Core Data Model Versioning and Data Migration Programming Guide

Data Management

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Contents

Figures and Listings

Introduction to Core Data Model Versioning and Data Migration Programming Guide

Core Data provides an architecture to support versioning of managed object models and migration of data from one version to another.

You should read this document if you are an experienced Core Data developer and want to learn how to support versioning in your application.

Important: This document assumes that you are familiar with the Core Data architecture and the fundamentals of using Core Data. You should be able to identify the parts of the Core Data stack and understand the roles of the model, the managed object context, and the persistent store coordinator. You need to know how to create a managed object model, how to create and programmatically interact with parts of the Core Data stack.

If you do not meet these requirements, you should first read the *Core Data Programming Guide* and related materials. You are strongly encouraged also to work through the *Core Data Utility Tutorial*.

Organization of This Document

This document contains the following articles:

- "Basic Concepts" (page 9) describes the fundamental ideas behind versioning and migration, and outlines the support Core Data provides for these processes.
- "Versioning" (page 11) describes what is meant by a "version" of a managed object model.
- "Lightweight Migration" (page 17) describes how you can easily migrate data using just a versioned managed object model.
- "Mapping Overview" (page 21) describes the mapping model.
- "The Migration Process" (page 25) describes the process of migrating data, including the three stages of migration.
- "Initiating the Migration Process" (page 29) describes how you start the migration process, and how the default migration process proceeds.
- "Customizing the Migration Process" (page 33) describes how you can customize the migration process—that is, how you programmatically determine whether migration is necessary; how you find the correct source and destination models and the appropriate mapping model to initialize the migration manager; and then how you perform the migration.

  You only customize the migration process if you want to initiate migration yourself. You might do this to, for example, search locations other than the application's main bundle for models or to deal with large data sets by performing the migration in several passes using different mapping models.

Basic Concepts

This article describes some of the considerations involved in creating different versions of your application, and discusses those aspects for which Core Data provides support.

Typically, as it evolves from one version to another there are numerous aspects of your application that change: the classes you implement, the user interface, the file format, and so on. You need to be aware of and in control of all these aspects; there is no API that solves the problems associated with all these—for example Cocoa does not provide a means to automatically update your user interface if you add a new attribute to an entity in your managed object model. Core Data does not solve all the issues of how you roll out your application. It provides support for a small—but important and non-trivial—subset of the tasks you must perform as your application evolves.

Core Data stores are conceptually bound to the managed object model used to create them. Since a model describes the structure of the data, changing a model will render it incompatible with (and so unable to open) the stores it previously created. If you change your schema, you therefore need to migrate the data in existing stores to new version. In general, managing all this yourself can be difficult.

Core Data provides support for model versioning, for mapping from one model to another, and for data migration. Moreover, it provides an infrastructure to support the process of migration, allowing you to focus on the details of conversion that are specific to your domain.

- Model versioning allows you to specify and distinguish between different configurations of your schema.

  How you create a versioned managed object model is discussed in "Versioning" (page 11).

  Core Data also makes it easy to find the right model to open a given persistent store, as discussed in "Initiating the Migration Process" (page 29).

- A mapping model parallels a managed object model, specifying how to transform objects in the source into instances appropriate for the destination.

  How you create a mapping model is discussed in "Mapping Overview" (page 21).

  On Mac OS X v10.6 and later and on iOS, in some simple cases you may not need to create a mapping model. Instead, Core Data can infer the model from existing versions of the managed object model. There can be significant performance benefits if you can use this approach. This is described in "Lightweight Migration" (page 17).

- Data migration allows you to convert data from one model (schema) to another, using mappings.

  How you perform a migration is discussed in "Initiating the Migration Process" (page 29), with further details on how you can customize the process given in "Customizing the Migration Process" (page 33).

Although Core Data makes versioning and migration easier than would typically otherwise be the case, it is important to understand that these processes are still non-trivial in effect. You still need to carefully consider the implications of releasing and supporting different versions of your application.

Versioning

This article provides an overview of schema versioning as it applies to Core Data, and how you can create a versioned managed object model.

Concepts

There are two distinct views of versioning: your perspective as a developer, and Core Data's perspective. These may not always be the same—consider the following models.

Figure 1 Recipes models "Version 1.0"

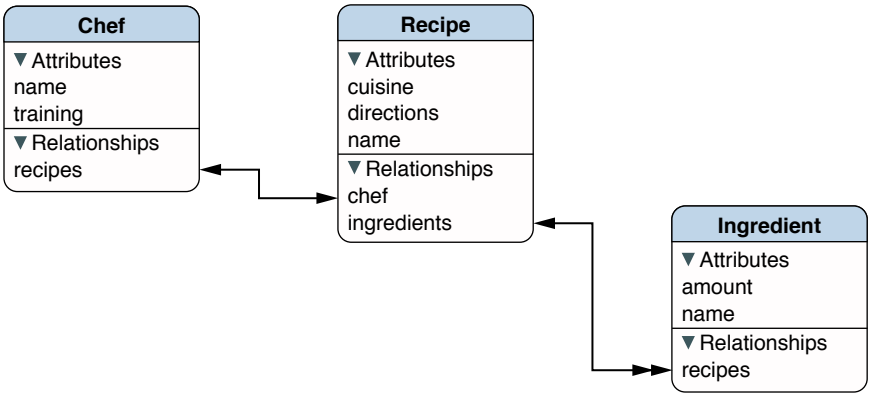


Figure 2 Recipes model "Version 1.1"

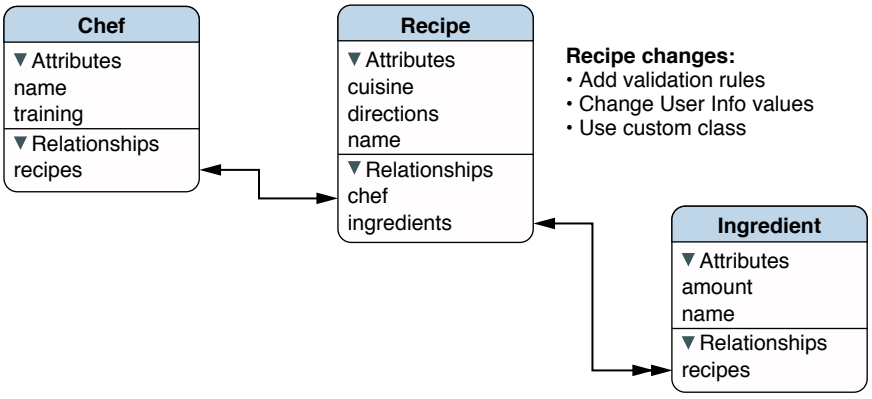
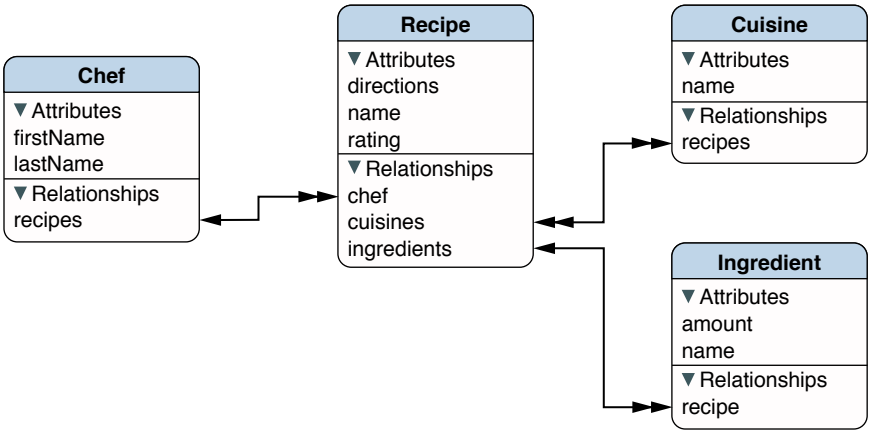


Figure 3 Recipes model "Version 2.0"



As a developer, your perspective is typically that a version is denoted by an identifier—a string or number, such as "9A218", "2.0.7", or "Version 1.1". To support this view, managed object models have a set of identifiers (see `versionIdentifiers`)—typically for a single model you provide a single string (the attribute itself is a set so that if models are merged all the identifiers can be preserved). How the identifier should be interpreted is up to you, whether it represents the version number of the application, the version that was committed prior to going on vacation, or the last submission before it stopped working.

Core Data, on the other hand, treats these identifiers simply as "hints". To understand why, recall that the format of a persistent store is dependent upon the model used to create it, and that to open a persistent store you must have a model that is compatible with that used to create it. Consider then what would happen if you changed the model but not the identifier—for example, if you kept the identifier the same but removed one entity and added two others. To Core Data, the change in the schema is significant, the fact that the identifier did *not* change is irrelevant.

Core Data's perspective on versioning is that it is only interested in features of the model that affect persistence. This means that for two models to be compatible:

- For each entity the following attributes must be equal: `name`, `parent`, `isAbstract`, and `properties`.

  `className`, `userInfo`, and validation predicates are not compared.

- For each property in each entity, the following attributes must be equal: `name`, `isOptional`, `isTransient`, `isReadOnly`, for attributes `attributeType`, and for relationships `destinationEntity`, `minCount`, `maxCount`, `deleteRule`, and `inverseRelationship`.

  `userInfo` and validation predicates are not compared.

Notice that Core Data ignores any identifiers you set. In the examples above, Core Data treats version 1.0 (Figure 1 (page 11)) and 1.1 (Figure 2 (page 11)) as being compatible.

Rather than enumerating through all the relevant parts of a model, Core Data creates a 32-byte hash digest of the components which it compares for equality (see `versionHash` (`NSEntityDescription`) and `versionHash` (`NSPropertyDescription`)). These hashes are included in a store's metadata so that Core Data can quickly determine whether the store format matches that of the managed object model it may use to try to open the store. (When you attempt to open a store using a given model, Core Data compares the version hashes of each of the entities in the store with those of the entities in the model, and if all are the same then the store is opened.) There is typically no reason for you to be interested in the value of a hash.

There may, however, be some situations in which you have two versions of a model that Core Data would normally treat as equivalent that you want to be recognized as being different. For example, you might change the name of the class used to represent an entity, or more subtly you might keep the model the same but change the internal format of an attribute such as a BLOB—this is irrelevant to Core Data, but it is crucial for the integrity of your data. To support this, Core Data allows you to set a hash modifier for an entity or property see `versionHashModifier` (`NSEntityDescription`) and `versionHashModifier` (`NSPropertyDescription`).

In the examples above, if you wanted to force Core Data to recognize that "Version 1.0" (Figure 1 (page 11)) and "Version 1.1" (Figure 2 (page 11)) of your models are different, you could set (using `setVersionHashModifier:`) an entity modifier for the Recipe entity in the second model to change the version hash Core Data creates .

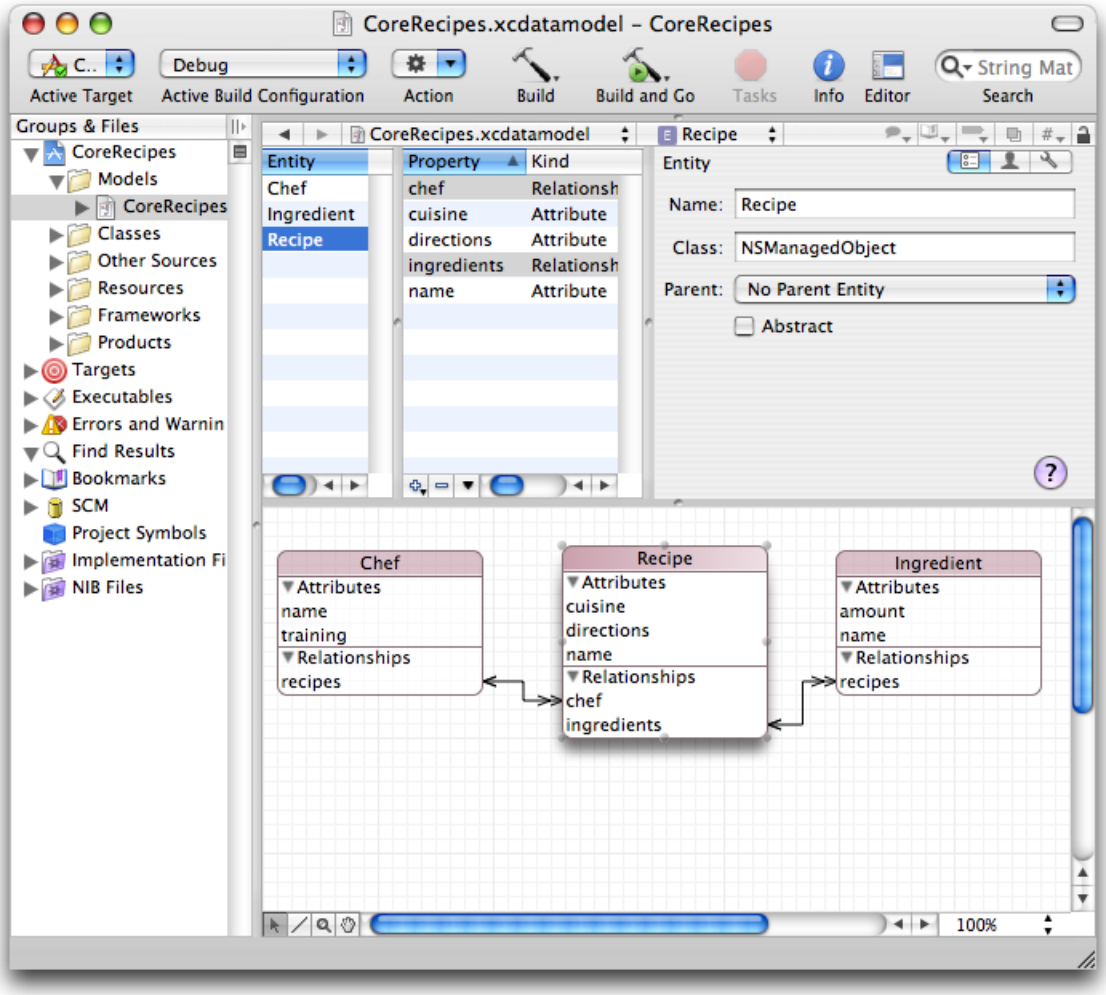
Model Versions

On Mac OS X v10.5 and later and on iOS, Core Data supports versioned managed object models. The Xcode file type is `.xcdatamodeld` (instead of `.xcdatamodel`) which is a directory that groups versions of a model, each represented by an individual `.xcdatamodel` file, and an `Info.plist` file that contains the version information. Xcode allows you to specify the "current" version.

The versioned model has a different runtime format (`.momd`) that is a bundle containing individually compiled `.mom` files. You load the `.momd` model just as you would a regular `.mom` file (using `NSManagedObjectModel`'s `initWithContentsOfURL:`).

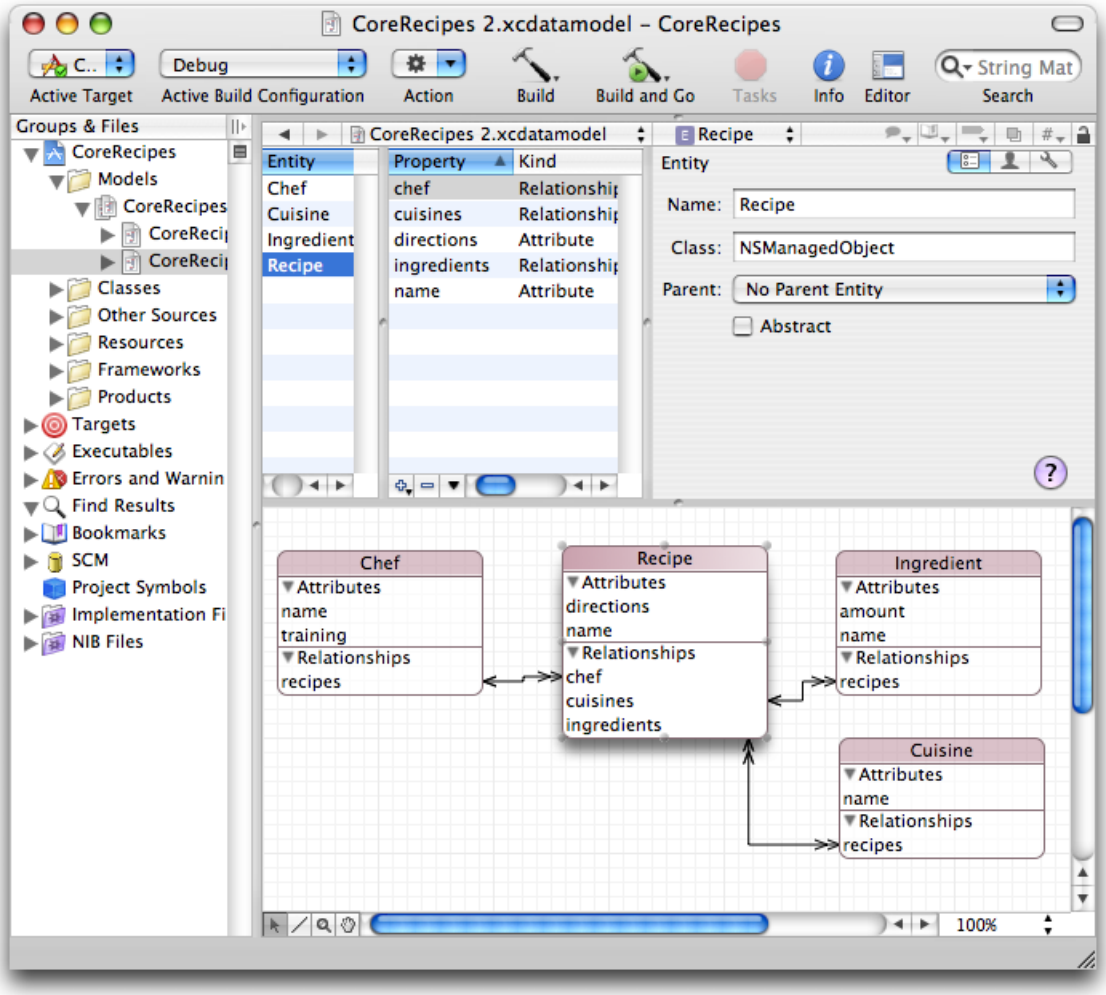
To create a versioned model, you start with a normal model such as that illustrated in Figure 4.

Figure 4 Initial version of the Core Recipes model



To add a version, you select the model in the Groups & Files pane, then select Design > Data Model > Add Model Version. This creates a new directory with the same name as the selected model but with the extension `.xcdatamodeld`, places the original model inside this directory, and makes a copy of the original model as a peer. You can now select the new model and choose Design > Data Model > Set Current Version to denote that it is the current version of the model. You edit the new model just as you would any other model (see Figure 5).

Figure 5 Version 2 of the Core Recipes model



Lightweight Migration

This article describes the "lightweight migration" feature you can use to perform automatic data migration for simple model changes.

Overview

If you just make simple changes to your model (such as adding a new attribute to an entity), on Mac OS X v10.6 and later and on iOS, Core Data can perform automatic data migration, referred to as **lightweight migration**. Lightweight migration is fundamentally the same as ordinary migration, except that instead of you providing a mapping model (as described in "Mapping Overview" (page 21)), Core Data infers one from differences between the source and destination managed object models.

Lightweight migration is especially convenient during early stages of application development, when you may be changing your managed object model frequently, but you don't want to have to keep regenerating test data. You can migrate existing data without having to create a custom mapping model for every model version used to create a store that would need to be migrated.

A further advantage of using lightweight migration—beyond the fact that you don't need to create the mapping model yourself—is that if you use an inferred model and you use the SQLite store, then Core Data can perform the migration in situ (solely by issuing SQL statements). This can represent a significant performance benefit as Core Data doesn't have to load any of your data. Because of this, you are encouraged to use inferred migration where possible, even if the mapping model you might create yourself would be trivial.

Requirements

To perform a lightweight migration, Core Data needs to be able to find the source and destination managed object models itself at runtime. (Core Data searches the bundles returned by `NSBundle`'s `allBundles` and `allFrameworks` methods.) It must then analyze the schema changes to persistent entities and properties and generate an inferred mapping model. For Core Data to be able to do this, the changes must fit an obvious migration pattern, for example:

- Simple addition of a new attribute
- A non-optional attribute becoming optional
- An optional attribute becoming non-optional, *and defining a default value*

If you rename an entity or property, you can set the renaming identifier in the destination model to the name of the corresponding property or entity in the source model. You typically set the renaming identifier using the Xcode Data Modeling tool, (for either an `NSEntityDescription` or an `NSPropertyDescription`

object). In Xcode, the renaming identifier is in the User Info pane of the Detail Pane, below the version hash modifier (see The Browser View in *Xcode Tools for Core Data*). You can also set the identifier at runtime using `setRenamingIdentifier:`. For example, to handle

- Renaming of an entity Car to Automobile, and
- Renaming the Car's `color` attribute to `paintColor`

you would include the following code after loading the destination data model, and before attempting to open a store file:

```
NSEntityDescription *automobile = [[destinationModel entitiesByName]
objectForKey:@"Automobile"];
[automobile setRenamingIdentifier:@"Car"];
NSPropertyDescription *paintColor = [[automobile attributesByName]
objectForKey:@"paintColor"];
[paintColor setRenamingIdentifier:@"color"];
```

iPhone Development on Mac OS X v10.5: The data modeling tool in Xcode for Leopard does not provide a renaming identifier text field for entities and properties. In-place and lightweight migration are still supported, but you must assign the renaming identifiers in code.

Automatic Lightweight Migration

To request automatic lightweight migration, you set appropriate flags in the options dictionary you pass in `addPersistentStoreWithType:configuration:URL:options:error:`. You need to set values corresponding to both the `NSMigratePersistentStoresAutomaticallyOption` and the `NSInferMappingModelAutomaticallyOption` keys to `YES`:

```
NSError *error;
NSURL *storeURL = <#The URL of a persistent store#>;
NSPersistentStoreCoordinator *psc = <#The coordinator#>;
NSDictionary *options = [NSDictionary dictionaryWithObjectsAndKeys:
    [NSNumber numberWithBool:YES], NSMigratePersistentStoresAutomaticallyOption,
    [NSNumber numberWithBool:YES], NSInferMappingModelAutomaticallyOption, nil];

if (![psc addPersistentStoreWithType:<#Store type#>
     configuration:<#Configuration or nil#> URL:storeURL
     options:options error:&error]) {
     // Handle the error.
}
```

If you want to determine in advance whether Core Data can infer the mapping between the source and destination models without actually doing the work of migration, you can use `NSMappingModel`'s `inferredMappingModelForSourceModel:destinationModel:error:` method. This returns the inferred model if Core Data is able to create it, otherwise `nil`.

Manual Migration

To perform automatic migration, Core Data has to be able to find the source and destination managed object models itself at runtime (see "Requirements" (page 17)). If you need to put your models in the locations not checked by automatic discovery, then you need to generate the inferred model and initiate the migration yourself. The following code sample illustrates how you can do this. The code assumes that you have implemented two methods—`model1` and `model2`—that return the source and destination managed object models respectively.

```
- (BOOL)migrateStore:(NSURL *)storeURL toVersionTwoStore:(NSURL *)dstStoreURL
{

    NSError *error;
    NSMappingModel *mappingModel = [NSMappingModel
inferredMappingModelForSourceModel:[self model1]
        destinationModel:[self model2] error:&error];
    if (error) {
        NSString *message = [NSString stringWithFormat:@"Inferring failed %@
[%@]",
            [error description], ([error userInfo] ? [[error userInfo]
description] : @"no user info")];
        NSLog(@"Failure message: %@", message);

        return NO;
    }

    NSValue *classValue = [[NSPersistentStoreCoordinator registeredStoreTypes]
 objectForKey:NSSQLiteStoreType];
    Class sqliteStoreClass = (Class)[classValue pointerValue];
    Class sqliteStoreMigrationManagerClass = [sqliteStoreClass
migrationManagerClass];

    NSMigrationManager *manager = [[sqliteStoreMigrationManagerClass alloc]
                                    initWithSourceModel:[self model1]
destinationModel:[self model2]];

    if (![manager migrateStoreFromURL:storeURL type:NSSQLiteStoreType
                  options:nil withMappingModel:mappingModel
toDestinationURL:dstStoreURL
                  destinationType:NSSQLiteStoreType destinationOptions:nil
error:&error]) {

        NSString *message = [NSString stringWithFormat:@"Migration failed %@
[%@]",
            [error description], ([error userInfo] ? [[error userInfo]
description] : @"no user info")];
        NSLog(@"Failure message: %@", message);

        return NO;
    }
    return YES;
}
```

Mapping Overview

This article provides an overview of the mapping model.

On Mac OS X v10.6 and later, and on iOS, in simple cases Core Data may be able to infer how to transform data from one schema to another (see "Lightweight Migration" (page 17)). On Mac OS X v10.5 and generally in more complex cases, in order to transform data from one version of a schema to another, you need a definition of how to perform the transformation. This information is captured in a mapping model.

A mapping model is a collection of objects that specifies the transformations that are required to migrate part of a store from one version of your model to another (for example, that one entity is renamed, an attribute is added to another, and a third split into two). You typically create a mapping model in Xcode. Much as the managed object model editor allows you to graphically create the model, the mapping model editor allows you to customize the mappings between the source and destination entities and properties.

Mapping Model Objects

Like a managed object model, a mapping model is a collection of objects. Mapping model classes parallel the managed object model classes—there are mapping classes for a model, an entity, and a property (`NSMappingModel`, `NSEntityMapping`, and `NSPropertyMapping` respectively).

- An instance of `NSEntityMapping` specifies a source entity, a destination entity (the type of object to create to correspond to the source object) and mapping type (add, remove, copy as is, or transform).
- An instance of `NSPropertyMapping` specifies the name of the property in the source and in the destination entity, and a value expression to create the value for the destination property.

The model does not contain instances of `NSEntityMigrationPolicy` or any of its subclasses, however amongst other attributes instance of `NSEntityMapping` can specify the *name* of an entity migration policy class (a subclass of `NSEntityMigrationPolicy`) to use to customize the migration. For more about entity migration policy classes, see "Custom Entity Migration Policies " (page 26).

You can handle simple property migration changes by configuring a custom value expression on a property mapping directly in the mapping model editor in Xcode. For example, you can:

- Migrate data from one attribute to another.

  To rename `amount` to `totalCost`, enter the custom value expression for the `totalCost` property mapping as `$source.amount`.

- Apply a value transformation on a property.

  To convert `temperature` from Fahrenheit to Celsius, use the custom value expression `($source.temperature - 32.0) / 1.8`.

- Migrate objects from one relationship to another.

To rename `trades` to `transactions`, enter the custom value expression for the transactions property mapping as `FUNCTION($manager, "destinationInstancesForEntityMappingNamed:sourceInstances:", "TradeToTrade", $source.trades)`. (This assumes the entity mapping that migrates Trade instances is named TradeToTrade.)

There are six predefined keys you can reference in custom value expressions. To access these keys in source code, you use the constants as declared. To access them in custom value expression strings in the mapping model editor in Xcode, follow the syntax rules outlined in the predicate format string syntax guide and refer to them as:

`NSMigrationManagerKey: $manager`

`NSMigrationSourceObjectKey: $source`

`NSMigrationDestinationObjectKey: $destination`

`NSMigrationEntityMappingKey: $entityMapping`

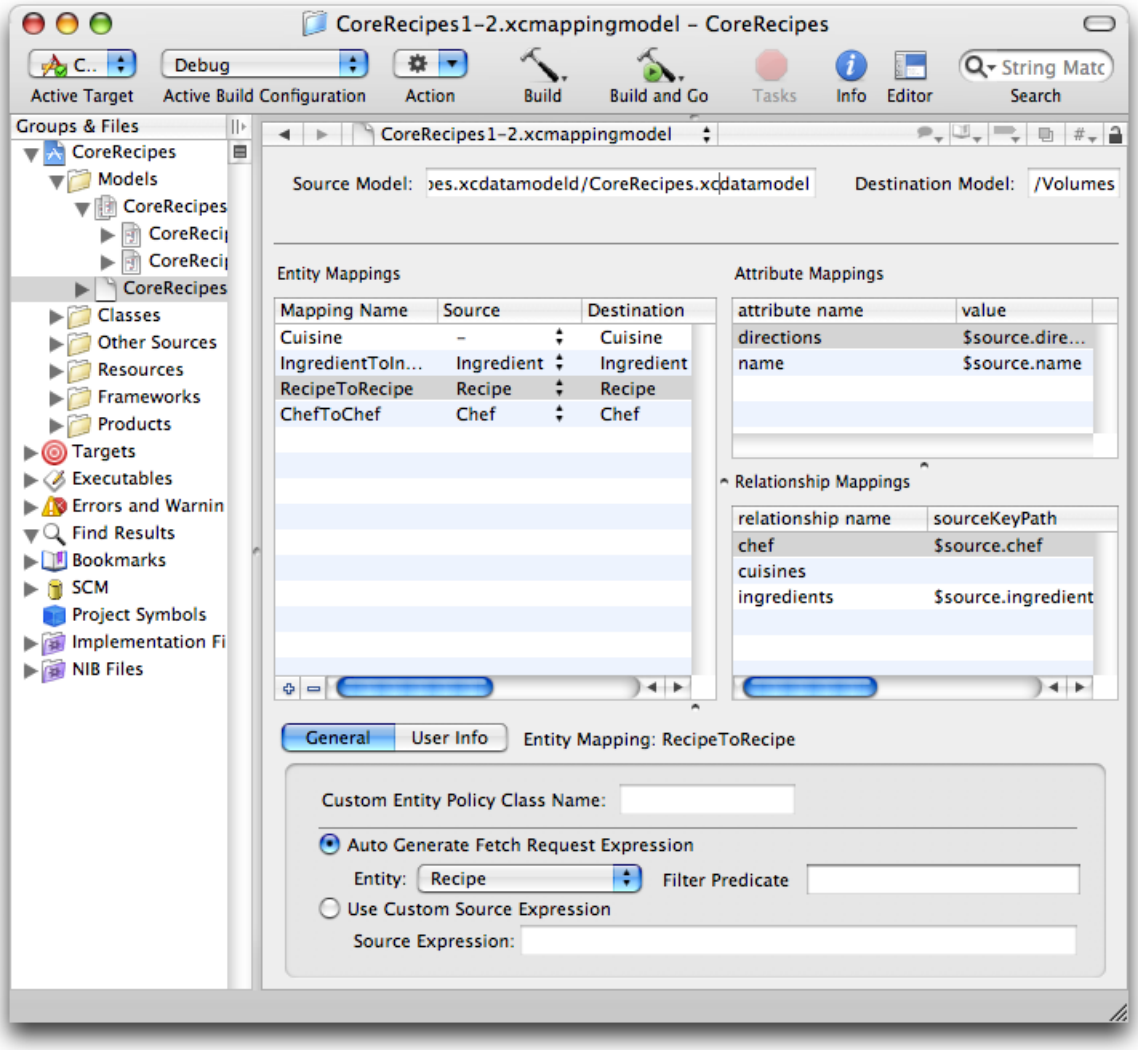
`NSMigrationPropertyMappingKey: $propertyMapping`

`NSMigrationEntityPolicyKey: $entityPolicy`

Creating a Mapping Model in Xcode

From the File menu, you select New File and in the New File pane select Design > Mapping Model. In the following pane, you select the source and destination models. When you click Finish, Xcode creates a new mapping model that contains as many default mappings as it can deduce from the source and destination. For example, given the model files shown in Figure 4 (page 14) and Figure 5 (page 15), Xcode creates a mapping model as shown in Figure 1.

Figure 1 Mapping model for versions 1-2 of the Core Recipes models



Reserved words in custom value expressions: If you use a custom value expression, you must escape reserved words such as `SIZE`, `FIRST`, and `LAST` using a `#` (for example, `$source.#size`).

The Migration Process

During migration, Core Data creates two stacks, one for the source store and one for the destination store. Core Data then fetches objects from the source stack and inserts the appropriate corresponding objects into the destination stack. Note that Core Data must *re-create* objects in the new stack.

Overview

Recall that stores are bound to their models. Migration is required when the model doesn't match the store. There are two areas where you get default functionality and hooks for customizing the default behavior:

- When detecting version skew and initializing the migration process.
- When performing the migration process.

To perform the migration process requires two Core Data stacks—which are automatically created for you—one for the source store, one for the destination store. The migration process is performed in 3 stages, copying objects from one stack to another.

Requirements for the Migration Process

Migration of a persistent store is performed by an instance of `NSMigrationManager`. To migrate a store, the migration manager requires several things:

- The managed object model for the destination store.

  This is the persistent store coordinator's model.
- A managed object model that it can use to open the existing store.
- Typically, a mapping model that defines a transformation from the source (the store's) model to the destination model.

  You don't need a mapping model if you're able to use lightweight migration—see "Lightweight Migration" (page 17).

You can specify custom entity migration policy classes to customize the migration of individual entities. You specify custom migration policy classes in the mapping model (note the "Custom Entity Policy Name" text field in Figure 1 (page 23)).

Custom Entity Migration Policies

If your new model simply adds properties or entities to your existing model, there may be no need to write any custom code. If the transformation is more complex, however, you might need to create a subclass of `NSEntityMigrationPolicy` to perform the transformation; for example:

- If you have a Person entity that also includes address information that you want to split into a separate Address entity, but you want to ensure uniqueness of each Address.
- If you have an attribute that encodes data in a string format that you want to change to a binary representation.

The methods you override in a custom migration policy correspond to the different phases of the migration process—these are called out in the description of the process given in "Three-Stage Migration."

Three-Stage Migration

The migration process itself is in three stages. It uses a copy of the source and destination models in which the validation rules are disabled and the class of all entities is changed to `NSManagedObject`.

To perform the migration, Core Data sets up two stacks, one for the source store and one for the destination store. Core Data then processes each entity mapping in the mapping model in turn. It fetches objects of the current entity into the source stack, creates the corresponding objects in the destination stack, then recreates relationships between destination objects in a second stage, before finally applying validation constraints in the final stage.

Before a cycle starts, the entity migration policy responsible for the current entity is sent a `beginEntityMapping:manager:error:` message. You can override this method to perform any initialization the policy requires. The process then proceeds as follows:

1. Create destination instances based on source instances.

   At the beginning of this phase, the entity migration policy is sent a `createDestinationInstancesForSourceInstance:entityMapping:manager:error:` message; at the end it is sent a `endInstanceCreationForEntityMapping:manager:error:` message.

   In this stage, only attributes (not relationships) are set in the destination objects.

   Instances of the source entity are fetched. For each instance, appropriate instances of the destination entity are created (typically there is only one) and their attributes populated (for trivial cases, `name = $source.name`). A record is kept of the instances per entity mapping since this may be useful in the second stage.

2. Recreate relationships.

   At the beginning of this phase, the entity migration policy is sent a `createRelationshipsForDestinationInstance:entityMapping:manager:error:` message; at the end it is sent a `endRelationshipCreationForEntityMapping:manager:error:` message.

For each entity mapping (in order), for each destination instance created in the first step any relationships are recreated.

3. Validate and save.

   In this phase, the entity migration policy is sent a `performCustomValidationForEntityMapping:manager:error:` message.

   Validation rules in the destination model are applied to ensure data integrity and consistency, and then the store is saved.

At the end of the cycle, the entity migration policy is sent an `endEntityMapping:manager:error:` message. You can override this method to perform any clean-up the policy needs to do.

Note that Core Data cannot simply fetch objects into the source stack and insert them into the destination stack, the objects must be re-created in the new stack. Core Data maintains "association tables" which tell it which object in the destination store is the migrated version of which object in the source store, and vice-versa. Moreover, because it doesn't have a means to flush the contexts it is working with, you may accumulate many objects in the migration manager as the migration progresses. If this presents a significant memory overhead and hence gives rise to performance problems, you can customize the process as described in "Multiple Passes—Dealing With Large Datasets" (page 35).

Initiating the Migration Process

This chapter describes how to initiate the migration process and how the default migration process works. It does not describe customizing the migration process—this is described in "Customizing the Migration Process" (page 33).

Initiating the Migration Process

When you initialize a persistent store coordinator, you assign to it a managed object model (see `initWithManagedObjectModel:`); the coordinator uses that model to open persistent stores. You open a persistent store using `addPersistentStoreWithType:configuration:URL:options:error:`. How you use this method, however, depends on whether your application uses model versioning and on how you choose to support migration—whether you choose to use the default migration process or custom version skew detection and migration bootstrapping. The following list describes different scenarios and what you should do in each:

- Your application does not support versioning

  You use `addPersistentStoreWithType:configuration:URL:options:error:` directly.

  If for some reason the coordinator's model is not compatible with the store schema (that is, the version hashes current model's entities do not equal those in the store's metadata), the coordinator detects this, generates an error, and `addPersistentStoreWithType:configuration:URL:options:error:` returns `NO`. You must deal with this error appropriately.

- Your application does support versioning and you choose to use either the lightweight or the default migration process

  You use `addPersistentStoreWithType:configuration:URL:options:error:` as described in "Lightweight Migration" (page 17) and "The Default Migration Process" (page 30) respectively.

  The fundamental difference from the non-versioned approach is that you instruct the coordinator to automatically migrate the store to the current model version by adding an entry to the options dictionary where the key is `NSMigratePersistentStoresAutomaticallyOption` and the value is an `NSNumber` object that represents `YES`.

- Your application does support versioning and you choose to use custom version skew detection and migration bootstrapping

  Before opening a store you use `isConfiguration:compatibleWithStoreMetadata:` to check whether its schema is compatible with the coordinator's model:

  - If it is, you use `addPersistentStoreWithType:configuration:URL:options:error:` to open the store directly;

- If it is not, you must migrate the store first then open it (again using `addPersistentStoreWithType:configuration:URL:options:error:`).

You could simply use `addPersistentStoreWithType:configuration:URL:options:error:` to check whether migration is required, however this is a heavyweight operation and inefficient for this purpose.

It is important to realize that there are two *orthogonal* concepts:

1. You can execute custom code during the migration.
2. You can have custom code for version skew detection and migration bootstrapping.

The migration policy classes allow you to customize the migration of entities and properties in a number of ways, and these are typically all you need. You might, however, use custom skew detection and migration bootstrapping so that you can take control of the migration process. For example, if you have very large stores you could set up a migration manager with the two data models, and then use a series of mapping models to migrate your data into your destination store (if you use the same destination URL for each invocation, Core Data adds new objects to the existing store). This allows the framework (and you) to limit the amount of data in memory during the conversion process.

The Default Migration Process

To open a store and perform migration (if necessary), you use `addPersistentStoreWithType:configuration:URL:options:error:` and add to the options dictionary an entry where the key is `NSMigratePersistentStoresAutomaticallyOption` and the value is an `NSNumber` object that represents `YES`. Your code looks similar to the following example:

Listing 1 Opening a store using automatic migration

```
NSError *error;
NSPersistentStoreCoordinator *psc = <#The coordinator#>;
NSURL *storeURL = <#The URL of a persistent store#>;
NSDictionary *optionsDictionary =
    [NSDictionary dictionaryWithObject:[NSNumber numberWithBool:YES]
                                forKey:NSMigratePersistentStoresAutomaticallyOption];

NSPersistentStore *store = [psc addPersistentStoreWithType:<#Store type#>
                                             configuration:<#Configuration or nil#>
                                             URL:storeURL
                                             options:optionsDictionary
                                             error:&error];
```

If the migration proceeds successfully, the existing store at `storeURL` is renamed with a "~" suffix before any file extension and the migrated store saved to `storeURL`.

In its implementation of `addPersistentStoreWithType:configuration:URL:options:error:` Core Data does the following:

1. Tries to find a managed object model that it can use to open the store.

Core Data searches through your application's resources for models and tests each in turn. If it cannot find a suitable model, Core Data returns `nil` and a suitable error.

2. Tries to find a mapping model that maps from the managed object model for the existing store to that in use by the persistent store coordinator.

   Core Data searches through your application's resources for available mapping models and tests each in turn. If it cannot find a suitable mapping, Core Data returns `NO` and a suitable error.

   Note that you must have created a suitable mapping model in order for this phase to succeed.

3. Creates instances of the migration policy objects required by the mapping model.

Note that even if you use the default migration process you can customize the migration itself using custom migration policy classes.

Customizing the Migration Process

You only customize the migration process if you want to initiate migration yourself. You might do this to, for example, to search for models in locations other than the application's main bundle, or to deal with large data sets by performing the migration in several passes using different mapping models (see "Multiple Passes—Dealing With Large Datasets" (page 35)).

Is Migration Necessary

Before you initiate a migration process, you should first determine whether it is necessary. You can check with `NSManagedObjectModel`'s `isConfiguration:compatibleWithStoreMetadata:` as illustrated in Listing 2 (page 33).

Listing 2 Checking whether migration is necessary

```
NSPersistentStoreCoordinator *psc = /* get a coordinator */ ;
NSString *sourceStoreType = /* type for the source store, or nil if not known
*/ ;
NSURL *sourceStoreURL = /* URL for the source store */ ;
NSError *error = nil;

NSDictionary *sourceMetadata =
    [NSPersistentStoreCoordinator metadataForPersistentStoreOfType:sourceStoreType
                                    URL:sourceStoreURL
                                    error:&error];

if (sourceMetadata == nil) {
    // deal with error
}

NSString *configuration = /* name of configuration, or nil */ ;
NSManagedObjectModel *destinationModel = [psc managedObjectModel];
BOOL pscCompatibile = [destinationModel
            isConfiguration:configuration
            compatibleWithStoreMetadata:sourceMetadata];

if (pscCompatibile) {
    // no need to migrate
}
```

Initializing a Migration Manager

You initialize a migration manager using `initWithSourceModel:destinationModel:`; you therefore first need to find the appropriate model for the store. You get the model for the store using `NSManagedObjectModel`'s `mergedModelFromBundles:forStoreMetadata:`. If this returns a suitable model, you can create the migration manager as illustrated in Listing 3 (page 34) (this code fragment continues from Listing 2 (page 33)).

Listing 3 Initializing a Migration Manager

```
NSArray *bundlesForSourceModel = /* an array of bundles, or nil for the main
bundle */ ;
NSManagedObjectModel *sourceModel =
    [NSManagedObjectModel mergedModelFromBundles:bundlesForSourceModel
                            forStoreMetadata:sourceMetadata];

if (sourceModel == nil) {
    // deal with error
}

MyMigrationManager *migrationManager =
    [[MyMigrationManager alloc]
            initWithSourceModel:sourceModel
            destinationModel:destinationModel];
```

Performing a Migration

You migrate a store using `NSMigrationManager`'s `migrateStoreFromURL:type:options:withMappingModel:toDestinationURL:destinationType:destinationOptions:error:`. To use this method you need to marshal a number of parameters; most are straightforward, the only one that requires some work is the discovery of the appropriate mapping model (which you can retrieve using `NSMappingModel`'s `mappingModelFromBundles:forSourceModel:destinationModel:` method). This is illustrated in Listing 4 (page 34) (a continuation of the example shown in Listing 3 (page 34)).

Listing 4 Performing a Migration

```
NSArray *bundlesForMappingModel = /* an array of bundles, or nil for the main
bundle */ ;
NSError *error = nil;

NSMappingModel *mappingModel =
    [NSMappingModel
            mappingModelFromBundles:bundlesForMappingModel
            forSourceModel:sourceModel
            destinationModel:destinationModel];

if (mappingModel == nil) {
        // deal with the error
}

NSDictionary *sourceStoreOptions = /* options for the source store */ ;
NSURL *destinationStoreURL = /* URL for the destination store */ ;
```

```
NSString *destinationStoreType = /* type for the destination store */ ;
NSDictionary *destinationStoreOptions = /* options for the destination store */
 ;

BOOL ok = [migrationManager migrateStoreFromURL:sourceStoreURL
                  type:sourceStoreType
                  options:sourceStoreOptions
                  withMappingModel:mappingModel
                  toDestinationURL:destinationStoreURL
                  destinationType:destinationStoreType
                  destinationOptions:destinationStoreOptions
                  error:&error];
```

Multiple Passes—Dealing With Large Datasets

The basic approach shown above is to have the migration manager take two models, and then iterate over the steps (mappings) provided in a mapping model to move the data from one side to the next. Because Core Data performs a "three stage" migration—where it creates all of the data first, and then relates the data in a second stage—it must maintain “association tables" (which tell it which object in the destination store is the migrated version of which object in the source store, and vice-versa). Further, because it doesn't have a means to flush the contexts it is working with, it means you'll accumulate many objects in the migration manager as the migration progresses.

In order to address this, the mapping model is given as a parameter of the `migrateStoreFromURL:type:options:withMappingModel:toDestinationURL:destinationType:destinationOptions:error:` call itself. What this means is that if you can segregate parts of your graph (as far as mappings are concerned) and create them in separate mapping models, you could do the following:

1. Get the source and destination data models
2. Create a migration manager with them
3. Find all of your mapping models, and put them into an array (in some defined order, if necessary)
4. Loop through the array, and call `migrateStoreFromURL:type:options:withMappingModel:toDestinationURL:destinationType:destinationOptions:error:` with each of the mappings

This allows you to migrate "chunks" of data at a time, while not pulling in all of the data at once.

From a "tracking/showing progress” point of view, that basically just creates another layer to work from, so you'd be able to determine percentage complete based on number of mapping models to iterate through (and then further on the number of entity mappings in a model you've already gone through).

Document Revision History

This table describes the changes to *Core Data Model Versioning and Data Migration Programming Guide*.

Date	Notes
2010-02-24	Added further details to the section on Mapping Model Objects.
2009-06-04	Added an article to describe the lightweight migration feature.
2009-03-05	First version for iOS.
2008-02-08	Added a note about migrating stores from Mac OS X v10.4 (Tiger).
2007-05-18	New document that describes managed object model versioning and Core Data migration.