High Performance Core Data

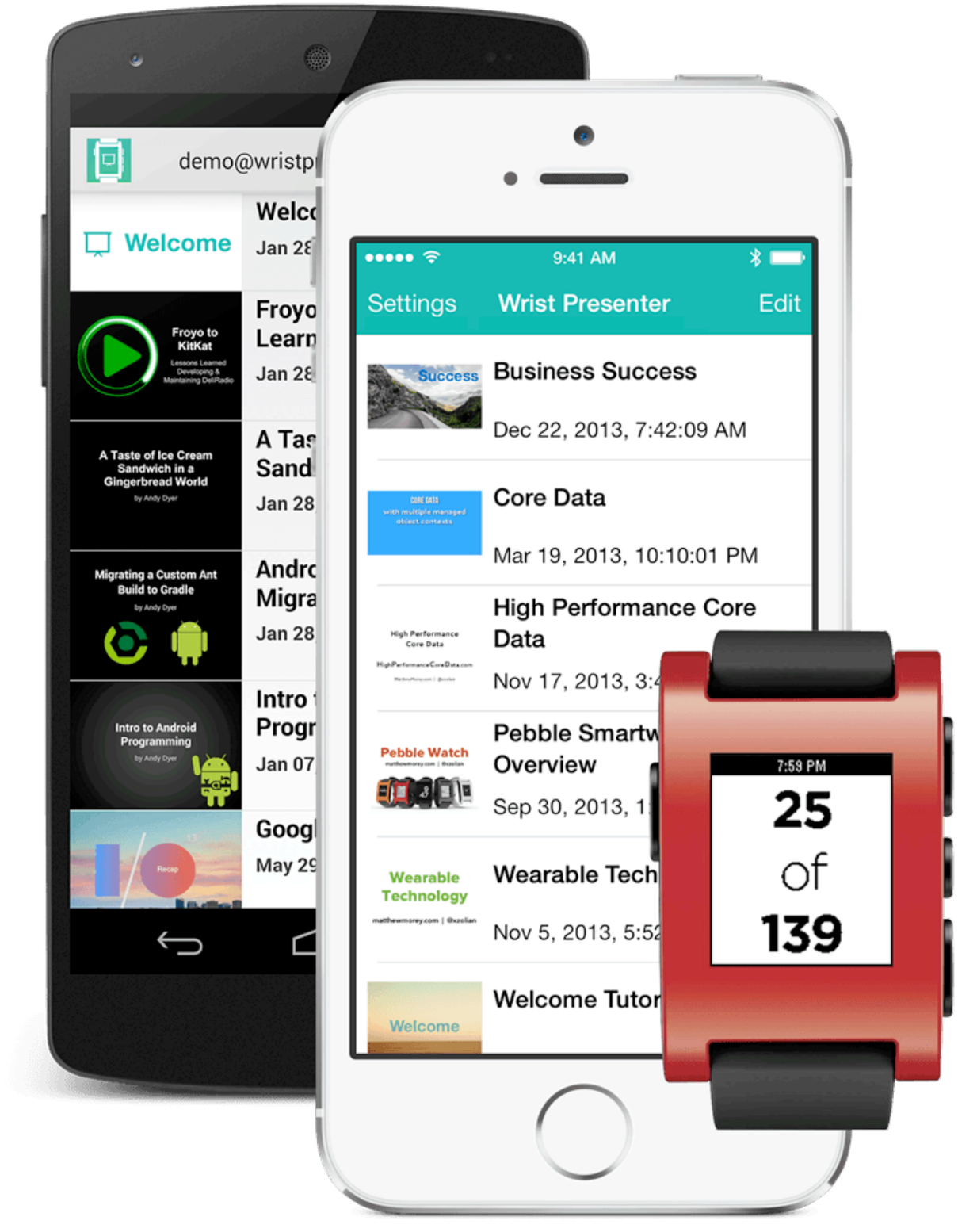
HighPerformanceCoreData.com

MatthewMorey.com | @xzolian

BuoyExplorer.com

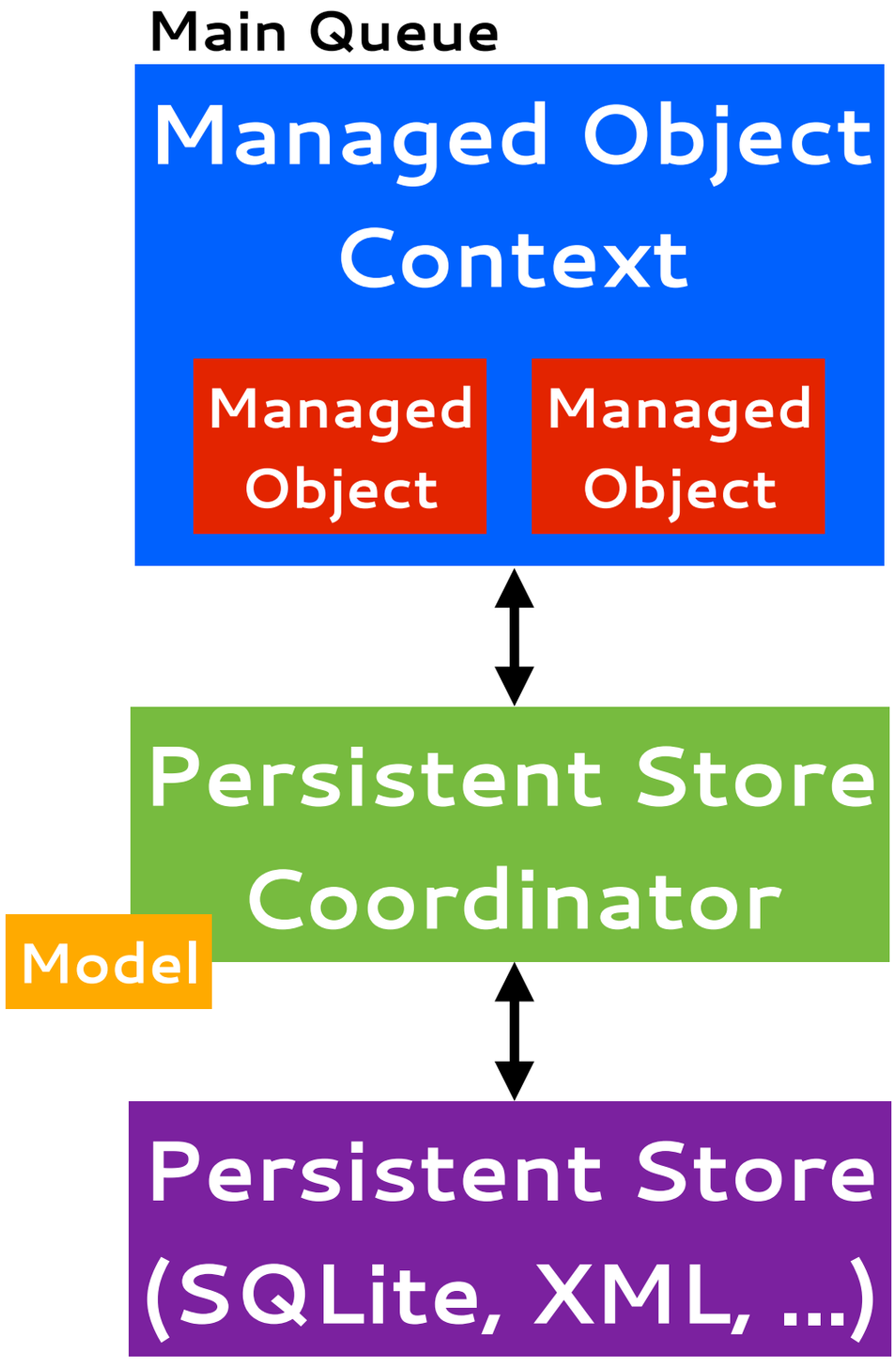
Wrist Presenter

WristPresenter.com

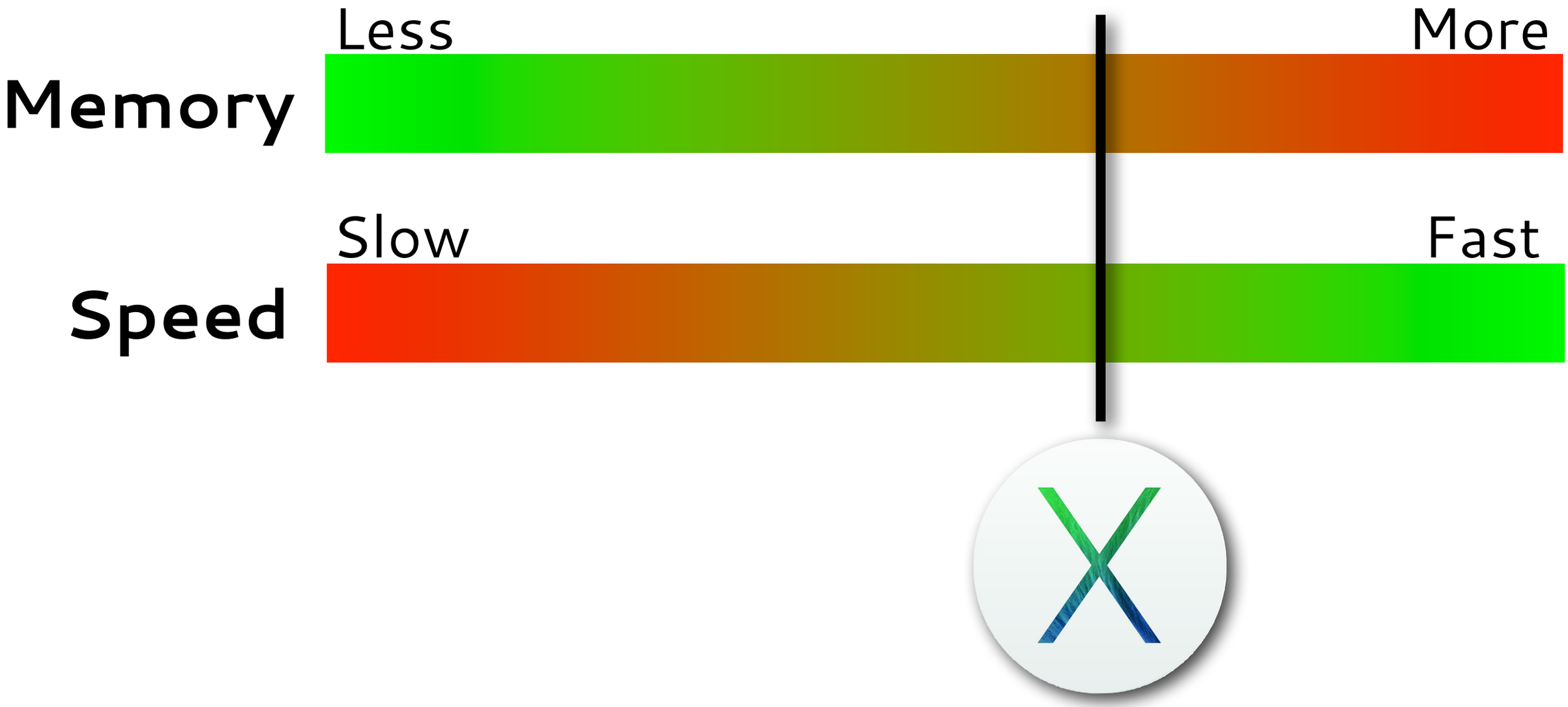


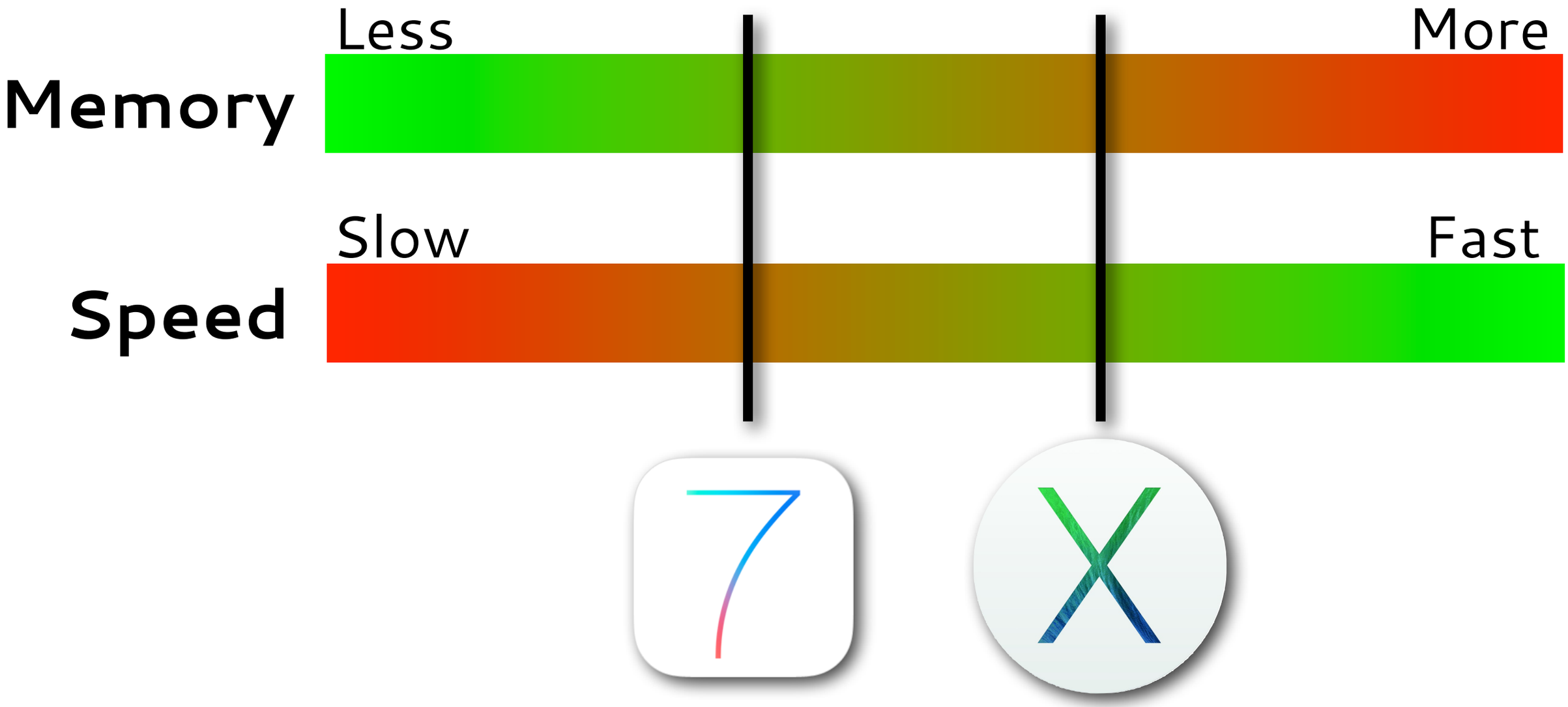
ChaiOne

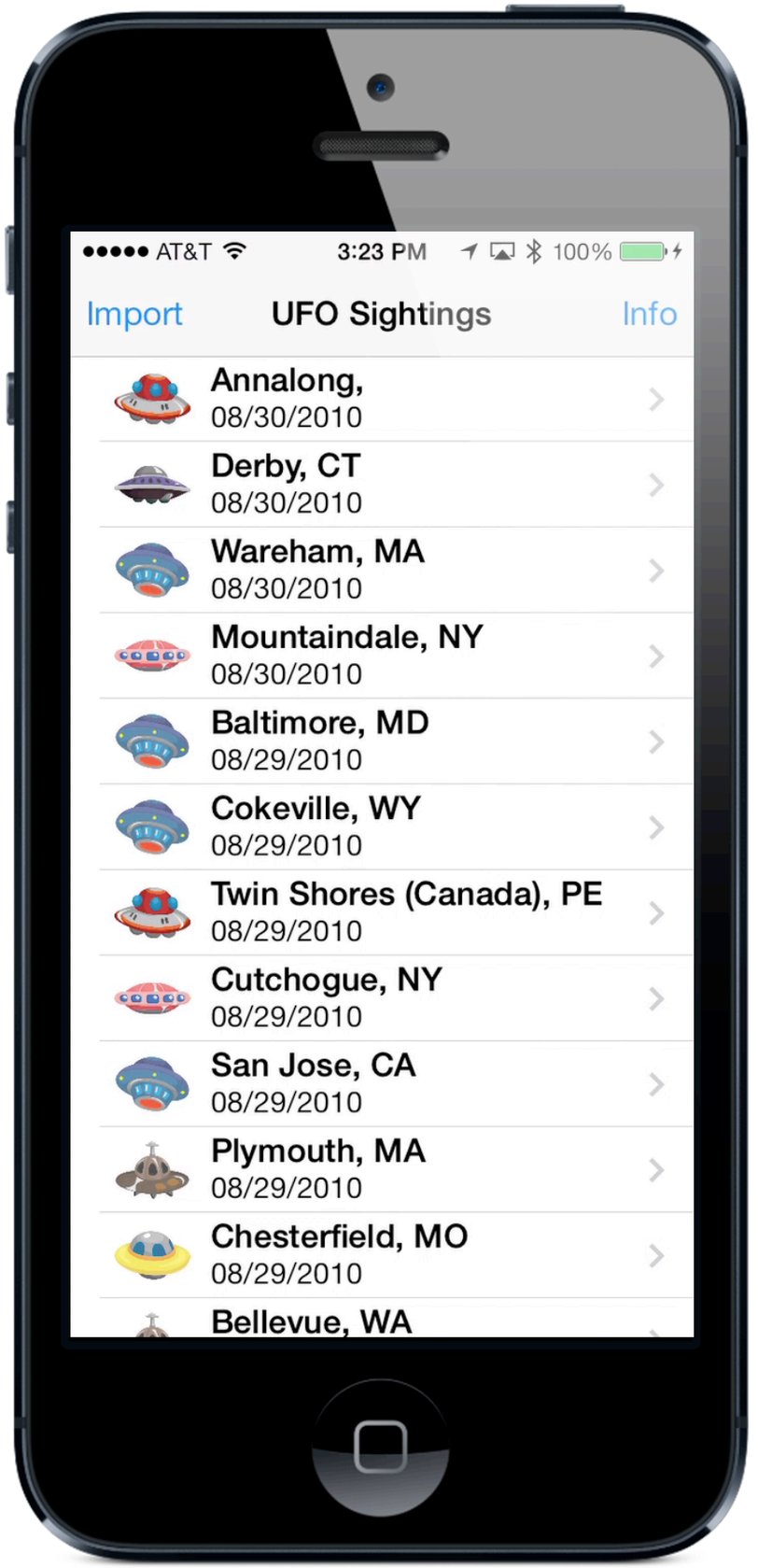
Agenda


Main Queue
Managed Object Context
Managed Object
Managed Object
Persistent Store Coordinator
Model
Persistent Store (SQLite, XML, ...)


Less
More
Memory
Slow
Fast
Speed


Less
More
Memory
Slow
Fast
Speed


Less
More
Memory
Slow
Fast
Speed


●●●●● AT&T
3:23 PM
100%
Import
UFO Sightings
Info
Annalong,
08/30/2010
Derby, CT
08/30/2010
Wareham, MA
08/30/2010
Mountaindale, NY
08/30/2010
Baltimore, MD
08/29/2010
Cokeville, WY
08/29/2010
Twin Shores (Canada), PE
08/29/2010
Cutchogue, NY
08/29/2010
San Jose, CA
08/29/2010
Plymouth, MA
08/29/2010
Chesterfield, MO
08/29/2010
Bellevue, WA

Tools

```
#define TICK NSDate *startTime = [NSDate date]

#define TOCK NSLog(@"Elapsed Time: %f",
                   -[startTime timeIntervalSinceNow])
```

```
#define TICK NSDate *startTime = [NSDate date]

#define TOCK NSLog(@"Elapsed Time: %f",
                   -[startTime timeIntervalSinceNow])
```

```
...


TICK;
[self methodYouWantToMeasure];
TOCK;
```

```
-com.apple.CoreData.SQLDebug [1,2,3]
```

MDMHPCoreData.xcodeproj — MDMUFOViewController.m

iPhone Retina (4-... | Running MDMHPCoreData on iPhone Retina (4-inch) | No Issues

MDMHPCoreData 〉 MDMHPCoreData 〉 controller 〉 MDMUFOViewController.m 〉 @implementation MDMUFOViewController

```
39
40 @implementation MDMUFOViewController
41
42 - (id)initWithStyle:(UITableViewStyle)style {
43
44     self = [super initWithStyle:style];
45     if (self) {
46         // Custom initialization
47     }
48     return self;
49 }
```

/Users/xzolian/xcode/projects/MDMHPCoreData/2/MDMHPCoreData/MDMHPCoreData/

-- VISUAL LINE --

MDMHPCoreData

```
2013-11-02 10:12:43.284 MDMHPCoreData[74586:70b] CoreData: annotation: Connecting to sqlite database file at "/Users/xzolian/Library/Application Support/
iPhone Simulator/7.0.3/Applications/D833E75D-7E6F-46DC-B394-B488C2FA5410/Documents/UFO.sqlite"
2013-11-02 10:12:43.286 MDMHPCoreData[74586:70b] CoreData: sql: pragma journal_mode=wal
2013-11-02 10:12:43.286 MDMHPCoreData[74586:70b] CoreData: sql: pragma cache_size=200
2013-11-02 10:12:43.287 MDMHPCoreData[74586:70b] CoreData: sql: SELECT Z_VERSION, Z_UUID, Z_PLIST FROM Z_METADATA
2013-11-02 10:12:43.297 MDMHPCoreData[74586:70b] CoreData: sql: SELECT 0, t0.Z_PK FROM ZUFOSIGHTING t0 ORDER BY t0.ZSIGHTED DESC
2013-11-02 10:12:49.322 MDMHPCoreData[74586:70b] CoreData: annotation: sql connection fetch time: 6.0256s
2013-11-02 10:12:49.323 MDMHPCoreData[74586:70b] CoreData: annotation: total fetch execution time: 6.0263s for 61392 rows.
2013-11-02 10:12:49.337 MDMHPCoreData[74586:70b] CoreData: sql: SELECT 0, t0.Z_PK, t0.Z_OPT, t0.ZDESC, t0.ZDURATION, t0.ZGUID, t0.ZLOCATION,
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2013-11-02 10:12:49.338 MDMHPCoreData[74586:70b] CoreData: annotation: sql connection fetch time: 0.0009s
2013-11-02 10:12:49.339 MDMHPCoreData[74586:70b] CoreData: annotation: total fetch execution time: 0.0014s for 20 rows.
2013-11-02 10:13:58.993 MDMHPCoreData[74586:70b] CoreData: sql: SELECT 0, t0.Z_PK, t0.Z_OPT, t0.ZDESC, t0.ZDURATION, t0.ZGUID, t0.ZLOCATION,
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2013-11-02 10:16:05.738 MDMHPCoreData[74586:70b] CoreData: annotation: sql connection fetch time: 6.2996s
2013-11-02 10:16:05.739 MDMHPCoreData[74586:70b] CoreData: annotation: total fetch execution time: 6.3003s for 31 rows.
2013-11-02 10:16:05.740 MDMHPCoreData[74586:70b] Elapsed Time: 6.308689
```

All Output

MDMHPCoreData.xcodeproj — MDMUFOViewController.m

iPhone Retina (4-... | Running MDMHPCoreData on iPhone Retina (4-inch) | No Issues

MDMHPCoreData 〉 MDMHPCoreData 〉 controller 〉 MDMUFOViewController.m 〉 @implementation MDMUFOViewController

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/Users/xzolian/xcode/projects/MDMHPCoreData/2/MDMHPCoreData/MDMHPCoreData/

-- VISUAL LINE --

MDMHPCoreData

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All Output

MDMHPCoreData.xcodeproj — MDMUFOViewController.m

iPhone Retina (4-... | Running MDMHPCoreData on iPhone Retina (4-inch) | No Issues

MDMHPCoreData 〉 MDMHPCoreData 〉 controller 〉 MDMUFOViewController.m 〉 @implementation MDMUFOViewController

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2013-11-02 10:16:05.740 MDMHPCoreData[74586:70b] Elapsed Time: 6.308689
```

All Output

-com.apple.CoreData.**SQLDebug** [1,2,3]

-com.apple.CoreData.**SyntaxColoredLogging** 1

-com.apple.CoreData.**MigrationDebug** 1

-com.apple.CoreData.**SQLiteDebugSynchronous** [0,1,2]

-com.apple.CoreData.**SQLiteIntegrityCheck** [1]

-com.apple.CoreData.**ThreadingDebug** [1,2,3]


```
$ sqlite3
```

Documents — bash — 83×28

```
$ sqlite3 UFO.sqlite

sqlite> select * from sqlite_master;

table|ZUFOSIGHTING|ZUFOSIGHTING|3|CREATE TABLE
                ZUFOSIGHTING ( Z_PK...VARCHAR )

table|Z_PRIMARYKEY|Z_PRIMARYKEY|4|CREATE TABLE
                Z_PRIMARYKEY (Z_ENT...INTEGER)

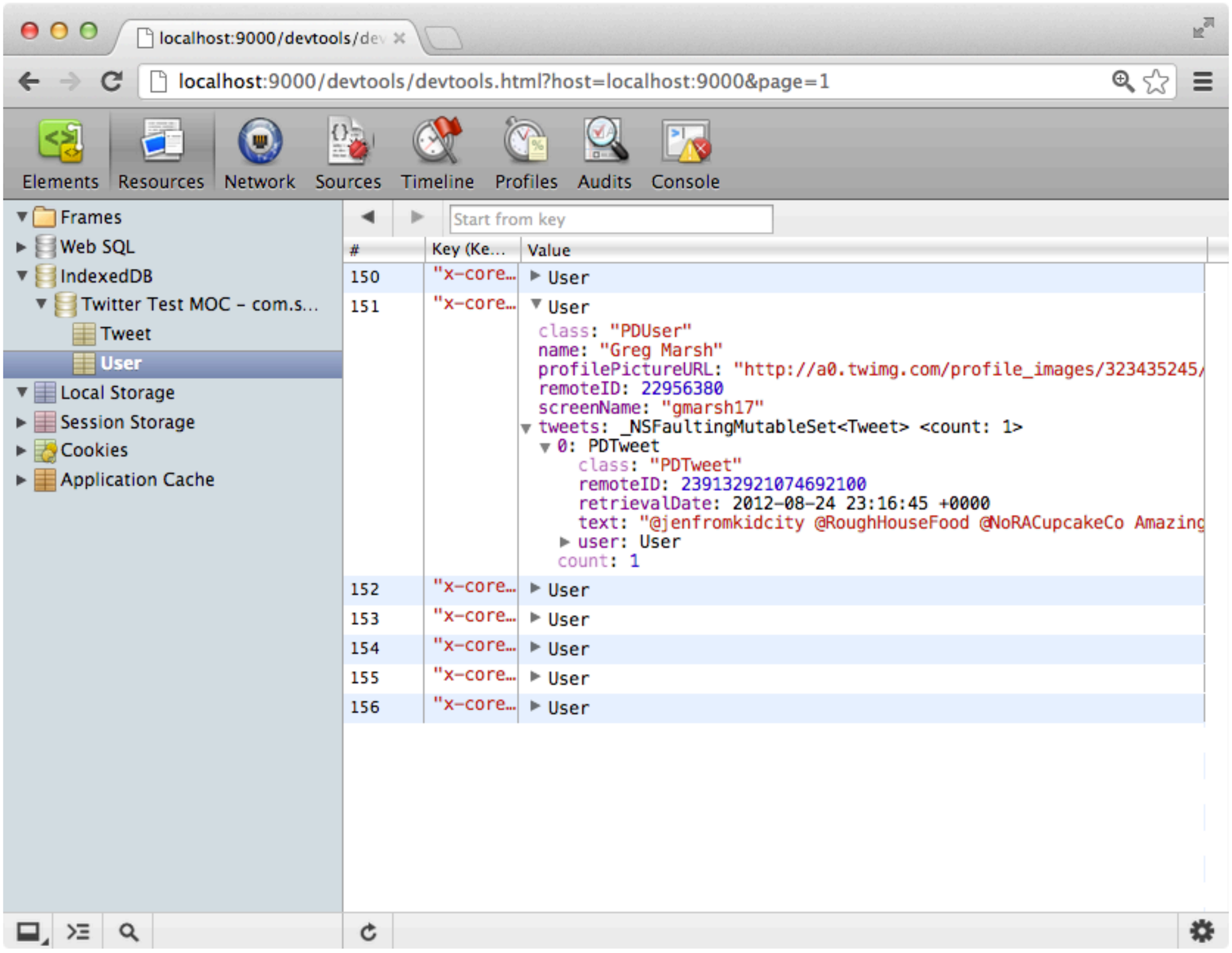
table|Z_METADATA|Z_METADATA|5|CREATE TABLE
                Z_METADATA (Z_VERSION...BLOB)
```

Documents — bash — 83×28

```
sqlite> SELECT t0.ZSHAPE, COUNT( t0.ZSHAPE )
        FROM ZUFOSIGHTING t0 GROUP BY t0.ZSHAPE;

changed|1
changing|1546
chevron|760
cigar|1782
circle|5271
cone|265
...
teardrop|595
triangle|6082
unknown|4490
```

Pony Debugger


localhost:9000/devtools/dev
localhost:9000/devtools/devtools.html?host=localhost:9000&page=1
Elements
Resources
Network
Sources
Timeline
Profiles
Audits
Console
Frames
Web SQL
IndexedDB
Twitter Test MOC - com.s...
Tweet
User
Local Storage
Session Storage
Cookies
Application Cache
Start from key
Key (Ke... Value
150 "x-core... User
151 "x-core... User
class: "PDUser"
name: "Greg Marsh"
profilePictureURL: "http://a0.twimg.com/profile_images/323435245/
remoteID: 22956380
screenName: "gmarsh17"
tweets: _NSFaultingMutableSet<Tweet> <count: 1>
0: PDTweet
class: "PDTweet"
remoteID: 239132921074692100
retrievalDate: 2012-08-24 23:16:45 +0000
text: "@jenfromkidcity @RoughHouseFood @NoRACupcakeCo Amazing
user: User
count: 1
152 "x-core... User
153 "x-core... User
154 "x-core... User
155 "x-core... User
156 "x-core... User

SQLite

Professional

UFO.sqlite — Edited

Execute | Schema | Data | Query | Structure | Export

Filter

Tables

- ZUFOSIGHTING — 61392 Rows
- Z_METADATA — 1 Row
- Z_PRIMARYKEY — 1 Row

Views

ZSIGHTED	ZDESC	ZDURATION	ZGUID	ZLOCATION	ZSHA
5200	Slow mo…	4-1/2minutes	21ec9972-2ff6-401…	Peru, IN	egg
4800	2 lights a…	10 seconds	c206a34b-0d59-48…	Plano, TX	light
5600	seven ob…	15 minutes	237ad81b-851b-43…	Liberty Hill, TX	light
5200	Large Bo…	35 seconds	67bd7dff-89db-469…	Houston, TX	formation
4800	Cluster o…	5 seconds	5d00c036-b9de-46…	Michigan City, IN	triangle
200	STRANGE…		46e183a5-fc0e-4b9…	Crown Point, IN	disk
6400	3 u.f.os…	2 minutes	9cb61158-6b97-4b…	Wabash, IN	light
200	4 bright…	7 seconds	42fb9469-95a0-4de…	Plover, WI	light
400	Stationar…	100 minutes	f8c28c8f-ad13-424…	Albuquerque, NM	unknown
8400	i was dri…	10 minutes	145b7e27-1c2c-4d…	Salt Lake City, UT	unknown
3200	don&apo…	5 min	9ef1e7f7-6318-4fd…	Winamac, IN	light
9600	egg-sha…	three minutes	04798678-cfc7-434…	Acworth, GA	sphere
3200	Object w…	1hr(still occuring)	997678f2-cef5-405…	Costa Mesa, CA	light
4400	Just unde…	ongoing	3a6c737b-10d3-4b…	Oshkosh, WI	fireball
6800	A STRAN…		8530ce0e-606a-45d…	Egypt (I can not tell y…	light
56800	Strange…	about 10 sec	125af3ec-08f3-4f06…	Skarysko-Kamienna (…	triangle
6400	You do r…	all my life	48e02263-ab36-4c…	Yakima, WA	light
4400	Bright cir…	2 minutes	d67cd667-90bd-45…	Hollywood, FL	sphere
000	AN ORA…	15 SECONDS	f3fbe1d1-1eea-44ca…	Wahpeton, ND	light
2800	2 Object…	5 minutes	d8a8ebea-27a5-446…	St. Louis Park, MN	formation
8000	Two brig…	a few minutes	ed02c7ca-bd55-40…	Bronxville, NY	light
800	Triangle…	2-3 minutes	7a415881-27e8-42…	Springfield, MO	triangle
30800	Large (2…	0:02 (Min.)	45c6d396-90f7-41d…	Van Nuys (Los Angel…	triangle
92000	Triangula…	1 hour	41ba31d0-01a1-4b…	Alston, MI	triangle
122800	9/17/19…	4-5 seconds	3d472f27-eac7-4c4…	Long Beach (Termina…	other
4800	Bright fla…	2 sseconds	f0044beb-dd9e-401…	San Diego, CA	flash
96800	I knew w…	over several days	063fc682-8504-490…	Dayton, OH	other
1600	White ov…	15 seconds	23fbcc30-d165-49f…	Tampa, FL	oval
400	((NUFOR…		626f4df2-d8ad-4f8f…	Soldatna, AK	disk
0000	Chevron…	3-4 seconds	fad1d542-a63b-4b7…	Las Vegas, NV	chevron
5600	Repeated…	10-15 mts	29457f31-7aa4-4fc…	South Bend, IN	rectangle
84400	i saw a s…	visiting	37f5096c-bda7-422…	Two Egg Mariana, FL	circle
8800	having ju…	2 seconds	1b3c3eb5-e331-4e7…	Seattle (Belmont &a…	other

+ | Edit | 61392 records. 0.491 seconds. | Filter

UFO.sqlite — Edited

Execute | Schema | Data | Query | Structure | Export

Filter

Tables

- ZUFOSIGHTING 61392 Rows
- Z_METADATA 1 Row
- Z_PRIMARYKEY 1 Row

Views

```
1 SELECT t0.ZSHAPE, COUNT( t0.ZSHAPE) FROM ZUFOSIGHTING t0 GROUP BY  t0.ZSHAPE
```

ZSHAPE	COUNT(t0.ZSHAPE)
fireball	3452
flare	1
flash	990
formation	1788
hexagon	1
light	12202
other	4593
oval	2869
pyramid	1
rectangle	966
round	2
sphere	3637
teardrop	595
triangle	6082

31 records. 0.139 seconds.

Core Data Editor Version 5

Untitled — Edited

Configuration | CSV Import | Generate Code

ENTITIES

UFO Sighting 61392

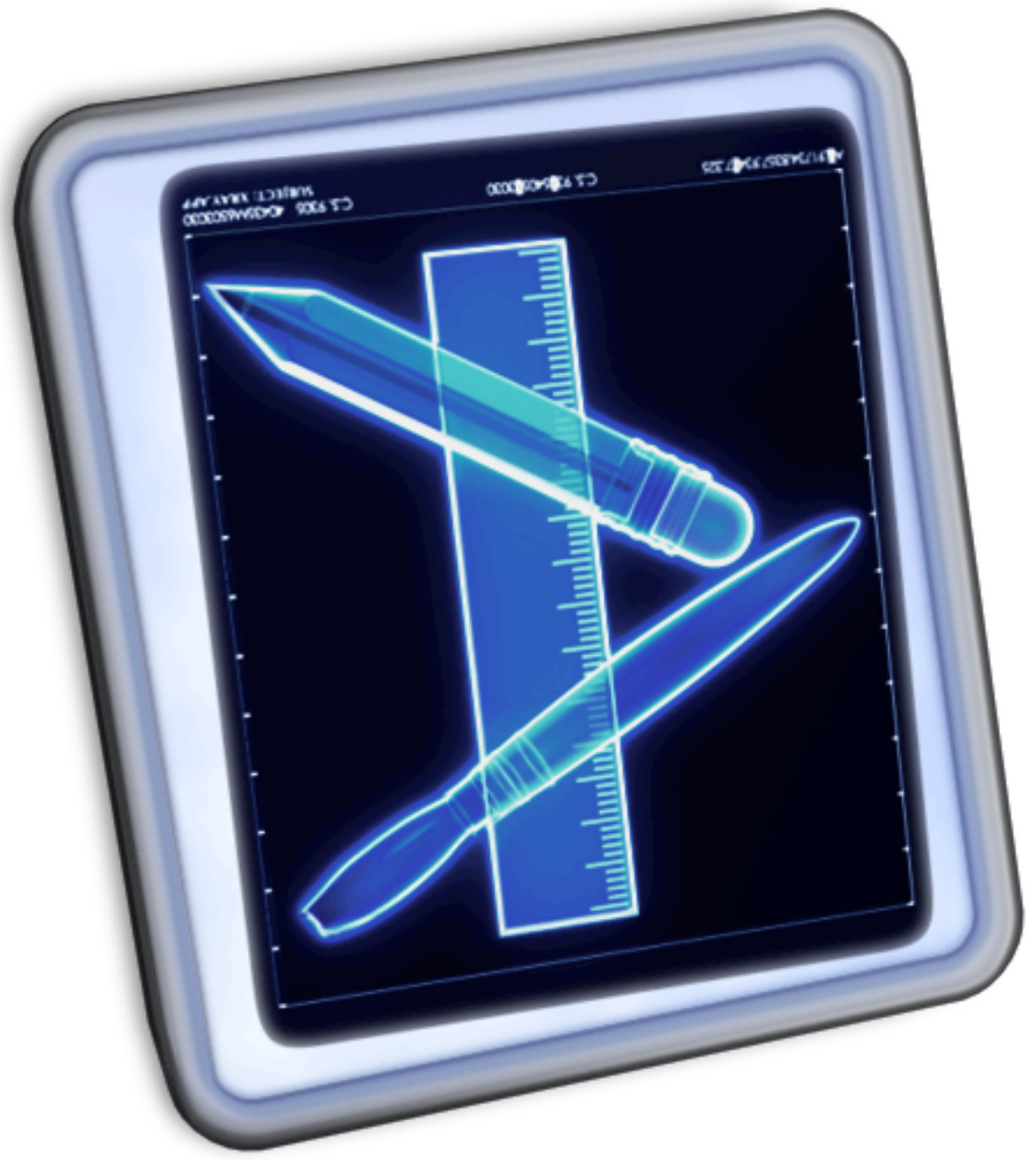
Object ID	Desc	Duration	Guid	Location	Reported	Shape	Sighted
p1	Siting of a...	5 minutes	c49497c8...	Wimberley...	4/8/04, 1...	triangle	2/25/90, 1...
p2	3:00am h...	5minutes	f3006465...	Knox, IN	12/23/05...	triangle	12/18/05,...
p3	I'm...	20 sec	0f72719e...	St-Louis d...	11/26/01...	light	11/18/01,...
p4	White fire...	45 seconds	4f1a8ec9...	Cerrillos, TN	10/10/06...	changing	10/1/06, 1...
p5	Likely exp...		d41a6a72...	Lake Wale...	2/14/05,...		1/24/05, 1...
p6	Possible U...	1-2 Min	04168c50...	Fayettevill...	1/14/09,...	light	9/30/08, 1...
p7	We were a...	2 to 3 min.	65df1341...	Camden P...	8/12/02,...	unknown	8/10/02, 1...
p8	Strange n...	About 7...	79fe5386...	Jesup, GA	5/18/10,...	unknown	5/17/10, 1...
p9	I observed...	10 minutes	5de42d76...	Westchest...	1/16/00,...	triangle	1/11/00, 1...
p10	Stationary...	over an hour	334c1250...	State Coll...	5/9/10, 1...	flash	5/9/10, 12...
p11	Multicolor...	2 or more...	9a858a1a...	Allentown...	10/9/06,...	sphere	10/9/06, 1...
p12	My girlfrie...	10 seconds	4f0debd7...	Basom, NY	7/7/05, 1...	fireball	3/12/05, 1...
p13	Pink anom...	10 minutes	54d58bbc...	Rolla, MO	10/28/01...	light	10/28/01,...
p14	TheFull*M...	5-6 seconds	6d0ff5e3-...	Portland (...	6/19/00,...	unknown	6/16/00, 1...

+ −

RELATIONSHIPS

No Validation Errors

No Selection



Instruments

Record | Target: MDMHPCoreData | Inspection Range | 00:00:16, Run 2 of 2 | View | Library | Filter: Recorded Data

Instruments

00:02 00:03 00:04 00:05 00:06 00:07 00:08 00:09 00:10 00:11 00:12

Core Data Fetches
Fetch count
Fetch duration

Core Data Cache...
RCM duration
CM duration

Core Data Saves
Save duration

Core Data Fetches > Event List > Core Data Fetches

Call Tree
- Separate by Thread
- Invert Call Tree
- Hide Missing Symbols
- Hide System Libraries
- Show Obj-C Only
- Flatten Recursion

Call Tree Constraints

Specific Data Mining

#	Caller	Fetch entity	Fetch count	Fetch duration
0	-[NSManagedObjectContext exe...	UFOSighting		
1	-[NSManagedObjectContext exe...		61392	413923
2	-[NSManagedObjectContext exe...	UFOSighting		
3	-[NSManagedObjectContext exe...		20	1126
4	-[NSManagedObjectContext exe...	UFOSighting		
5	-[NSManagedObjectContext exe...		20	849
6	-[NSManagedObjectContext exe...	UFOSighting		
7	-[NSManagedObjectContext exe...		20	682
8	-[NSManagedObjectContext exe...	UFOSighting		
9	-[NSManagedObjectContext exe...		20	840
10	-[NSManagedObjectContext exe...	UFOSighting		
11	-[NSManagedObjectContext exe...		20	707
12	-[NSManagedObjectContext exe...	UFOSighting		
13	-[NSManagedObjectContext exe...		20	730

Tools

- Macros
- Launch Arguments
- SQL
- Instruments
- Measure, Measure, Measure

Fetching

MDMHPCoreData.xcodeproj — MDMUFOListViewController.m

iPhone Retina (4-...

Finished running MDMHPCoreData on iPhone Retina (4-inch) No Issues

MDMHPCoreData › MDMHPCoreData › controller › MDMUFOListViewController.m › -setupTableDataSource

No Debug Session

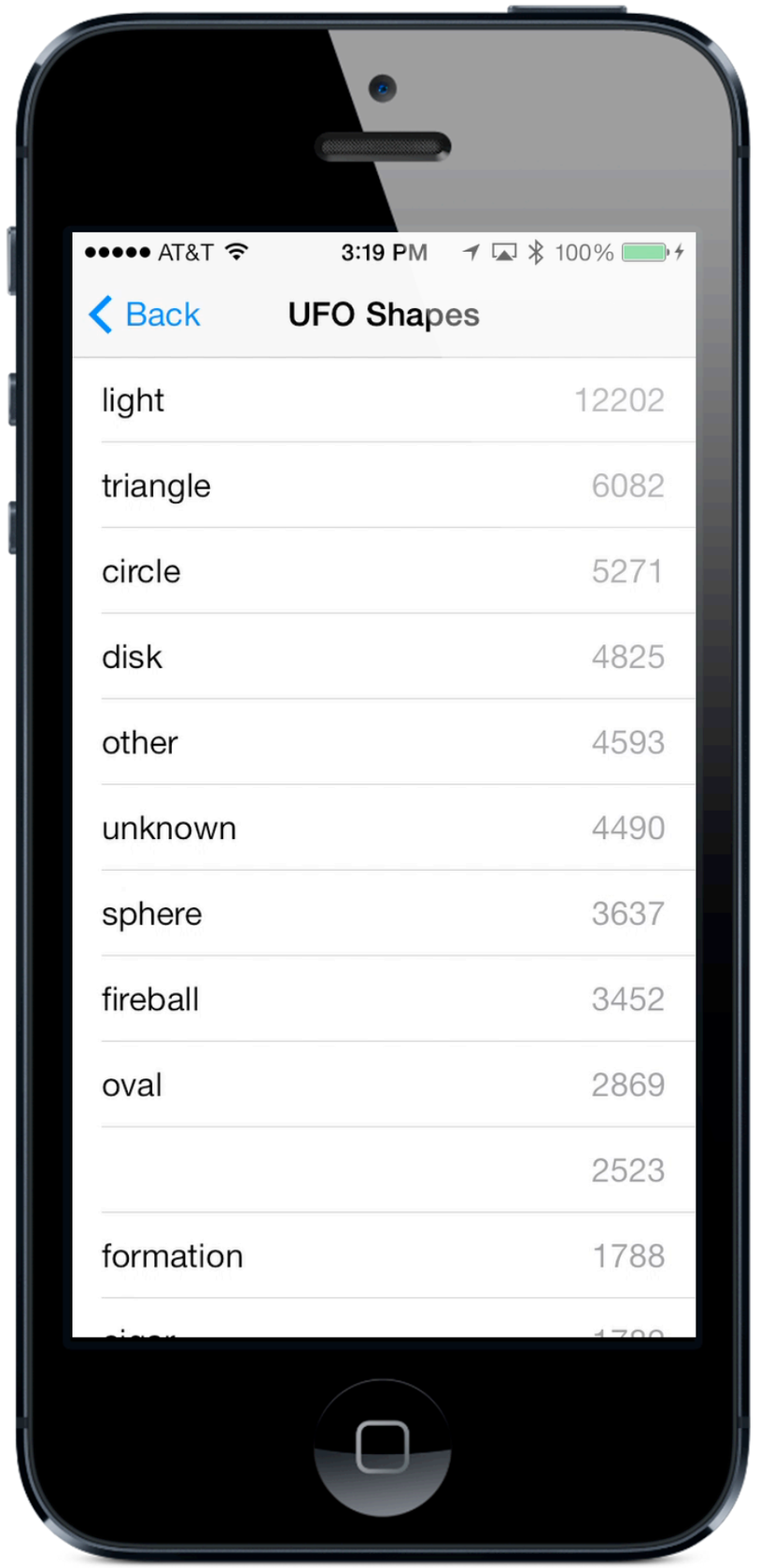
```
75  - (void)setupTableDataSource {
76
77      NSAssert(self.managedObjectContext, @"Forgot to set managed
78      NSFetchRequest *fetchRequest = [NSFetchRequest fetchRequestW
79      [fetchRequest setSortDescriptors:@[[NSSortDescriptor sortDes
80
81
82
83      NSFetchedResultsController *fetchedResultsController = [[NSF
84
85
86
87
88      self.dataSource = [[MDMFetchedResultsTableDataSource alloc]
89
90      __typeof(self) __weak weakSelf = self;
91      self.dataSource.configureCellBlock = ^(MDMUFOSightingCell *c
92          [weakSelf configureCell:cell withUFOSighting:sighting];
93      };
94
95      self.tableView.dataSource = self.dataSource;
96      [self.tableView reloadData];
97  }
98
99  - (void)configureCell:(MDMUFOSightingCell *)cell withUFOSighting
```

/Users/xzolian/xcode/projects/MDMHPCoreData/2/MDMHPCoreData/

-- INSERT --

```
NSFetchRequest *fetchRequest =
    [NSFetchRequest fetchRequestWithEntityName:@"UFOSighting"];
[fetchRequest setFetchBatchSize:20];
```

```
74
75  - (void)setupTableDataSource {
76
77      NSAssert(self.managedObjectContext, @"Forgot to set managed
78      NSFetchRequest *fetchRequest = [NSFetchRequest fetchRequestW
79      [fetchRequest setSortDescriptors:@[[NSSortDescriptor sortDes
80
81
82
83      NSFetchedResultsController *fetchedResultsController = [[NSF
84
85
86
87
88      self.dataSource = [[MDMFetchedResultsTableDataSource alloc]
89
90      __typeof(self) __weak weakSelf = self;
91      self.dataSource.configureCellBlock = ^(MDMUFOSightingCell *c
92          [weakSelf configureCell:cell withUFOSighting:sighting];
93      };
94
95      self.tableView.dataSource = self.dataSource;
96      [self.tableView reloadData];
97  }
98
```


●●●●● AT&T
3:19 PM
100%
Back
UFO Shapes
light 12202
triangle 6082
circle 5271
disk 4825
other 4593
unknown 4490
sphere 3637
fireball 3452
oval 2869
2523
formation 1788

NSManagedObject

```
NSFetchRequest *fetchRequest =
  [NSFetchRequest fetchRequestWithEntityName:@"UFOSighting"];

NSArray *UFOSightingsArray =
  [self.managedObjectContext executeFetchRequest:fetchRequest
                                           error:NULL];
```

```
NSMutableDictionary *uniqueShapesDictionary =
  [NSMutableDictionary dictionary];

for (UFOSighting *sighting in UFOSightingsArray) {
    ...
    // Count unique shape items
    ...
}
```

NSDictionaryResultType

```
NSFetchRequest *fetchRequest =
  [NSFetchRequest fetchRequestWithEntityName:@"UFOSighting"];
[fetchRequest setResultType:NSDictionaryResultType];
[fetchRequest setPropertiesToFetch:@"shape"];
```

NSExpression

```
NSFetchRequest *fetchRequest =
  [NSFetchRequest fetchRequestWithEntityName:@"UFOSighting"];

NSExpressionDescription *expressionDescription =
  [[NSExpressionDescription alloc] init];

[expressionDescription setName:@"count"];
[expressionDescription setExpression:
  [NSExpression expressionForFunction:@"count:" arguments:
    @[[NSExpression expressionForKeyPath:@"shape"]]]];

[fetchRequest setPropertiesToFetch:@[@"shape", expressionDescription]];
[fetchRequest setPropertiesToGroupBy:@[@"shape"]];
[fetchRequest setResultType:NSDictionaryResultType];
```

Function	Parameter	Returns	Availability
`average:`	An `NSArray` object containing `NSExpression` objects representing numbers	An `NSNumber` object (the average of values in the array)	OS X v10.4 and later
`sum:`	An `NSArray` object containing `NSExpression` objects representing numbers	An `NSNumber` object (the sum of values in the array)	OS X v10.4 and later
`count:`	An `NSArray` object containing `NSExpression` objects representing numbers	An `NSNumber` object (the number of elements in the array)	OS X v10.4 and later
`min:`	An `NSArray` object containing `NSExpression` objects representing numbers	An `NSNumber` object (the minimum of the values in the array)	OS X v10.4 and later
`max:`	An `NSArray` object containing `NSExpression` objects representing numbers	An `NSNumber` object (the maximum of the values in the array)	OS X v10.4 and later
`median:`	An `NSArray` object containing `NSExpression` objects representing numbers	An `NSNumber` object (the median of the values in the array)	OS X v10.5 and later
`mode:`	An `NSArray` object containing `NSExpression` objects representing numbers	An `NSArray` object (the mode of the values in the array)	OS X v10.5 and later
	An `NSArray` object		

Prefetch Required Relationships

```
[fetchRequest
    setRelationshipKeyPathsForPrefetching:
        @[@"photo"]];
```

Fetch in the background

```
[backgroundContext performBlock:^{

    NSFetchRequest *fetchRequest = [NSFetchRequest
                                    fetchRequestWithEntityName:@"UFOSighting"];
    fetchRequest.resultType = NSManagedObjectIDResultType;

    NSArray *managedObjectIDs = [backgroundContext
                                 executeFetchRequest:fetchRequest
                                               error:nil];

    [mainQueueContext performBlock:^{

        for (NSManagedObjectID *managedObjectID in managedObjectIDs) {
            UFOSighting *UFOSighting = [mainQueueContext
                                        objectWithID:managedObjectID];
            //
            // Update UI on main queue
            //
        }
    }];

}];
```

```
[backgroundContext performBlock:^{

    NSFetchRequest *fetchRequest = [NSFetchRequest
                                    fetchRequestWithEntityName:@"UFOSighting"];
    fetchRequest.resultType = NSManagedObjectIDResultType;

    NSArray *managedObjectIDs = [backgroundContext
                                 executeFetchRequest:fetchRequest
                                               error:nil];

    [mainQueueContext performBlock:^{

        for (NSManagedObjectID *managedObjectID in managedObjectIDs) {
            UFOSighting *UFOSighting = [mainQueueContext
                                        objectWithID:managedObjectID];
            //
            // Update UI on main queue
            //
        }
    }];

}];
```

```objc
[backgroundContext performBlock:^{

    NSFetchRequest *fetchRequest = [NSFetchRequest
                                    fetchRequestWithEntityName:@"UFOSighting"];
    fetchRequest.resultType = NSManagedObjectIDResultType;

    NSArray *managedObjectIDs = [backgroundContext
                                 executeFetchRequest:fetchRequest
                                               error:nil];

    [mainQueueContext performBlock:^{

        for (NSManagedObjectID *managedObjectID in managedObjectIDs) {
            UFOSighting *UFOSighting = [mainQueueContext
                                        objectWithID:managedObjectID];
            //
            // Update UI on main queue
            //
        }
    }];

}];
```

```
[backgroundContext performBlock:^{

    NSFetchRequest *fetchRequest = [NSFetchRequest
                                    fetchRequestWithEntityName:@"UFOSighting"];
    fetchRequest.resultType = NSManagedObjectIDResultType;

    NSArray *managedObjectIDs = [backgroundContext
                                 executeFetchRequest:fetchRequest
                                               error:nil];

    [mainQueueContext performBlock:^{

        for (NSManagedObjectID *managedObjectID in managedObjectIDs) {
            UFOSighting *UFOSighting = [mainQueueContext
                                        objectWithID:managedObjectID];
            //
            // Update UI on main queue
            //
        }
    }];

}];
```

Fetching

- Don’t fetch more than you need
- Set a batch size
- Let SQLite do the calculations
- Prefetch required relationships
- Fetch in the background

Predicates

Light Comparisons First

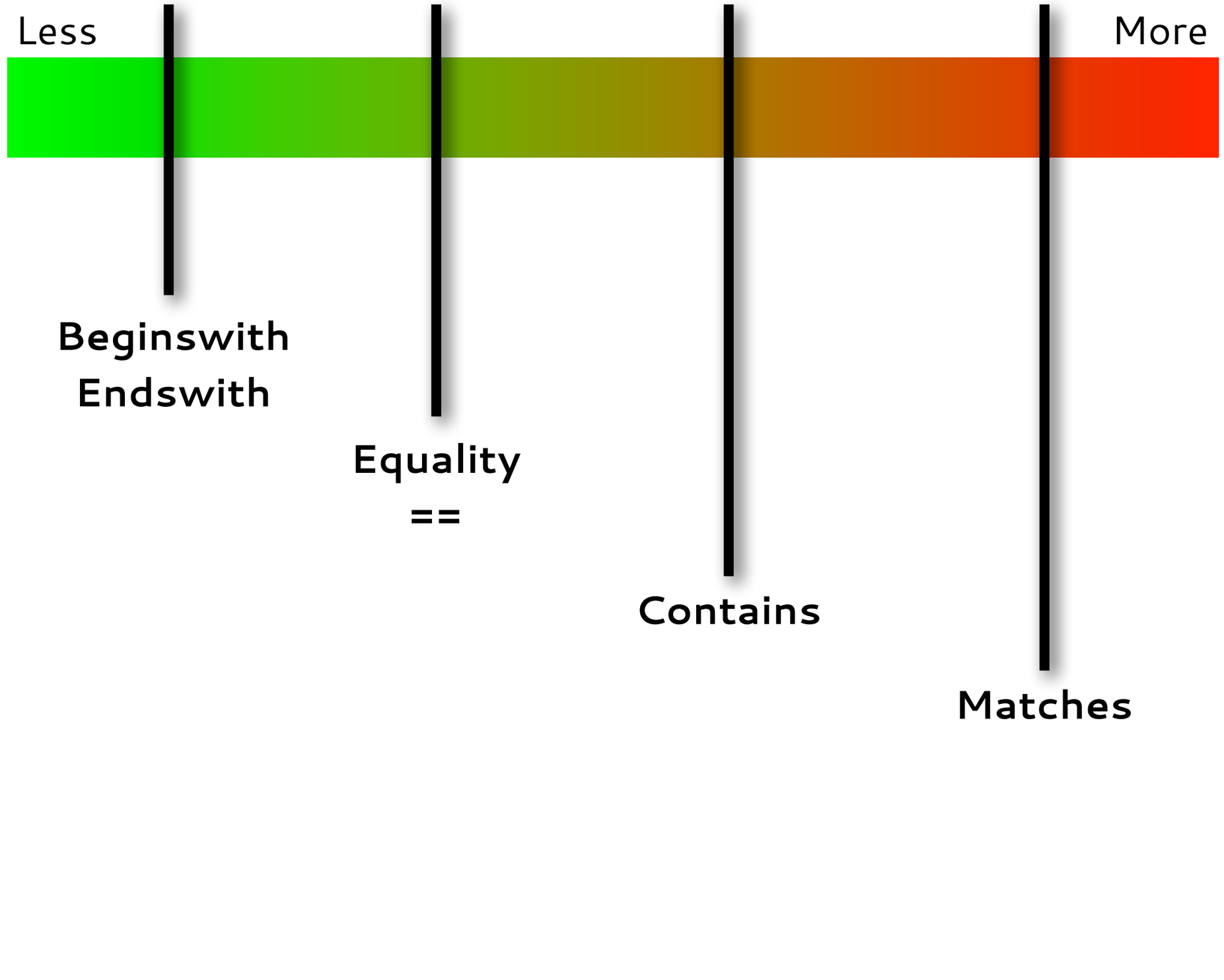
```
[fetchRequest setPredicate:
    [NSPredicate predicateWithFormat:
        @"shape == %@ AND duration > %i", @"sphere", 30]];
```

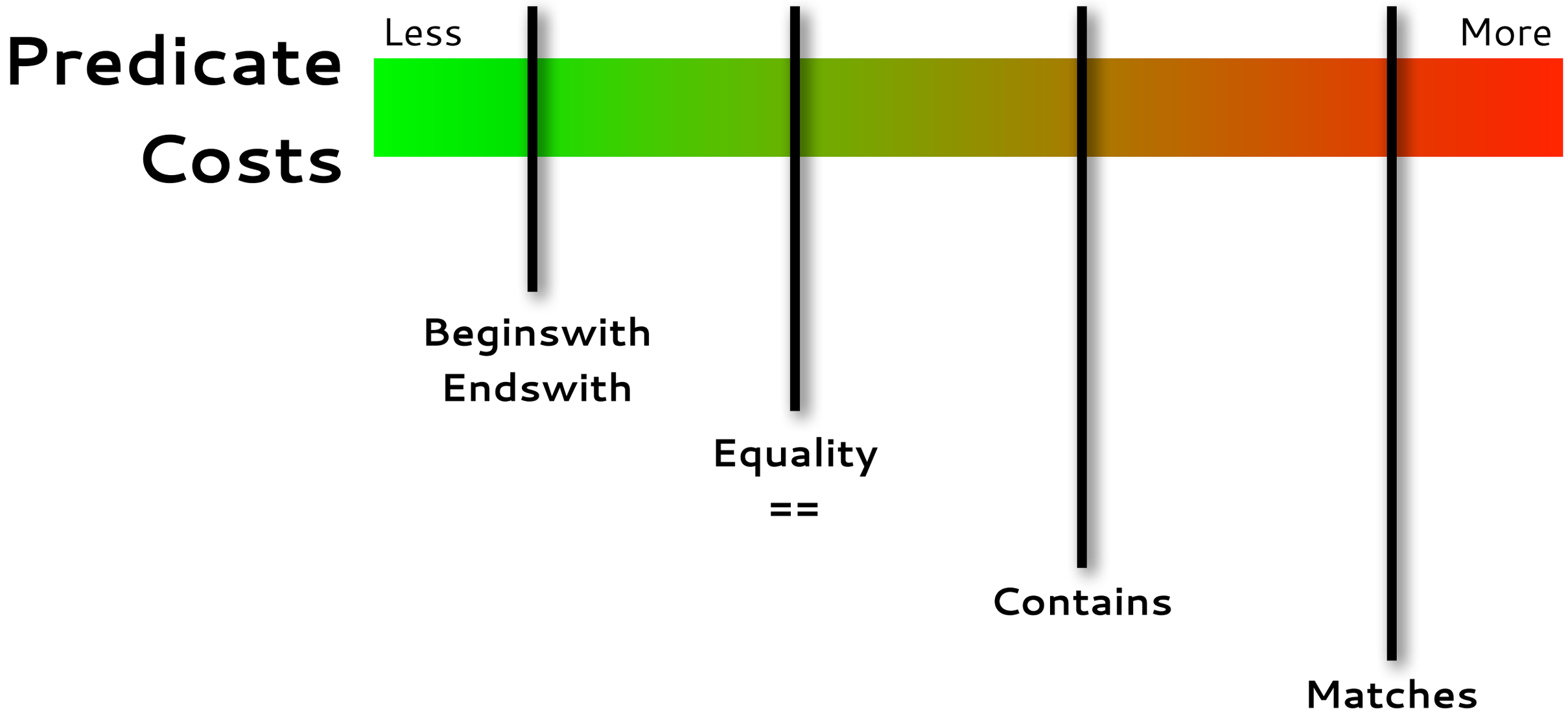
```
[fetchRequest setPredicate:
    [NSPredicate predicateWithFormat:
        @"shape == %@ AND duration > %i", @"sphere", 30]];
```

```
[fetchRequest setPredicate:
    [NSPredicate predicateWithFormat:
        @"duration > %i AND shape == %@", 30, @"sphere"]];
```

Be cautious with strings

Predicate Costs





[cd] cost you even more

Predicates

- Do light (numerical) comparisons first
- Beginswith/Endswith instead of Contains/Matches
- Don’t use [cd]

Searching

Canonicalize String Properties

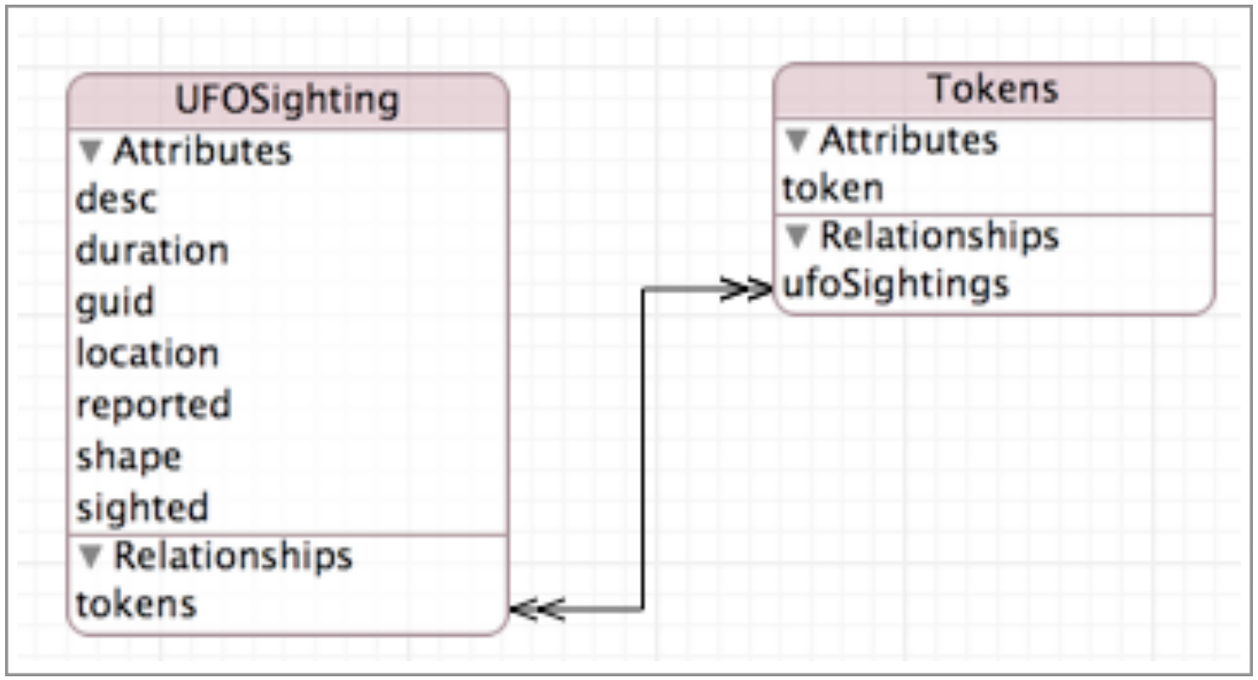
Canonicalize String Properties

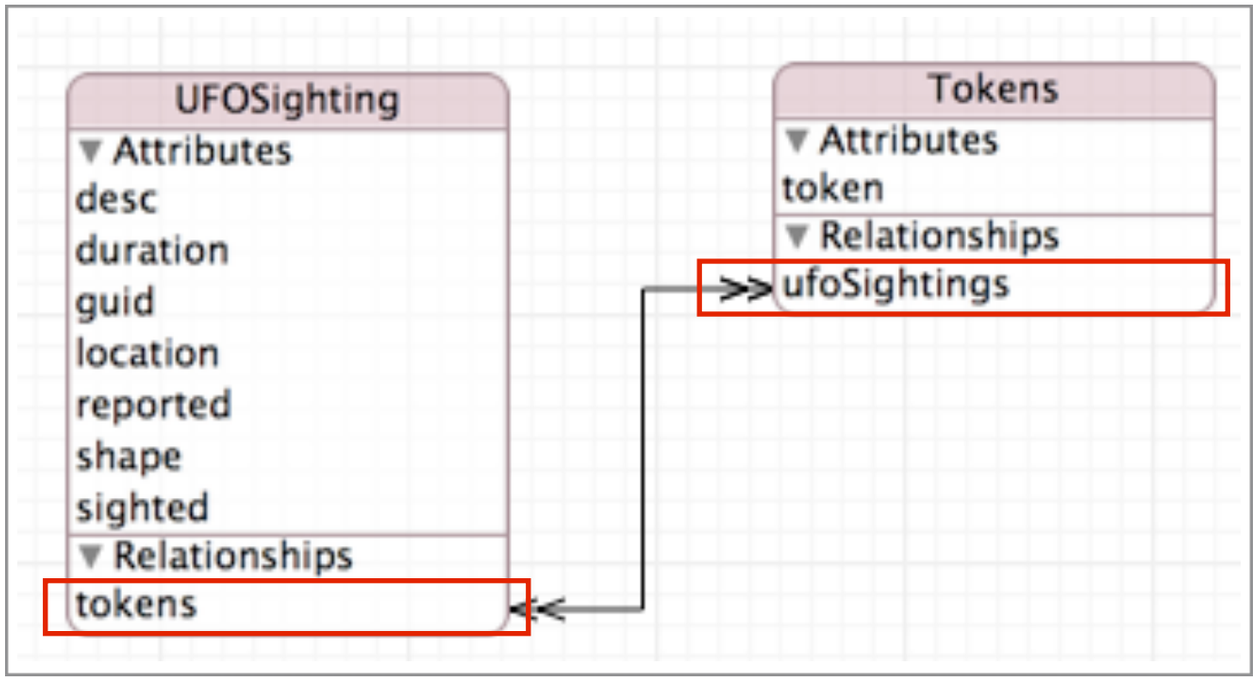
Description	canonicalizedDesc
Green Mën	green men
BEAM	beam
Próbë	probe
ABDUCTION	abduction

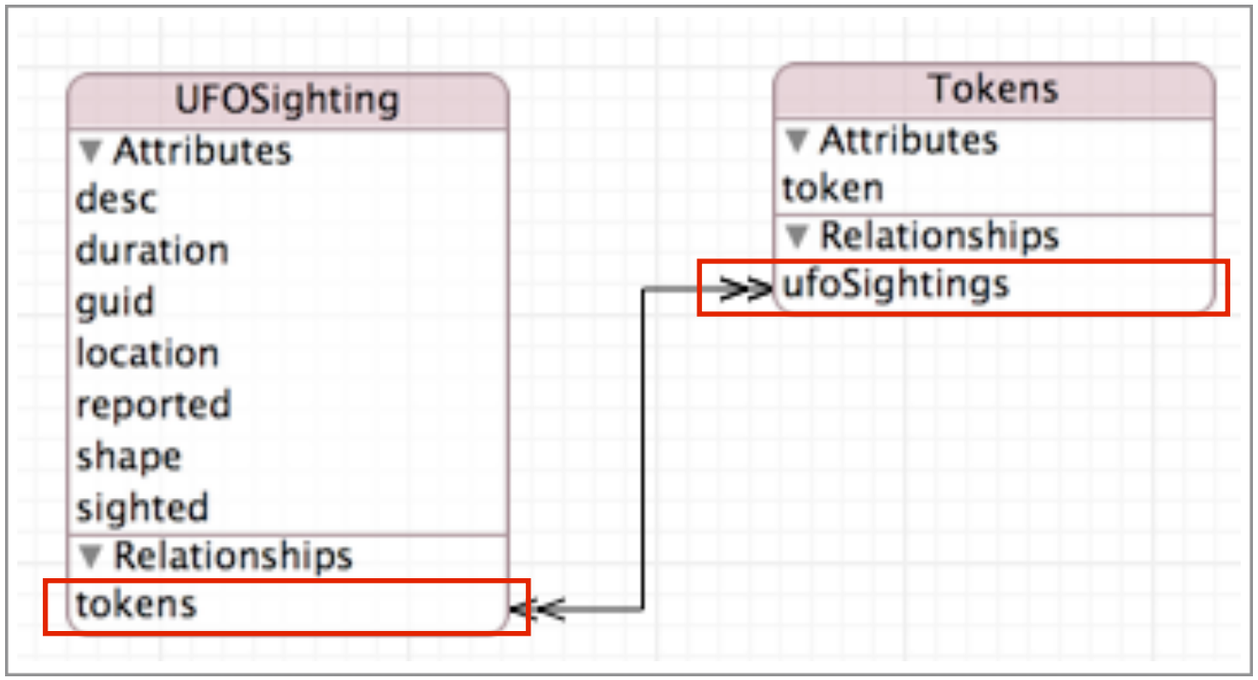
```objc
- (void)setDesc:(NSString *)desc {

    if (_desc != desc) {
        _desc = desc;
        [self updateCanonicalizedDesc:desc];
    }
}

- (void)updateCanonicalizedDesc:(NSString *)desc {

    NSMutableString *result = [NSMutableString stringWithString:desc];

    CFStringNormalize((CFMutableStringRef)result,
                                        kCFStringNormalizationFormD);
    CFStringFold((CFMutableStringRef)result,
                                        kCFCompareCaseInsensitive |
                                        kCFCompareDiacriticInsensitive |
                                        kCFCompareWidthInsensitive, NULL);

    self.canonicalizedDesc = [NSString stringWithString:result];
}
```

```
- (void)setDesc:(NSString *)desc {

    if (_desc != desc) {
        _desc = desc;
        [self updateCanonicalizedDesc:desc];
    }
}

- (void)updateCanonicalizedDesc:(NSString *)desc {
    NSMutableString *result = [NSMutableString stringWithString:desc];

    CFStringNormalize((CFMutableStringRef)result,
                                        kCFStringNormalizationFormD);
    CFStringFold((CFMutableStringRef)result,
                                        kCFCompareCaseInsensitive |
                                        kCFCompareDiacriticInsensitive |
                                        kCFCompareWidthInsensitive, NULL);

    self.canonicalizedDesc = [NSString stringWithString:result];
}
```

Canonicalized Tokens

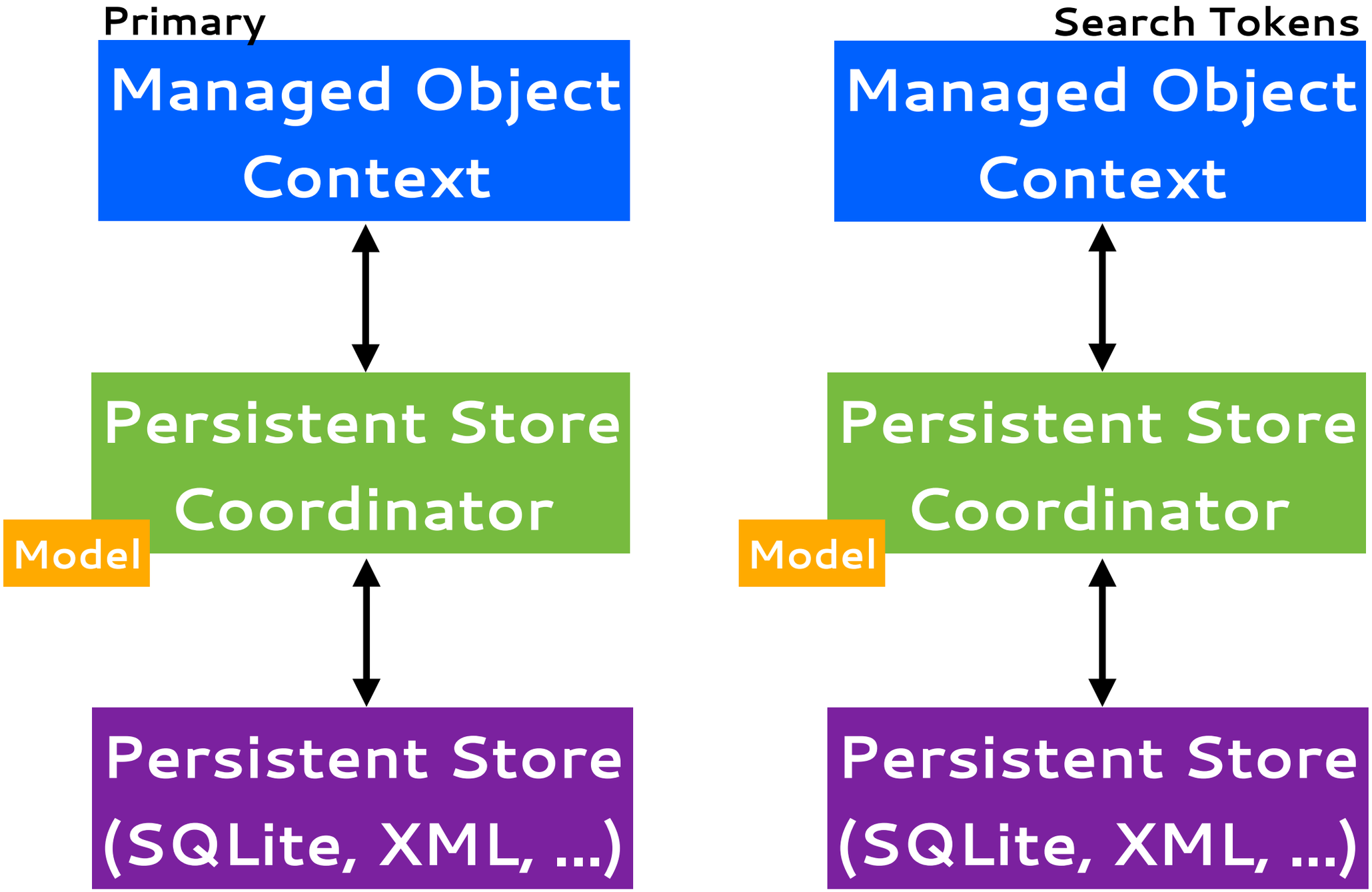

UFOSighting
Attributes
desc
duration
guid
location
reported
shape
sighted
Relationships
tokens
Tokens
Attributes
token
Relationships
ufoSightings

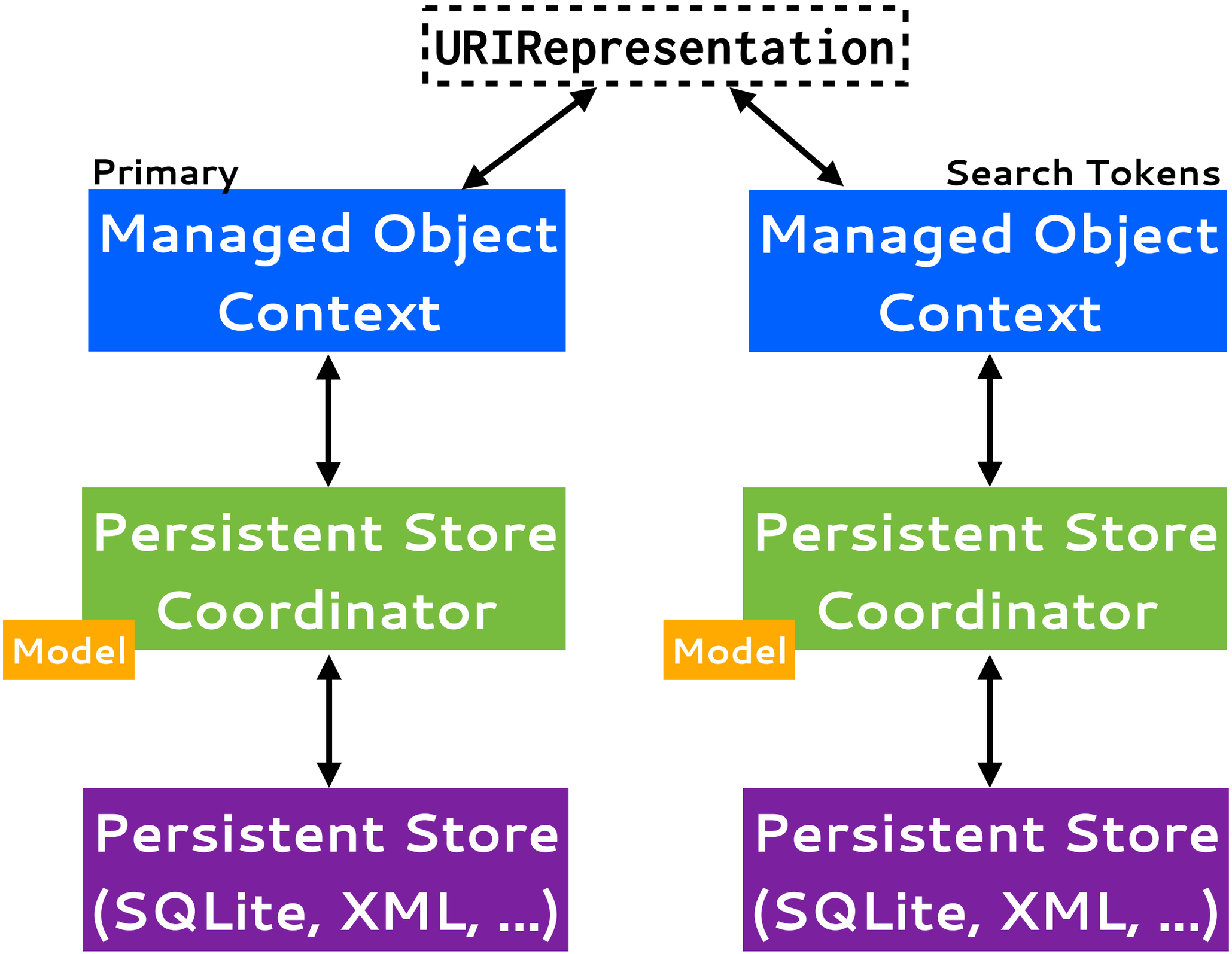

UFOSighting
Attributes
desc
duration
guid
location
reported
shape
sighted
Relationships
tokens
Tokens
Attributes
token
Relationships
ufoSightings



componentsSeperatedByCharactersInSet

Separate Stack


Primary
Managed Object Context
Persistent Store Coordinator
Model
Persistent Store (SQLite, XML, ...)
Search Tokens
Managed Object Context
Persistent Store Coordinator
Model
Persistent Store (SQLite, XML, ...)


URIRepresentation
Primary
Search Tokens
Managed Object Context
Managed Object Context
Persistent Store Coordinator
Persistent Store Coordinator
Model
Model
Persistent Store (SQLite, XML, ...)
Persistent Store (SQLite, XML, ...)

Hash of Tokens

Searching

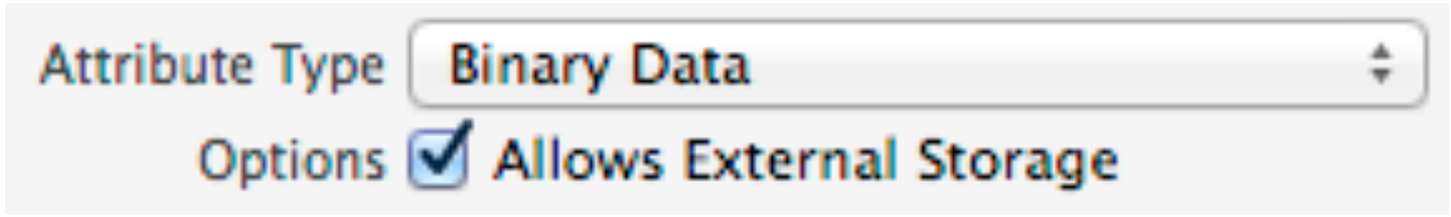
- Canonicalize text properties
- Use tokens
- Separate persistence stack
- Hash of tokens

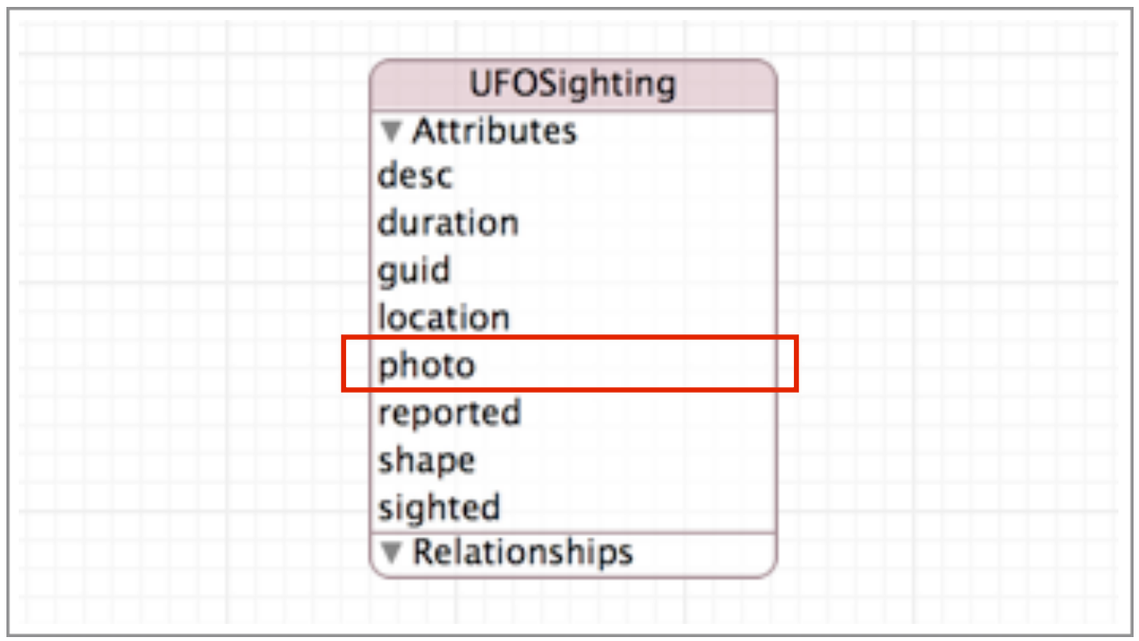
Data Model

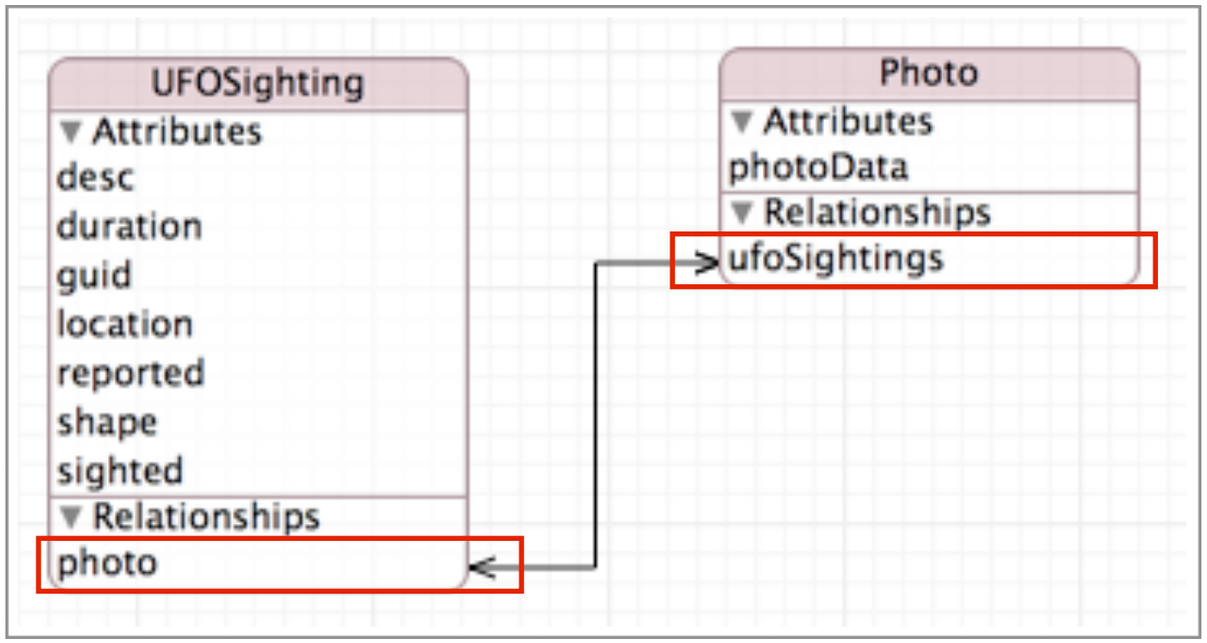
Don't Overnormalize

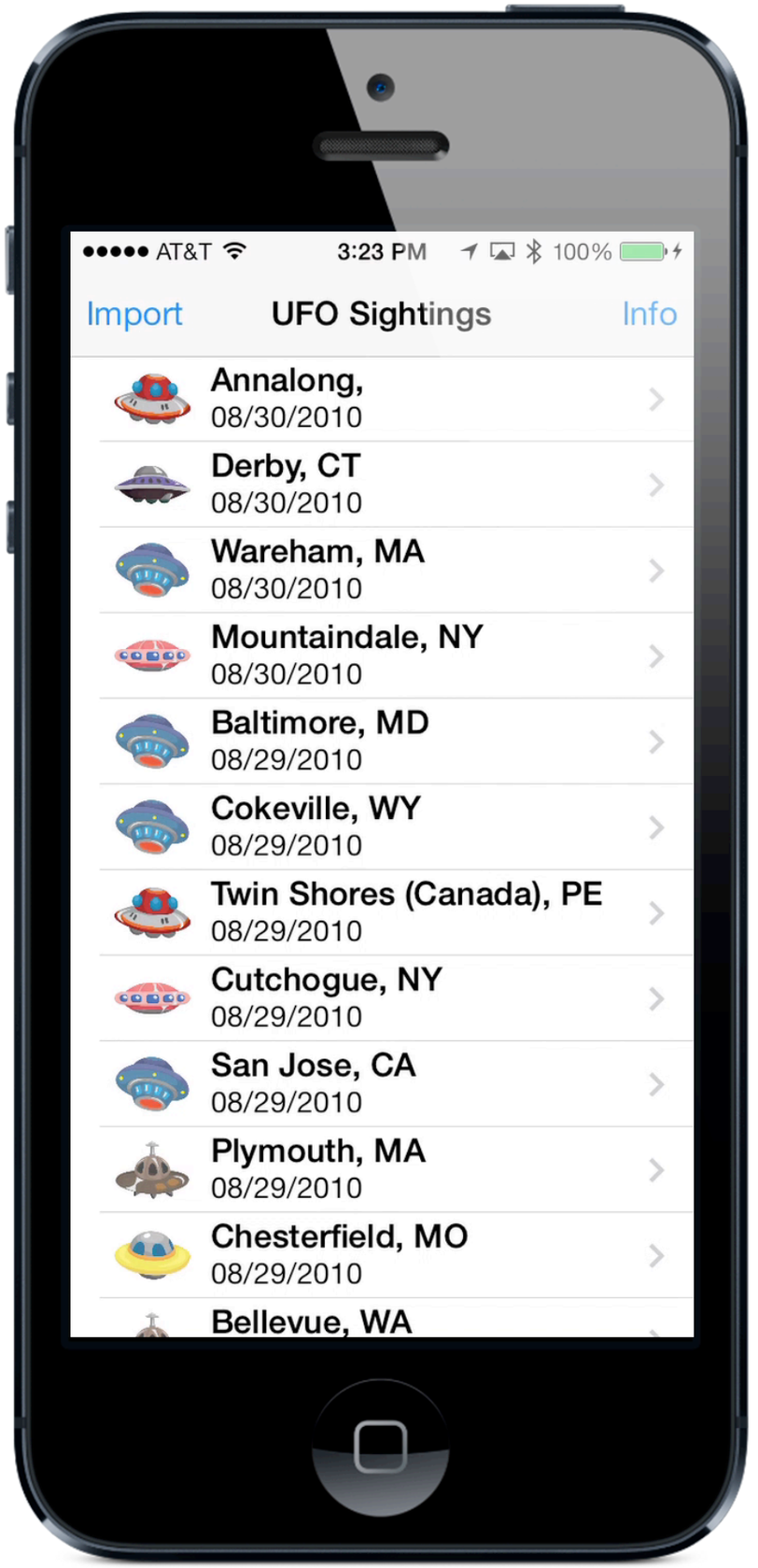
- Duplication isn't always bad
- Let UI drive data model
- What list are needed?
- What items will be detailed from the list?

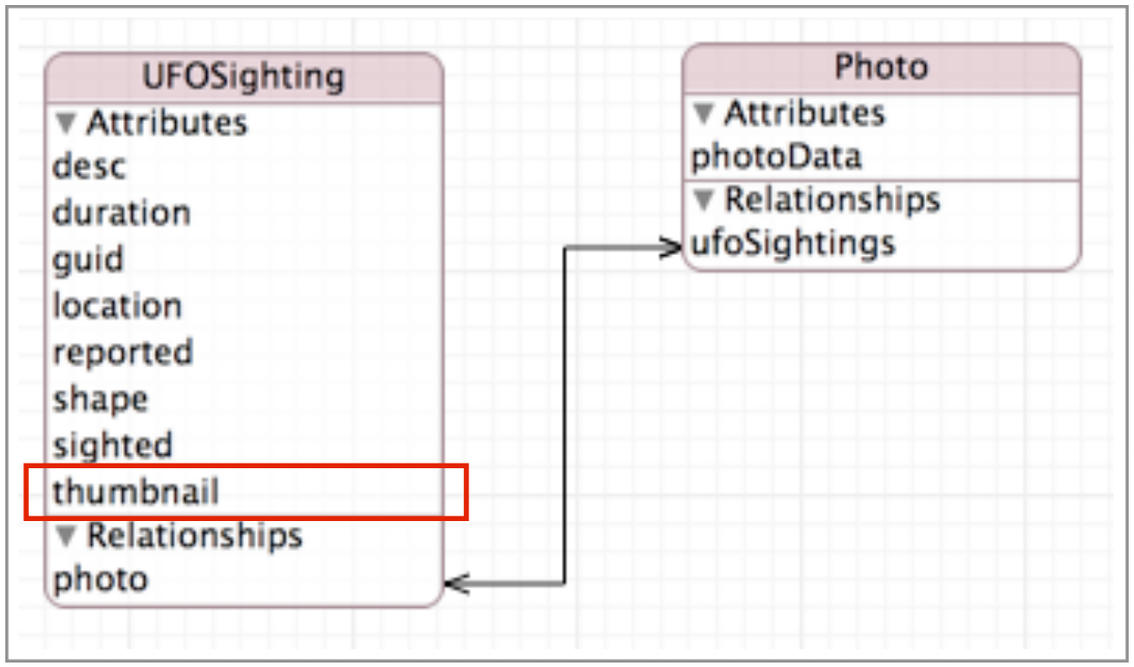
Use External Storage




UFOSighting
Attributes
desc
duration
guid
location
photo
reported
shape
sighted
Relationships


UFOSighting
Attributes
desc
duration
guid
location
reported
shape
sighted
Relationships
photo
Photo
Attributes
photoData
Relationships
ufoSightings


●●●●● AT&T
3:23 PM
100%
Import
UFO Sightings
Info
Annalong,
08/30/2010
Derby, CT
08/30/2010
Wareham, MA
08/30/2010
Mountaindale, NY
08/30/2010
Baltimore, MD
08/29/2010
Cokeville, WY
08/29/2010
Twin Shores (Canada), PE
08/29/2010
Cutchogue, NY
08/29/2010
San Jose, CA
08/29/2010
Plymouth, MA
08/29/2010
Chesterfield, MO
08/29/2010
Bellevue, WA


UFOSighting
Attributes
desc
duration
guid
location
reported
shape
sighted
thumbnail
Relationships
photo
Photo
Attributes
photoData
Relationships
ufoSightings

Data Model

- Don’t overnormalize
- Use external storage for large attributes
- Large blobs as separate entity
- Less data takes less time to fetch

App Launch

```
dispatch_queue_t queue =
        dispatch_get_global_queue(DISPATCH_QUEUE_PRIORITY_DEFAULT, 0);
dispatch_async(queue, ^{

    // Create persistent store coordinator with model

    // Add persistent store to store coordinator

    // Create managed object context

    // Context is fully initialized, notify view controllers
    dispatch_sync(dispatch_get_main_queue(), ^{

        // Send out notification

    });
});
```

```
dispatch_queue_t queue =
        dispatch_get_global_queue(DISPATCH_QUEUE_PRIORITY_DEFAULT, 0);
dispatch_async(queue, ^{

    // Create persistent store coordinator with model

    // Add persistent store to store coordinator

    // Create managed object context

    // Context is fully initialized, notify view controllers
    dispatch_sync(dispatch_get_main_queue(), ^{

        // Send out notification

    });
});
```

```
dispatch_queue_t queue =
        dispatch_get_global_queue(DISPATCH_QUEUE_PRIORITY_DEFAULT, 0);
dispatch_async(queue, ^{

    // Create persistent store coordinator with model

    // Add persistent store to store coordinator

    // Create managed object context

    // Context is fully initialized, notify view controllers
    dispatch_sync(dispatch_get_main_queue(), ^{

        // Send out notification

    });
});
```

"Lots of Things" Problem

```objc
- (void)applicationDidEnterBackground:(UIApplication *)application {

    UIApplication *app = [UIApplication sharedApplication];
    __block UIBackgroundTaskIdentifier backgroundTask = 0;

    backgroundTask = [app beginBackgroundTaskWithExpirationHandler:^{

        [app endBackgroundTask:backgroundTask];
        backgroundTask = UIBackgroundTaskInvalid;

    }];

    dispatch_async(
          dispatch_get_global_queue(DISPATCH_QUEUE_PRIORITY_DEFAULT, 0), ^{

        // Delete or update a bunch of NSManagedObjects

        // If success
         [app endBackgroundTask:backgroundTask];
         backgroundTask = UIBackgroundTaskInvalid;

        // If failure
         [app endBackgroundTask:backgroundTask];
         backgroundTask = UIBackgroundTaskInvalid;
    });

}
```

```
- (void)applicationDidEnterBackground:(UIApplication *)application {

    UIApplication *app = [UIApplication sharedApplication];
    __block UIBackgroundTaskIdentifier backgroundTask = 0;

    backgroundTask = [app beginBackgroundTaskWithExpirationHandler:^{

        [app endBackgroundTask:backgroundTask];
        backgroundTask = UIBackgroundTaskInvalid;

    }];

    dispatch_async(
        dispatch_get_global_queue(DISPATCH_QUEUE_PRIORITY_DEFAULT, 0), ^{

        // Delete or update a bunch of NSManagedObjects

        // If success
        [app endBackgroundTask:backgroundTask];
        backgroundTask = UIBackgroundTaskInvalid;

        // If failure
        [app endBackgroundTask:backgroundTask];
        backgroundTask = UIBackgroundTaskInvalid;
    });

}
```

```objc
- (void)applicationDidEnterBackground:(UIApplication *)application {

    UIApplication *app = [UIApplication sharedApplication];
    __block UIBackgroundTaskIdentifier backgroundTask = 0;

    backgroundTask = [app beginBackgroundTaskWithExpirationHandler:^{

        [app endBackgroundTask:backgroundTask];
        backgroundTask = UIBackgroundTaskInvalid;

    }];

    dispatch_async(
            dispatch_get_global_queue(DISPATCH_QUEUE_PRIORITY_DEFAULT, 0), ^{

        // Delete or update a bunch of NSManagedObjects

        // If success
            [app endBackgroundTask:backgroundTask];
            backgroundTask = UIBackgroundTaskInvalid;

        // If failure
            [app endBackgroundTask:backgroundTask];
            backgroundTask = UIBackgroundTaskInvalid;
    });
}
```

Core Data Batch Deleting

rdar://15183213

Core Data Batch Updating Properties

rdar://15183235

"Lots of Things" Problem

- Do work while app is in the background
- You could also do it at app startup

Importing Data

MDMHPCoreData.xcodeproj — MDMUFOSightingImportOperation.m

iPhone Retina (4-...

Finished running - Profiling MDMHPCoreData.app on iPhone Retina (4-inch) 1

MDMHPCoreData › MDMHPCoreData › model › MDMUFOSightingImportOperation.m › -main

```
52
53  - (void)main {
54
55      //
56      // 1) WORST: Main queue context with naive find-or-create alg
57      //           Will block UI and take a long time
58
59          self.managedObjectContext = self.persistenceStack.managed
60          self.managedObjectContext.undoManager = nil;
61          [self.managedObjectContext performBlockAndWait:^{
62              [self import];
63          }];
64
65      //
66      // 2) BAD: Private queue context with naive find-or-create al
67      //          Will not block UI, but will take a long time
68      //
69      //    self.managedObjectContext = [self.persistenceStack newF
70      //    self.managedObjectContext.undoManager = nil;
71      //    [self.managedObjectContext performBlockAndWait:^{
```

No Debug Session

/Users/xzolian/xcode/projects/MDMHPCoreData/2/MDMHPCoreData/MDMHPCoreData/model/

No Selection

```
2013-11-10 16:25:39.012 MDMHPCoreData[15098:1303] Progress: 0.968546
2013-11-10 16:25:39.046 MDMHPCoreData[15098:1303] Progress: 0.978531
2013-11-10 16:25:39.085 MDMHPCoreData[15098:1303] Progress: 0.988516
2013-11-10 16:25:39.123 MDMHPCoreData[15098:1303] Progress: 0.998501
2013-11-10 16:25:39.129 MDMHPCoreData[15098:1303] Progress: 1.000000
```

Auto

All Output

Main Queue vs Private Queue

```
self.managedObjectContext = self.persistenceStack.managedObjectContext;
self.managedObjectContext.undoManager = nil;
[self.managedObjectContext performBlockAndWait:^{
    [self import];
}];
```

Main Queue vs Private Queue

```
self.managedObjectContext = self.persistenceStack.managedObjectContext;
self.managedObjectContext.undoManager = nil;
[self.managedObjectContext performBlockAndWait:^{
    [self import];
}];
```

```
NSManagedObjectContext *privateManagedObjectContext =
    [[NSManagedObjectContext alloc]
        initWithConcurrencyType:NSPrivateQueueConcurrencyType];

[privateManagedObjectContext setPersistentStoreCoordinator:
         self.managedObjectContext.persistentStoreCoordinator];
privateManagedObjectContext.undoManager = nil;

[privateManagedObjectContext performBlockAndWait:^{
    [self import];
}];
```

MDMHPCoreData.xcodeproj — MDMUFOSightingImportOperation.m

iPhone Retina (4-...

Finished running – Profiling MDMHPCoreData.app on iPhone Retina (4-inch) 1

Build and then profile the current scheme

MDMHPCoreData › MDMHPCoreData › model › MDMUFOSightingImportOperation.m › -main

```
58  //
59  //    self.managedObjectContext = self.persistenceStack.manag
60  //    self.managedObjectContext.undoManager = nil;
61  //    [self.managedObjectContext performBlockAndWait:^{
62  //        [self import];
63  //    }];
64
65  //
66  // 2) BAD: Private queue context with naive find-or-create al
67  //         Will not block UI, but will take a long time
68  //
69      self.managedObjectContext = [self.persistenceStack newPri
70      self.managedObjectContext.undoManager = nil;
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72          [self import];
73      }];
74
75  //
76  // 3) GOOD: Private queue context with batch importing algori
77  //          Will not block UI, but will have high memory usag
```

No Debug Session

/Users/xzolian/xcode/projects/MDMHPCoreData/2/MDMHPCoreData/MDMHPCoreData/model/

No Selection

```
2013-11-10 16:25:39.012 MDMHPCoreData[15098:1303] Progress: 0.968546
2013-11-10 16:25:39.046 MDMHPCoreData[15098:1303] Progress: 0.978531
2013-11-10 16:25:39.085 MDMHPCoreData[15098:1303] Progress: 0.988516
2013-11-10 16:25:39.123 MDMHPCoreData[15098:1303] Progress: 0.998501
2013-11-10 16:25:39.129 MDMHPCoreData[15098:1303] Progress: 1.000000
```

Auto

All Output

Typical Import Algorithm

1) JSON to NSDictionary

2) Find existing NSManagedObject

3) Optionally, create new NSManagedObject

4) Set attributes of new/updated NSManagedObject

Typical Import Algorithm

1) JSON to NSDictionary

2) Find existing NSManagedObject

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Inefficient Find-Or-Create Algorithm

```
+ (instancetype)findOrCreateWithIdentifier:(id)identifier
                                 inContext:(NSManagedObjectContext *)context {

    NSFetchRequest *fetchRequest = [NSFetchRequest
        fetchRequestWithEntityName:@"UFOSighting"];

    fetchRequest.predicate = [NSPredicate predicateWithFormat:@"%K = %@",
        @"GUID", identifier];

    fetchRequest.fetchLimit = 1;

    id object = [[context executeFetchRequest:fetchRequest error:NULL]
        lastObject];

    if (object == nil) {
        object = [UFOSighting insertNewObjectIntoContext:context];
    }
    return object;
}
```

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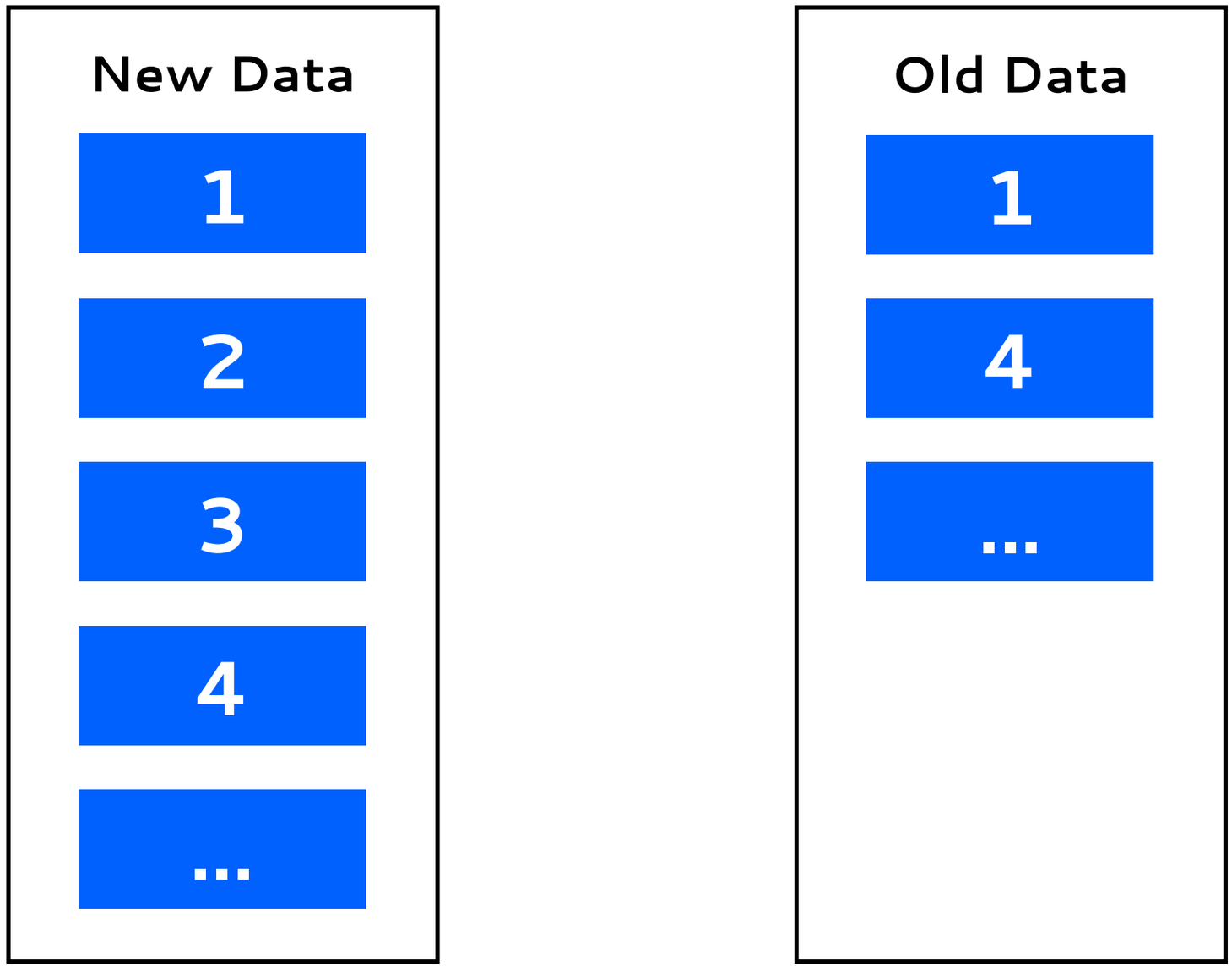
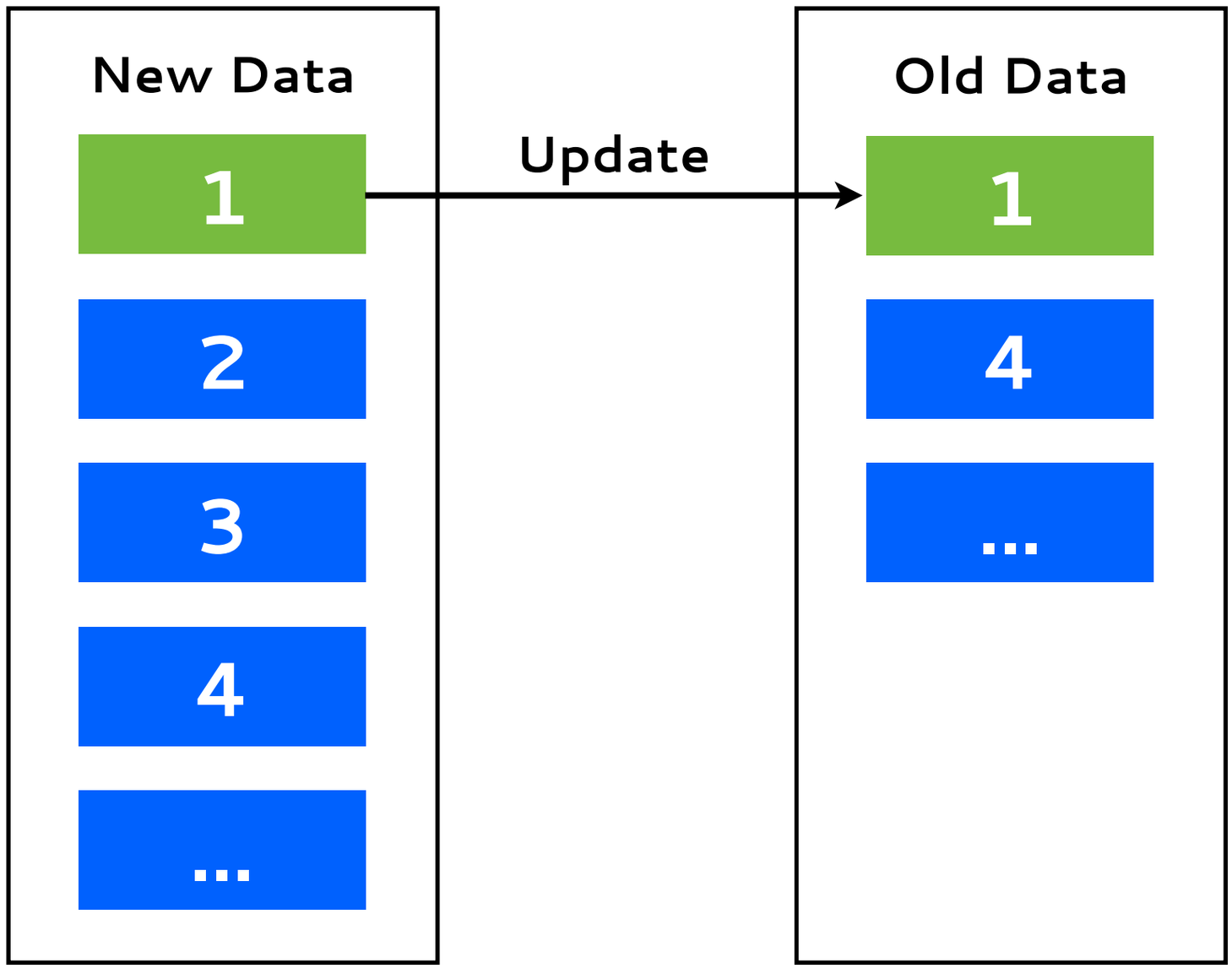
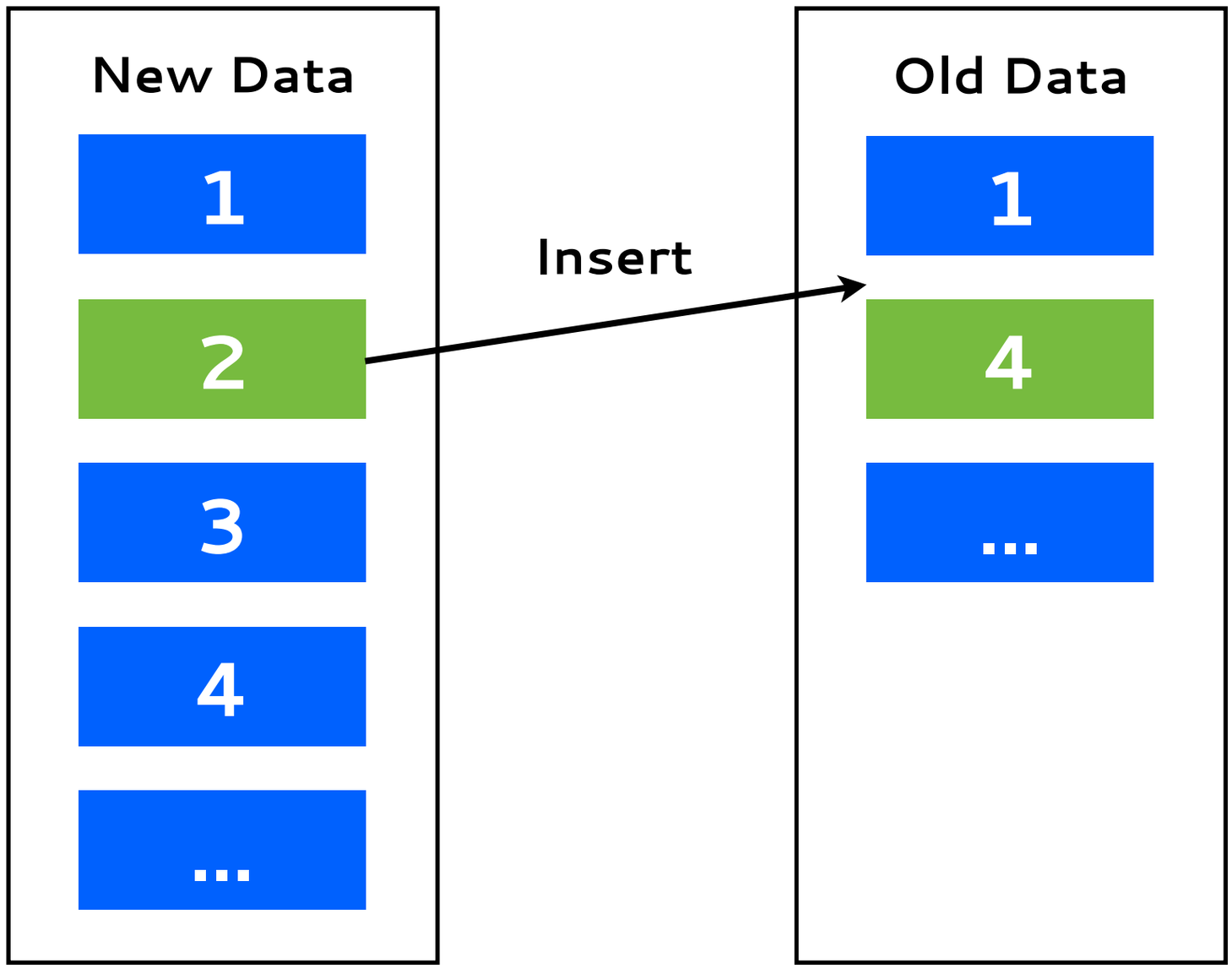
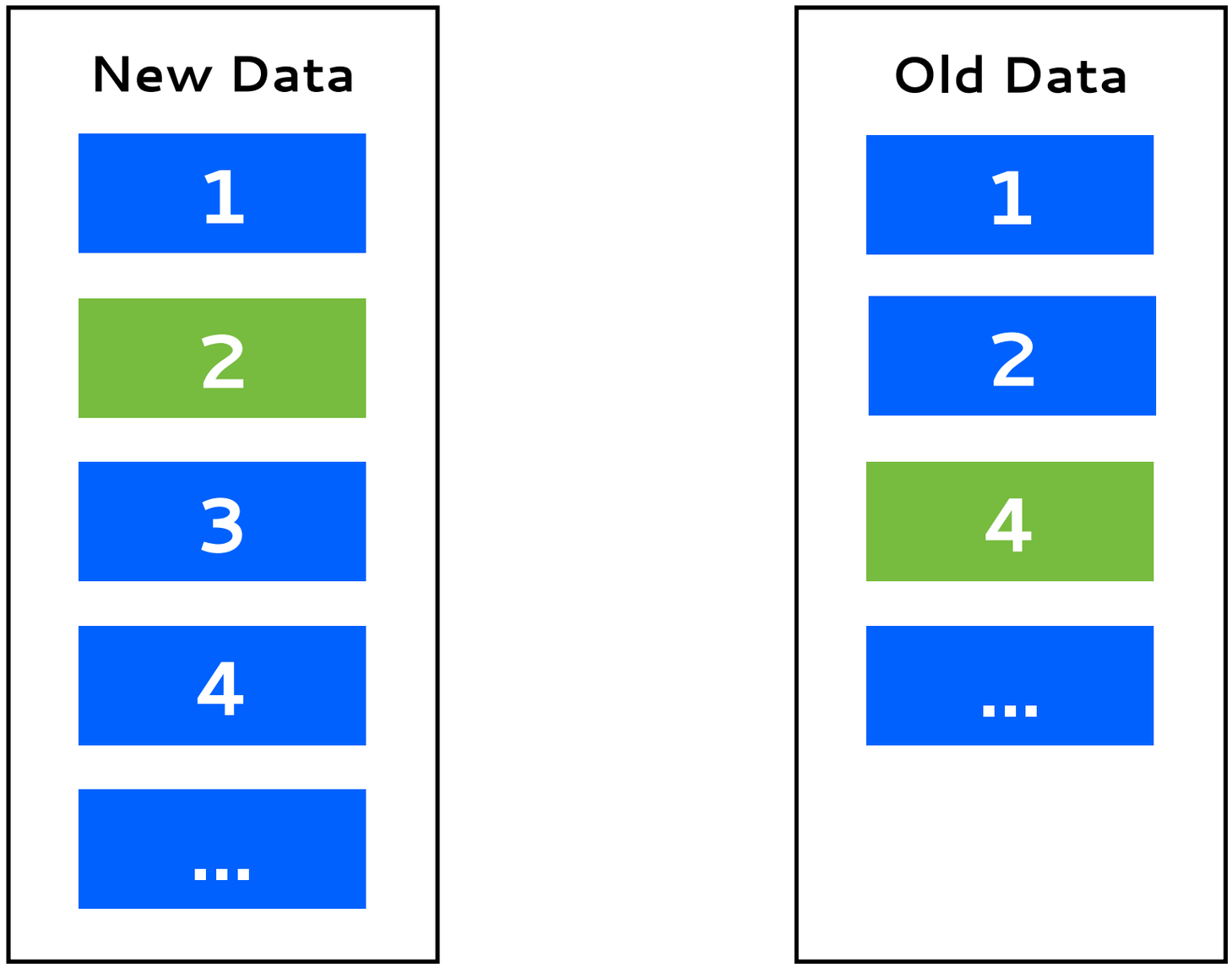
}
```


New Data
1
2
3
4
...
Old Data
1
4
...


New Data
1
2
3
4
...
Update
Old Data
1
4
...


New Data
1
2
3
4
...
Insert
Old Data
1
4
...


New Data
1
2
3
4
...
Old Data
1
2
4
...

New Data

1

2

3

4

...

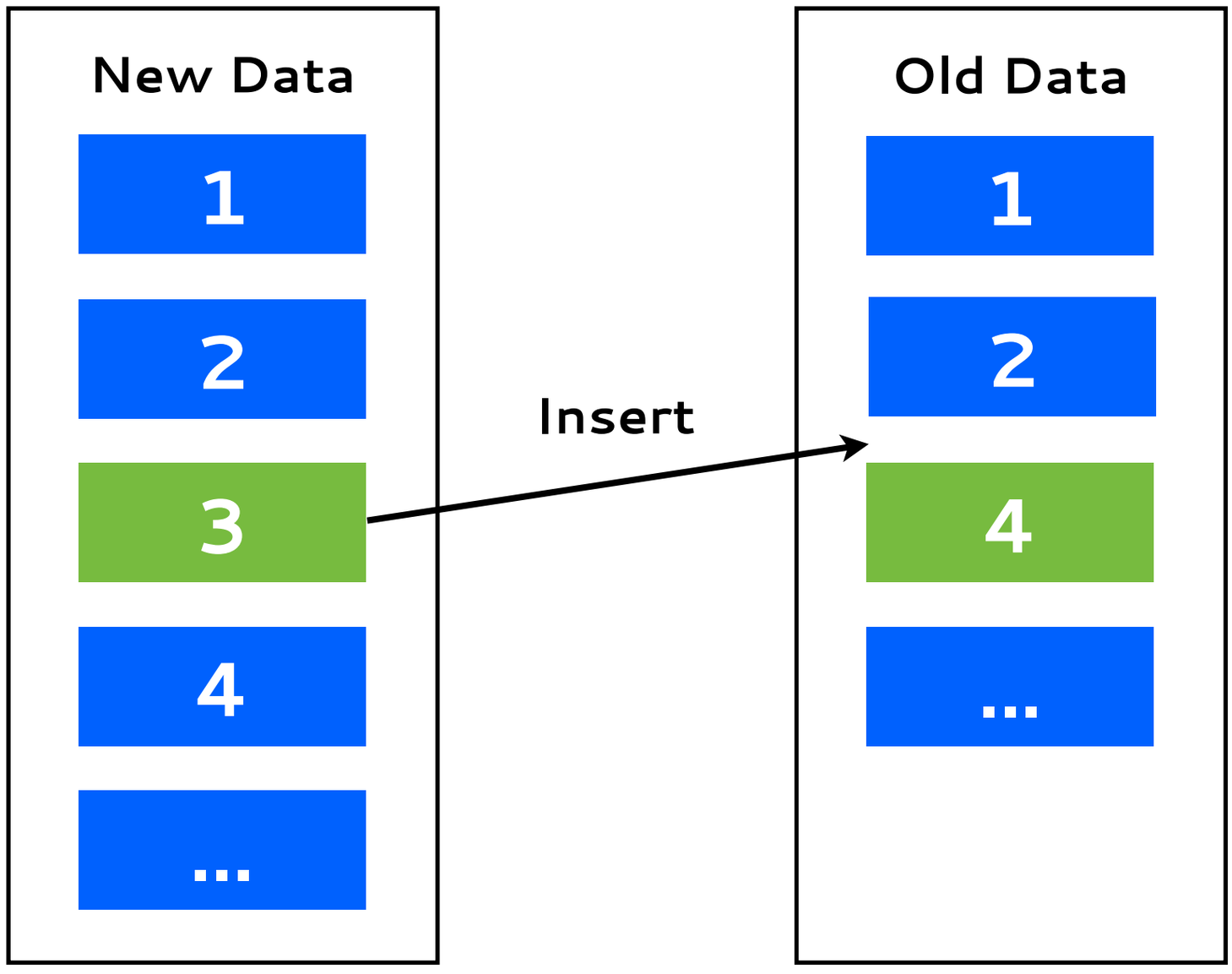
Old Data

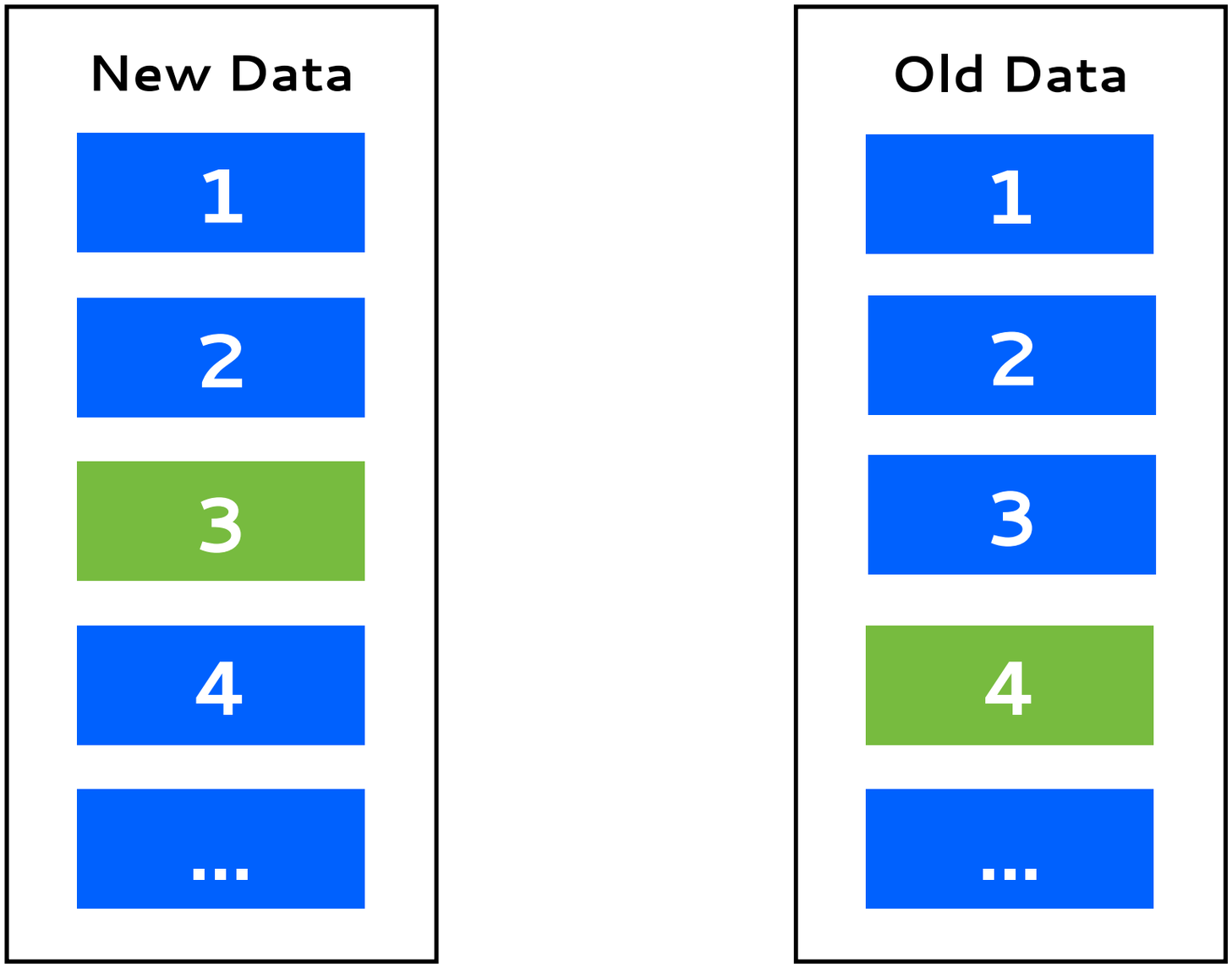
1

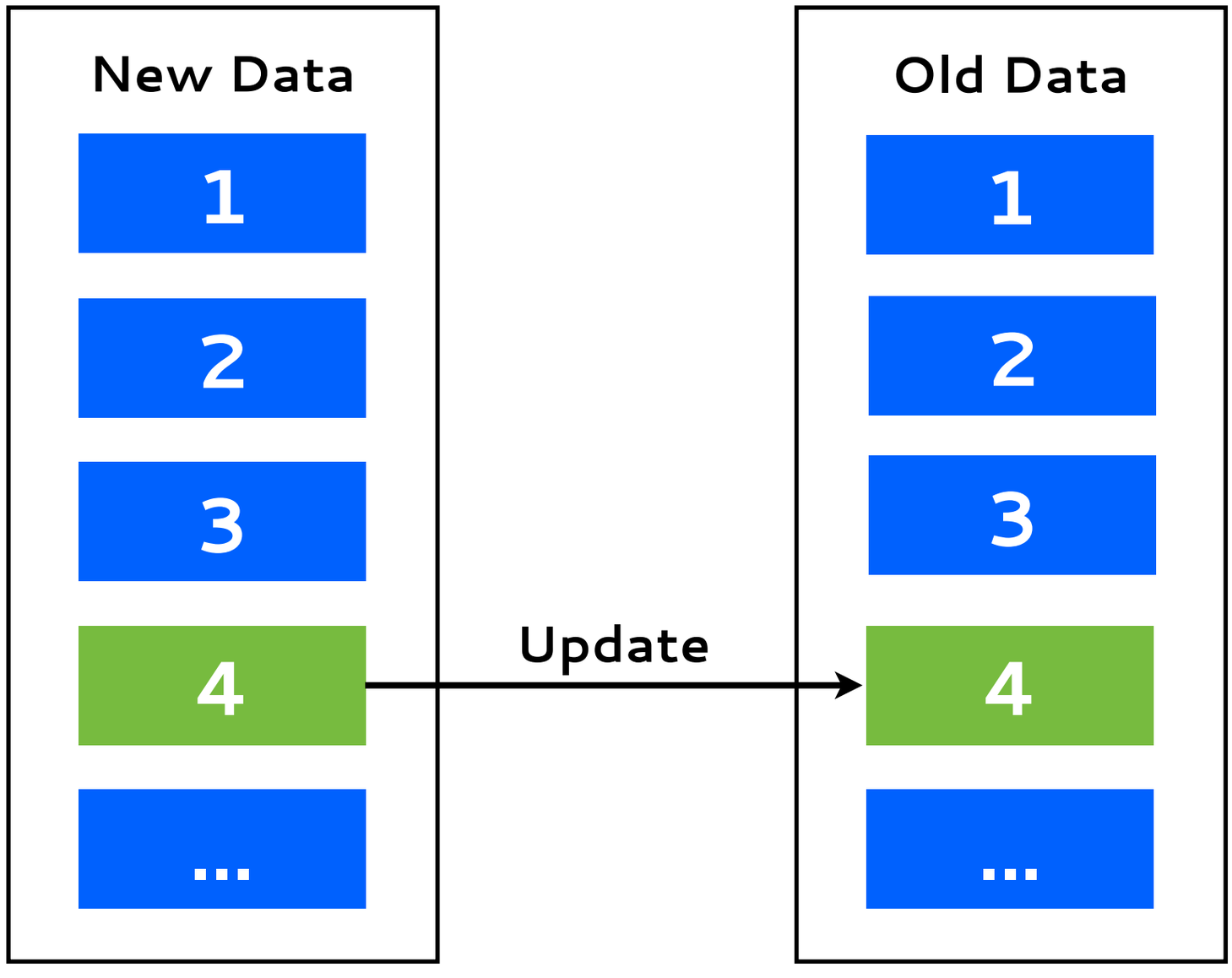
2

4

...


New Data
1
2
3
4
...
Insert
Old Data
1
2
4
...


New Data
1
2
3
4
...
Old Data
1
2
3
4
...


New Data
1
2
3
4
...
Update
Old Data
1
2
3
4
...

~~Inefficient~~ Find-Or-Create Algorithm

```
NSEnumerator *jsonEnumerator = [sortedArray objectEnumerator];
NSEnumerator *fetchResultsEnumerator = [fetchResults objectEnumerator];
NSDictionary *UFOSightingDictionary = [jsonEnumerator nextObject];
UFOSighting *UFOSightingManagedObject = [fetchResultsEnumerator nextObject];

while (UFOSightingDictionary) {

    // Check if managed object already exist

    // Not an update, create new managed object

    // Set new attributes

    if (isUpdate) {
        UFOSightingDictionary = [jsonEnumerator nextObject];
        UFOSightingManagedObject = [fetchResultsEnumerator nextObject];
    } else {
        UFOSightingDictionary = [jsonEnumerator nextObject];
    }
}
```

~~Inefficient~~ Find-Or-Create Algorithm

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```

```
66      // 2) BAD: Private queue context with naive find-or-create al
67      //         Will not block UI, but will take a long time
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79          self.managedObjectContext = [self.persistenceStack newPri
80          self.managedObjectContext.undoManager = nil;
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82              [self batchImport];
83          }];
84
85      //
```

No Debug Session

/Users/xzolian/xcode/projects/MDMHPCoreData/2/MDMHPCoreData/MDMHPCoreData/model/

No Selection

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2013-11-10 16:25:39.129 MDMHPCoreData[15098:1303] Progress: 1.000000
```

Auto

All Output

```
NSUInteger totalUFOSightings = [UFOSightingsArray count];
NSInteger totalBatches = totalUFOSightings / MDM_BATCH_SIZE_IMPORT;

// Create array with just the unique keys
NSArray *jsonGUIDArray = [sortedArray valueForKey:UFO_KEY_JSON_GUID];

for (NSInteger batchCounter = 0; batchCounter <= totalBatches; batchCounter++) {

    // Create batch range based on batch size
    NSRange range = NSMakeRange(batchCounter*MDM_BATCH_SIZE_IMPORT,MDM_BATCH_SIZE_IMPORT);
    NSArray *jsonBatchGUIDArray = [jsonGUIDArray subarrayWithRange:range];

    // Grab sorted persisted managed objects, based on the batch
    NSFetchRequest *fetchRequest = [[NSFetchRequest alloc]initWithEntityName:@"UFOSighting"];
    NSPredicate *fetchPredicate = [NSPredicate predicateWithFormat:@"%K IN %@",
                                                                   @"GUID", jsonBatchGUIDArray];
    // ...

    while (UFOSightingDictionary) {
        // ...
        // Efficient find-or-create algorithm
        // ...
    }
}
```

```objc
NSUInteger totalUFOSightings = [UFOSightingsArray count];
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    // ...

    while (UFOSightingDictionary) {
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        // Efficient find-or-create algorithm
        // ...
    }
}
```

Pre-Populated SQLite File in App Bundle

Download Pre-Populated SQLite File

Importing Data

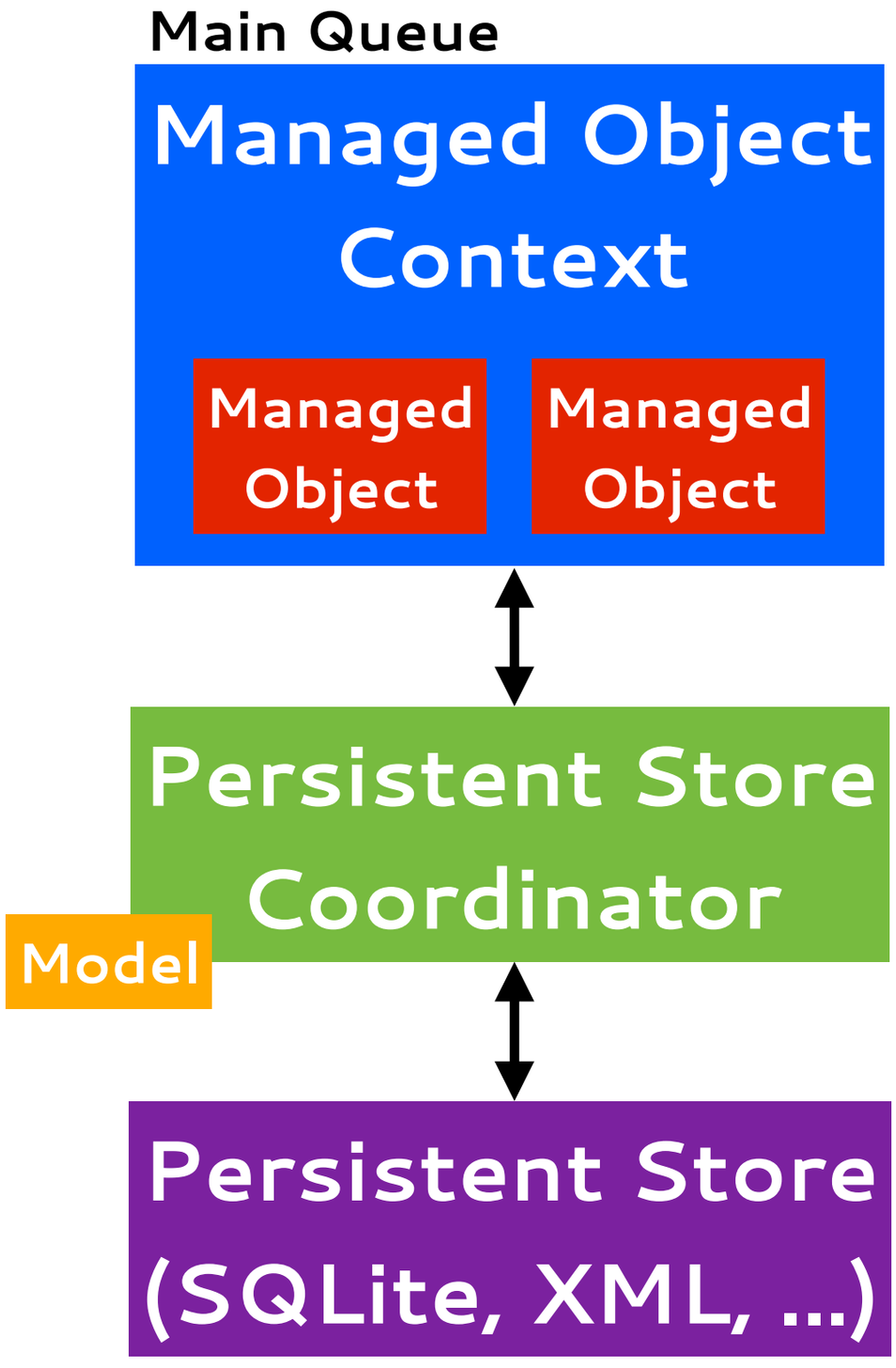
- Do import work on private queues
- Use efficient find-or-create algorithm
- Work in batches to keep memory low
- Use pre-populated SQLite file

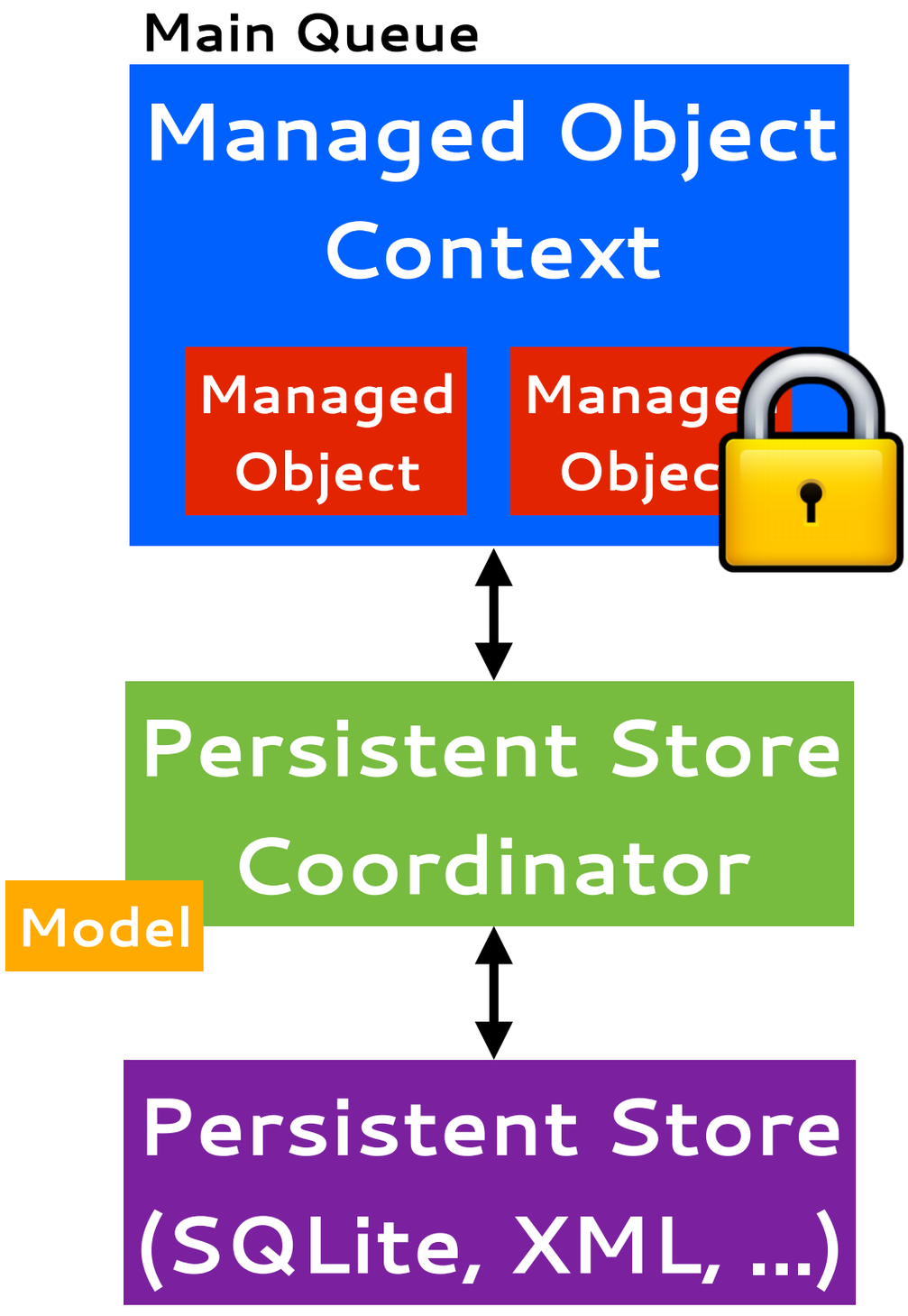
Memory

```
[context refreshObject:UFOSightingManagedObject mergeChanges:NO];
```

```
[context reset];
```

Concurrency Models


Main Queue
Managed Object Context
Managed Object
Managed Object
Persistent Store Coordinator
Model
Persistent Store (SQLite, XML, ...)


Main Queue
Managed Object Context
Managed Object
Manage Objec
Persistent Store Coordinator
Model
Persistent Store (SQLite, XML, ...)

Main Queue

Managed Object Context

Private Queue

Managed Object Context

Persistent Store Coordinator

Model

Persistent Store (SQLite, XML, ...)

Main Queue

Managed Object Context

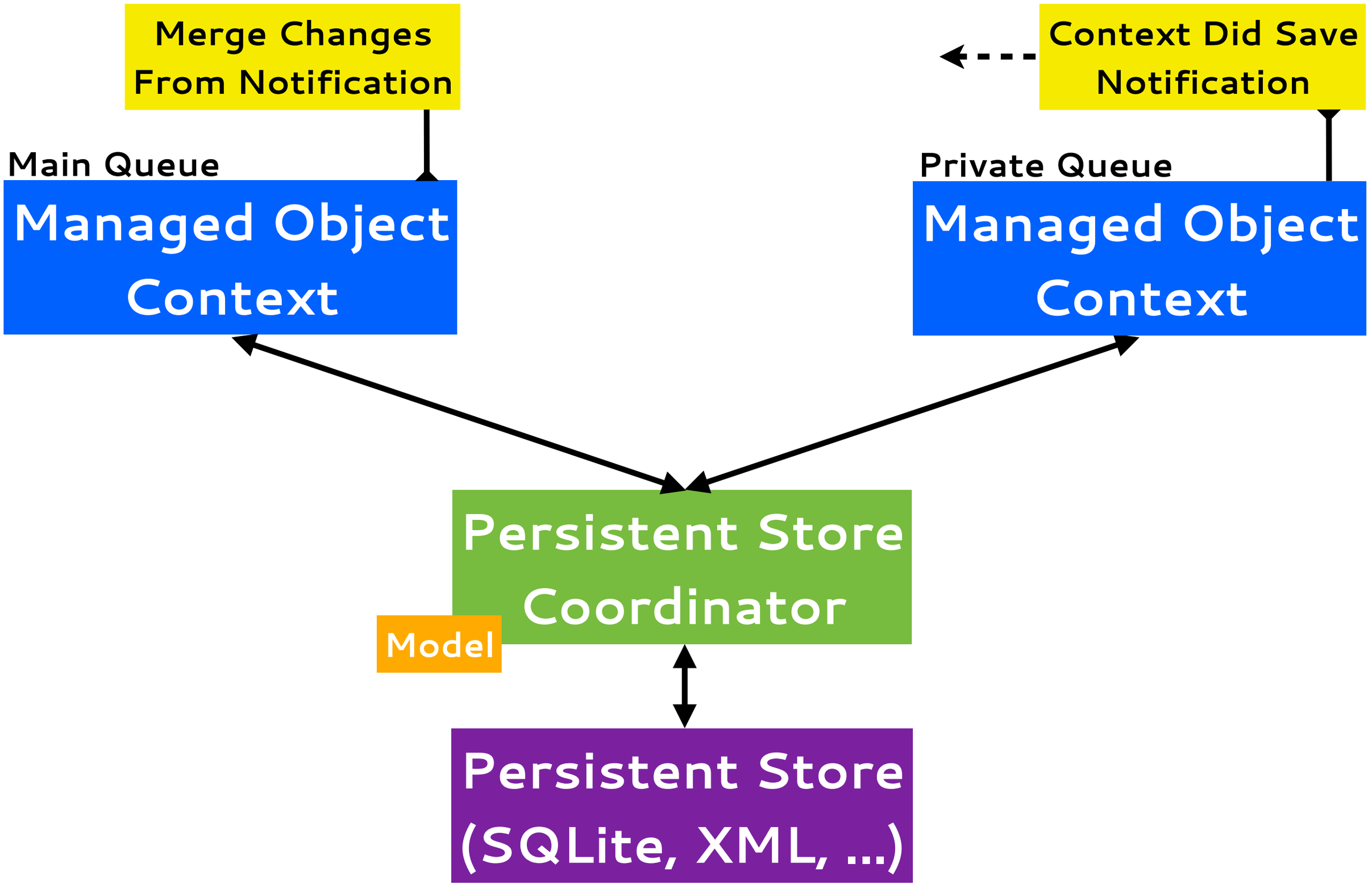
Private Queue

Managed Object Context

Persistent Store Coordinator

Model

Persistent Store (SQLite, XML, ...)


Merge Changes From Notification
Context Did Save Notification
Main Queue
Private Queue
Managed Object Context
Managed Object Context
Persistent Store Coordinator
Model
Persistent Store (SQLite, XML, ...)

Refetch and Reload

Context Did Save Notification

Main Queue

Managed Object Context

Private Queue

Managed Object Context

Persistent Store Coordinator

Model

Persistent Store (SQLite, XML, ...)

Main Queue

Managed Object Context

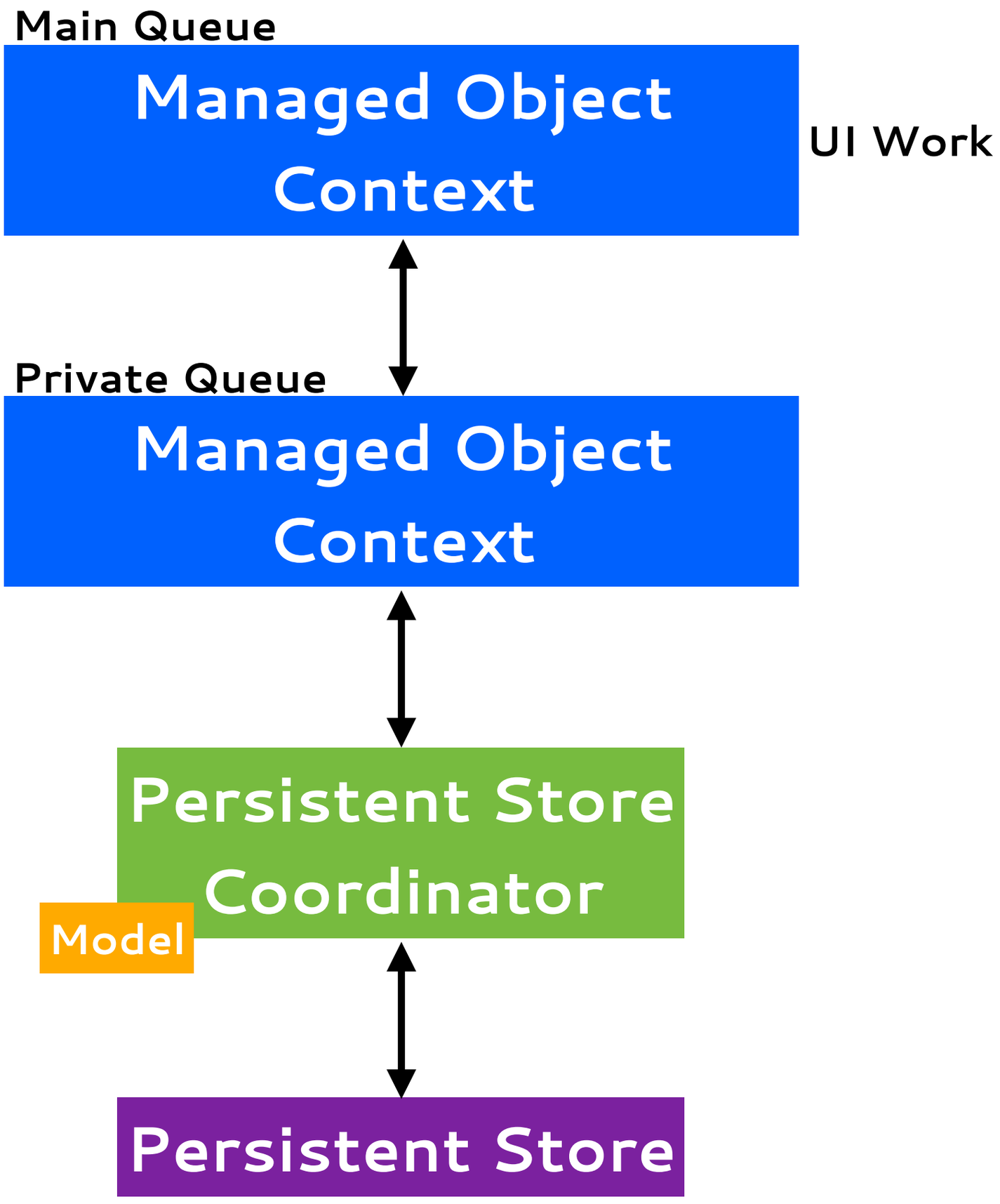
Private Queue

Managed Object Context

Persistent Store Coordinator

Model

Persistent Store


Main Queue
Managed Object Context
UI Work
Private Queue
Managed Object Context
Persistent Store Coordinator
Model
Persistent Store

Main Queue

Managed Object Context

UI Work

Private Queue

Managed Object Context

Persisting to Disk

Persistent Store Coordinator

Model

Persistent Store

Main Queue

Managed Object Context

UI Work

Private Queue

Managed Object Context

Persisting to Disk

Persistent Store Coordinator

Model

Persistent Store

Main Queue

Managed Object Context

UI Work

Private Queue

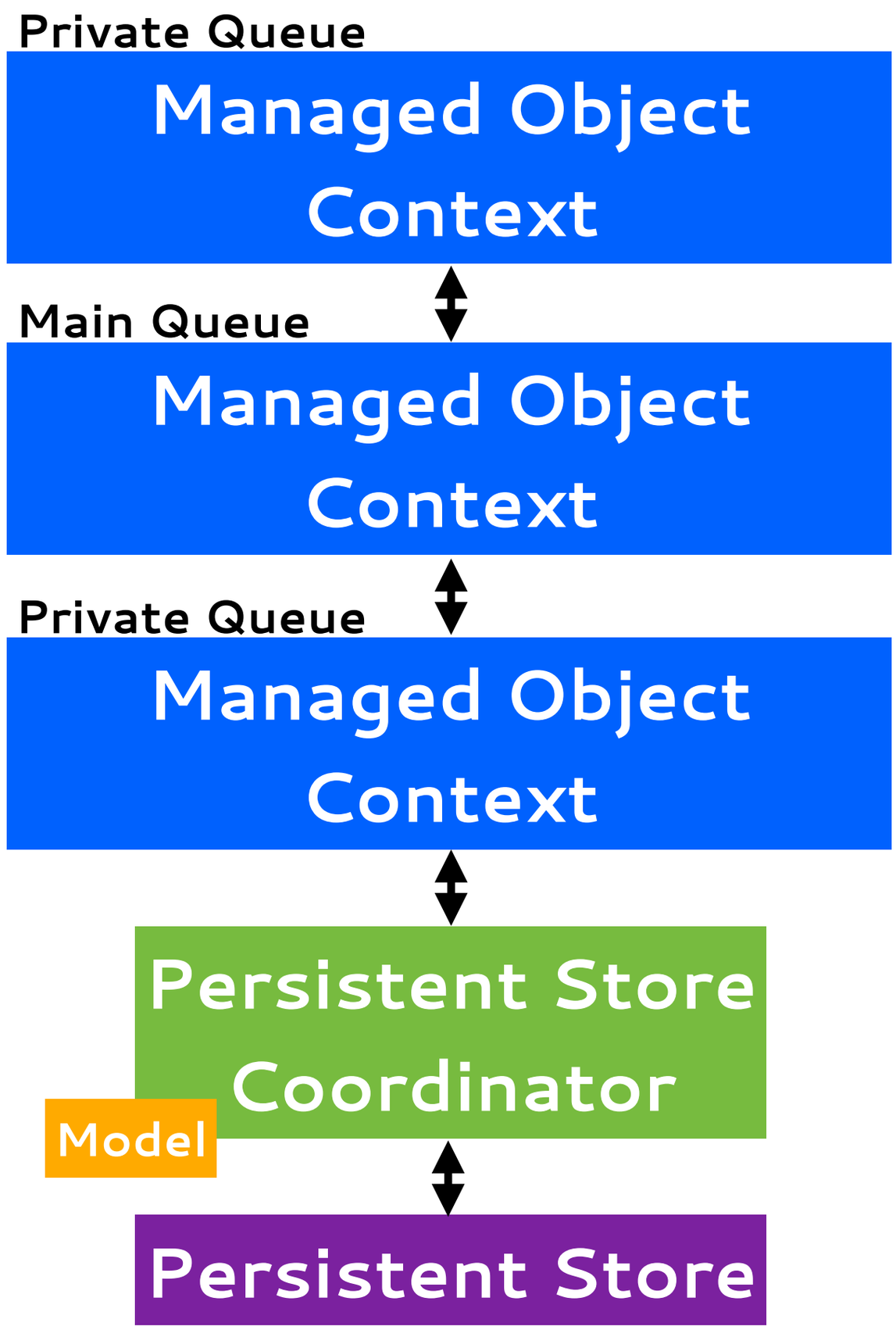
Managed Object Context

Persisting to Disk

Persistent Store Coordinator

Model

Persistent Store


Private Queue
Managed Object Context
Main Queue
Managed Object Context
Private Queue
Managed Object Context
Persistent Store Coordinator
Model
Persistent Store

Private Queue

Managed Object Context

Background Updates

Main Queue

Managed Object Context

Private Queue

Managed Object Context

Persistent Store Coordinator

Model

Persistent Store

Private Queue

Managed Object Context

Background Updates

Main Queue

Managed Object Context

UI Work

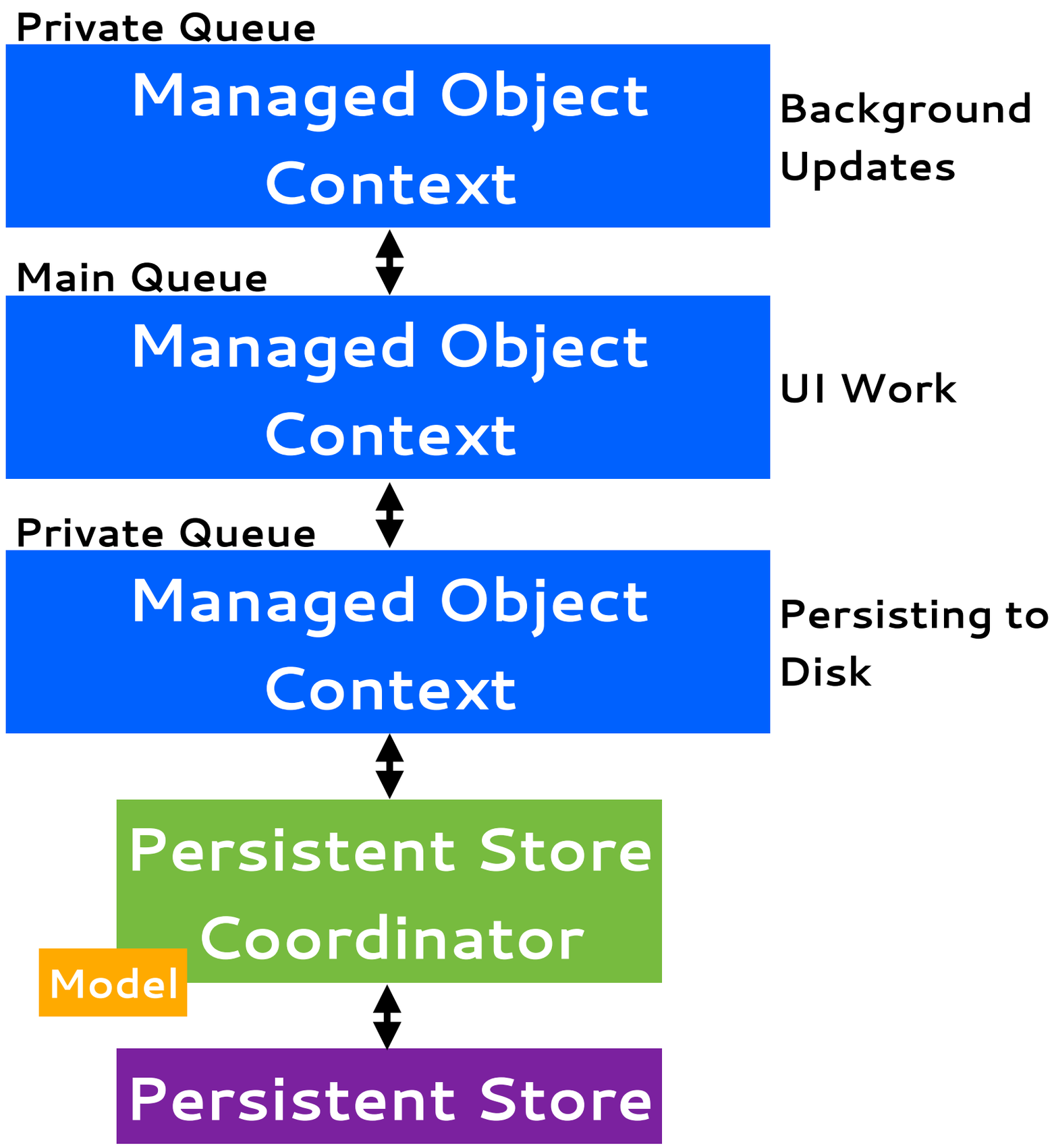
Private Queue

Managed Object Context

Persistent Store Coordinator

Model

Persistent Store


Private Queue
Managed Object Context
Background Updates
Main Queue
Managed Object Context
UI Work
Private Queue
Managed Object Context
Persisting to Disk
Persistent Store Coordinator
Model
Persistent Store

Private Queue

Managed Object Context

Background Updates

Main Queue

Managed Object Context

UI Work

Private Queue

Managed Object Context

Persisting to Disk

Persistent Store Coordinator

Model

Persistent Store

```objc
__block NSManagedObjectContext *temporaryContext = self.workerObjectContext;
__block NSManagedObjectContext *managedObjectContext = self.managedObjectContext;
__block NSManagedObjectContext *writerObjectContext = self.writerManagedObjectContext;

[temporaryContext performBlock:^{

    NSError *error = nil;
    if (![temporaryContext save:&error]) {
        // TODO: Handle error
    }

    [managedObjectContext performBlock:^{

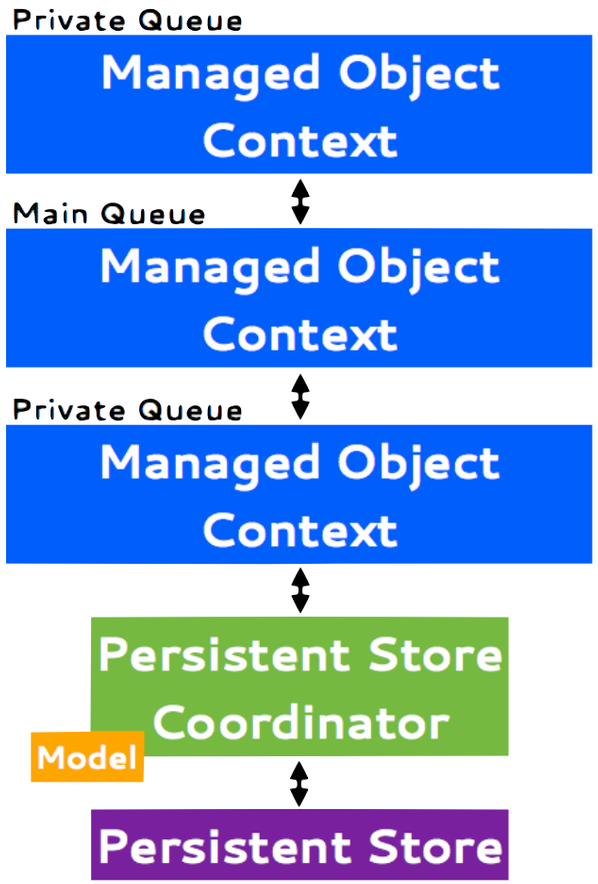
        NSError *error = nil;
        if (![managedObjectContext save:&error]) {
            // TODO: Handle error
        }

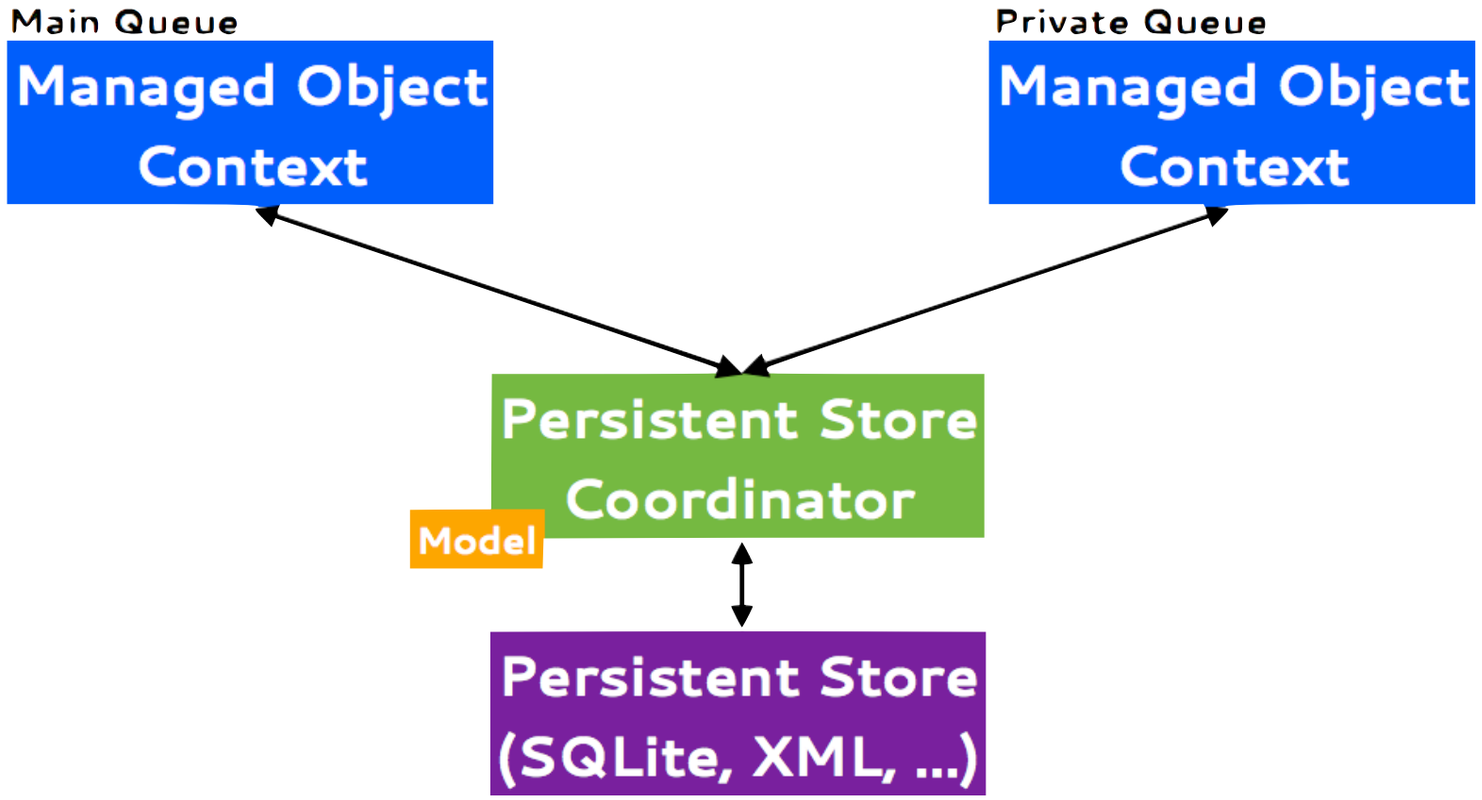
        [writerObjectContext performBlock:^{

            NSError *error = nil;
            if (![writerObjectContext save:&error]) {
                // TODO: Handle error
            }

            // Success!!!

        }]; // writerObjectContext
    }]; // managedObjectContext
}]; // temporaryContext
```


Private Queue
Managed Object Context
Main Queue
Managed Object Context
Private Queue
Managed Object Context
Persistent Store Coordinator
Model
Persistent Store


Main Queue
Managed Object Context
Private Queue
Managed Object Context
Persistent Store Coordinator
Model
Persistent Store (SQLite, XML, ...)

Main Queue

Managed Object Context

Persistent Store Coordinator

Model

Private Queue

Managed Object Context

Persistent Store Coordinator

Model

Persistent Store (SQLite, XML, ...)

Main Queue

Managed Object Context

Persistent Store Coordinator

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Private Queue

Managed Object Context

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Model

Persistent Store (SQLite, XML,

Main Queue

Managed Object Context

Persistent Store Coordinator

Model

Private Queue

Managed Object Context

Persistent Store Coordinator

Model

Persistent Store (SQLite, XML)

Context Did Save Notification

Main Queue

Managed Object Context

Persistent Store Coordinator

Model

Private Queue

Managed Object Context

Persistent Store Coordinator

Model

Persistent Store (SQLite, XML, ...)

Merge Changes From Notification

Main Queue

Managed Object Context

Persistent Store Coordinator

Model

Context Did Save Notification

Private Queue

Managed Object Context

Persistent Store Coordinator

Model

Persistent Store (SQLite, XML, ...)

Refetch and Reload

Main Queue

Managed Object Context

Persistent Store Coordinator

Model

Context Did Save Notification

Private Queue

Managed Object Context

Persistent Store Coordinator

Model

Persistent Store (SQLite, XML, ...)

```
116     //          View controllers should reload/refresh after impo
117     //          Takes advantage of SQLite WAL mode (only avilable
118     //
119     self.managedObjectContext = [self.persistenceStack newPrivate
120     self.managedObjectContext.undoManager = nil;
121     [self.managedObjectContext performBlockAndWait:^{
122         self.persistenceStack.disableMergeNotifications = YES;
123         [self batchImport];
124         self.persistenceStack.disableMergeNotifications = NO;
125
126         // Notify everyone that an import operation has been comp
127         [[NSNotificationCenter defaultCenter] postNotificationNam
128                                                                 objec
129     }];
130
131 }
132
133 - (void)saveManagedObjectContext {
134
135     NSError *saveError;
```

No Debug Session

/Users/xzolian/xcode/projects/MDMHPCoreData/2/MDMHPCoreData/MDMHPCoreData/model/

No Selection

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2013-11-10 16:25:39.129 MDMHPCoreData[15098:1303] Progress: 1.000000
```

Auto

All Output

Refetch and Reload

Context Did Save Notification

- Cannot pass objects between persistent store coordinators

- Cannot pass **objectID**s between persistent store coordinators

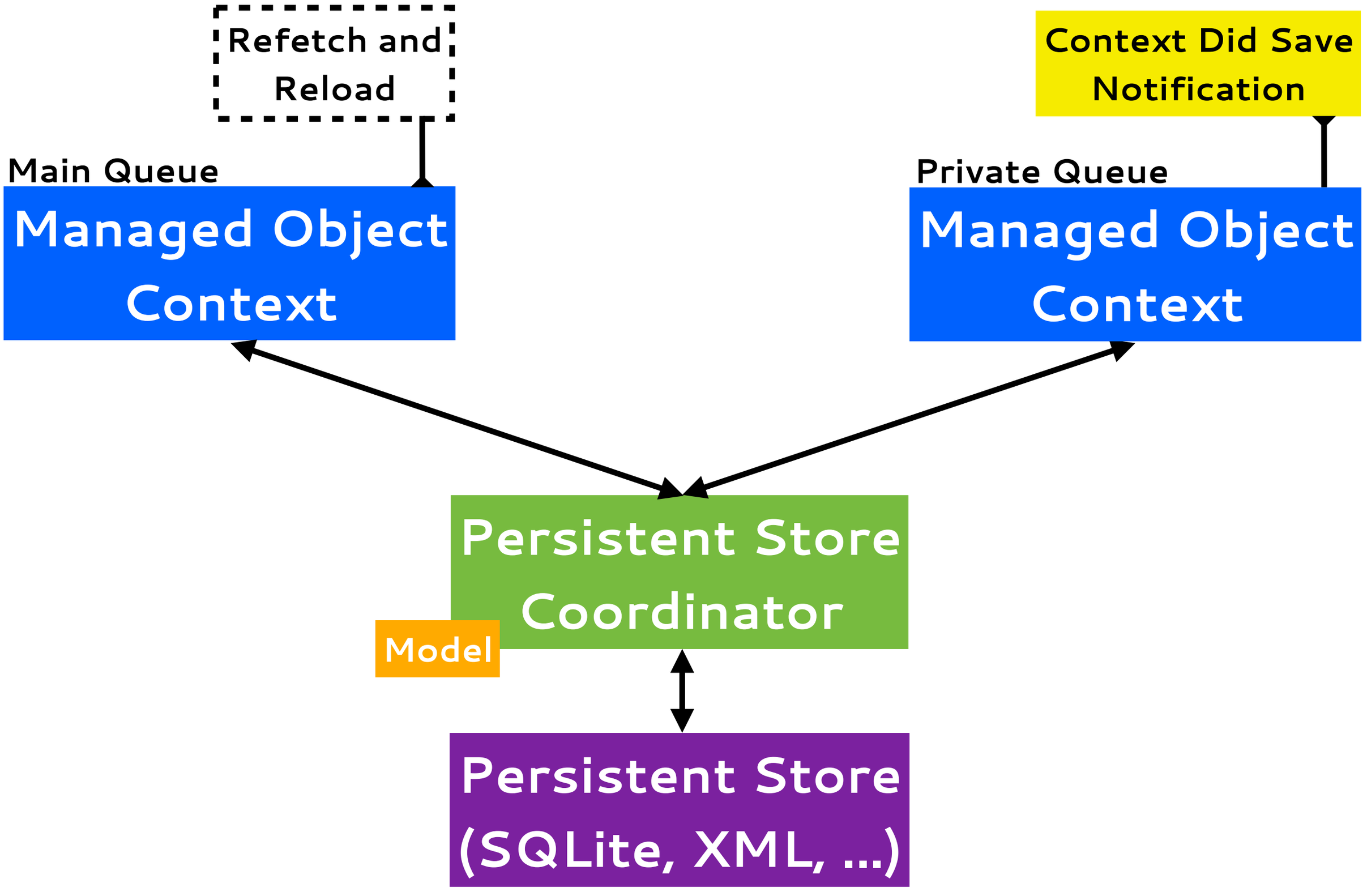
- You can use **URIRepresentation**

- You can use

  mergeChangesFromContextDidSaveNotification

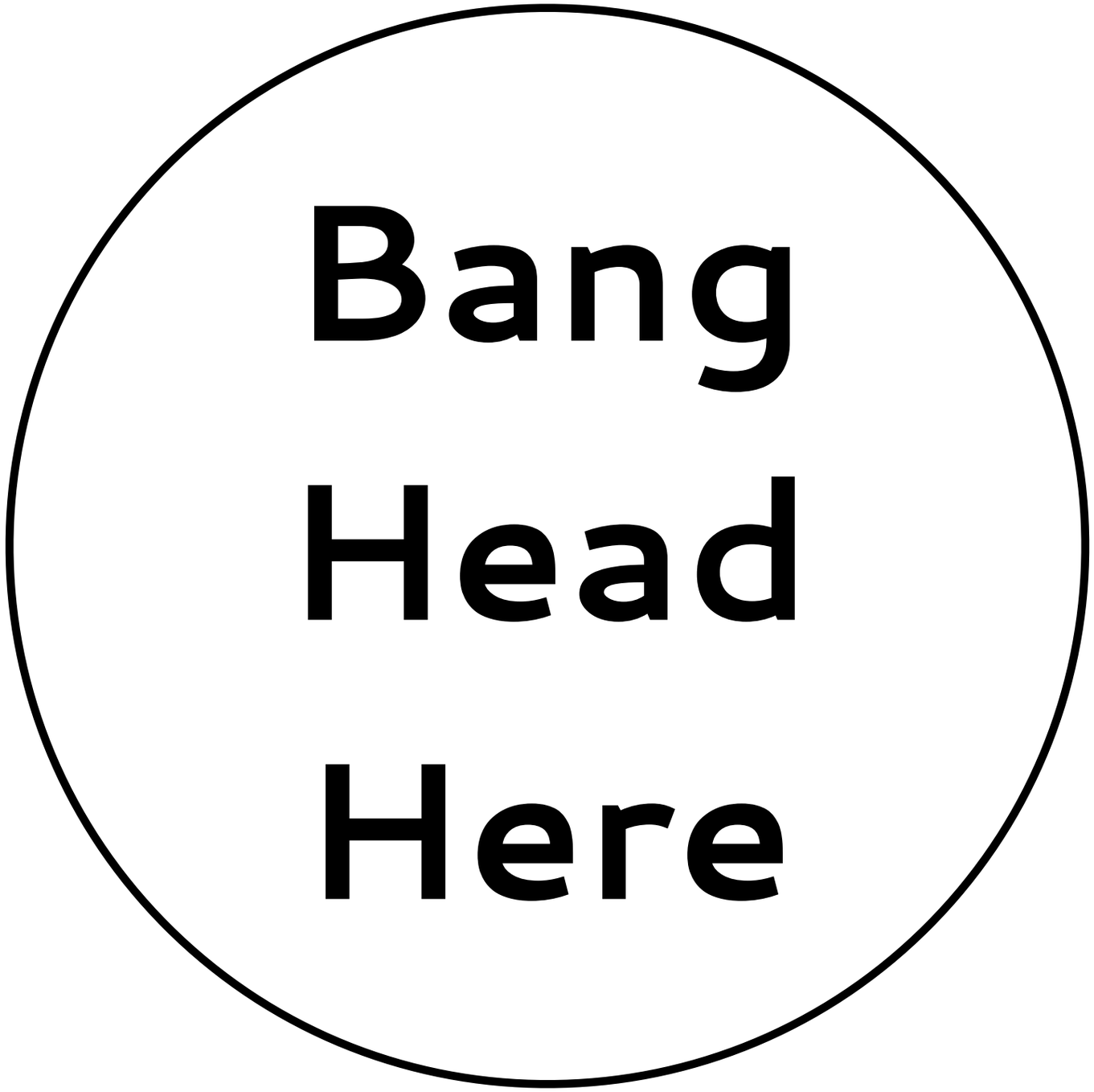
(SQLite, XML, ...)

TLDR


Refetch and Reload
Context Did Save Notification
Main Queue
Private Queue
Managed Object Context
Managed Object Context
Persistent Store Coordinator
Model
Persistent Store (SQLite, XML, ...)

Concurrency Models

- Use the simplest model that meets your needs
- Update main context after large imports have completed


Bang
Head
Here

In general…

- Use the tools, and measure, measure, measure
- Don’t load more than you need to
- Don’t use [cd]
- Be smart with your data model
- Import on a private queue in batches
- Pick the correct (but simplest) concurrency model

Questions?

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