Data Storage

Mobile Application Development in iOS

School of EECS

Washington State University

Instructor: Larry Holder

Outline

- Already seen
  - UserDefaults
  - iCloud
- File I/O (review)
- Database support: Core Data, SQLite
- Data backup to iCloud
- Data protection

File I/O

- Class objects to be written must inherit from NSObject and NSCoding
- Class must implement
  - `required init(coder aDecoder: NSCoder)`
  - `func encode(with aCoder: NSCoder)`

File I/O

```
class MarioCharacter: NSObject, NSCoding {
    var name: String
    var health: Int

    init (_ name: String, _ health: Int) {
        self.name = name
        self.health = health
    }

    required init(coder aDecoder: NSCoder) {
        name = aDecoder.decodeObject(forKey: "name") as! String
        health = aDecoder.decodeInteger(forKey: "health")
    }

    func encode(with aCoder: NSCoder) {
        aCoder.encode(name, forKey: "name")
        aCoder.encode(health, forKey: "health")
    }
}
```

File I/O

- Get document directory
- Create URL to file
- Use NSKeyedArchiver to write
- Use NSKeyedUnarchiver to read

File I/O

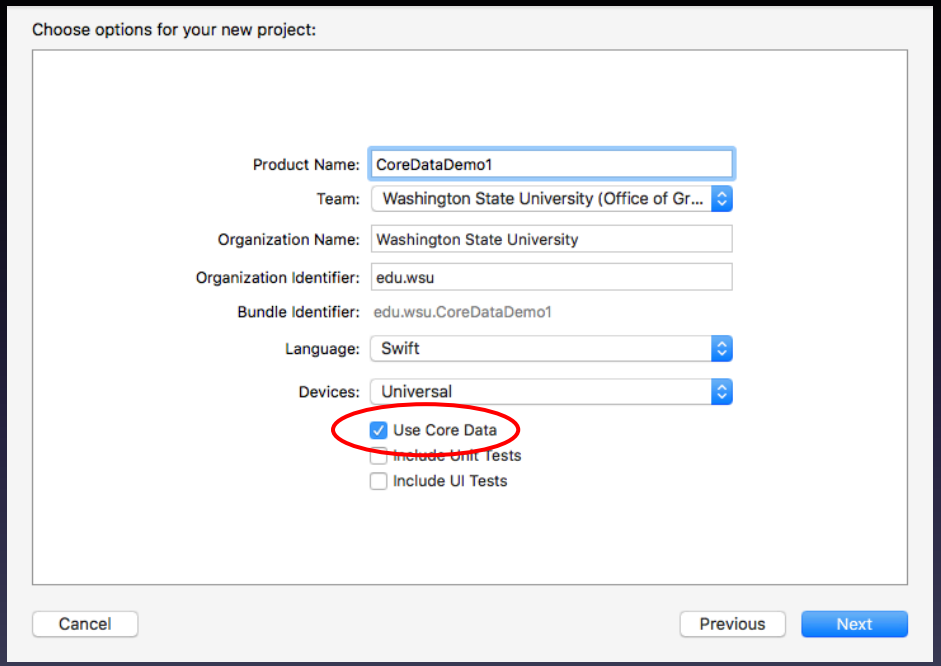
```
let marioCharactersFile = "MarioCharactersFile"

func readFromFile () { // call from initial view controller's viewDidLoad
  let fileDir = FileManager.default.urls(for: .documentDirectory,
                  in: .userDomainMask).first!
  let fileURL = fileDir.appendingPathComponent(marioCharactersFile)
  if FileManager.default.fileExists(atPath: fileURL.path) {
    marioCharacters = NSKeyedUnarchiver.unarchiveObject(withFile: fileURL.path)
        as! [MarioCharacter]
  }
}

func writeToFile () { // call whenever marioCharacters array changed
  let fileDir = FileManager.default.urls(for: .documentDirectory,
                  in: .userDomainMask).first!
  let fileURL = fileDir.appendingPathComponent(marioCharactersFile)
  NSKeyedArchiver.archiveRootObject(marioCharacters, toFile: fileURL.path)
}
```

Database Support

- Core Data
  - iOS specific
  - Object store
- SQLite
  - Cross-platform (already available in iOS)
  - Table store
- Realm
  - Cross-platform
  - Object store

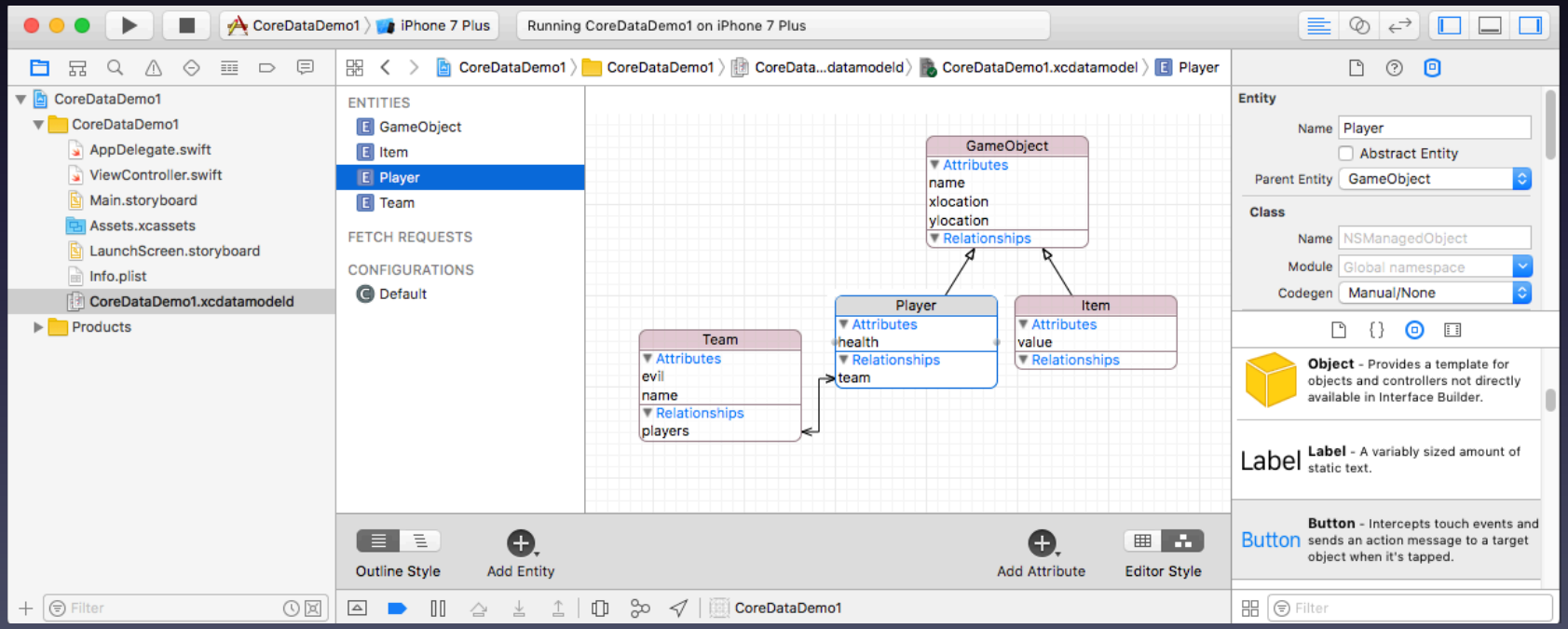
Core Data

- Check “Use Core Data” for New Project
- Includes empty data model
- Includes boilerplate code to create database



Core Data: Create Managed Object Model (Schema)

- Schema consists of entities, their attributes, and relationships



Core Data Stack

- Handles interactions with data store
  - Persistent container (NSPersistentContainer)
    - Obtained from UIApplication.shared.delegate
  - Managed object context (NSManagedObjectContext)
    - Obtained from NSPersistentContainer.viewContext

Core Data: Insert

- Methods
  - NSEntityDescription.insertNewObject(forEntityName: String, into: NSManagedObjectContext) -> NSManagedObject
  - NSManagedObject.setValue(value: Any?, forKey: String)
  - NSManagedObjectContext.save()

Core Data: Insert

```
import CoreData

class ViewController: UIViewController {

  var managedObjectContext: NSManagedObjectContext!
  var appDelegate: AppDelegate!

  override func viewDidLoad() {
    super.viewDidLoad()
    self.appDelegate = UIApplication.shared.delegate as! AppDelegate
    self.managedObjectContext = appDelegate.persistentContainer.viewContext
  }

  func addPlayer() {
    let player = NSEntityDescription.insertNewObject(forEntityName:
                   "Player", into: self.managedObjectContext)
    player.setValue("Mario", forKey: "name")
    player.setValue(100, forKey: "health")
    self.appDelegate.saveContext() // In AppDelegate.swift
  }
}
```

Core Data: Fetch

- Methods
  - NSFetchRequest<NSManagedObject>(entityName: String) -> NSFetchRequest<NSManagedObject>
  - NSFetchRequest<NSManagedObject>.predicate = NSPredicate(format: String, args...)
  - NSManagedObjectContext.fetch(request: NSFetchRequest<NSManagedObject>) throws

Core Data: Fetch

```
func getPlayers() {
  let fetchRequest = NSFetchRequest<NSManagedObject>(entityName: "Player")
  var players: [NSManagedObject]!
  do {
    players = try self.managedObjectContext.fetch(fetchRequest)
  } catch {
    print("getPlayers error: \(error)")
  }
  print("Found \(players.count) players")
  for player in players {
    let name = player.value(forKey: "name") as! String
    let health = player.value(forKey: "health") as! Int
    print("  Found player \(name) with health \(health)")
  }
}
```

Core Data: Delete

- Methods
  - NSManagedObjectContext.delete(object: NSManagedObject)
  - NSManagedObjectContext.save()

Core Data: Delete

```
func removePlayers() {
  let playerName = "Mario"
  let fetchRequest = NSFetchRequest<NSManagedObject>(entityName: "Player")
  fetchRequest.predicate = NSPredicate(format: "name == %@", playerName)
  var players: [NSManagedObject]!
  do {
    players = try self.managedObjectContext.fetch(fetchRequest)
  } catch {
    print("removePlayers error: \(error)")
  }
  for player in players {
    self.managedObjectContext.delete(player)
  }
  self.appDelegate.saveContext() // In AppDelegate.swift
}
```

SQLite

- C API to SQL database
- Swift wrappers provided by SQLite.swift
  - https://github.com/stephencelis/SQLite.swift
  - Install via CocoaPods

SQLite.swift: Create Database

- Connection(pathToDB: String) throws -> Connection
- Table(name: String)
- Expression<Type>(name: String)
- Connection.run(Table.create() { t in t.column(Expression<Type>)}) throws

SQLite.swift: Create Database

```
import SQLite
class ViewController: UIViewController {
  var db: Connection!
  var playersTable: Table!
  var nameExp: Expression<String>!
  var healthExp: Expression<Int>!

  func createDatabase() {
    // Connect to writable database in app's Documents directory.
    let path = NSSearchPathForDirectoriesInDomains(.documentDirectory,
                .userDomainMask, true).first!
    db = try? Connection("\(path)/db.sqlite3")
    // Create Players table
    playersTable = Table("Players")
    nameExp = Expression<String>("name")
    healthExp = Expression<Int>("health")
    do {
      try db?.run(playersTable.create(ifNotExists: true) { t in
                t.column(nameExp)
                t.column(healthExp)})
    } catch {
      print("error creating table")
    }
  }
}
```

SQLite.swift: Insert

- Connection.run(Table.insert(Expression<Type> <- Any?, …) throws

SQLite.swift: Insert

```
func addPlayers() {
  do {
    try db.run(playersTable.insert(nameExp <- "Mario", healthExp <- 100))
    try db.run(playersTable.insert(nameExp <- "Yoshi", healthExp <- 200))
  } catch {
    print("insert error")
  }
}
```

SQLite.swift: Fetch

- Connection.scalar(Table.count) throws -> Int
- Connection.prepare(Table) throws

SQLite.swift: Fetch

```
func getPlayers() {
  if let count = try? db.scalar(playersTable.count) {
    print("Found \(count) players")
    if let players = try? db.prepare(playersTable) {
      for player in players {
        print("  Found player \(player[nameExp]) with health \(player[healthExp])")
      }
    }
  }
}
```

SQLite.swift: Delete

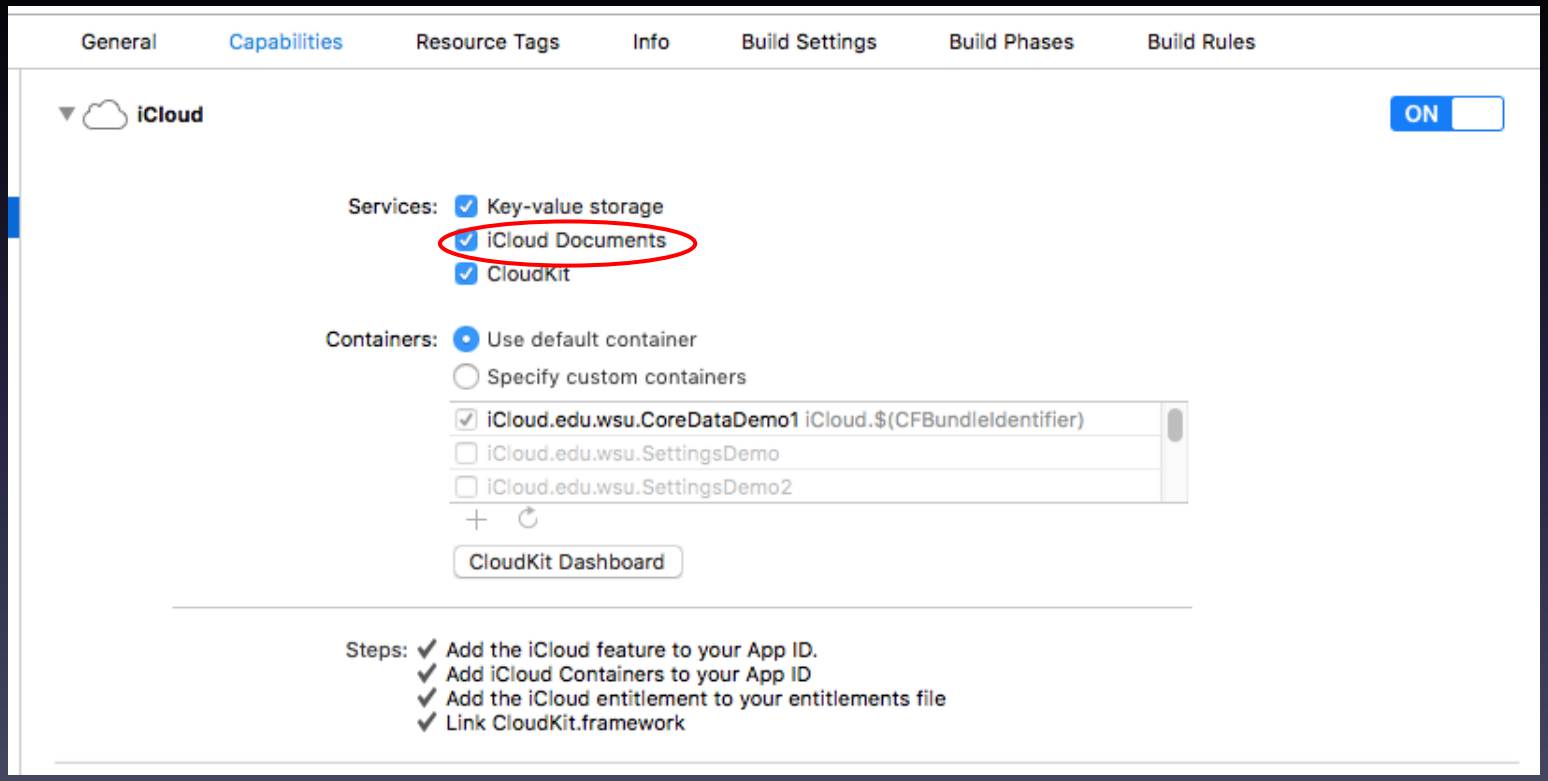
- Table.Filter(Expression<Type> == Any?)
- Connection.run(Filter.delete()) throws

SQLite.swift: Delete

```
func removePlayers() {
  let marioFilter = playersTable.filter(nameExp == "Mario")
  do {
    try db.run(marioFilter.delete())
  } catch {
    print("delete error")
  }
}
```

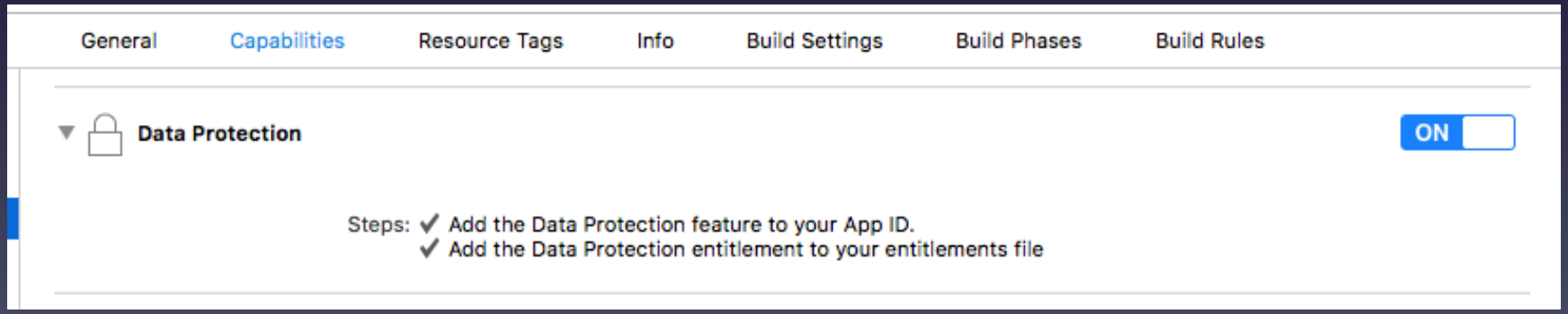
Data Backup to iCloud

- Available with iCloud capability



Data Protection

- Files encrypted and inaccessible with device locked
- Can selectively encrypt files



Resources

- Core Data
  - developer.apple.com/library/content/documentation/Cocoa/Conceptual/CoreData/
  - www.raywenderlich.com/145809/getting-started-core-data-tutorial
- SQLite
  - www.raywenderlich.com/123579/sqlite-tutorial-swift
  - github.com/stephencelis/SQLite.swift
- iCloud
  - developer.apple.com/icloud/
- Data Protection
  - developer.apple.com/library/content/documentation/IDEs/Conceptual/AppDistributionGuide/AddingCapabilities/AddingCapabilities.html