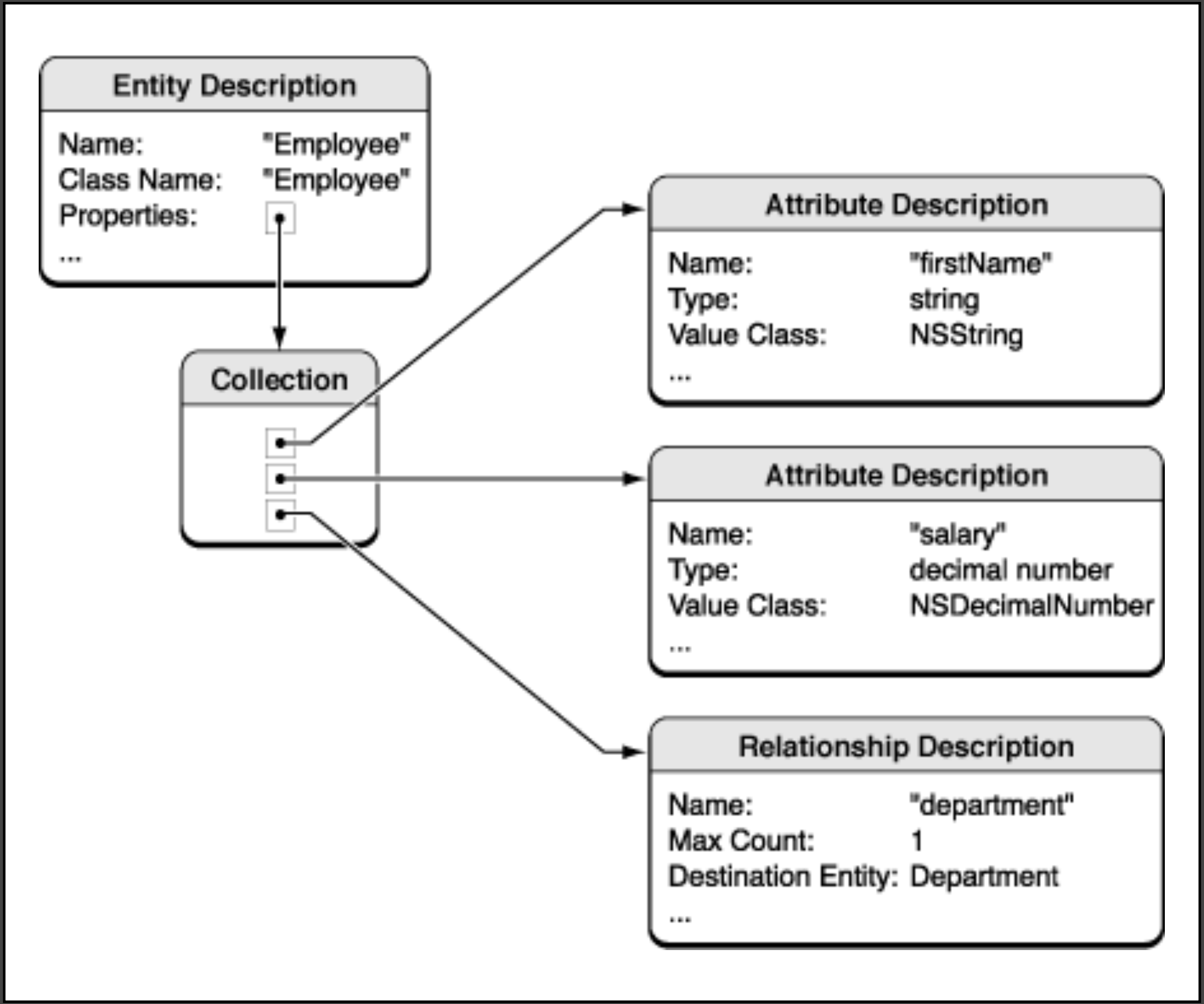
1.2 What Can Core Data Do For You? I

- Save, search, & load objects from disk (i.e. to the "persistent store")
- No need to worry about storage details -- could be any of:
  - XML
  - SQLite database
  - Flat text file
- Ideal for managing the '*Model*' in MVC

1.3 What Can Core Data Do For You? II

- Maintains object relationship integrity, enforces property constraints:
- "**Pizza** *always* has **crust**, **tomato sauce** and cheese. It □*may* have 1 or more **Toppings**"
- If we try to save a *Pizza* entity without cheese or cream sauce, Core Data would complain -- it would also not let us save the object!

1.4 Core Data Illustrated



Source: http://developer.apple.com/library/ios/#documentation/Cocoa/Conceptual/CoreData/Articles/cdBasics.html

1.5 Core Concepts

1. **Managed Objects**
   - Managed Object Model
   - Managed Object Context
2. **Fetch Requests**
   - Predicates
   - Sort Descriptors
3. **Persistent Stores**
   - Persistent Store Coordinator

1.6 Managed Objects

- In Object Oriented Programming, we worry about ***Objects***, not tables, records, or files
- Stored objects are known as ***Entities***
- Entities differ from a ***Class***, they do not contain code when stored
- Entities contain code when loaded in memory
- You can store, retrieve and search entities

1.7 Managed Object Model

- ***Entities*** may have relationships with each other (meaningful ones, of course)
- Relationships are defined in a ***Schema***
- The schema describes each entity's:
  - properties (attributes)
  - constraints on its properties
  - relationships

1.8 The Managed Object Context (MOC)

"You can think of a ***managed object context*** as an intelligent scratch pad."

"When you fetch objects ... you bring temporary copies onto the scratch pad where they form an object graph (or a collection of object graphs)."

"You can then modify those objects however you like [but] unless you actually save those changes ... the persistent store [will] remain unaltered."

Source: http://developer.apple.com/library/ios/#documentation/Cocoa/Conceptual/CoreData/Articles/cdBasics.html

1.9 Fetch Requests

- ***Fetch Requests*** retrieve stored objects
- They usually require 3 parts:

1. Entity to fetch	"get me Pizzas"
2. Predicate (filter)	"with no toppings"
3. Sort descriptor	"sorted by size"

NB: A Managed Object Context (MOC) is needed to fetch anything - it retrieves the managed objects for us

1.10 Predicates

- Use ***Predicates*** to filter fetch requests
- Built from formatted string
- Boolean syntax similar to SQL
- Compound predicates supported

```
// Get pizzas with marinara sauce
[NSPredicate predicateWithFormat:
        @"sauce = %@", kMarinaraSauce];
```

1.11 Sort Descriptors

- **Sort Descriptors** take:
  - An property name
  - A sort direction for that property
- Combine in array to use in ***fetch requests***

```
// Sort our pizzas by size, biggest to smallest
sortDescriptor =
[NSSortDescriptor sortDescriptorWithKey:@"pizzaSize"
                                        ascending:NO];
NSArray *sortDescriptors = [NSArray
                        arrayWithObject:sortDescriptor];
```

1.12 Example of a Fetch Request

```
NSManagedObjectContext *moc = /*assume this exists*/
NSFetchRequest *fetch = [[NSFetchRequest alloc] init];

NSEntityDescription *pizza =
   [NSEntityDescription entityForName:@"Pizza"
                 inManagedObjectContext:moc];

fetchRequest.entity = pizza;
fetchRequest.sortDescriptors = sortDescriptors;
fetchRequest.predicate = predicate;

NSError *error = NULL;
NSArray *results = [moc executeFetchRequest:fetch
                               error:&error];
[fetch release];
```

1.13 Persistent Stores

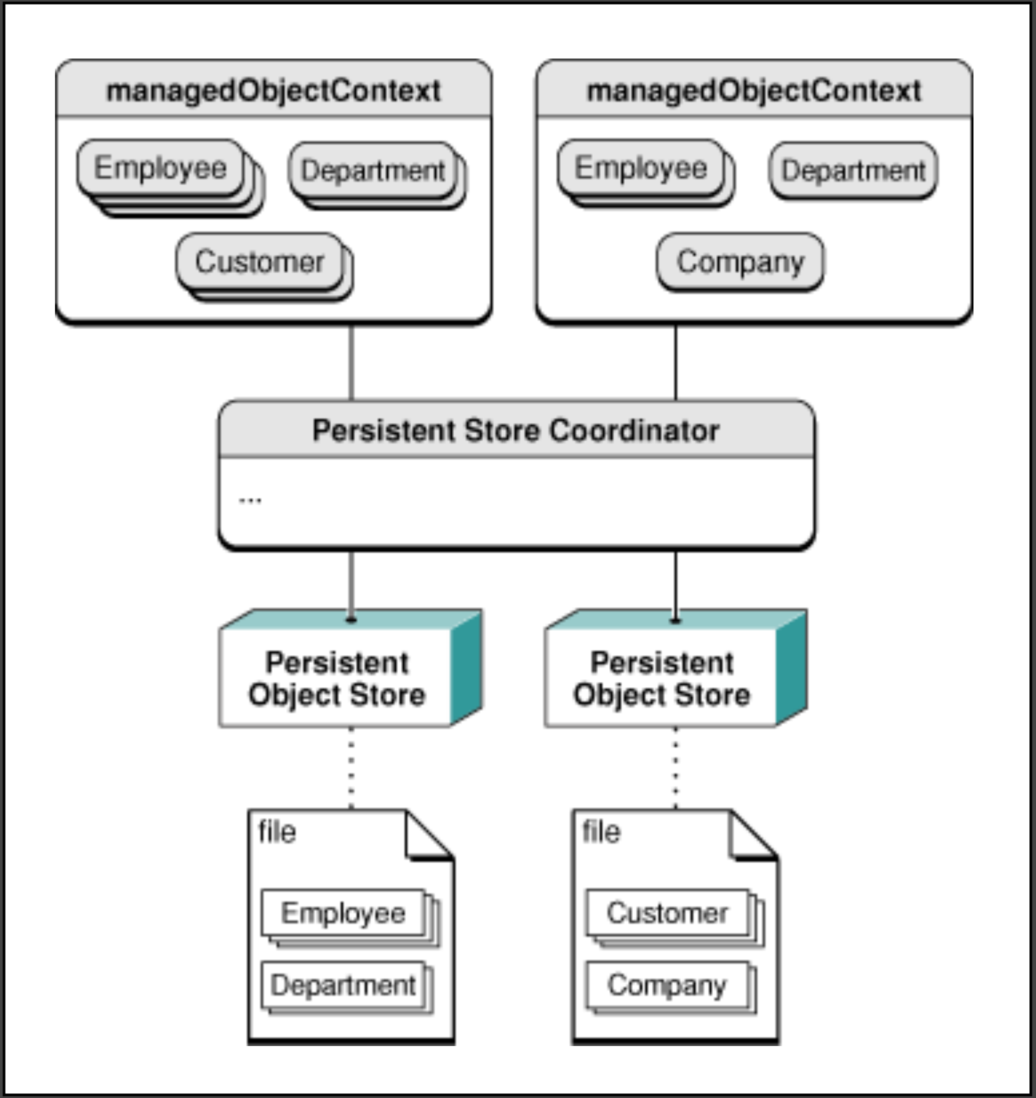
- Discrete sources of data, including flat files and databases
- Rarely used, except to define "where" it is
- Core Data abstracts away implementation details of each storage format providing a consistent interface

Benefits of Abstraction:
If your data store format changes, your app does not need to change.

1.14 Persistent Store Coordinator

- Groups together different ***Persistent Stores***
- Presents them as a single store
- The components coordinating your objects with external data sources are collectively known as the ***Persistence Stack***

1.15 Persistence Stack Illustrated



Source: http://developer.apple.com/library/ios/#documentation/Cocoa/Conceptual/CoreData/Articles/cdBasics.html

1.16 Core Concepts Reviewed

1. **Managed Objects**
   - Managed Object Model
   - Managed Object Context
2. **Fetch Requests**
   - Predicates
   - Sort Descriptors
3. **Persistent Stores**
   - Persistent Store Coordinator

1.17 When to use Core Data

- Core Data will fit most needs
- 3rd party add-ons like *Magical Record* make it easier and much less verbose
- However Core Data is not recommended for:
    1. Large object counts
    2. Bulk object updates
    3. Fulltext indexing
- For these cases, SQLite is often better

Further Reading:
Switching from Core Data - http://inessential.com/2010/02/26/on_switching_away_from_core_data
Magical Record - https://github.com/magicalpanda/MagicalRecord

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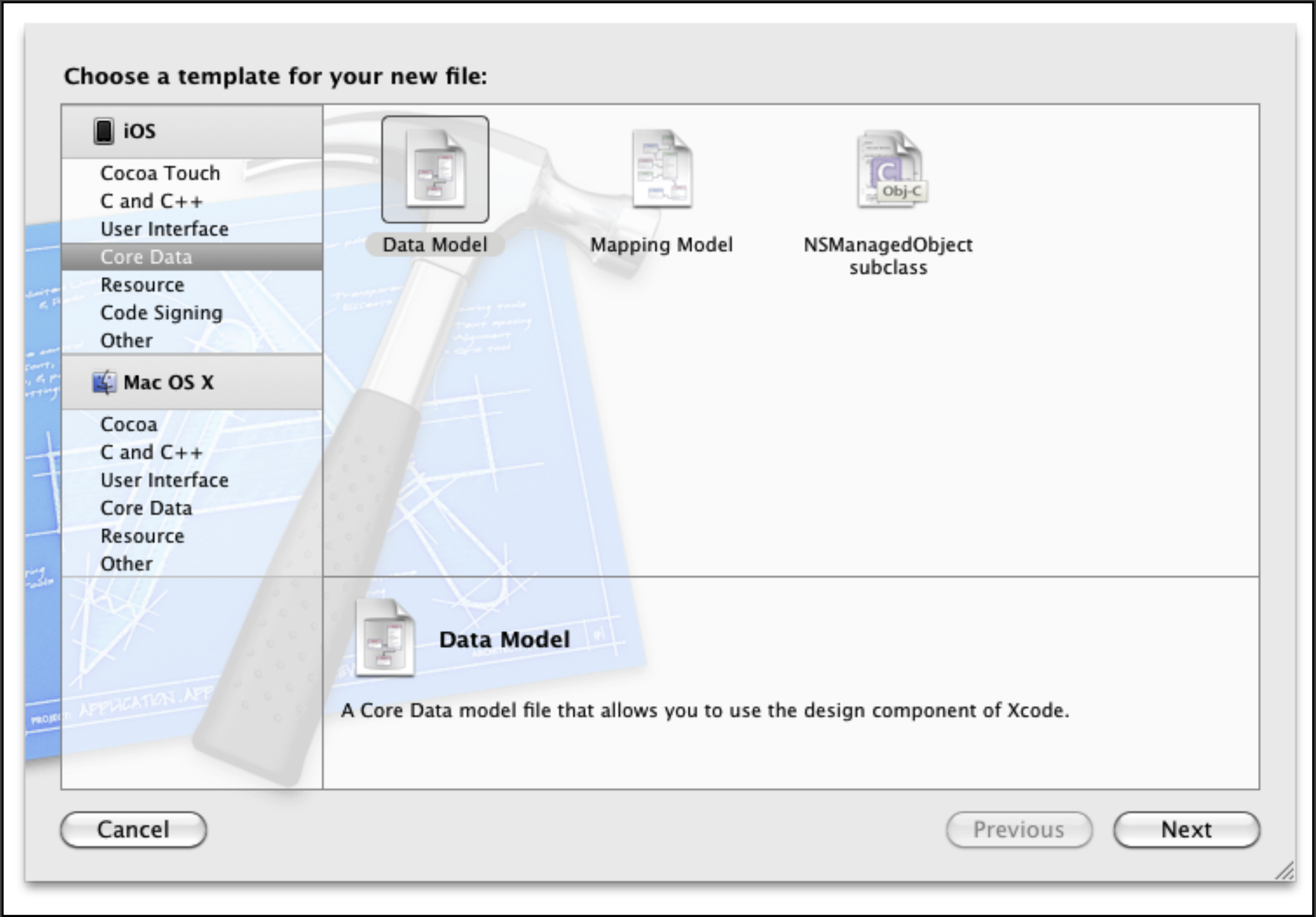
2.0 Creating a Managed Model

Before using Core Data we need to setup a managed model:

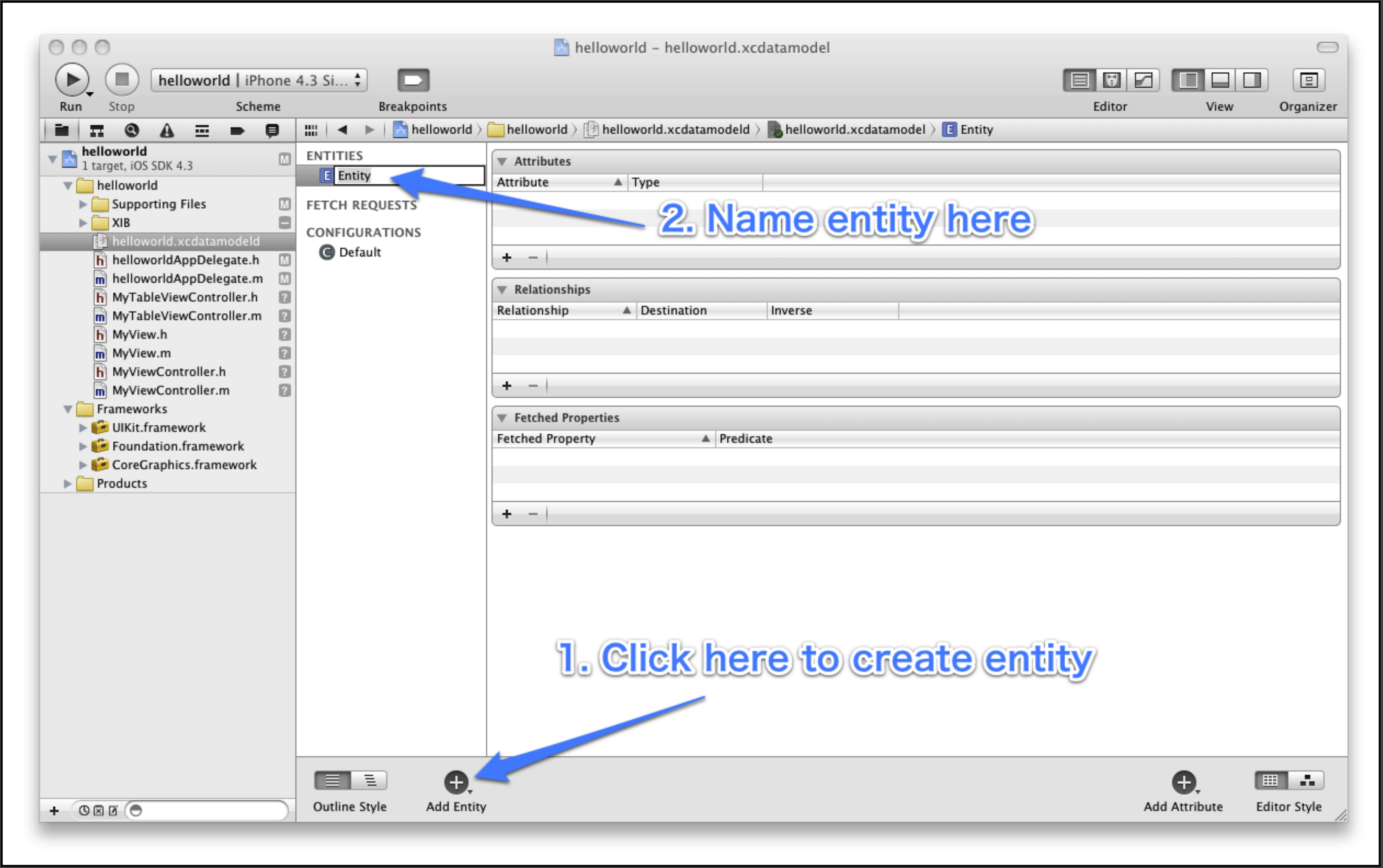
1. Create a Data Model
2. Add Entities
3. Add Attributes (Properties)
4. Define Relationships, if any
5. Create Managed Object Classes


Choose a template for your new file:

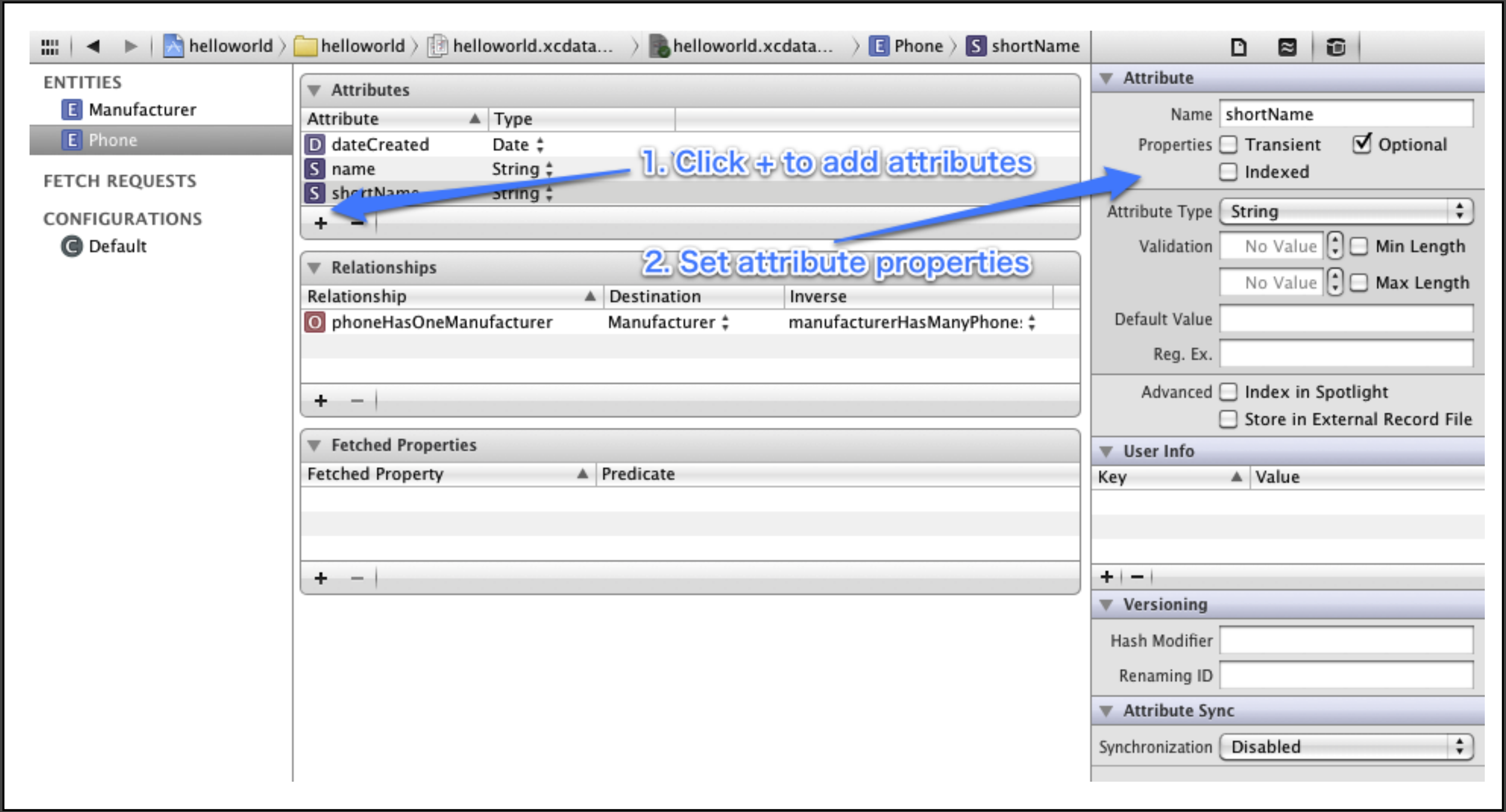
Data Model

A Core Data model file that allows you to use the design component of Xcode.

2.0.1 Create a Data Model



2.0.2 Add Entities



1. Click + to add attributes

2. Set attribute properties

ENTITIES
- Manufacturer
- Phone

FETCH REQUESTS

CONFIGURATIONS
- Default

Attributes

Attribute	Type
dateCreated	Date
name	String
shortName	String

Relationships

Relationship	Destination	Inverse
phoneHasOneManufacturer	Manufacturer	manufacturerHasManyPhone:

Fetched Properties

Fetched Property	Predicate

Attribute

Name: shortName
Properties: Transient [ ] Optional [✓] Indexed [ ]
Attribute Type: String
Validation: No Value Min Length [ ]
No Value Max Length [ ]
Default Value:
Reg. Ex.:
Advanced: Index in Spotlight [ ] Store in External Record File [ ]

User Info

Key	Value

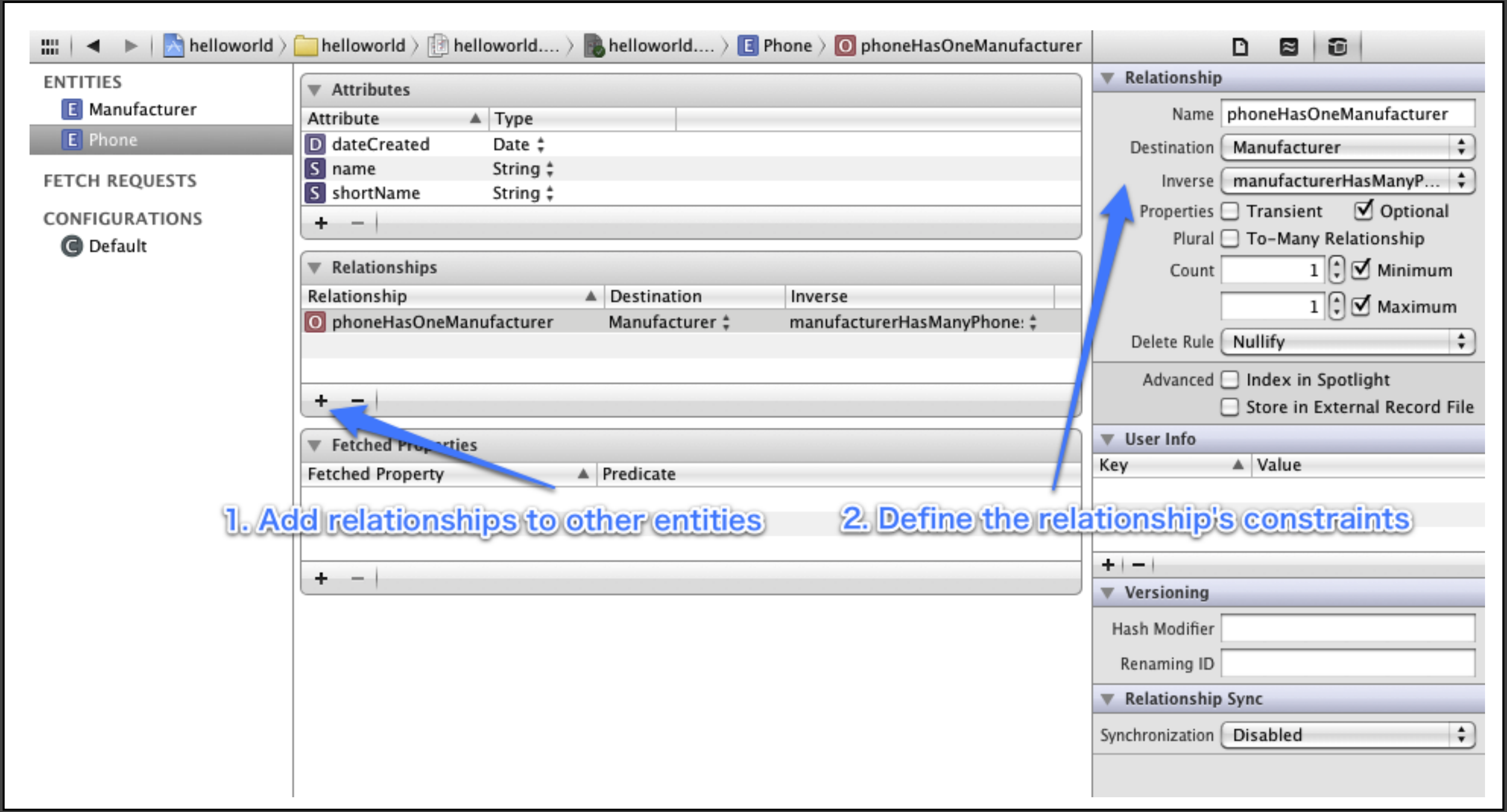
Versioning

Hash Modifier:
Renaming ID:

Attribute Sync

Synchronization: Disabled

2.0.3 Add Attributes



Attribute	Type
dateCreated	Date
name	String
shortName	String

Relationship	Destination	Inverse
phoneHasOneManufacturer	Manufacturer	manufacturerHasManyPhone:

Fetched Property	Predicate

Name	phoneHasOneManufacturer
Destination	Manufacturer
Inverse	manufacturerHasManyP...
Properties	☐ Transient ☑ Optional
Plural	☐ To-Many Relationship
Count	1 ☑ Minimum
	1 ☑ Maximum
Delete Rule	Nullify
Advanced	☐ Index in Spotlight
	☐ Store in External Record File
Hash Modifier	
Renaming ID	
Synchronization	Disabled

Key	Value

1. Add relationships to other entities

2. Define the relationship's constraints

2.0.4 Define Relationships

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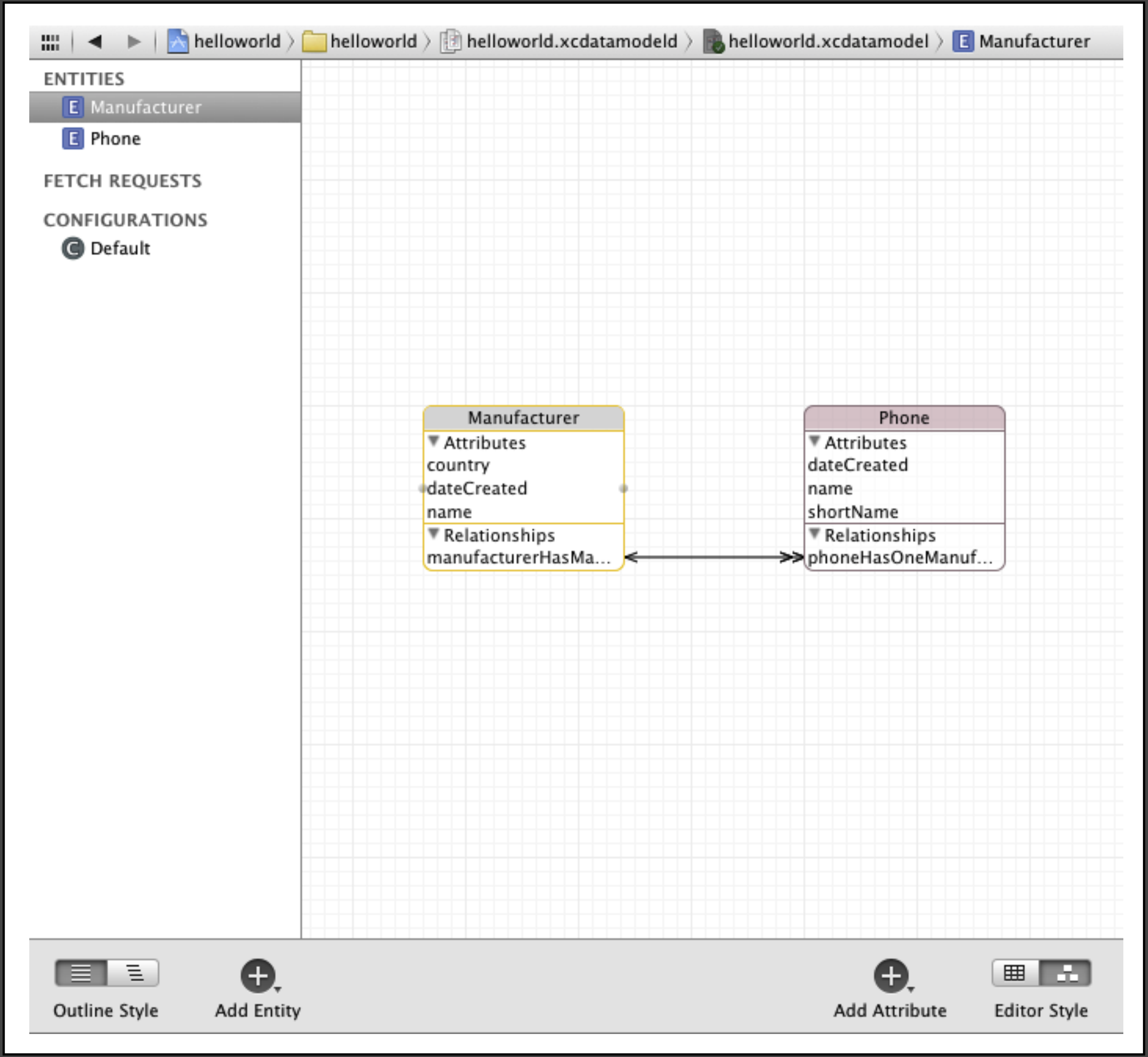
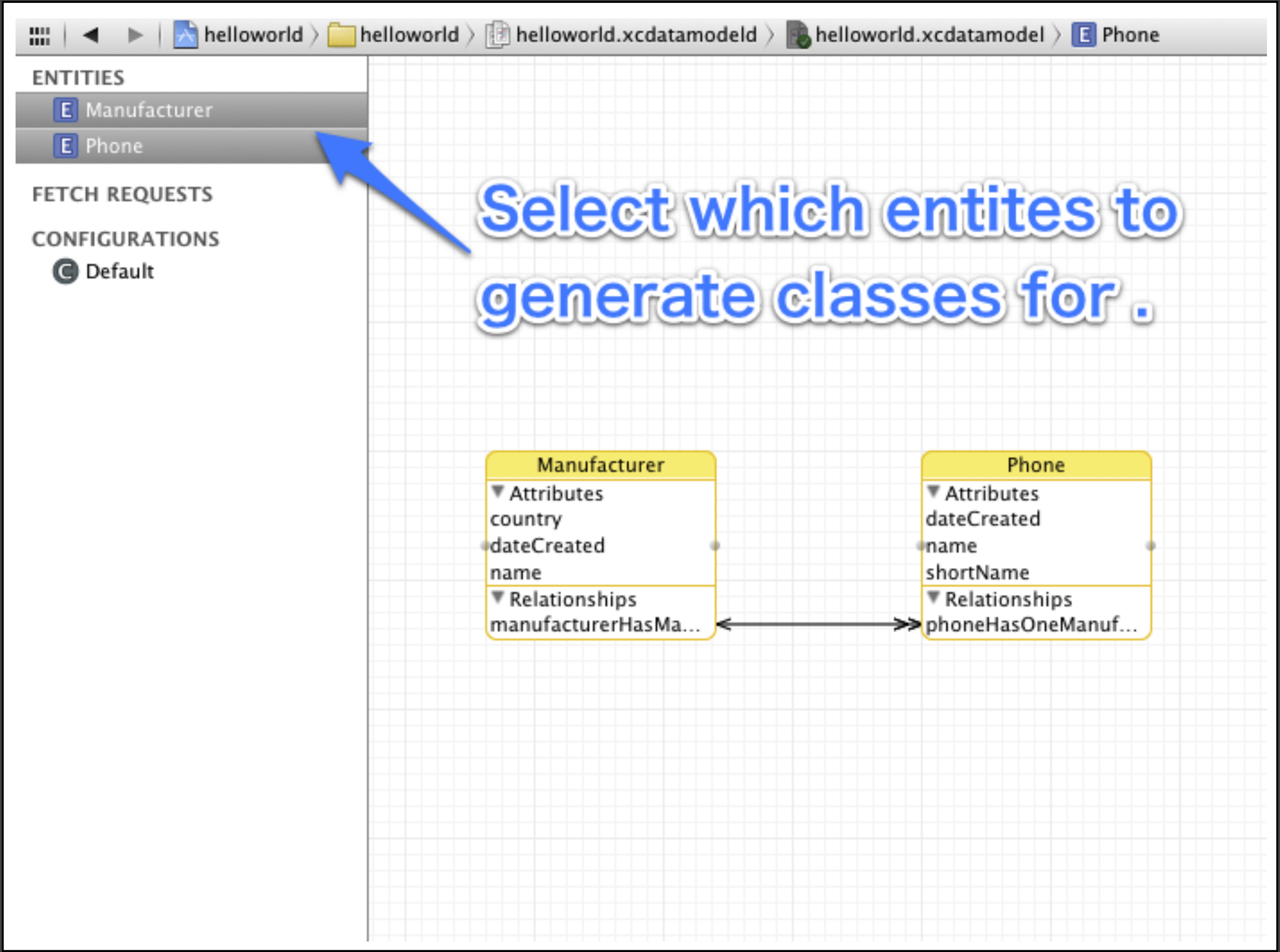
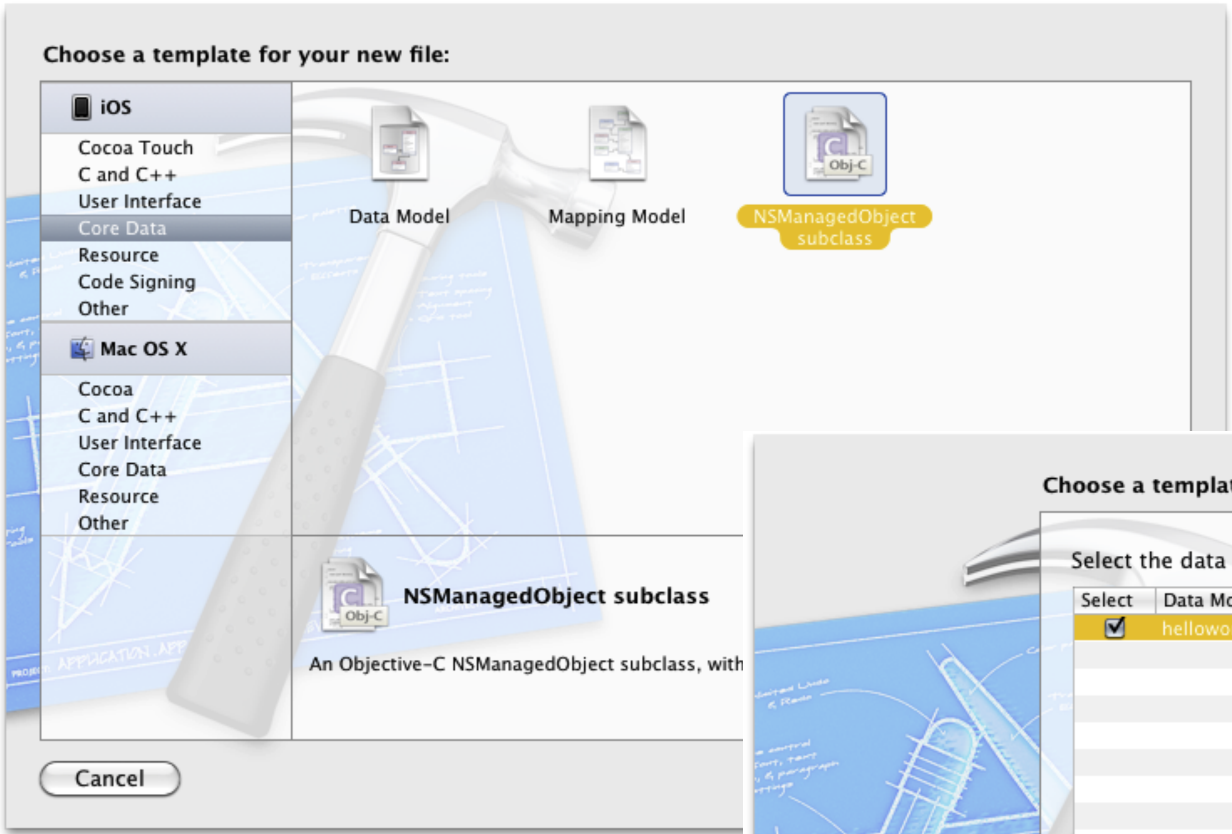


2.0.5 Completed Schema

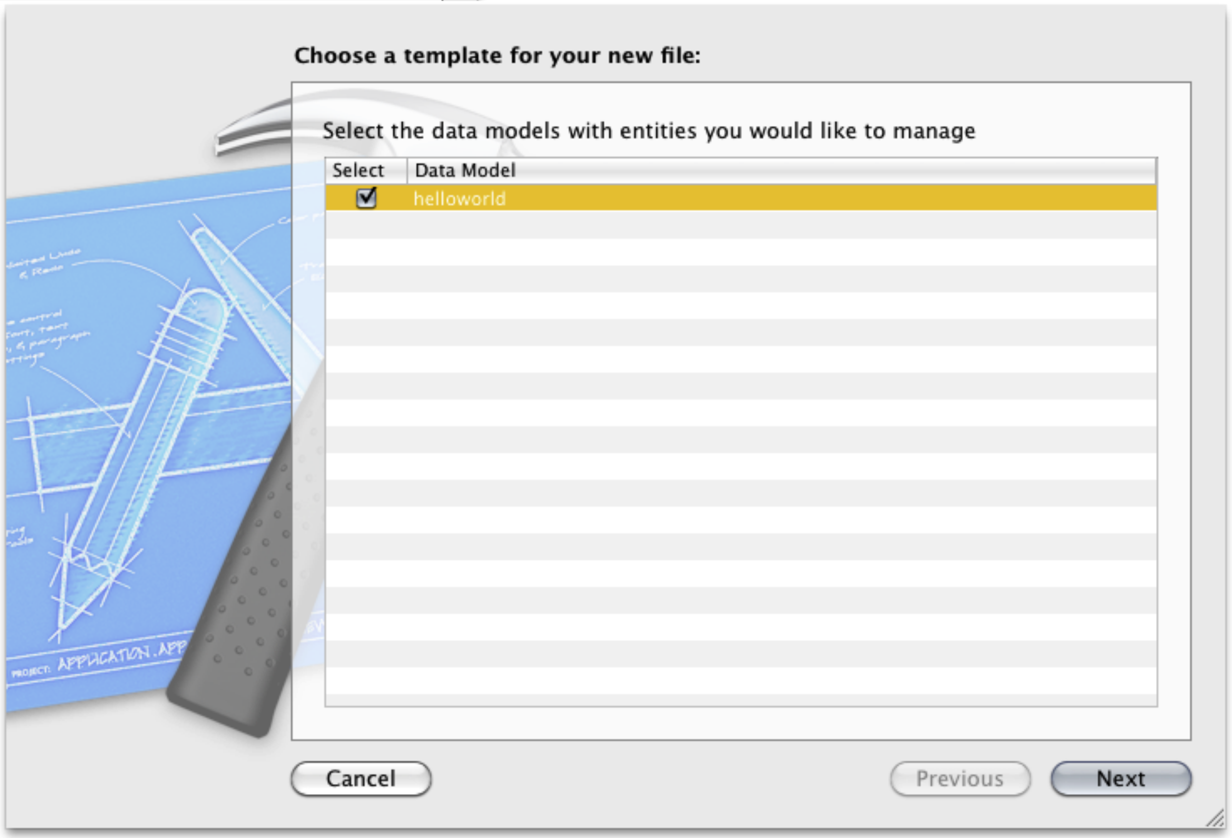


2.0.6 Creating Managed Objects - Select Entities



NSManagedObject subclass

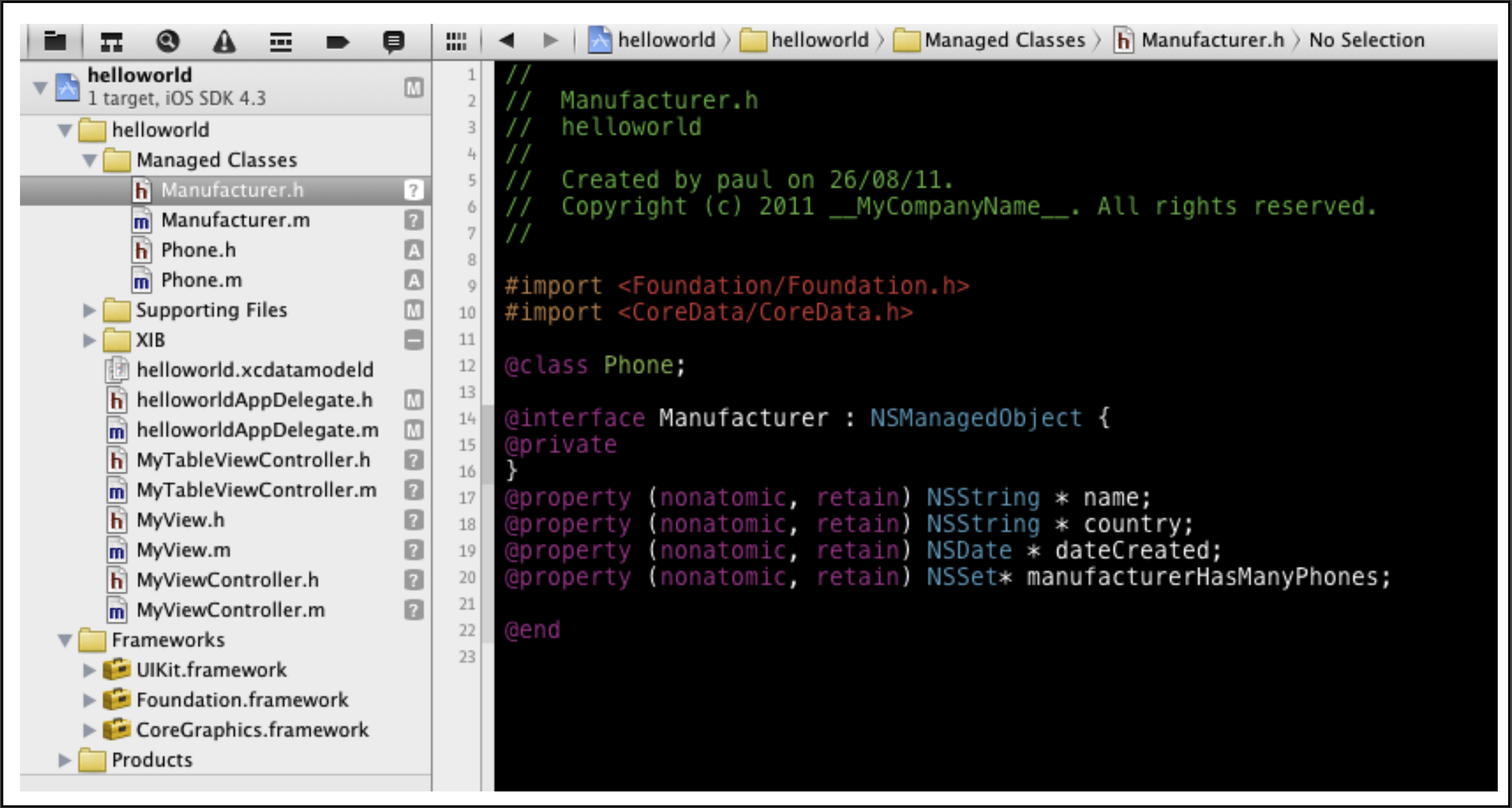
An Objective-C NSManagedObject subclass, with



Select the data models with entities you would like to manage

Select	Data Model
✓	helloworld

2.0.7 Creating Managed Objects - Generate Classes



```
//
//  Manufacturer.h
//  helloworld
//
//  Created by paul on 26/08/11.
//  Copyright (c) 2011 __MyCompanyName__. All rights reserved.
//

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

@class Phone;

@interface Manufacturer : NSManagedObject {
@private
}
@property (nonatomic, retain) NSString * name;
@property (nonatomic, retain) NSString * country;
@property (nonatomic, retain) NSDate * dateCreated;
@property (nonatomic, retain) NSSet* manufacturerHasManyPhones;

@end
```

2.0.8 Generated Class Files in Tree

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3.0 Retrieving Data

1. Create Managed Object Model **= DONE**
2. Setup App Delegate
3. Pass Core Data objects to *view controller*
4. Create a Fetch Request

Reminder:

CRUD = Create - Retrieve - Update - Delete

3.1 Setup App Delegate Header

Include Core Data headers:

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

Add 3 declared properties:

```
@property (nonatomic, retain, readonly)
   NSManagedObjectContext *managedObjectContext;
@property (nonatomic, retain, readonly)
   NSManagedObjectModel *managedObjectModel;
@property (nonatomic, retain, readonly)
   NSPersistentStoreCoordinator *persistentStoreCoordinator;
```

3.2 Setup App Delegate Implementation

Synthesize your declared properties:

```
@synthesize managedObjectContext, managedObjectModel,
  persistentStoreCoordinator;
```

*Add custom getters:**

```
- (NSManagedObjectContext *)managedObjectContext;

- (NSManagedObjectModel *)managedObjectModel;

- (NSPersistentStoreCoordinator *)persistentStoreCoordinator;
```

**These are templated for you by Xcode*

```
// Returns 'managed object context' for application
- (NSManagedObjectContext *)managedObjectContext {

  if (managedObjectContext != nil) {
      return managedObjectContext;
  }
  NSPersistentStoreCoordinator *coordinator =
                        [self persistentStoreCoordinator];
  if (coordinator != nil) {
    managedObjectContext =
                    [[NSManagedObjectContext alloc] init];
    [managedObjectContext
              setPersistentStoreCoordinator:coordinator];
  }
  return managedObjectContext;
}
```

3.2.1 ManagedObjectContext Get Method

```
// Returns 'managed object model' for application
- (NSManagedObjectModel *)managedObjectModel {

    if (managedObjectModel != nil) {
        return __managedObjectModel;
    }
    NSURL *modelURL = [[NSBundle mainBundle]
       URLForResource:@"coreDataHello" withExtension:@"momd"];

    managedObjectModel = [[NSManagedObjectModel alloc]
                              initWithContentsOfURL:modelURL];
    return managedObjectModel;
}
```

3.2.2 ManagedObjectModel Get Method

```
// Returns 'persistent store coordinator' for application
- (NSPersistentStoreCoordinator *)persistentStoreCoordinator {

  if (persistentStoreCoordinator != nil) {
      return persistentStoreCoordinator;
  }
  NSURL *storeURL = [[self applicationDocumentsDirectory]
      URLByAppendingPathComponent: @"yourCoreDataStore.sqlite"];

  NSError *error = nil;

  persistentStoreCoordinator = [[NSPersistentStoreCoordinator
   alloc] initWithManagedObjectModel:[self managedObjectModel]];

  // continued next slide ...
```

3.2.3 PersistentStoreCoordinator Get Method

```
  // ... continued
  if (![persistentStoreCoordinator
        addPersistentStoreWithType:NSSQLiteStoreType
        configuration:nil URL:storeURL options:nil error:&error])
  {
      NSLog(@"Error %@, %@", error, [error userInfo]);
      abort();
  }
  return persistentStoreCoordinator;
}
```

3.2.4 PersistentStoreCoordinator Get Method (cont)

```
// Pass MOC into the Navigation Controller's root VC
- (void)awakeFromNib {

  RootViewController *rootVC =(RootViewController *)
                  [self.navigationController topViewController];

  rootVC.managedObjectContext = self.managedObjectContext;
}
```

3.2.5 Pass MOC to View Controller

3.3 Meanwhile, In Your View Controller

We create Entity Description, Request and Sort Descriptor objects.

```
NSFetchRequest *request = [[NSFetchRequest alloc] init];

NSEntityDescription *entity = [NSEntityDescription entityForName:
  @"Phone" inManagedObjectContext:managedObjectContext];

// set request's entity
[request setEntity:entity];
```

3.4 Optional: Sort Descriptor & Predicate

We create Entity Description, Request and Sort Descriptor objects.

```
NSSortDescriptor *sortDesc = [[NSSortDescriptor alloc]
  initWithKey:@"name" ascending:NO];

// wrap in array - you can sort on multiple criteria
NSArray *sortDescArray = [NSArray arrayWithObject:sortDesc];
[request setSortDescriptors:sortDescArray]; // add to req obj
[sortDescriptor release];

NSPredicate *predicate = [NSPredicate predicateWithFormat:
 @"(name like %@) or (name like %@)", @"iPhone", @"Android"];

[request setPredicate:predicate]; // add to req obj
[predicate release];
```

3.5 Core Data, Fetch!

Run fetch request and store objects in an array:

```
NSArray *results = [managedObjectContext executeFetchRequest:
  request error:&error];
```

Or store a mutable copy instead:

```
NSMutableArray *mutableResults = [[managedObjectContext
  executeFetchRequest:request error:&error] mutableCopy];
```

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4.0 CRUD Operations

C = Create (Create Managed Object)
R = Retrieve (Fetch Request)
U = Update (Update Managed Object)
D = Delete (Remove from Store)

4.1 Creating a Managed Object

Create and save an NSManagedObject in a Managed Object Context object.

```
NSManagedObjectContext *context = /* assume this exists */;
NSManagedObject *newPhone = [NSEntityDescription
  insertNewObjectForEntityForName:@"Phone"
  inManagedObjectContext:context];

[newPhone setValue:@"iPhone 5" forKey:@"shortName"];
[newPhone setValue:@"Apple iPhone 5G" forKey:@"name"];
[newPhone setValue:[NSDate date] forKey:@"dateCreated"];

// Tell context to "save" unsaved changes
NSError *error = NULL;
if (![context save:&error]) {
    NSLog(@"Error on save: %@", [error localizedDescription]);
}
```

4.2 Managed Objects Inherit form NSManagedObject

A managed object's generated class inherits from NSManagedObject so instead of this:

```
NSManagedObject *newPhone = [NSEntityDescription
  insertNewObjectForEntityForName:@"Phone"
  inManagedObjectContext:context];
```

We can write this:

```
Phone *newPhone = (Phone*)[NSEntityDescription
  insertNewObjectForEntityForName:@"Phone"
  inManagedObjectContext:context];
```

4.3 Retrieving Managed Objects (Reviewed)

```
// get context and create a request object
NSManagedObjectContext *context = /* assume this exists */;
NSFetchRequest *request = [[NSFetchRequest alloc] init];

// set the entity on the request object
NSEntityDescription *entity= [NSEntityDescription entityForName:
  @"Phone" inManagedObjectContext:managedObjectContext];
[request setEntity:entity];

// Run our 'fetch request' on context object
NSArray *results = [context executeFetchRequest:request
  error:nil];
```

Note: We have note used a predicate (filter) or assigned a sort descriptor for simplicity. See slides 3.3 - 3.5 for a detailed fetch request example.

4.4 Updating a Managed Object

Continuing the previous example, let's update the first object returned by the fetch request.

```
// get first object in results from previous slide
Phone *phoneObject = [results objectAtIndex:0];

// change a value on it
[phoneObject setValue:@"iPhone 5.1" forKey:@"shortName"];

// tell context to "save" unsaved changes
NSError *error;
if (![context save:&error]) {
    NSLog(@"Error on save: %@", [error localizedDescription]);
}
```

4.5 Deleting Managed Objects

A delete object message needs to be sent to the Managed Object Context as follows.

```
NSManagedObjectContext *context = /* assume this exists */;

// remove phoneObject from context
[context deleteObject:phoneObject];

// tell context to "save" unsaved changes
NSError *error;
if (![context save:&error]) {
    NSLog(@"Error on save: %@", [error localizedDescription]);
}
```

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5.0 Notification Center

- A method for objects to broadcast notifications of state changes to other objects in memory
- An object 'posts' a notification
- Objects registered for that notification are alerted and allowed to respond

5.1 Posting A Notification

Call -postNotificationName: on the default NSNotificationCenter object

Specify i) notification name, ii) delegate object

```
// Posts a "doSomething" message
- (void)notify
{
  [[NSNotificationCenter defaultCenter]
     postNotificationName:@"doSomething" object:self];
}
```

5.2 Registering for Notification

Specify:

1. Object registering as an observer
2. Selector called when notification received
3. Name of the notification (a string)
4. Object being observed

```
// Meanwhile, in another object...
[[NSNotificationCenter defaultCenter] addObserver:self
   selector:@selector(myNotificationHandler:)
      name:@"doSomething" object:nil];
```

5.3 Cleaning Up

When a class is deallocated, its observers must be removed, otherwise they might be called on a nil object.

```
// Typically called in observer's -dealloc method
- (void) dealloc
{
  [[NSNotificationCenter defaultCenter]
                                        removeObserver:self];
}
```

5.4 When to Use Notifications

Tightly coupled objects create problems. Ideally objects have no knowledge of another object's implementation details.

Post Notifications are useful for:

- Decoupling objects
- Notifying more than one object (without knowing what they are)

Read More:
http://developer.apple.com/library/mac/#documentation/Cocoa/Reference/Foundation/Classes/NSNotificationCenter_Class/Reference/Reference.html

What We Covered Today

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End of Lecture 5

1. Lab
2. Assignments
3. Aiight